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Regional and subregional assessments of biodiversity and ecosystem services: regional and subregional assessment for Asia and the Pacific

Chapters of the regional and subregional assessment of biodiversity and ecosystem services for Asia and the Pacific

Note by the secretariat

1. In paragraph 2 of section III of decision IPBES-3/1, the Plenary of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) approved the undertaking of four regional and subregional assessments of biodiversity and ecosystem services for Africa, the Americas, Asia and the Pacific, and Europe and Central Asia (hereinafter referred to as regional assessments) in accordance with the procedures for the preparation of the Platform’s deliverables set out in annex I to decision IPBES-3/3, the generic scoping report for the regional assessments of biodiversity and ecosystem services set out in annex III to decision IPBES-3/1, and the scoping reports for each of the four regional assessments (decision IPBES-3/1, annexes IV–VII).

2. In response to decision IPBES-3/1, a set of six chapters (IPBES/6/INF/3–6), together with a summary for policymakers (IPBES/6/4–7), were produced for each of the regional assessments by an expert group, in accordance with the procedures for the preparation of the Platform’s deliverables, for consideration by the Plenary at its sixth session.

3. In paragraph 6 of section IV of decision IPBES-6/1, the Plenary approved the summary for policymakers of the regional assessment for Asia and the Pacific (IPBES/6/15/Add.3) and accepted the chapters of the assessment, on the understanding that the chapters would be revised following the sixth session as document IPBES/6/INF/5/Rev.1 to correct factual errors and to ensure consistency with the summary for policymakers as approved. The annex to the present note, which is presented without formal editing, sets out the final set of chapters of the assessment for Asia and the Pacific including their executive summaries.

4. A laid-out version of the final regional assessment report of biodiversity and ecosystem services for Asia and the Pacific (including a foreword, statements from key partners, acknowledgements, a preface, the summary for policymakers, the revised chapters and annexes setting out a glossary and lists of acronyms, authors, review editors and expert reviewers) will be made available on the website of the Platform prior to the seventh session of the Plenary.

Annex

Chapters of the regional assessment report on biodiversity and ecosystem services for Asia and the Pacific of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services

Disclaimer on maps
The designations employed and the presentation of material on the maps used in this report do not imply the expression of any opinion whatsoever on the part of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystems Services concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. These maps have been prepared for the sole purpose of facilitating the assessment of the broad biogeographical areas represented therein.

Chapter 1. Setting the scene: biodiversity and ecosystem services in the Asia-Pacific region

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Table of Contents

Executive summary

PART I: Rich biodiversity and complex transitions

The Asia-Pacific region is bio-geographically one of the most diverse and rich regions in the world (*well established*). It has numerous endemic species and more global biodiversity hotspots (16) and megadiverse countries (7) than any other region of the world (*well established*). The Asia-Pacific region has a very contrasting geography spanning from the highest Himalayan Mountains to the deepest Pacific Ocean floors {1.1.1}, which translates into unique and highly diverse terrestrial and marine ecosystems {1.1.2; 1.1.3}.

The Asia-Pacific region is particularly rich in marine and costal biodiversity due to innumerable islands and an extensive coastline that contain highly diverse coral reefs, seagrass beds and mangroves (*well established*). Terrestrial species endemism is also high, particularly on some the region's islands (*well established*). The `Coral Triangle' alone contains more than 700 species of corals, while the iconic Great Barrier Reef of Australia is the longest reef in the world and home to an exceptionally large number of marine species {1.1.2}. The region contains many rare terrestrial species including highly endemic (e.g. marsupials of Australia) and charismatic species (e.g. orang-utan, giant panda, Sumatran tiger, Komodo dragon, kiwi). Terrestrial species endemism is extremely high in islands of Indonesia, Papua New Guinea, the Philippines, and New Zealand {1.1.2}. Furthermore the Asia-Pacific region is of vital importance for migratory species, including several marine and bird species {1.1.2}.

The Asia-Pacific region has extremely high socio-cultural diversity, containing the largest population of indigenous people in the world and some of the most extensive indigenously managed landscapes and seascapes (*well established*). Indigenous and local communities across the region have distinct traditions, languages, knowledge and practices that have helped them maintain a harmonious co-existence with Nature for generations (*established but incomplete*). The large number of languages and traditions prevalent throughout the region exemplifies its high cultural diversity {1.1.3.2}. Indigenous and local communities have nurtured the bio-cultural diversity of their ancestral lands and waters, and commonly consider themselves as stewards and custodians of Nature {1.1.3.2}. They apply their indigenous and local knowledge (ILK) to manage agricultural, forestry, fisheries and freshwater systems, among others, as a basis of their livelihoods and culture {1.1.3.2}. There is a growing recognition of the need to preserve these diverse ILK systems and cultural practices and build synergies with modern scientific knowledge for conserving Nature and ensuring the sustainable provision of its contributions to people {1.3.2}. This is because single knowledge systems are inadequate for addressing the emerging challenges due to the loss of biodiversity in the region {1.3.2}.

The Asia-Pacific region contains more than 60 per cent of the total global population, 52 per cent of the global poor and is undergoing rapid urbanization and economic transformation (*well established*). Many countries have experienced rapid and sustained economic growth for decades, elevating millions of people out of poverty, but often at the cost of the region's biodiversity (*well established*). With a current total population of 4.5 billion the Asia-Pacific region hosts some of the most populous countries in the world {1.1.3.1}. The region has maintained very high rates of economic growth in the past decades (7.6 per cent as compared to 3.4 per cent for the rest of the world between 1990-2010, 5.3 per cent in 2016) {1.1.3.1; 1.4.3}. Despite containing three of the ten largest economies globally, the region also has the most people living below the poverty line (i.e. more than 400 million or 52 per cent of the global share) {1.1.3.1}. At the same time the region has experienced one of the highest expansion of agricultural land expansion globally {1.1.4}, as well as some of the fastest rates of urbanization, infrastructure expansion and rural-urban migration {1.1.3.1; 1.4.3}. However, a substantial number of indigenous and local communities still live in extreme poverty, have poor access to natural resources and social services, and are losing their ILK and distinct cultures {1.1.3.2}. Ultimately these rapid socioeconomic transitions have come at a high environmental cost, leading to the accelerated and permanent destruction of forest, grassland, wetland, coastal and marine habitats, and the biodiversity they harbour {1.1.3; 1.1.4}.

Overall, the rich and unique biological and socio-cultural diversity of the Asia-Pacific region contributes directly and indirectly to good quality of life of this large population through the provision of numerous ecosystem services (*well established*). The sustainable management of these resources can help the world's most populous region improve its food, water, energy and environmental security (*established but incomplete*). Biodiversity at the level of genes, species/taxa, functional traits, and ecosystems provide multiple ecosystem services and material (e.g. food, water, energy), non-material (e.g. recreation, cultural values) and regulating benefits (e.g. carbon sequestration, freshwater purification, hazard mitigation) {1.1.3; 1.3.2}. These ecosystem services are of particular importance for the rapidly increasing and urbanizing populations of the region, and especially the poor and indigenous communities that rely extensively on these services for their livelihoods {1.1.3}.

PART II: Threats to biodiversity, ecosystems and ecosystem services

Most of the critically important areas for biodiversity in the Asia-Pacific region are increasingly threatened and are vulnerable to a combination of indirect and direct drivers of ecosystem change (*well established*). Overall, the status of biodiversity and ecosystems is rapidly (and mostly negatively) changing, with the region as a whole exhibiting high rates of habitat loss and risk of species extinction (*well established*). Major terrestrial ecosystem types, such as tropical rain/cloud forests, temperate grasslands and wetlands are particularly threatened {1.1.2}. For example, 6 of the 15 biodiversity hotspots with the lowest fraction of original intact vegetation are located in the Asia-Pacific region {1.1.2}. Several coastal and marine ecosystems are under extreme stress, facing the extinction of marine species primarily due to overfishing, overexploitation of marine species, pollution and unregulated tourism {1.1.2; 1.1.4}.

Major direct drivers of ecosystem change and biodiversity loss in the Asia-Pacific region include land use and cover change, natural hazards, climate change, pollution, over-exploitation of natural resources, and invasive alien species (IAS) (*well established*). These direct drivers interact with (and are often reinforced by) indirect drivers including demographic change, economic development, cultural transformation, technological change, and urbanization (*established but incomplete*). There has been extensive conversion of ecosystems and cultural landscapes to agricultural systems that are often mono-cultural (e.g. palm oil, rubber plantations) {1.1.4}. Urbanization and the development of ancillary infrastructure have been also contributed substantially to land use and cover change, and ecosystem fragmentation {1.1.4; 1.4.3}. Natural hazards affect biodiversity and ecosystem services in large parts of the region, as the Asia-Pacific is particularly vulnerable to such extreme events {1.1.4}. Several natural hazards induced by climate change (e.g. cyclones, coastal storms, typhoons, droughts, floods), coupled with sea-level rise and glacial melting, are expected to have increasingly negative effects on ecosystems, biodiversity and ecosystem services in the future {1.1.4}. Air, water and soil pollution is reaching critical levels in several parts of the region {1.1.4}, while invasive alien species have serious impacts on ecosystem productivity leading to the loss of species and the degradation of habitats, particularly in some islands {1.1.4}. The unsustainable exploitation of natural resources has been rampant in several parts of the region, as witnessed by extensive logging (both legal and illegal), illegal wildlife trade and unsustainable and destructive fishing {1.1.4}.

Rapid demographic and economic transitions, massive technological change, cultural and behavioural change, loss of ILK and weak governance systems in many countries are important indirect drivers of ecosystem change and biodiversity loss in the Asia-Pacific (*established but incomplete*). The nexus of globalization, economic liberalisation, urbanization and migration is a dominant socioeconomic context within which ecosystem degradation and biodiversity loss needs to be understood in the region (*established but incomplete*). Globalization and economic liberalization has generally led to the commercialisation and increased economic value of some natural products by allowing greater access to regional and global markets {1.4.3}. However it has often (but not always) led to their unsustainable overexploitation and unfair benefit-sharing with local communities, which can have strong implications for ecosystem conservation and biodiversity loss {1.4.3}. Urbanization is a complex phenomenon that has generally negative effects on biodiversity, both directly (e.g. through land use change and pollution) and indirectly (e.g. by catalysing changes in consumption patterns) {1.1.4; 1.4.3}.

PART III: Institutional and governance context in the Asia-Pacific region

All countries in the Asia-Pacific region are signatories to the Convention on Biological Diversity (CBD) and most have submitted their National Biodiversity Strategies and Action Plans (NBSAP) (*well established*). Some countries are also globally recognized as pioneers in implementing community-based, participatory and trans-boundary conservation initiatives at different scales (*well established*). Policy and institutional reforms related to the management of forests, rangelands and protected areas, as well as the mainstreaming of participatory processes is gradually progressing in the region {1.4.1; 1.4.2; 1.4.4}. This is often due to participation in global and regional multilateral environmental agreements (MEAs) and greater advocacy by civil society organizations {1.4.1; 1.4.2; 1.4.4}. Important lessons from such reforms include the need for the clear definition of property rights, innovative partnerships with the private sector, and collective management and enforcement of regulations with local communities, all of which have the potential to be up-scaled and/or replicated at national and regional levels {1.4.4}.

Some countries in the Asia-Pacific region, face significant challenges in meeting their multiple international commitments such as the Aichi Biodiversity Targets, United Nations Sustainable Development Goals (SDGs) and the Paris Agreement (*established but incomplete*). This is especially true for countries that are highly vulnerable (and not well prepared) to face emerging drivers of ecosystem change, and particularly climate change, due to poor capacity and technological/financial constraints (*established but incomplete*). Several countries in the region face a critical lack of human, institutional and financial capacity to implement effectively NBSAPs, and multi-scale and multi-sector governance systems and conservation measures {1.4.4}. Significant knowledge gaps exist for properly assessing and analysing the status and trends of biodiversity and ecosystem services in a spatially-explicit manner {1.1.2; 1.4.4}. There are also substantial financial constraints, political challenges and capacity gaps to design and implement effectively transboundary and regional initiatives to halt biodiversity loss, ecosystem degradation, climate change, and unsustainable development {1.4.4}. Significant challenges emerge due to the loss of ILK primarily due to socioeconomic transformation and migration {1.1.3.2; 1.4.3}.

PART IV: Methodology and structure of the Asia-Pacific Regional Assessment

The Asia-Pacific Regional Assessment identifies the causes and consequences of biodiversity loss and the associated decline in Nature's Contributions to People, and provides appropriate options to policy-makers to reverse this decline. The regional assessment adopts an integrated and inclusive methodology, which acknowledges that human and natural systems are interconnected, that multiple and changing value concepts exist in relation to Nature and its contribution to people, and that diverse knowledge systems are necessary to unravel this interconnectivity and interdependence. The seven guiding principles of the Asia-Pacific Regional Assessment are to: a) adopt a social-ecological systems approach, b) unravel the combined and accelerated effects of multiple direct and indirect drivers on change, c) conduct integrated cross-scale analysis, d) consider the multiple concepts of value of Nature and its contribution to people, e) integrate multiple sources of knowledge and practice, f) acknowledge the importance of formal and informal institutional and governance frameworks, and g) adhere to the conceptual framework and principles of the IPBES {1.3.1; 1.3.2}. The assessment explores the wider application of different innovative governance and management mechanisms that can offer diverse options to policymakers to manage biodiversity and ecosystem services at multiple scales, and meet multiple policy objectives such as biodiversity conservation, poverty alleviation, climate change adaptation and mitigation, as envisioned by the Aichi Biodiversity Targets, the Sustainable Development Goals (SDGs), and the Paris Agreement (1.5).

1.1 Introduction

1.1.1 Extent and geographical diversity of the Asia-Pacific region

The Asia-Pacific region comprises five subregions with a total of 62 individual nation states, politically autonomous areas, and dependencies of countries outside the region. These subregions are Western Asia, South Asia, South-East Asia, North-East Asia and Oceania including the Hawaiian Archipelago (Figure 1.1) (see Appendix, Table S1 for a list of countries and territories in each subregion).

Among the four geographic regions defined by IPBES, the Asia-Pacific is the largest and possibly the most physically, biologically and culturally diverse (Section 1.1.2-1.1.3). Geographically it extends more than halfway around the globe; from the sparsely populated deserts of Western Asia, to the small isolated oceanic islands (including the Hawaiian Archipelago) and ocean trenches and seamounts of the Pacific Ocean (including some Sub-Antarctic Island territories). It contains most of the central and eastern part of Eurasia (the world's largest continent), and the "island continent" of Australia**.** It also contains most of the Pacific Ocean and large portions of the Indian Ocean, with their marginal seas and ocean trenches (IPCA, 2017).

Ecologically, it ranges from the cold dry steppes and boreal forests of North-East Asia to the subtropical and tropical rainforests of Borneo, the woodlands and savannah grasslands of South-East Asia, the western Indo-Pacific and Australia (Figure 1.1). The region also contains the highest, steepest and youngest mountain ranges of the world, the deepest ocean floor near the Marianas Islands, and some of the widest and the longest rivers and extensive deltas in the World (Table 1.1, Figure 1.2).

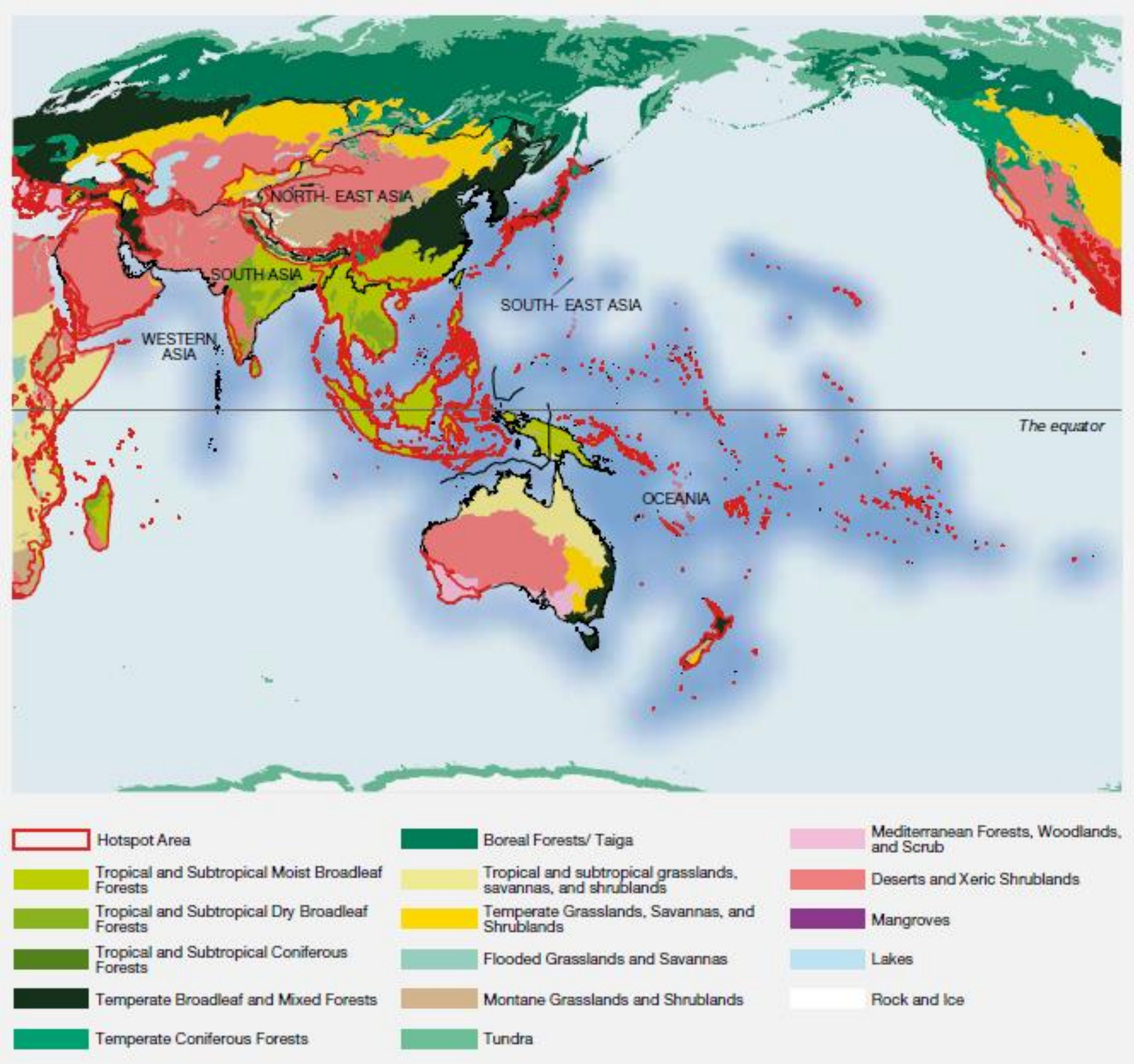


Figure 1.1 Major ecoregions and the five geographical subregions of the Asia-Pacific region as defined by IPBES
Data source: biomes data from Olson *et al.* (2001), and hotspots data from Conservation Synthesis - Center for Applied Biodiversity Science at Conservation International (2004) and R. A. Mittermeier *et al.* (2004)

The Asia-Pacific region contains a large variety of unique terrestrial, freshwater and marine systems, which underpin the region’s high biological and cultural diversity (Section 1.1.2-1.1.3). These include:

- **Islands and Coastlines**: Contains the majority of all continental and oceanic islands, and half of the world’s largest islands (IPCA, 2017). Contains large archipelagos and surrounding near-shore ecosystems, including almost all of the main atoll groups, such as the atolls of Kiribati, Tuvalu, Marshall Islands and the Tuamotu Archipelago in the Pacific Ocean, and the Maldives in the Indian Ocean. The region contains extensive beaches and coastlines;
- **Cryosphere and Mountain Ranges**: Contains 8 of the 10 highest mountain ranges in the world (Van Hinsbergen *et al.*, 2012).The Hindu Kush Himalayan (HKH) region holds the largest volume of ice and snow outside the Arctic and Antarctic regions;
- **Volcanic and seismically active areas**: Contains the most volcanically and seismically active terrestrial and marine areas, including the oldest pre-Cambrian mineral-rich shields and stable bathyal ocean floors and trenches;
- **Large River basins**: Contains 11 of the world’s 20 largest river systems that play a key

controlling factor for sustaining the health of terrestrial and marine ecosystems (Sullivan *et al.*, 2011) (Table 1.1, Figure 1.2). Many of these river systems are hearths of urbanization [e.g., Mesopotamia, Indus, Ganges and Hwei-Huang (Yellow) River Valleys], and centers of crop/animal domestication and agricultural diversity (Revenga & Tyrrell, 2016). There are also major river systems of similar ecological and cultural importance on some of the larger Pacific Islands, such as the Fly and Sepik Rivers on the island of New Guinea, and the Rewa and Sigatoka Rivers in Fiji;

- **Deserts and steppe**: Contains some of the largest deserts in the world, such as the Arabian Desert, Gobi Desert and the Australian deserts, including one of the largest bodies of continuous sand in the world - the Rub'al-Khali or the "Empty Quarter" (Vincent, 2008). Contains extensive areas of steppes and grasslands, such as those of the Tibetan and Mongolian Plateaus;
- **Forests, Savannas and Grasslands**: Contains some of the globally most diverse and extensive areas of rainforest, montane forest, cloud forest, dry forest, woodland, savanna and grasslands (Section 1.1.2);
- **Mangroves:** Contains 54 per cent of the world's remaining mangrove areas (Giri *et al.*, 2011), including the Sundarbans ("Beautiful Forest") on the Gangetic-Brahmaputra Delta in the Bay of Bengal, which is the world's largest mangrove;
- **Coral Reefs:** Contains the longest and most diverse coral reef systems in the world, including the Great Barrier Reef, the New Caledonia Barrier Reef and the Great Sea Reef of Fiji. The region also includes the reefs of Malaysia, Indonesia, Philippines, New Guinea, Solomon Islands and Palau known as the "Coral Triangle", which is the epicenter of global marine diversity (IPCA, 2017) (Section 1.1.2);
- **Seagrass and Algal Beds:** Contains the most extensive seagrass and algal beds in the world that are keystone habitats, spawning grounds and nurseries for a large number of marine species (Short *et al.*, 2007).

Table 1.1 Major river systems in the Asia-Pacific region. Main source: Revenga & Tyrrell (2016)

River System	Major characteristics
Yangtze (Chang Jiang) 6,300 km 1,800,000 km²	The river basin is home to one-third of China's population. The highly productive rice fields along its basin provide sufficient food for the mega-city region extending from Nanjing to Shanghai. Its diverse aquatic fauna includes 118 endemic fish species (Heiner *et al.*, 2011), including the Yangtze finless porpoise. The surrounding wetlands are important habitats for several species of water birds, whose communities are under pressure due to habitat loss, the introduction of invasive species (Ma *et al.*, 2009), as well as changes in the water regime following the melting of glaciers (Xu *et al.*, 2009).
Yellow River (Huang He) 5,465 km 745,000 km²	The river basin contains approximately 13 million ha of arable land, harbouring about 20 per cent of China's domestic grain production (Wohlfart *et al.*, 2016). The characteristic yellow water of the river is due to the 1.6 billion tons of silt transported annually from the Loess Plateau. Fish abundance and diversity seem to have declined dramatically due to overexploitation and hydraulic engineering (HuiJun *et al.*, 2010). The estuary provides a critical spawning areas for several marine species, thus contributing substantially to fisheries in the northern China Sea (Shan *et al.*, 2013). Runoff has been constantly declining due to climate change and water withdrawals (Piao *et al.*, 2010).
Mekong 4,909 km 795,000 km²	The river basin area contains about 65 million people (two thirds of which rely on subsistence fishing), making the Mekong basin the largest inland fishery globally (Ziv *et al.*, 2012). The urban population of the corridor is about 4.6 million (mainly concentrated in the Delta, Phnom Penh and Vientiane) and is less dependent on the river (Hall & Bouapao, 2010). The high fish biodiversity and abundance of the Mekong River Basin is particularly threatened by the planned construction of hydropower dams (Ziv *et al.*, 2012)

Murray Darling River 3,672 km 1,061,000 km²	This river system flows from the center of Australia to the Southern Ocean and provides water for a significant production of livestock (mainly sheep) and wheat. The growing demand for irrigation and potable water has led to the construction of over 10,000 barriers, which hinder fish movement (Baumgartner *et al.*, 2014). Surface water and river flow decline due to the impacts of climate change on ground water aquifers (principally due to declining surface recharge) is the major future threat (Pratchett *et al.*, 2011).
Tigris, Euphrates and Arvand Rud (Shatt al-Arab) 3,596 km 884,000 km²	The river system originates in Turkey and flows through Syria, Iraq and Iran. It is one of the cradles of civilization, and includes some of the earliest ancient cities. Water flow in the Tigris river has been negatively affected by the development of large water projects in Iraq and Turkey, which has led to dwindling water supplies in the Mesopotamian Marshlands. Water quality is threatened by rising levels of salinity due to intensive irrigated agriculture and high evaporation rates.
Indus River 3,180 km 960,000 km²	The river flows through China, India and Pakistan into the Arabian Sea. It is one of the cradles of civilization and has been highly susceptible to past and current climate change. The Indus Basin Irrigation System is one of the largest in the world supporting more than 180,000 km^2 of arid and semi-arid agricultural lands, which account for 90 per cent of Pakistan's agricultural output. The Indus basin contains rich biodiversity with a significant number of Ramsar Sites, which nevertheless face threat. For example, the range of the endemic Indus River dolphin has been fragmented and has been reduced to 20 per cent of its original range (Braulik *et al.*, 2015).
Brahmaputra (Yarlung Tsangpo) 2.948 km 1,730, 000 km² - Ganges River 2.620 km 907, 000 km²	This river system comprises two major transboundary rivers that originate on opposite sides of the Himalayas and merge in the Ganges-Brahmaputra Delta (1,500 km^2), which is the world's largest delta. The river system discharges into the Bay of Bengal passing through the Sundarbans, the world's largest mangrove forest. The floodplains are among the world's most fertile, highly populated and flood- and disaster-prone areas on Earth. The river system contains two of the most sacred rivers in Asia, and the lifeline and transportation network for millions of people who reside along its banks. It is one of the world's most degraded river system, with dam construction, irrigation, pollution and sedimentation threatening both humans and wildlife (including river dolphins). In recent years water flow has been declining due to climate change due to declining snow and ice accumulation, and increasing glacier melting, evaporation and drying up of natural springs (ICIMOD, 2011)

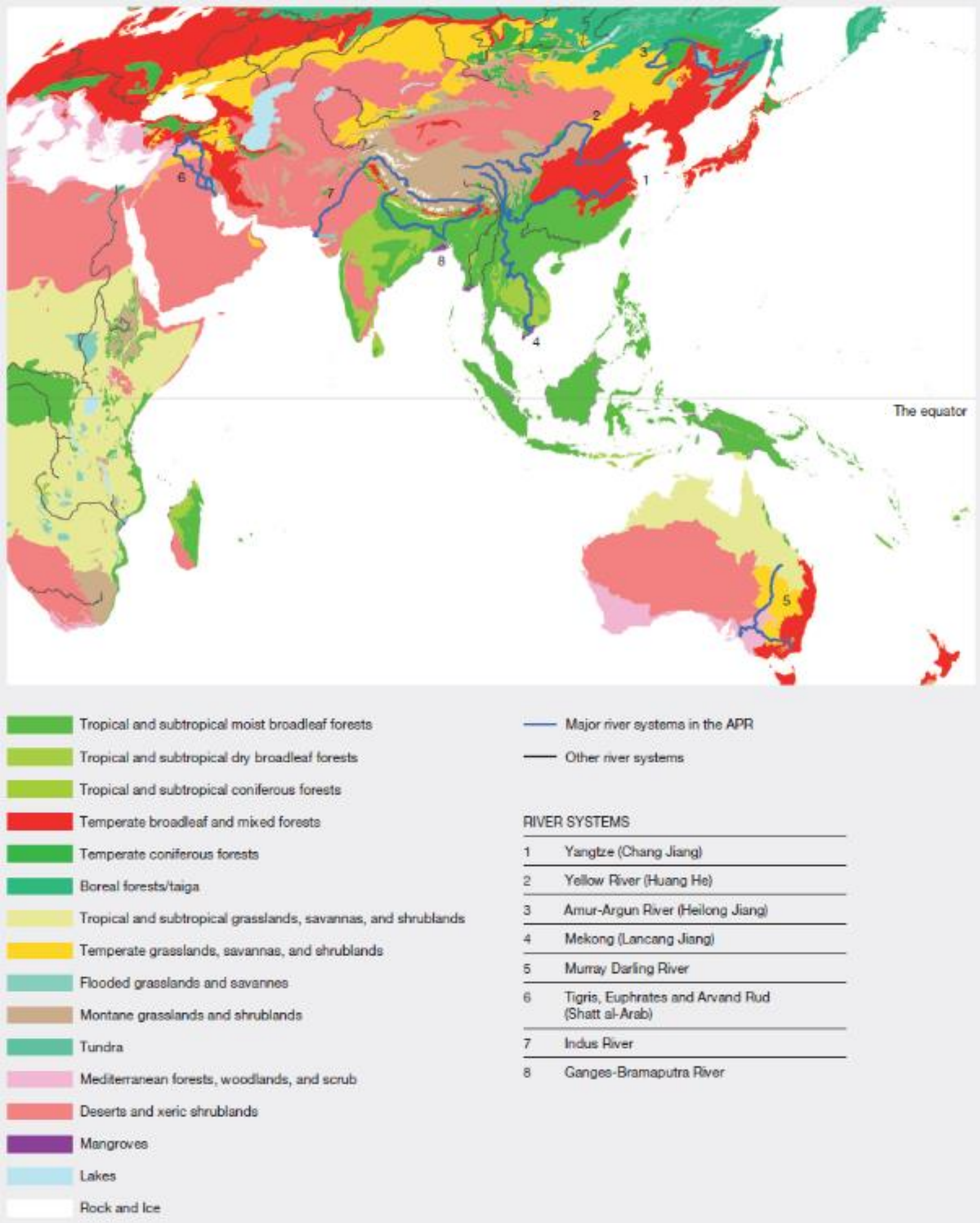


Figure 1.2 Main river systems in the Asia-Pacific region. Data source: biomes data from Olson *et al*. (2001)

1.1.2 Ecological and biological richness of the Asia-Pacific region

Considering its large physical extent, geographical diversity, and ecological range, the Asia-Pacific region is highly biodiverse. It contains numerous areas of endemism and richness that are globally important[1], including 16 out of the 36 global biodiversity hotspots (one of which is shared with Europe and Central Asia) (Table 1.2), and seven out of 17 of the globally megadiverse countries (Australia, China, India, Indonesia, Malaysia, Papua New Guinea and Philippines[2]) (R. A. Mittermeier *et al.*, 2004; Russell A. Mittermeier *et al.*, 2011; Noss *et al.*, 2015). According to BirdLife International (2016), the Asia-Pacific region contains1571 of the 4308 Important Bird and Biodiversity Areas (IBAs)[3] that are particularly important for bird diversity (see Appendix, Table S2). Some areas such as Sumatra and New Guinea contain unique types of ecosystems and extremely high biodiversity within relatively small areas.

The Asia-Pacific region is also an area of high endemism and diversity for coral reef ecosystems (e.g., Chou *et al.*, 2002; IPCA, 2017; Oliver & Noordeloos, 2002; Roberts *et al.*, 2002; Spalding *et al.*, 2001; Wilkinson, 2002)[4]. Species richness reaches it maximum in the "coral triangle" of South-East Asia (central Philippines and central Indonesia), and then declining rapidly moving east, and less rapidly moving west (Carpenter & Springer, 2005; Roberts *et al.*, 2002; Sanciangco *et al.*, 2013; Werner & Allen, 1998). The iconic Great Barrier Reef of Australia is home to more than 11,000 species of plants and animals (GCRMN, 2009), and provides multiple ecosystem services (N. A. Marshall *et al.*, 2016). The Asia-Pacific region also contains extensive mangrove ecosystems (Section 1.1.1). These mangrove ecosystems can withstand some of the most stressful environmental conditions (Giri *et al.*, 2011), provide habitat to terrestrial and marine biodiversity, and offer multiple ecosystem services related to carbon sequestration, coastal protection, natural products and tourism (Finn Danielsen *et al.*, 2005).

The extent of protected areas in the Asia-Pacific region has increased steadily since 1990. In 2014 there were reportedly 29,773 protected areas in 54 countries and territories across the region (Juffe-Bignoli *et al*., 2014), covering an estimated 13.3 per cent of terrestrial ecosystems (global average in 2016: 15.4 per cent) and 15.3 per cent of marine and coastal ecosystems (global average in 2016: 8.4 per cent) (UNEP-WCMC, 2016)(see also Chapter 3). Despite these substantial conservation efforts several important ecosystems in the region are highly threatened.

For example, in several biodiversity hotspots the original habitat area has declined drastically. It has been estimated that 7 of the 15 biodiversity hotspots with the lowest original intact vegetation are located in the Asia-Pacific region (Sloan *et al.*, 2014) (Table 1.2). While extensive habitat areas remain in some of the most species-rich areas, (e.g. islands of Indonesia), there are critically imperilled habitats across the region (Dinerstein *et al.*, 2017) (Figure 1.3). Other less well-documented but highly threatened areas of critical terrestrial biodiversity importance include the remaining lowland tropical forests of Solomon Islands, Vanuatu and Fiji in the Pacific, and the dry deciduous and cloud forests of Eastern Himalayas.

[1] These areas host several unique species, including highly endemic species (e.g. marsupials of Australia, kiwi bird and the tuatara lizard of New Zealand) and charismatic species such as the orang-utan, giant panda, Sumatra tiger and Komodo dragon,to name just a few.

[2] Megadiverse are defined as those countries that have: (a) at least 5,000 endemic plant species and (b) marine ecosystems within heir borders (R. A. Mittermeier *et al.*, 2004).

[3] The protection of IBAs can be a very cost-effective and efficient way of ensuring the survival of a large number of bird species and other animals and plants (BirdLife International, 2016).

[4] Collectively, these authors have identified 18 global centres of coral reef endemism that cover only 0.028 per cent of the world's oceans, but include 35.2 per cent of the coral reefs and 58.6-68.7 per cent of the restricted-range marine endemic species. Seven of the top-ten "marine biodiversity hotspots" are located in the Asia-Pacific region.

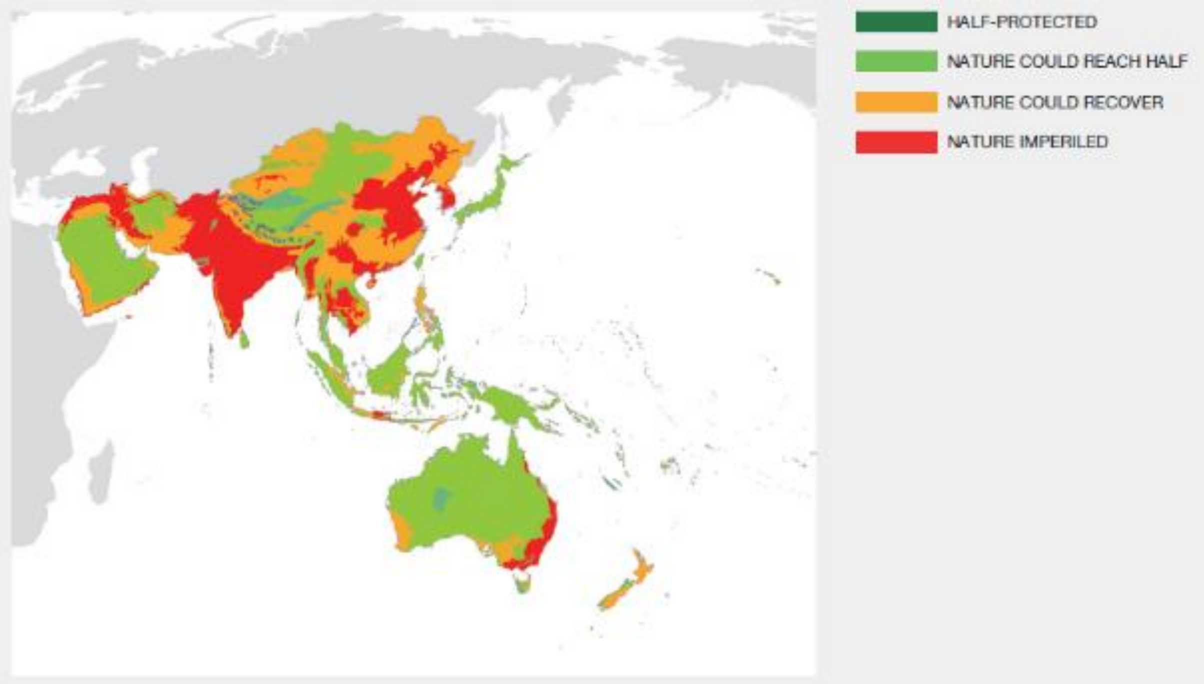


Figure 1.3: Protection status of eco-regions in the Asia-Pacific region. Source: Dinerstein *et al.* (2017) and Olson *et al.* (2001)

Table 1.2 Natural vegetation area as percentages of originally-vegetated area for the 36 global biodiversity hotospots. Source: Hotspots 1-35 (Sloan *et al.*, 2014), Hotspot 36 (Noss *et al.*, 2015).

	Hotspot	Area (km^2)	Located in the Asia-Pacific	Remaining native vegetation (%)
1	Atlantic Forest of Brazil	123664	No	3.5
2	Irano-Anatolia	900790	Yes	3.6
3	Coastal Forest of Eastern Africa	291905	No	3.8
4	Madagascar and Indian Ocean	601830	No	4.4
5	Mediterranean Basin	2089974	No	4.4
6	Polynesia-Micronesia	47361	Yes	5.2
7	Carribbean Islands	230073	No	5.8
8	Mountains of Central Asia	865299	Partly (shared with Europe and Central Asia region)	5.8
9	Western Ghats and Sri Lanka	190037	Yes	6.3
10	Maputaland-Pondoland-Albany	273018	No	6.4
11	Succulent Karoo	102922	No	6.5
12	Phillipines	297846	Yes	8.0
13	Caucasus	533852	No	8.2
14	Japan	374328	Yes	8.2
15	Indo-Burma	2378318	Yes	8.7
16	Easter Afromontane	1020095	No	9.0
17	Guinean Forests of West Africa	621706	No	10.6
18	East Melanesia Islands	99630	Yes	10.7
19	Wallacea	339258	Yes	13.8

20	Mesoamerica	1132551	No	14.1
21	New Caledonia	19015	Yes	17.5
22	Himalaya	743371	Yes	17.6
23	Madrean Pine-Oak Woodland	462300	No	18.1
24	Cerrado	2036548	No	19.8
25	Mountains of Southwest China	263034	Yes	21.3
26	Sundaland	1504430	Yes	22.8
27	Horn of Africa	1663112	No	23.8
28	Tumbes-Choco-Magdalena	275203	No	29.8
29	New Zealand	270803	Yes	30.2
30	Southwest Australia	357516	Yes	30.6
31	Cape Floristic Region	78731	No	32.9
32	Tropical Andes	1546119	No	33.3
33	Chilean Winter Rainfall and Valvidian Forests	398035	No	34.2
34	California Floristic Province	294463	No	34.8
35	Forests of Eastern Australia	255328	Yes	34.8
36	North American Coastal Plain	1130000	No	NA

Several of the region's highly biodiverse coastal and marine ecosystems are also under threat. For example, over 55 per cent of the world's coral reefs, most of which are in the Asia-Pacific region, are now considered threatened due to overfishing and destructive fishing (Burke *et al.*, 2011) (Table 1.2) (Section 1.1.4). Four of the marine biodiversity hotspots in Asia-Pacific (i.e. Philippines, Sunda Islands, North Indian Ocean, South Japan) are among the most heavily fished and degraded reef areas globally (Costello *et al.*, 2010; Jenkins & Van Houtan, 2016; Selig *et al.*, 2014; Spalding *et al.*, 2007). Although the areas of greatest coral reef species richness are more highly threatened from human activity compared to less diverse areas, there are also extensive coral reef areas that remain less impacted, relatively healthy and highly biodiverse (e.g. Lord Howe Island, Western Australia, Hawaiian Islands, New Caledonia, Andaman Sea, Palawan) (GCRMN, 2009). However, some of the reef areas that were considered less impacted, such as the Great Barrier Reef, have recently experienced massive coral bleaching events (40 per cent of the corals are believed to be lost) that have affected the population of vulnerable marine species (UNEP-WCMC, 2016).

While the above clearly illustrate the high biodiversity in the Asia-Pacific region, it is important to note the large discrepancy in the availability and quality of data, both regionally and subregionally (Kier *et al*., 2009; Meyer *et al.*, 2015; Mihoub *et al.*, 2017; Amano & Sutherland, 2013). Reliable data is still only available for some taxonomic groups. For example, maps showing alpha diversity, the extent of endemism, and biodiversity hotspots are usually only available for plants (Joppa *et al.*, 2013), mammals (Schipper *et al.*, 2008), birds (Stattersfield *et al.*, 1998), reptiles (Böhm *et al.*, 2013), and amphibians (Stuart *et al.*, 2008). Other highly diverse species groups are less well-researched and understood (Kiel, 2010). When it comes to marine biodiversity, there are still significant gaps about the status of several important species and ecosystems (e.g., Costello *et al.*, 2010; Selig *et al.*, 2014).

Table 1.2 Status of coral reefs globally in 2008. Source: GCRMN (2009)

Region	Coral reef area (km^2)	Effectively Lost Reefs (%)[1]	Reefs at critical stage (%)[2]	Reefs at threatened stage (%)[3]	Reefs at low threat level (%)[4]
Red Sea	17,640	4	4	10	82
The Gulfs	3,800	70	15	12	3

Eastern Africa	6,800	15	22	28	35
Southwest Indian Ocean	5,270	9	24	39	29
South Asia	19,210	25	20	25	30
South-East Asia	91,700	40	20	25	15
East and North Asia	5,400	20	22	18	40
Australia, Papua New Guinea	62,800	3	4	10	83
Southwest Pacific Islands	27,060	4	17	35	44
Polynesian Islands	6,733	3	2	5	90
Micronesian Islands	12,700	8	7	15	70
Hawaiian Islands	1,180	2	4	8	86
US Caribbean	3,040	21	31	19	29
North Caribbean	9,800	12	13	30	45
Central America	4,630	14	24	22	40
Lesser Antilles	1,920	13	31	22	34
South Tropical America	5,120	13	40	17	30
Total	284,803	19	15	20	45

Note:

1. Reefs effectively lost: 90 per cent of the corals lost and unlikely to recover soon
2. Reefs at a critical stage: 50-90 per cent of the corals lost and likely to join category 2 in 10-20 years
3. Reefs threatened with moderate signs of damage: 20-50 per cent of the corals lost and likely to join category 1 in 20-40 years
4. Reefs under no immediate threat of significant losses (except for global climate change)

1.1.3 Social, economic and cultural characteristics of the Asia-Pacific region

1.1.3.1 Key socioeconomic characteristics

The Asia-Pacific region is densely populated, and is home to approximately 4.5 billion people (more than 60 per cent of the global population) (UNDESA, 2015). Even though the population growth rate in 2014 was 0.9 per cent (lower than the global average of 1.1 per cent), the region will still account for more than half of the projected global population increase by 2050 (UNDESA, 2015)[5]. By 2050, the Asia-Pacific region will contain four of the six countries expected to exceed a population 300 million inhabitants (i.e. China, India, Indonesia, and Pakistan) (UNESCAP, 2015a). These countries, along with Bangladesh, Vietnam and Nepal, will constitute some of the most densely populated regions of the world (United Nations, 2015).

The Asia-Pacific region also contains the largest urban population in the world. While, urbanization rates vary widely among the five subregions, there is a large expansion of urban population in most of them (Figure 1.4). In 2018, more than 50 per cent of the region's population is expected to reside in urban areas (mostly in small/medium-sized cities that are rapidly transforming), with the trend expected to increase significantly by 2050 (UNESCAP, 2015a). By 2010, the region is expected to contain to 22 megacities with a population over 10 million (up from 15 in 2015) (UN-ESCAP, 2015).

[5] The global population is predicted to increase by more than 1 billion people within the next 15 years, reaching 8.5 billion in 2030, 9.7 billion in 2050, and to 11.2 billion by 2100 (UNDESA, 2015).

Much like urbanization, the development of ancillary infrastructure such as roads has been uneven across the region but growing rapidly, fragmenting habitats and affecting conservation areas (Ibisch *et al.*, 2016) (Figure 1.5).

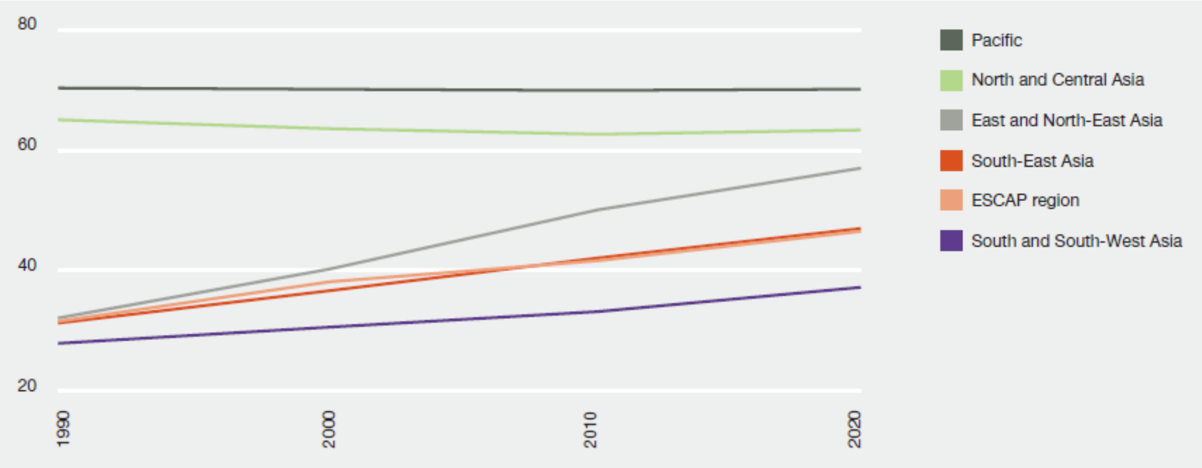


Figure 1.4 Urbanization trends in the Asia-Pacific region. Source: United Nations (2015).

The Asia-Pacific region as a whole has a growing geopolitical influence due to its increasing share in the world economy, accounting from 14 per cent of global Gross Domestic Product (GDP) in 2000, to 25 per cent in 2012 (UNESCAP/ADB/UNDP, 2013) (see Section 1.4.3). However this economic power is uneven between areas. For example the region currently contains the second, third and tenth largest economies in terms of GDP (China, Japan and India respectively), as well as some of the least developed economies located in South Asia and the Pacific Islands (Bajpai, 2015; United Nations, 2014).

Despite its rapid economic development, many countries in the region are characterised by high political instability, social conflicts, gender/income inequality, weak governance, poor infrastructure, low labour productivity and high incidence of extreme poverty, among others (UNESCAP, 2015b). For example, 400 million, or more than 52 per cent, of the global poor (earning less than $1.90/day) live in the region (UNESCAP, 2017). In this respect, while this unprecedented economic growth has ‘lifted hundreds of millions of people out of poverty and created a rapidly growing urban middle class that now accounts for almost 2 billion people’ (UN-Habitat & UNESCAP, 2015, p. 10), the region is also ‘home to the world’s largest urban slum populations and the largest concentrations of people living below the poverty line’ (UN-Habitat & UNESCAP, 2015, p. 10). The urban poor often experience high unemployment (especially among the youth) (ILO, 2013), and escalating living costs that threaten social cohesion and religious harmony. These are some of the growing socioeconomic challenges, inequalities and vulnerabilities that will increasingly be compounded by ongoing climate change (Section 1.1.4).

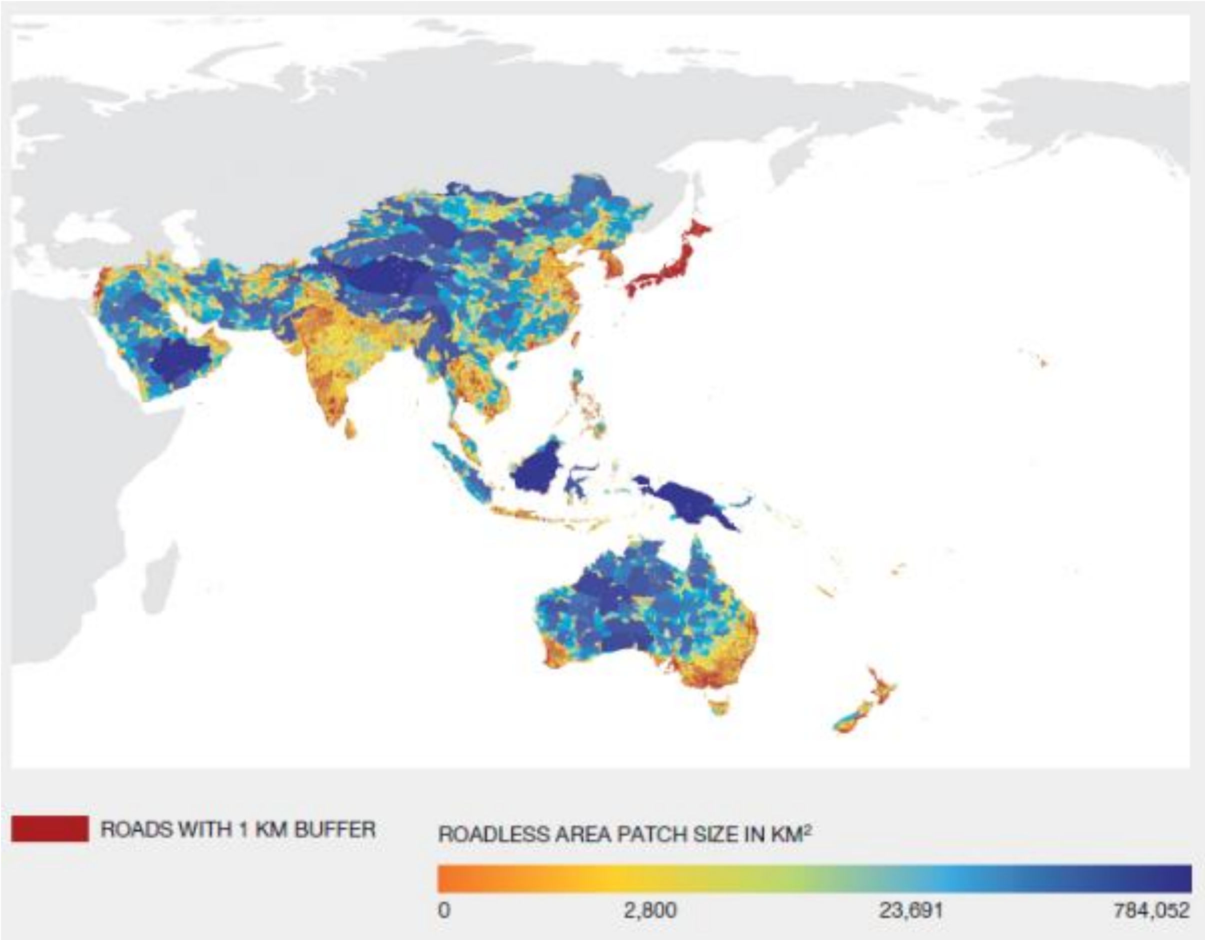


Figure 1.5 Roadless patch sizes in the Asia-Pacific region. Source: adapted from Ibisch *et al.* (2016).

1.1.3.2 Unique social-ecological dimensions

Superimposed on the extreme physical and biological diversity of the Asia-Pacific region, is the imprint of a long human occupancy. The region has a similarly rich diversity of rural and urbanized landscapes, cultural landscapes and social-ecological production systems. It is fair to say that the enormous bio-geographical diversity and geographical extent of the Asia-Pacific (Section 1.1.1) is the basis of its rich biodiversity (Section 1.1.2), upon which the region's vast bio-cultural diversity has been created and flourished (Maffi, 2007). For example the Asia-Pacific has a huge diversity of languages, cultures and traditions, transposed to some of the most diverse ecosystems (e.g. Gorenflo *et al.*, 2012; Turvey & Pettorelli, 2014) (Figure 1.6).

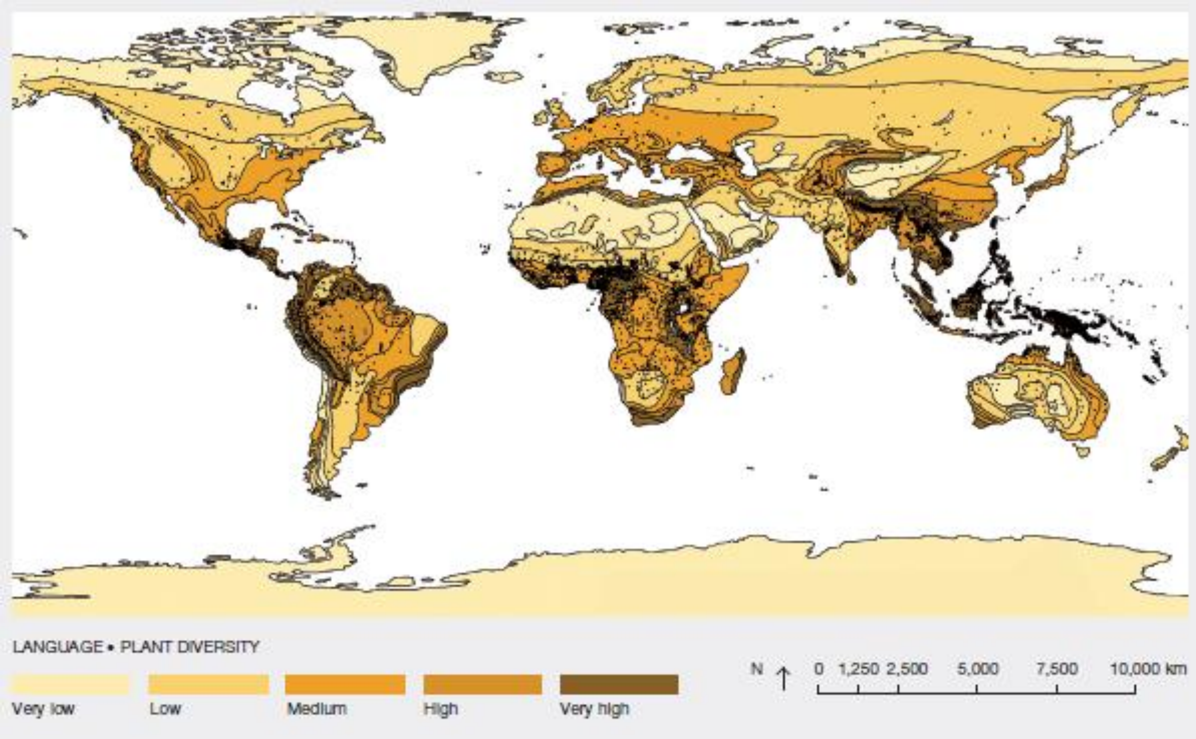


Figure 1.6 Global plant diversity and language distribution. Source: Stepp *et al.* (2004).

Some of the unique social-ecological systems in the region (see below), are inhabited by indigenous people and local communities[6]. As many as 370 million of indigenous people live across the world, with about 3/4 living in the Asia-Pacific region (Hall & Patrinos, 2012). Such communities are recognised as having evolved rich indigenous, traditional and local ecological knowledge systems, collectively referred to as indigenous and local knowledge (ILK) in this assessment. ILK systems are essentially cumulative bodies of multi-scalar social-ecological knowledge, practices and beliefs, about the relationship of living beings (including humans) with their environment that have evolved over time through adaptive processes and transmitted across generations through different cultural practices (Berkes, 2012; Berkes, Colding, & Folke, 2000; Borrini-Feyerabend, Kothari, & Oviedo, 2004; Nuuhiwa, Lilly, Nobrega-Olivera, & Huihui, 2016). These ILK systems have contributed substantially to the sustainable management of ecosystems in the region over millennia (Alangui, Ichikawa, & Takahashi, 2016; Karki, Chaudhary, Shrestha, & Sakurai, 2017) and have been central to the maintenance of some traditional cultures and good environmental stewardship practices throughout much of the region (AIPP, 2015; IUFRO, 2014; MRGI, 2003).

Chapter 2 discusses in length some of the most unique social-ecological systems and management practices in the region such as:

- cultural social-ecological production landscapes (both extensive and intensive) such as the Satoyama-Satoumi systems of Japan and poly-cultural systems of Pacific islands (Duraiappah *et al.*, 2012; Ichikawa, 2012; Takeuchi, 2010; Thaman, 2009, 2014);
- indigenous agricultural and pastureland management systems such as Australia's fire-stick farming, North-East India's Alder-based rice farming, and the Apatani fish-paddy cultivation of Arunachal Pradesh in India, among several others (Bhatta *et al.*, 2015; Pandit & Bevilacqua, 2011; Tangjang & Nair, 2015; van Oort *et al.*, 2015);
- indigenous forestry systems where tenure security, as well as access to (and benefit from) resources is guaranteed under the principle of "care and share" (Karki & Adhikari, 2015).

[6] For the purpose of Asia Pacific regional assessment, the term 'indigenous' relates to people who identify as part of groups that may occupy ancestral lands, hold traditional knowledge, engage in bio-cultural practices (e.g. languages, spiritual beliefs) to interpret nature's benefit to people, and operate under different ethnic, tribal and aboriginal systems (United Nations, 2015). "First people" and "traditional custodians" are also terms often used to describe indigenous people.

- traditional marine tenure and resource management systems that have provided a foundation for modern community-based sustainable fisheries management systems (e.g. Govan, 2009)[7].

Biodiversity (and the ecosystem services[8] it provides) within such social-ecological systems contributes substantially to the food, water, shelter and energy needs of local communities and larger segments of society (see Chapter 3). For example, close to 100 million indigenous people in the Asia-Pacific region draw their livelihoods directly from forest-based ecosystem services (Deb *et al.*, 2013). As discussed above, several of these indigenous and local communities have kept intact the provision of such ecosystem services through traditional resource management practices that evolved over generations (see several examples in Chapter 2).

At the same time some of the poorest people across the Asia-Pacific (including numerous indigenous and local communities), live in some of the richest areas in terms of biodiversity and ecosystem services (Fisher & Christopher, 2007). Several of these areas have been widely undermined by factors as diverse as the expansion of industrial agriculture/forestry/fisheries, inequitable access to market economies, population growth and loss of land tenure, to mention just a few (see Section 1.1.4, 1.4.3, and Chapter 4). The significant degradation of such social-ecological systems has almost invariably compromised the access of indigenous and local communities to the ecosystem services upon which they critically depend. This, combined with the fact that for some of these communities there is a lack of access to resources, health services and education (that is often far from being acceptable for 21st century standards), has resulted in higher prevalence of malnutrition, gender-based violence, child mortality and infectious diseases in many of these communities when compared to non-indigenous communities living in the same areas (AIPP, 2015; MRGI, 2003; University of Florida, 2015).

1.1.4 Growing threats to biodiversity

Biodiversity in the Asia-Pacific region is under serious threat due to a combination of anthropogenic and natural factors. These include a large number of direct and indirect drivers that are discussed in more detail in Chapters 3 and 4. The main direct drivers discussed below include land use change and degradation, pollution, resource overharvesting, invasive alien species, natural hazards, and human-induced climate change, sea-level rise and ocean acidification. These direct drivers can have synergistic and particularly devastating effects to ecosystems. They have often led to species extinctions and serious declines in biodiversity and ecosystem services across the region (Chapter 4).

The Asia-Pacific is historically the most vulnerable region on Earth to natural hazards and extreme events (Table 1.3) such as tropical cyclones, flash/seasonal floods, prolonged droughts, king tides, earthquakes, tsunamis, and volcanic eruptions, among others (see Table S3, Appendix). In particular, the Asia-Pacific region is the most seismically active region in the world, experiencing numerous non-climatic hazards such as earthquakes, tsunamis and volcanic eruptions that can have a significant effect on humans and ecosystems. For example the 2004 Indonesian tsunami caused approximately 280,000 human casualties in 14 countries, and destroyed extensive areas of coastal ecosystems and agricultural areas (Hayasaka *et al.*, 2012; Srinivas, 2015).

Climatic hazards, such as the periodic and erratic droughts and flooding can affect significantly ecosystems and biodiversity across the region (Estes *et al.*, 2012; Zhang *et al.*, 2014). For example, the region contains 11 of the 15 most flood-prone countries globally that have the highest proportion of their population exposed to riverine flooding, with India, Bangladesh, China, Vietnam and Pakistan

[7] For example, more than 500 communities spanning 15 independent countries have established such community managed systems, most of which include some form of “closed” marine protected area (Govan, 2009).

[8] For the purpose of this chapter “ecosystem services” refer to the benefits that humans derive directly and indirectly from ecosystems. These can include provisioning (e.g. food, fuel), regulating (e.g. carbon sequestration, water purification), cultural (e.g. recreation) and supporting services (e.g. habitat provision, nutrient cycling) (Millenium Ecosystem Assessment, 2005).

topping the list (Luo *et al.*, 2015)[9]. At the same time eight of the ten most water stressed rivers are found in the region (in China, Iran, Afghanistan, India and Jordan), and face periodic droughts with significant effects to humans and ecosystems (Maddocks & Reig, 2014). Other climatic hazards such as typhoons can have pronounced impacts to some highly biodiverse areas in the tropics and sub-tropics. For example the 2013 tropical cyclone Haiyan (also known as super typhoon Yolanda) killed approximately 2,300 people in the Philippines and affected mangroves and coral reefs in wider area of Micronesia including Palau (Long *et al.*, 2016; Reyes *et al.*, 2015). Tropical cyclones can also affect the southern Pacific as exemplified by the 2017 tropical cyclone Debbie that affected Australia and New Zealand causing loss of life and property, while also affecting agricultural areas and iconic ecosystems such as the Whitsunday Islands National Park and its endemic population of hoop pines (*Araucaria cunninghamii*). Notable is the extreme vulnerability of some ecosystems in low-lying coastal areas and small islands, particularly atolls, to extreme weather and tidal events (Thaman, 2008, 2013b; UNEP, 2014). For example, several small islands are submerging along with their ecosystems (Keener *et al.*, 2012), while climatic hazards and unusual temperature patterns have contributed to massive coral bleaching and loss (De'ath *et al.*, 2012; Heron *et al.*, 2016).

Table 1.3 Disaster occurrence in each continent between 1900-2016. Source: International Disaster Database[10], as of 1 October 2016.

	Number disasters	Total deaths	Injured	Homeless	Unaccounted[1]
Africa	4,544	1,481,687	282,816	9,321,994	2,1
Americas	4,866	887,913	3,142,949	12,053,150	2,4
Asia	9,215	26,970,648	4,831,726	146,710,072	1,1
Europe	2,853	9,202,680	173,656	3,571,350	2,7
Oceania	701	21,441	12,124	468,608	12,4

[1.] percentage of disasters with deaths unaccounted for

The projected temperature increase by the middle of the century is expected to be higher than the global average in both continental and insular Asia and Oceania. Temperatures are expected to reach 3ºC above current levels by the end of the century in continental Asia,, affecting, among others, the occurrence of those natural hazards that are strongly associated with El Niño/La Niña (ENSO) changes within the Pacific Ocean basin (Almassy, 2014; CSIRO, 2016; IPCC, 2014). The effect of anthropogenic activity in the increased severity of such extreme events is well documented for the Asia-Pacific region (IPCC, 2012, 2014; UNEP, 2014) (see Chapter 4). Changes in the patterns of climate-related natural disasters, together with the incremental effects of climate change, will most likely affect disproportionately vulnerable populations and ecosystems in the region, most notably in its many small islands (IPCC, 2014).

Land use and cover change is a particularly important driver of ecosystem change and biodiversity loss across the Asia-Pacific region. Massive deforestation and conversion of native ecosystems and/or traditional social-ecological systems in prevalent in many parts of the region that are almost entirely used for agriculture and pasture (Chapter 4) (Figure 1.7). The expansion of agricultural and pasture land has been among the highest in the world over the past decades, with the overall fraction of land in 2014 under being in 55.1 per cent in Eastern Asia, 49.4 per cent in Southern Asia, 30.2 per cent in South-East Asia, 56.8 per cent in Western Asia and 56.4 per cent in Oceania (from 42.3 per cent, 50.4 per cent, 19.1 per cent, 37.6 per cent and 49.5 per cent respectively in 1961) (FAO, 2017). South-East Asia is a key example, as it experienced rapid land use and cover change through the logging of highly biodiverse forests and their subsequent conversion to oil palm/rubber monocultures, other agricultural activities and ancillary developments such as roads (Stibig *et al.*, 2014). About half of the oil palm expansion in Indonesia and Malaysia after 1990 happened at the expense of (often primary) forests (Koh & Wilcove, 2008; Vijay *et al.*, 2016), including areas with high carbon stocks such as

[9] India, Bangladesh, Vietnam and Pakistan are among the top five most affected countries globally in terms of the percentage of their GDP affected by floods (Luo *et al.*, 2015); .

[10] Available from https://www.emdat.be/

peatlands (Koh *et al.*, 2011). The conversion of primary forests to rubber and oil palm monocultures can cause substantial loss of biodiversity (F. Danielsen *et al.*, 2009; Fitzherbert *et al.*, 2008; Vijay *et al.*, 2016) and other globally important ecosystem services such as carbon sequestration and storage (Carlson *et al.*, 2013; Ziegler *et al.*, 2012). At the same time there is an ever-closer proximity and direct influence between urban areas and protected sites in the Asia-Pacific region (McDonald *et al.*, 2009), which is expected to become stronger in the future (Seto *et al.*, 2012). Expanding road networks play an ever-increasing role in the fragmentation of habitats across the region that are of critical importance for biodiversity (Ibisch *et al.*, 2016; Laurance *et al.*, 2014) (see also Figure 1.5).

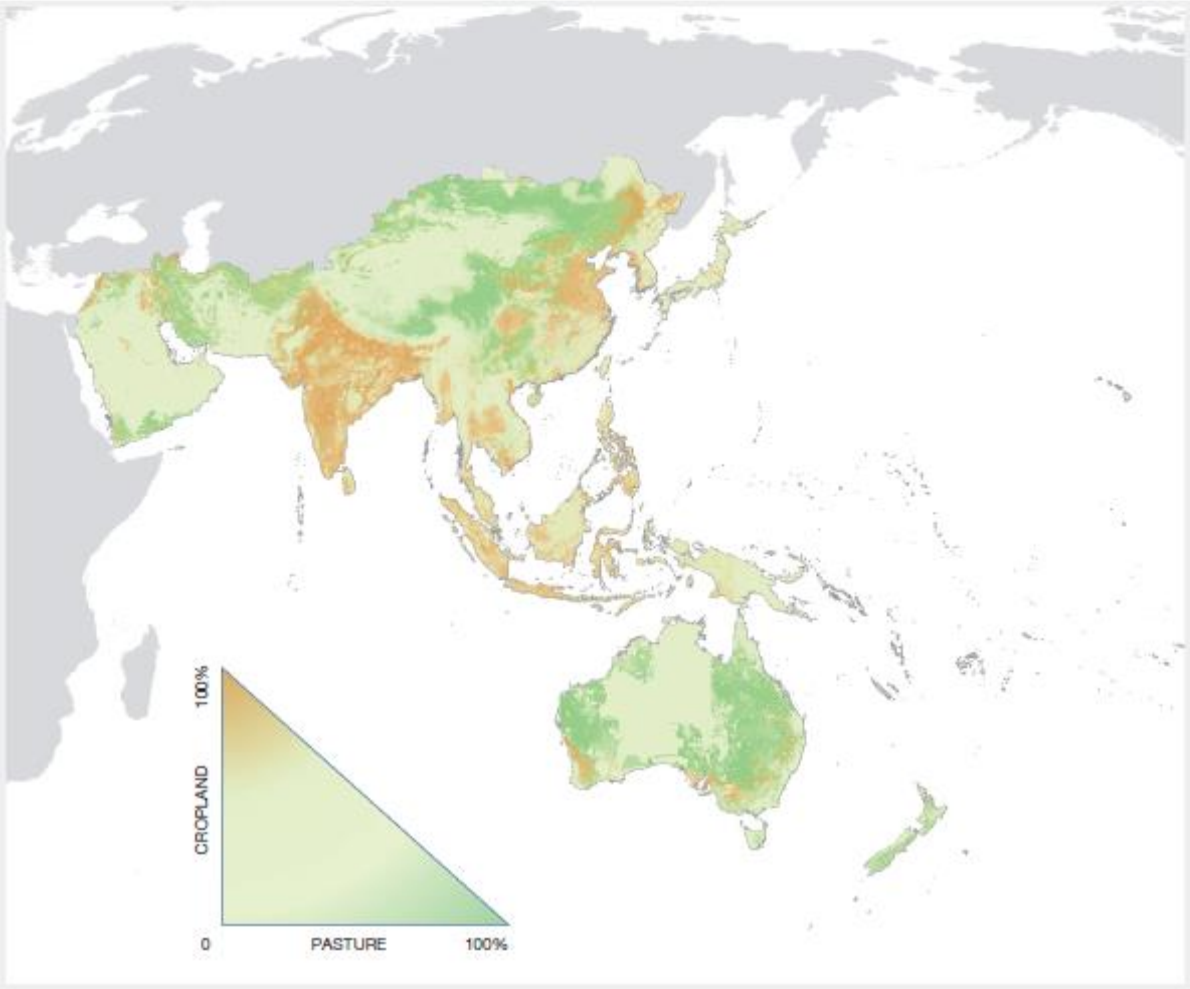


Figure 1.7 Land allocation for agriculture and pasture. Source: Redrawn using data from Ramankutty *et al.* (2008).
Note: Dark brown denotes land used primarily for agriculture. Dark green denotes land used primarily for pasture.

Land degradation[11] is another threat to biodiversity in the Asia-Pacific, having affected about 850 million ha (or about 28 per cent) of its land area (FAO, 2009). Based on relative extent and degree of degradation (i.e. light, moderate, strong, extreme), by the end of the 20th century about 73 per cent of the land area in the Asia-Pacific had been affected by some form of land degradation, with about 12 per cent corresponding to light degradation, 32 per cent to moderate, 22 per cent to severe and 7 per cent to very severe degradation (Stavi & Lal, 2015). Key causes of land degradation include, among

[11] IPBES defines degraded land as a state of land that has resulted from the persistent decline or loss in biodiversity, ecosystem functions and services that cannot fully recover unaided within decadal time scales (IPBES, 2018). In this respect land degradation, refers to the myriad of processes that drive the decline or loss in biodiversity, ecosystem functions or services, and includes the degradation of freshwater and coastal ecosystems, which are closely interconnected with terrestrial ecosystems.

others, deforestation, unsustainable agriculture (combined with inadequate soil conservation and cultivation of steep slopes), and overgrazing (Gibbs & Salmon, 2015; Stavi & Lal, 2015).

The increasing air, water and soil pollution from rapid socioeconomic transitions (e.g. population growth, urbanization, industrialisation) and land use change (e.g. monocultural agriculture) are negatively affecting ecosystems throughout the region. For example the excessive use of fertilisers and agrochemicals has been linked to acute toxicity and eutrophication in freshwater and near-shore marine ecosystems throughout the region (e.g. see Katayama *et al.*, 2015; Liu *et al.*, 2013, among numerous other studies), with nitrogen deposition increasing significantly in most subregions over the past decades (see Chapter 4). The combustion of fossil fuels in cities and industrial areas, and the indiscriminate burning of agricultural/forested areas, has been responsible for the emission of air pollutants that can cause acidification and long-range tropospheric ozone pollution that degrade agricultural areas, natural ecosystems and human health (Burney & Ramanathan, 2014; EANET, 2015; Izuta, 2017). The substantial soil and water pollution from heavy metals (and its effects to different species and humans) is well documented within the region (FAO & ITPS, 2015). The dumping of solid waste (including plastics) along the coasts and the ocean can impact significantly fisheries and marine biodiversity (e.g. Todd, Ong, & Chou, 2010). Overall, the Asia-Pacific region is responsible for a large amount of the plastic waste that ends up to the seas and oceans (Jambeck *et al.*, 2015).

The overexploitation of species with economic value through indiscriminate logging, overfishing and illegal trade is another important threat to biodiversity in the region. Such species include a wide array of timber species for construction and fuel, and non-timber forest products for medicinal products and food, among other uses (see Chapter 3). Timber overharvesting through intensive and selective logging has been an important driver of biodiversity loss in different forest types, including highly biodiverse tropical rainforests (Edwards *et al.*, 2014; Ewers *et al.*, 2015; Hughes, 2017). Furthermore, numerous terrestrial and marine wild species are hunted (both legally and illegally) for food, medicinal products, trophies and recreation (see Mendiratta, Sheel, & Singh, 2017, among numerous studies). Poaching and illegal wildlife trade is rampart in the region, with South-East Asia being a key supplier and transit point for illicit wildlife trade (Squires, 2014). This trade has often led to the overexploitation of rare species and the destruction of important habitats (e.g. Moran & Kanemoto, 2017; Phelps & Webb, 2015)[12]. Commercial overfishing has resulted in the decline of marine biodiversity in many marine and coastal areas across the region (see Section 1.1.2). Although smaller in scale, the fishing grounds near urban areas and on most of the highly populated Pacific Islands are also seriously overfished, a trend that started some 50 years ago with the active subsidization of artisanal commercial fishing, increasing population, and commercialization of nearshore species. A wide range of finfish, shellfish, crustaceans, echinoderms and other species have been fished to local, ecological or economic extinction, or have fallen to unsustainable exploitation levels (Jackson *et al.*, 2001; Lavides *et al.*, 2016; Nadon, 2017; Thaman, 2014). Progress towards sustainable fishing in the region remains still slow, despite some recent increases in the amount of fish captured from fisheries certified as sustainable by the Marine Stewardship Council (MSC) (Figure 1.8).

[12] For an overview of issues related to illegal wildlife trade in Asia refer to the Wildlife Trade Monitoring Network (TRAFFIC): http://www.traffic.org/publications/category/Asia

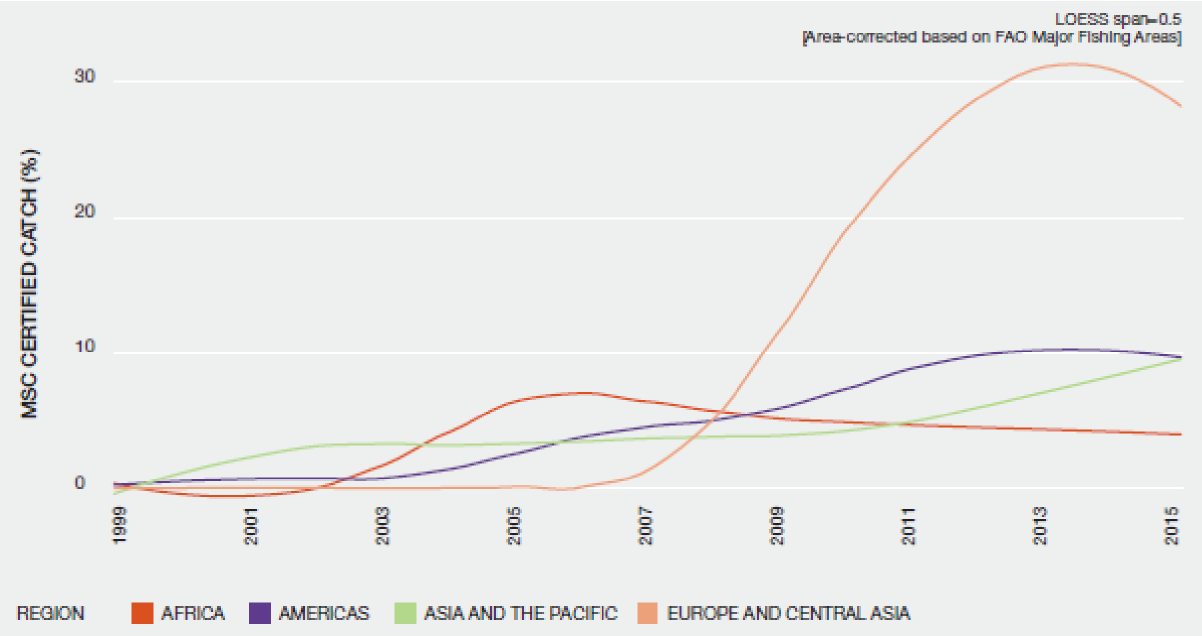


Figure 1.8 Trends in fisheries certified by the Marine Stewardship Council.
Figure prepared by the IPBES Task Group on Indicators and Knowledge and Data Technical Support Unit. Indicator data source: Marine Stewardship Council.

Finally, invasive alien species (IAS) constitute one of the most serious, but under-acknowledged, drivers of ecosystem change and biodiversity loss in the Asia-Pacific region (Bisht *et al.*, 2016; IPBES, 2016a; UNEP, 2014). This is particularly true for oceanic islands, where the recent extinctions of many plant and animal species have been linked to IAS due to the low in-built resistance of local ecosystems (Cox & Moore, 2010; Jupiter, Mangubhai, & Kingsford, 2014; Quammen, 1996; Thaman, 2011, 2013c). There is also growing evidence that marine IAS constitute an extremely serious, but less well-understood, threat to fisheries, coral reefs and the overall functioning of marine ecosystems and food webs in the region (Como *et al.*, 2016; Heather & Jeffrey, 2007).

1.1.5 Rationale of the Asia-Pacific Regional Assessment

As highlighted in Section 1.1.3.1, the Asia-Pacific region experiences massive socioeconomic transitions that have weakened the traditional links between nature and human society (Section 1.1.3.2). A key policy challenge for many nations in the region is how to improve the standard of living and ensure the equitable access to resources, without degrading further biodiversity and the ecosystem services it provides.

The sustainable use of biodiversity and ecosystem services can play a critical role in reducing poverty and granting livelihood security to poor and vulnerable communities in the region. However the reality is that biodiversity and the ecosystem services it provides is under extreme threat in the Asia-Pacific region due to the synergistic effects of multiple drivers of ecosystem change (Brooks *et al.*, 2015). These include, among others, an increasing population, poverty, changing consumption patterns, unsustainable environmental engineering/construction, pollution, unsustainable agriculture, overfishing, invasive alien species, and human-induced climate change, sea-level rise and ocean acidification (Section 1.1.4, 1.4.3). Thus, there is an urgent need to assess the status and trends of biodiversity and ecosystem services throughout the Asia-Pacific, and to initiate actions to contain their further loss (Baral *et al.*, 2014; Grantham *et al.*, 2009).

This urgency forms the main rationale for an assessment at the Asia-Pacific context that:

- Undertakes an extensive analysis of the major direct and indirect drivers on the status biodiversity and ecosystem services;

- Discusses how changes in the status of biodiversity and ecosystem services can ultimately affect human quality of life;
- Considers the bio-cultural and traditional practices of indigenous groups in managing biodiversity and ecosystem services, and integrates meaningfully ILK with modern scientific knowledge.

Section 1.2 of this chapter briefly introduces the aim, objectives and audience of the Asia-Pacific Regional Assessment. Particular attention is paid on the value that the regional assessment can add in building on the existing knowledge base about the status of biodiversity and ecosystem services in the Asia-Pacific.

Section 1.3 outlines the underlying principles and methodology of the Asia-Pacific Regional Assessment, including the central role of the IPBES conceptual framework in structuring the assessment. It also highlights the approach towards integrating insights and building complementarities between ILK and modern scientific knowledge.

Section 1.4 explains how the Asia-Pacific Regional Assessment sits within the current international and regional institutional landscape. In particular it provides an overview of the major ongoing national, regional and global policy initiatives related to biodiversity and ecosystem services related to various multilateral environmental agreements (MEAs). This includes an overview of regional goals, targets, and milestones agreed by the Member States of MEAs across diverse environmental policy domains such as:

- Biodiversity [e.g. the Aichi targets of the Convention on Biological Diversity (CBD), the 2050 CBD vision, the Ramsar Convention, UNESCO's initiative on agricultural and cultural biodiversity and the Strategic Plan for Migratory Species 2015-2023];
- Climate change [e.g. major agreements under the United Nation Framework Convention on Climate Change (UNFCCC), especially the 2015 Paris Agreement on Climate Change];
- Land degradation [e.g. the sustainable land management goals of the UN Convention to Combat Desertification (UNCCD)];
- Sustainable development: [the Sustainable Development Goals (SDGs) of the United Nations].

Section 1.5 elucidates the overall structure and organization of the Asia-Pacific Regional Assessment. It highlights how different chapters are organized to form this integrated and cohesive regional assessment. Special attention is paid on how this regional assessment feeds to the CBD Aichi Biodiversity Targets and the SDGs.

1.2 The Asia-Pacific Regional Assessment at a glance

1.2.1 Aim and objectives

Overall, the Asia-Pacific Regional Assessment aims to critically evaluate the state of knowledge of Nature, and Nature's Contributions to People (NCP), and their effects on quality of life. It focuses on the five subregions outlined in Section 1.1.1, i.e. Western Asia, South Asia, South-East Asia, North-East Asia, and Oceania, covering the major ecological regions and ecosystems across 62 countries and territories.

Its objectives are to answer the following five policy relevant questions:

1) The status, trends and potential future dynamics of Nature and NCP;
2) The way Nature and NCP contribute to the economy, livelihoods, food security, and quality of life, as well as the interdependencies among them;
3) The pressures that drive the changes in the status and trends of Nature, NCP and quality of life;
4) The actual and potential impact of different policies and interventions that aim to enhance the contribution of Nature and NCP, to the economy, livelihoods, food security and good quality of life;
5) The gaps in knowledge and capacity building needs that must be addressed to better understand and tackle the drivers, impacts and responses of changes to Nature and NCP at the regional and subregional levels.

Ultimately the regional assessment seeks to enhance the science-policy interface and to assist policymakers and other decision makers across the Asia-Pacific region to make informed choices. Towards this end, the assessment is based on the generic and region-specific scoping reports produced by IPBES (IPBES-3/1 Annex 3) that identified the need for knowledge synthesis, capacity building and development of policy support tools for member countries to implement national policies/strategies (e.g. NBSAPs), and other regional/global biodiversity and development targets (see also Section 1.4).

Ideally the Asia-Pacific Regional Assessment will also support national stakeholders to develop and reform more inclusive and implementable policies. This will be achieved, among others, by identifying practical management options and tools, and best practices for catalysing the effective conservation and sustainable management of biodiversity and ecosystem services. At the same time the assessment will seek to forge the mutual understanding of common issues and goals at the multi-national level, as the conservation of biodiversity and ecosystem services goes beyond national barriers.

1.2.2 Main audience

The Asia-Pacific Regional Assessment acknowledges that reducing the loss of biodiversity and ecosystem services must be achieved by building synergies between different sectors and stakeholders. This will require a more systematic consideration of the synergies and trade-offs between the conservation of biodiversity and ecosystem services on the one hand, with other societal needs (Baral *et al.*, 2013; Johnston *et al.*, 2010; Kumar *et al.*, 2011; McCartney *et al.*, 2010; Senaratna Sellamuttu *et al.*, 2011).

Thus the Asia-Pacific Regional Assessment is geared towards appealing to a broad range of stakeholders. The primary audience of the regional assessment includes:

a) Policymakers whose work may affect or be affected by biodiversity or nature's contributions to people at all levels (e.g. IPBES Member States, ministries of environment, energy, industry, planning, finance, fisheries and agriculture, local authorities and the scientific advisers to policymakers that need to be informed about IPBES so that they can use it as a source of independent expert knowledge). The regional assessment will not just target the forestry, wildlife and environment ministries in these countries, but also sectors and agencies that control finance, health, education, agriculture, fisheries, energy, transportation, construction, water and local/rural development, among others.

b) United Nations entities and MEAs. Several United Nations entities and MEA secretariats are key clients for IPBES's reports;

The broader audience includes:

c) Scientific community (inclusind international associations of scientists) as the IPBES depends on it to produce its reports and assist with outreach activities;
d) ILK holders and experts;
e) Business and industry. In particular IPBES's reports and scenarios can be useful to businesses and industries to plan how to avoid, minimize or mitigate, harm to ecosystems;
f) Practitioners or implementers. This inclused the multitude of organizations and individuals involved in the implementation of programmes depending on or affecting biodiversity and ecosystem services working on the ground;
g) Intergovernmental and non-governmental organizations by providing outreach to their constituencies (including policymakers or the private sector);
h) The media;
i) Communities and the public at large.

Additionally, the Asia-Pacific Regional Assessment seeks to inform the activities the various non-governmental, inter-governmental and private agencies that operate in the region at different levels, from state to local (See Box S1, Appendix). These include funding bodies that support research and learning related to biodiversity and ecosystem services such as the Global Environment Facility (GEF), the Asian Development Bank (ADB), the Asian Infrastructure Investment Bank *(*AIIB*)*, the World Bank, development agencies (e.g. USAID, JICA, DFID), the Global Green Growth Institute (GGGI), and the Belmont Forum, among several others.

The outputs of the regional assessment are presented in an accessible format to enhance the value to ILK experts and local communities. We see this as a basis for building future synergies, build capacity and highlight the importance of ILK for the sustainable management of biodiversity and ecosystem services in the region. We hope that this broadens significantly the target audience of the regional assessment and will influence positively the way decisions are made locally, nationally and regionally.

1.2.3 Added value of the regional assessment

Firstly, by adopting a problem-oriented perspective, the Asia-Pacific Regional Assessment seeks to assist a broad range of stakeholders understand the true value of biodiversity and ecosystem services in the region (Section 1.2.2). It strives to enhance the science-policy interface by illustrating how to take the necessary actions to curb the loss and restore biodiversity and ecosystem services, through knowledge-based solutions and sustainable practices. While policy options will be provided, the Asia-Pacific Regional Assessment will not make policy prescriptions.

Secondly, the Asia-Pacific Regional Assessment collects and synthesises evidence that is of high relevance to the entire region. While there have been several assessments on the state of biodiversity/ecosystem services [e.g. the Millennium Ecosystem Assessment (MA), the Global Biodiversity Outlook (GBO)], the drivers and impacts of climate change on ecosystems (e.g. IPCC reports), or the interrelations between natural capital and the economy (e.g. TEEB reports, UNEP Green Economy Report), there have not been any assessments that have focused exclusively on the intricate context of the Asia-Pacific (see Section 1.1 and 1.4). Towards this end, this regional assessment does not only consider the full array of the drivers of ecosystem change and biodiversity loss (e.g. Section 1.1.4, Chapter 4), but further focuses on those that are specific to the Asia-Pacific subregions. The regional assessment also considers highly context-specific aspects of biodiversity and ecosystem services in the Asia-Pacific such as (a) species that face a high risk of extinction [i.e. fall under the International Union for Conservation of Nature (IUCN) Red List categories\, (b) threatened species/taxa of cultural, ecological and economic importance, (c) threatened ecosystems, ecosystem function/services and genetic diversity.

Thirdly, the Asia-Pacific regional assessment fully embraces the recent appeals for inclusive knowledge synthesis in scientific assessments. It considers insights from modern scientific knowledge, ILK, and other knowledge systems/practices to come up with integrative and practical policy options. It embraces concepts such as “Care and Share”, mother nature, cultural landscapes, ancestral domains and other different worldviews about respecting and using sustainably biodiversity and ecosystem services. The options provided are to the extent possible inclusive, politically neutral, and grounded on robust scientific evidence and good practice to inform evidence-based decision-making (Koetz *et al.*, 2008).

Fourthly, considering the need to have a trans-boundary and regional approach in the conservation of biodiversity and ecosystem services, several of the results are geared towards the regional and subregional scale. Knowledge and evidence is synthesised through the expertise, experience and learned practices of experts, whom are mostly nominated by the governments of the member countries of the IPBES that are the main users of the Asia-Pacific Regional Assessment. As this is one of the four Regional Assessments of the IPBES, it provides fundamental support to the IPBES Global Assessment.

Finally, the regional assessment attempts to identify conservation interventions and efforts that have had both positive and negative outcomes for the conservation of biodiversity and ecosystem services. This includes top-down command-and-control instruments (which combined with a poor involvement of local communities have often yielded negative conservation outcomes) and bottom-up, participatory and collaborative community-driven efforts (which have often created some positive conservation outcomes). The Asia-Pacific Regional Assessment seeks to collate such experiences in a constructive and accessible manner in order to promote success stories and improve examples of failure (Agrawal & Verma, 2017; Lopez-Casero *et al*., 2016).

1.3 Methodology of the Asia-Pacific Regional Assessment

1.3.1 Guiding principles

The Asia-Pacific Regional Assessment follows the decisions adopted by the IPBES Plenary to produce knowledge products that can enhance the science-policy interface especially at national levels. The assessment adopts the IPBES conceptual framework (Section 1.3.2) and has formulated the seven guiding principles below. Chapters 2-6 have adopted these principles to the extent enabled by the availability of data and literature.

Principle 1: Adopt a coupled social-ecological systems (CSES) approach: The regional assessment recognises that social and ecological systems are strongly interlinked and form coupled social-ecological systems (CSESs). CSESs are nested, multilevel systems that provide essential provisioning ecosystem services to society (e.g. food, fibre, energy, drinking water), as well as other critical supporting, regulating and cultural ecosystem services (Berkes & Folke, 1998). A CSES approach can help elucidate how human actions affect the structure and functions of such systems and ultimately the multiple benefits that humans derive from them (Berkes & Folke, 1998; Berkes *et al.*, 2000; Binder *et al.*, 2013; McGinnis & Ostrom, 2014; Ostrom, 2009). Adopting a CSES approach is highly appropriate at the Asia-Pacific context considering the long history of human dependence on (and management of) social-ecological systems as collected, among others, by the International Partnership for the Satoyama Initiative (IPSI) (Duraiappah *et al.*, 2012; Ichikawa, 2012; Takeuchi, 2010), and community-based natural resources management movements (see Section 1.1.3.2).

Principle 2: Unravel the effects of multiple drivers of ecosystem change: Based on the IPBES Conceptual Framework (Section 1.3.2), the Asia-Pacific Regional Assessment acknowledges that multiple anthropogenic and natural drivers contribute to ecosystem change and biodiversity loss across the region. These drivers can be direct (e.g. natural hazards, pollution, land use change) or indirect generated outside ecosystems by different institutions and governance systems (e.g. poverty, inequality, globalization) (Díaz, Demissew, Carabias, *et al.*, 2015; Díaz, Demissew, Joly, *et al.*, 2015; Thompson, 2015; Zarandian *et al.*, 2016) (see Section 1.1.4, 1.4.3, Chapter 4).

Principle 3: Conduct integrated cross-scale analysis: CSESs are highly interlinked over space and time (Binder *et al.*, 2013; Kohsaka, 2010). In order to understand how the multiple drivers of ecosystem change affects biodiversity and ecosystem services (and ultimately good quality of life) it requires an integrated cross-scale analysis across different spatial and temporal domains (Baral, Keenan, Fox, Stork, & Kasel, 2013; Baral, Keenan, Sharma, Stork, & Kasel, 2014).

Principle 4: Consider multiple value systems: There are diverse ways to conceptualise the multiple values associated with biodiversity and ecosystem services (Martín-López *et al.*, 2014), including social, cultural and spiritual values (Bhatta *et al.*, 2015; Chan *et al.*, 2012; van Oort *et al.*, 2015) (see Section 1.3.5, Chapter 2). For example, the traditional worldview of "*living in harmony with nature*", which has been adopted as CBD's vision for 2050 (Section 1.4.1) is widely observed in the Asia-Pacific region (Ichikawa, 2012; cf. Aichi Biodiversity Targets of the CBD). In order to acknowledge the highly diverse socio-cultural contexts of the region and the multiple value systems embedded within them, the Asia-Pacific Regional Assessment adopts and utilises the findings of the IPBES Deliverable 3d on the diverse conceptualisation of the values of biodiversity (IPBES, 2015; Pascual *et al.*, 2017).

Principle 5: Integrate multiple sources of knowledge: The Asia-Pacific Regional Assessment acknowledges the importance of (and need to) integrate insights from different knowledge systems. It taps on modern scientific knowledge, ILK and other knowledge systems both from in-situ and ex-situ sources (Kohsaka *et al.*, 2015; Thaman, 2013a; van Oort *et al.*, 2015; Zarandian *et al.*, 2016). ILK is particularly pertinent in the Asia-Pacific considering given the long history of indigenous and sustainable ways to manage biodiversity and ecosystem services utilised by various indigenous groups throughout the region (e.g. Bhatta *et al.*, 2015; Cochran *et al.*, 2008; Hernández-Morcillo *et al.*, 2014; Karki & Adhikari, 2015; Oteros-Rozas *et al.*, 2013) (Section 1.1.3.2).

Principle 6: Acknowledge the importance of institutions and governance mechanisms: Both formal and informal/traditional institutions[13] affect, and are affected by, the biophysical systems within which they are embedded (Anderies & Janssen, 2013). The Asia-Pacific Regional Assessment views institutions and governance mechanisms as the interface of CSES. The regional assessment adopts an analytical framework that considers the role of local, national and international institutions as they inadvertently influence the biodiversity and ecosystem services. This is particularly important as the CBD and other MEAs allow national sovereign decisions over biodiversity issues, as per the different national situations and needs (Section 1.4.1).

***Principle 7: Relation to the Guiding Principles of other IPBES Deliverables*:** The Asia-Pacific Regional Assessment uses the thematic and the regional coupling framework of the IPBES. Overarching thematic topics of the IPBES such as Land Degradation are integrated in a relevant and contextual manner. Methodological applications and experiences are shared in a cross-thematic and cross-regional manner with IPBES Deliverable 4(c), the guide on policy support tools and methodologies to global and regional assessments.

1.3.2 Conceptual framework

[13] Informal institutions include informal rules for the management of common pool resources, such as local forests, water bodies and urban parks, among others.

Following **Principles 1-2**, the Asia-Pacific regional assessment adopts a coupled social-ecological systems (CSES) approach that aims to understand the effects of multiple drivers of ecosystem change within the Asia-Pacific region. It uses the IPBES Conceptual Framework to highlight how Nature contributes to peoples' good quality of life (Díaz, Demissew, Carabias, *et al.*, 2015; Díaz, Demissew, Joly, *et al.*, 2015). The IPBES Conceptual Framework describes how human actions (i.e. anthropogenic drivers) and natural processes (i.e. natural drivers) can push global ecosystem change, and how this change affects the flow of Nature Contribution to People (NCP), which are closely related to ecosystem services, that ultimately affect good quality of life.

Figure 1.9 visualises the relationships between people and nature and Box 1.1 explains the main terminology of the Conceptual Framework. This furnishes a common terminology within the Asia-Pacific Regional Assessment that is consistent with all other IPBES deliverables. The grey boxes and their connecting grey arrows denote the elements of nature and society that are the main focus of IPBES. In each of the boxes, the headlines in black are inclusive categories that should be relevant to all stakeholders involved in IPBES and embrace the categories of modern science (in green) and comparable or similar categories according to other knowledge systems (in blue). Solid grey arrows denote influence between elements. The dotted grey arrows denote links that are acknowledged as important, but are not the main focus of IPBES.

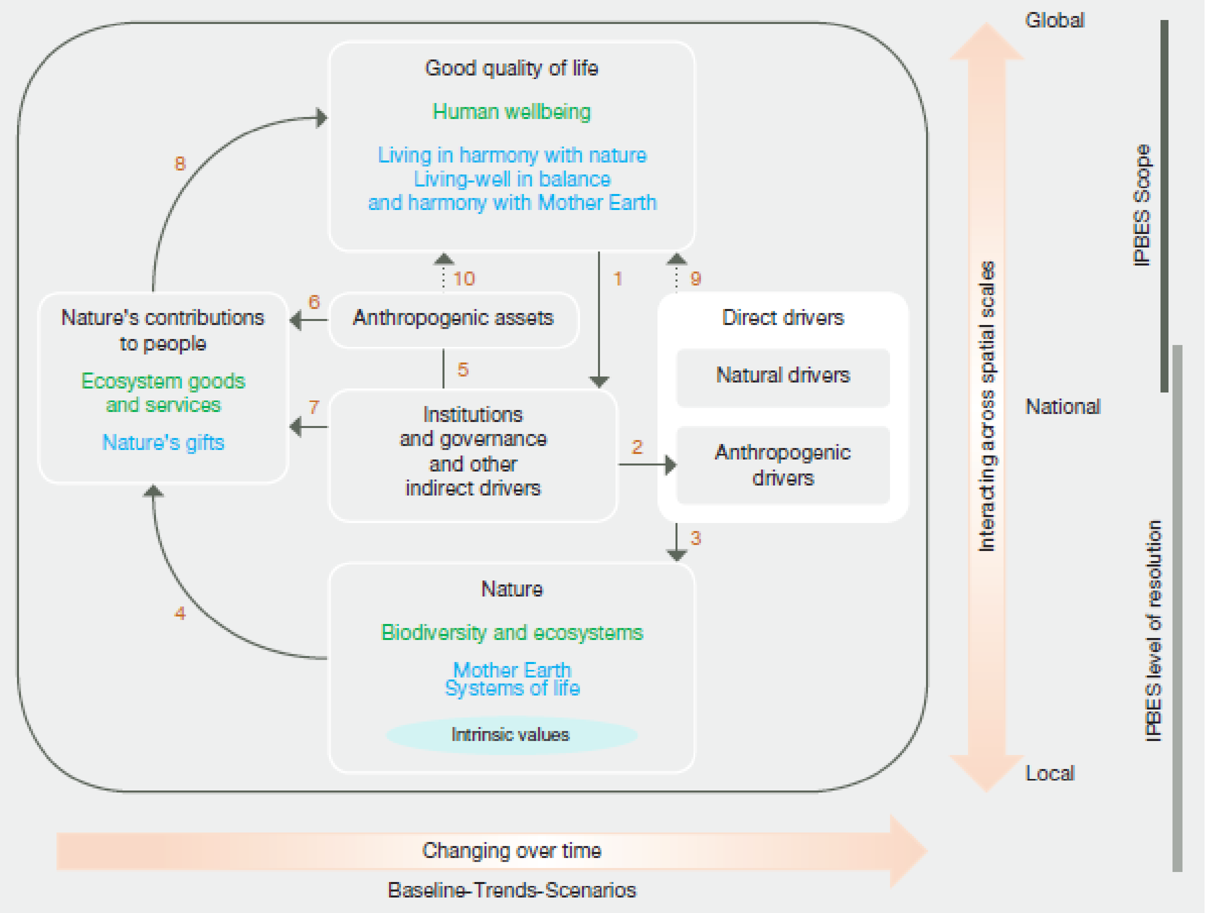


Figure 1.9 The IPBES Conceptual Framework. Source: Díaz *et al.* (2015)

Box 1.1 Major elements of the IPBES Conceptual Framework

As a summary, the main elements of the IPBES Conceptual Framework include**:**

- **Nature**: the natural world with an emphasis on the diversity of living organisms and their interactions among each other and with their environment.
- **Anthropogenic assets** refer to knowledge, technology, work, financial assets, built infrastructure, etc. that, together with nature, are essential in the co-production of nature's contributions to people.
- **Nature's contributions to people (NCP) are all the** contributions of nature, both positive and negative, to the quality of life of humans as individuals and societies.
- **Drivers of change** refer to all those external factors that affect **nature, and, consequently, affect the supply of NCP.** The conceptual framework includes drivers of change as two of its main elements: **institutions and governance systems and other indirect drivers** and **direct drivers** (both natural, such as earthquakes and volcanic eruptions; and anthropogenic, such as habitat conversion and chemical pollution).
    - **Institutions and governance systems and at least some other indirect drivers** are the root causes of the **direct anthropogenic drivers** that affect **nature**. They include systems of access to land, legislative arrangements, and international regimes such as agreements for the protection of endangered species, and economic policies.
    - **Direct drivers**, both natural and anthropogenic, affect nature directly. **Direct anthropogenic drivers** are those that flow from **human institutions and governance systems and other indirect drivers**. They include positive and negative effects, such as habitat conversion, human-caused climate change, and species introductions. Direct natural drivers can directly affect **anthropogenic assets** and **quality of life (e.g. a volcanic eruption can destroy roads and cause human deaths)**, but these impacts are not the main focus of IPBES.

Good quality of life is the achievement of a fulfilled human life. It is a highly values-based and context-dependent element comprising multiple factors such as access to food, water, health, education, security, and cultural identity, material prosperity, spiritual satisfaction, and freedom of choice. A society's achievement of **good quality of life** and the vision of what this entails directly influences **institutions and governance systems and other indirect drivers** and, through them, all other elements in the Conceptual Framework. **Good quality of life**, also indirectly shapes, via institutions, the ways in which individuals and groups relate to **nature**. Likewise, institutions and governance systems can influence a society's value system and perception of what constitutes quality of life. IPBES does not address this aspect of the conceptual framework in the assessments, but actions that Governments and societies may choose to take based on the findings of the IPBES assessments often require addressing this pathway wisely.

Interactions between the elements change over time (horizontal broad red arrow) and occur at various spatial scales (vertical broad red arrow). The vertical lines on the right indicate that the scope of IPBES assessments is at the supranational (from subregional to global) scale, but that they build on properties and relationships often assessed at finer (national and subnational) scales. The line indicating level of resolution does not extend all the way up to the global level because, for the types of relationship explored by IPBES, the spatially heterogeneous nature of biodiversity is important. Hence IPBES assessments are most useful if they retain finer resolution. Figure 1.9 is a simplified version of that adopted by the second session of the Plenary of IPBES (IPBES, 2014) and modified by the fifth session of the Plenary (IPBES, 2017a). A more complete description of all elements and linkages in the IPBES Conceptual Framework, together with examples, are given in Diaz *et al*, (2015).

IPBES introduces the term of NCP that represents an inclusive category across knowledge systems that emerged from a thorough multi-stakeholder consultative process. It includes all the contributions, both positive and negative, of nature to the quality of life of humans, whether as individuals, societies or humanity as a whole. For the purposes of IPBES, the emphasis (both in the case of nature and NCP) is on the living components of the planet (from individual organisms to ecosystems), rather than on its non-living components, such as fossil fuels, deep aquifers, underground minerals, winds, or tides. People (i.e. individuals, communities, societies, nations or humanity as a whole) obtain these benefits purely from nature or, more often, co-produce them with nature, through the application of knowledge and work.

The classification distinguishes three broad groups of NCP, (a) regulating, (b) material, and (c) non-material. These represent different facets of the complex flow from nature to a good quality of life (Fig. 1.8), ranging from indispensable direct biological connections (e.g. oxygen, water), to symbolic components that give meaning to the identity of different social groups, and their relationships with nature.

Regulating contributions denote functional and structural aspects of organisms and ecosystems that modify environmental conditions experienced by people, and/or sustain and/or regulate the generation of material and non-material benefits. These NCP include, for example, water purification, climate regulation, and soil erosion regulation. They are often not experienced directly by people, though their products are. The regulating ecosystem services as defined in the Millennium Ecosystem Assessment (MA) largely align with this category.

Material contributions denote substances, objects or other material elements from nature that sustain the physical existence of people and infrastructure (i.e. basic physical and organizational structures and facilities, such as buildings, roads, power supplies) needed for the operation of a society or enterprise. They are typically consumed, for example when plants or animals are transformed into food, energy, or materials for shelter or ornamental purposes. The provisioning ecosystem services defined in the Millennium Ecosystem Assessment (MA) largely align with this category.

Non-material contributions denote the contributions of Nature to people’s subjective or psychological quality of life, whether individually or collectively. The sources of these intangible contributions can be consumed (e.g. animals in recreational or ritual fishing/hunting) or not (e.g. individual trees or ecosystems as sources of inspiration). Many cultural ecosystem services as defined in the Millennium Ecosystem Assessment (MA) fit within this category, while some cultural ecosystem services are now considered part of “values” or a “good quality of life”.

Detailed description on the 18 specific NCP categories can be found in (IPBES, 2017a; Pascual *et al.*, 2017). It is worth mentioning that rather than being a radical departure from previous classifications of ecosystem services, the present system is strongly rooted in the MA as highlighted above. It represents an evolution of the MA classification of ecosystem services that reflects more than a decade of progress in interdisciplinary thinking, including the increasing contribution of the social sciences. Many of the differences are differences of emphasis rather than of an ontological nature, particularly with respect to the earlier texts of the MA. This evolution is represented schematically in Figure 1.10, which shows many important similarities between these classification systems. NCP in a sense is an all-encompassing term that is more inclusive than that of ecosystem services. In particular the transformation of “supporting ecosystem services” into either Nature or regulation NCP reflects an evolving view directly stemming from within the ecosystem services community.

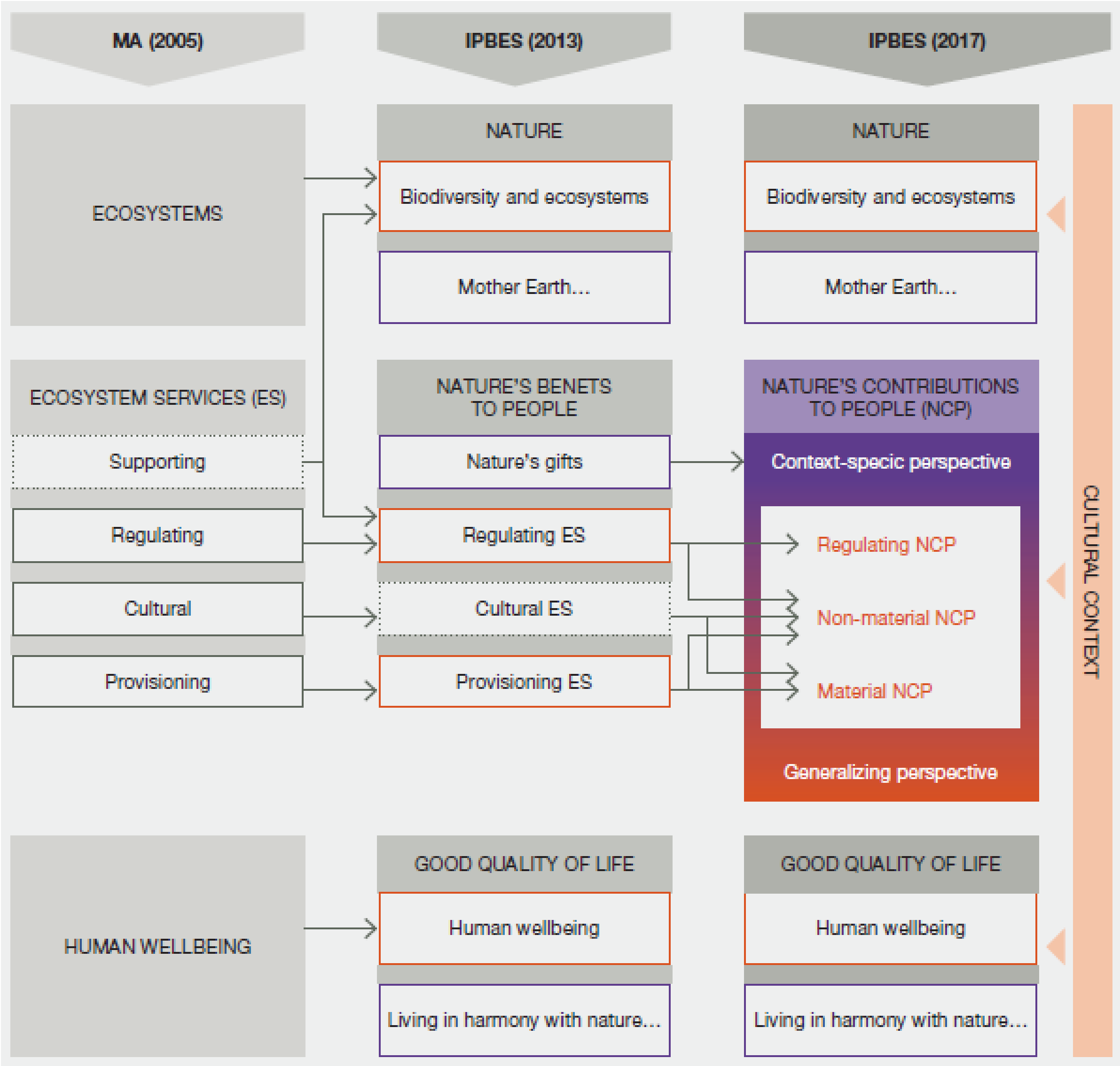


Figure 1.10 Evolution of some major categories in the IPBES conceptual framework. Source: Reprinted with permission from Díaz *et al.* (2018).

Finally, it should be noted that the IPBES Conceptual Framework views governance mechanisms and institutions as central elements that can influence the continuous provision of NCP in an equitable and sustainable manner (**Principle 6**). In this sense it assumes that the science-policy interface needs to be strengthened through holistic, resilient, and interactive solutions, instruments and mechanisms, to achieve the interlinked goals of conservation, development, and sustainable use of Nature and NCP.

1.3.3 Unit of analysis and classification system

Following ***Principle 3***, depending on the focus/objective of a given chapter or assessment component, the Asia-Pacific Regional Assessment uses a combination of spatial, biological, ecological, and bio-cultural classifications. However, the subdivision of the Earth's surface into units for the purposes of analysis is notoriously controversial. Thus there is no single agreed upon system that IPBES can adopt as a standard.

To capture the high regional variation this assessment uses, to the extent possible, a broad ecosystem-based classification that is based on the IPBES common ecosystem classification and draws extensively from several other global, regional and national ecosystem assessments (e.g. Binder *et al*., 2013; Ladle & Whittaker, 2011; TEEB, 2010; Millennium Ecosystem Assessment, 2005).

Table 1.5 outlines the broad ecosystem-based classification system of the Asia-Pacific Regional Assessment, across 4 major units and 23 sub-units. This classification is tailored to the present assessment, and reflects the unique characteristics of the region. However it also fits well within the units of analysis of the broader IPBES classification, with no misalignments between the two (se right-hand column of Table 1.5).

Table 1.5 Classification system used in the Asia-Pacific Assessment and correspondence with IPBES terrestrial and aquatic units of analysis

APR Units	APR sub-units	Corresponding IPBES Units
Terrestrial	Forests and Woodlands	Unit 1: Tropical and subtropical dry and humid forests Unit 2: Temperate and boreal forests and woodlands
	Grasslands and Savannas	Unit 5: Tropical and subtropical savannas and grasslands Unit 6: Temperate Grasslands Unit 7: Deserts and xeric shrublands (partially) Unit 3: Mediterranean forests, woodlands and scrub (partially)
	Alpine Ecosystems	Unit 4: Tundra and High Mountain habitats
	Deserts and semi-deserts	Unit 7: Deserts and xeric shrublands (partially)
	Agro-ecosystems	Unit 10: Cultivated areas
	Urban Ecosystem	Unit 9: Urban and Semi-urban areas
Inland Freshwater and wetlands	Lakes and Ponds	Unit 13:Inland surface waters and water bodies/freshwater (partially)
	Rivers and Streams	Unit 13:Inland surface waters and water bodies/freshwater (partially)
	Inland wetlands	Unit 13:Inland surface waters and water bodies/freshwater (partially) Unit 8: Wetlands – peatlands, mires, bogs (partially)
Coastal	Mangroves	Unit 14: Shelf ecosystems (partially)
	Other intertidal habitats	Unit 14: Shelf ecosystems (partially)
	Seagrass beds	Unit 14: Shelf ecosystems (partially)
	Kelp forests and other algal communities	Unit 14: Shelf ecosystems (partially)
	Coral and other reefs	Unit 14: Shelf ecosystems (partially)
	Aquaculture and other artificial substrata	Unit 12: Aquaculture areas Unit 17: Coastal areas intensively and multiply used by human (partially)
Marine	Pelagic euphotic	Unit 14: Shelf ecosystems (partially)
	Pelagic aphotic and benthic	Unit 15: Open ocean pelagic systems (partially) Unit 16: Deep-Sea (partially)
	Shipwrecks, debris and other substrates	Unit 17: Coastal areas intensively and multiply used by human (partially)
	Sea Mount and Rise	Unit 15: Open ocean pelagic systems (partially)
	Chemosynthetic Ecosystem	Unit 16: Deep-Sea (partially)
Complex ecosystems	Islands	Compilation of multiple units
	Mountains	Compilation of multiple units
Special ecosystems	Karsts and Outcrops	Not applicable in global scale Unit 3: Mediterranean forests, woodlands and scrub (partially)

1.3.4 Data collection and interpretation

The five subregions of the Asia-Pacific (i.e. Western Asia, South Asia, South-East Asia, North-East Asia, and Oceania) are the entry point for analysing the status of biodiversity, as well as providing the different options and solutions. As already mentioned, the Asia-Pacific Regional Assessment does not conduct new research, nor does it generates primary data. It rather seeks to synthesise existing information in new ways, as a means of offering policy insights at different geographical and temporal scales (Section 1.2.1).

Chapters within the Asia-Pacific Regional Assessment share common thematic aspects such as the commercial use of biodiversity in all five subregions, or highly contextual/specific issues and challenges for the subregions (e.g., floods in South Asia, droughts in Western Asia, wild fires in South-East Asia). Each chapter has a specific frame of reference to capture the human-nature interactions, which is largely defined by the boundaries suggested by the IPBES Conceptual Framework (Section 1.3.2).

Each chapter gathers appropriate data, information and evidence via systematic literature reviews. Relevant information is collected from the published scientific and grey literature, as well as appropriate ILK sources (Section 1.3.5). These cover evidence from different knowledge systems (e.g. modern scientific knowledge, ILK), lessons learnt through good conservation practices, as well as existing data/information/knowledge relevant to established global agreements and conventions (Section 1.4.1). Sources of information also come from various global, regional, national and local institutional sources such as national biodiversity and strategic action plans (NBSAPs), national policy reports and data portals, government research institutes and non-governmental organizations (see examples in Box S2, Appendix).

Secondary data is analysed through cross-tabular statistics and interpreted through various analytical approaches such as trade-off analysis, risk assessment, ecosystem services mapping, participatory discourse analysis, and multi-criteria analysis. The assessment uses various “core” and “socio-economic” indicators. Core indicators include key environmental variables developed at the global scale by various international and national organizations through consistent approaches (see Table S4, Appendix). These are supplemented with a set of "socio-economic indicators" particularly related for the NCP, Good Quality of Life and Institutional Drivers elements of the IPBES conceptual framework (see Appendix, Table S5). The use of globally consistent indicators allows a direct comparison among the four regional assessments and between the regional and global assessments. It also ensures that the quantitative evidence used has passed a careful review process regarding quality and fit. It also acknowledges the considerable efforts of indicator providers and the broader IPBES to prepare this information.

Finally, the Asia-Pacific Regional Assessment contains several case studies for all five subregions. Case studies relate to specific habitats (especially those that are unique and/or threatened), and are highlighted in selected box items as a means of providing relevant finer-scale information.

1.3.5 Integration of diverse values and knowledge systems

The valuation of Nature and NCP needs to be carried out in a ,manner that is open to and inclusive of diverse perspectives (Pascual *et al*., 2017). Such valuations can be of great value a range of decision-makers for designing inclusive governance mechanisms, institutions and policies. To inform better such efforts, following ***Principle 4***, the Asia-Pacific Regional Assessment adopts diverse conceptualizations of the multiple values of nature and its benefits to people (IPBES, 2016a; Pascual *et al*., 2017) (see Box 1.2). The present regional assessment seeks to achieve this by:

a) Identifying the range and scope of the different dimensions of values as they relate to Nature;
b) Categorising and assessing values as they relate to Nature and its contributions (and the methods involved);
c) Synthesising and integrating these diverse values within the wider regional assessment;
d) Communicating these diverse values effectively in the results of the regional assessment.

Box 1.2 Values in the context of the Asia-Pacific Regional Assessment

Societies value Nature and NCP in diverse ways. There are multiple worldviews regarding Nature and ways of understanding human-nature relationships and social interactions. These multiple worldviews often lead to the emergence of diverse values among individuals and social groups. Thus, values can be understood as the:
(1) principles or core beliefs underpinning rules and moral judgement;
(2) preferences people have for something or for a particular state of the world;
(3) importance of nature and NCP for itself or for others, now or in the future;
(4) measures used to quantify NCP and their attributes.

Values can be intrinsic, instrumental and relational (Figure 1.11). Intrinsic values often refer to the value inherent to nature, independent of human experience and evaluation. Therefore it is beyond our capacity to reflect intrinsic value accurately in this assessment. Instrumental value refers to the direct and indirect contribution of NCP to the achievement of multiple understandings of good quality of life. Relational values reflect elements of cultural identity, social cohesion, social responsibility and moral responsibility towards nature (Pascual *et al*., 2017).

Values can be in conflict, as they may respond to different worldviews or represent distinct types of value. It is the recognition of these different worldviews and values associated to NCP that can result in diverse perspectives regarding conservation, equity, resilience and the ways of achieving the Aichi Biodiversity Targets and the Sustainable Development Goals (Pascual *et al*., 2017) (see Section 1.4.1).

However, this wide spectrum of values through which different people and social groups attribute meaning and importance to Nature and NCP is rarely recognized or explicitly considered in decision-making. Identifying this diversity of values between individuals and social groups is often challenging but necessary for understanding the implications of policy responses to biodiversity loss (and the trade-offs associated with such choices) (Pascual *et al*., 2017). Recognizing, articulating, and respecting the diverse values at stake is necessary when making decisions about nature and NCP, not the least for harmonizing the different value systems through which individuals and social groups regulate their behavior and the ways they interact with nature (Pascual *et al*., 2017). For a more detailed and comprehensive discussion on values, value systems, and NCP in the context of the Asia-Pacific, please refer to Chapter 2.

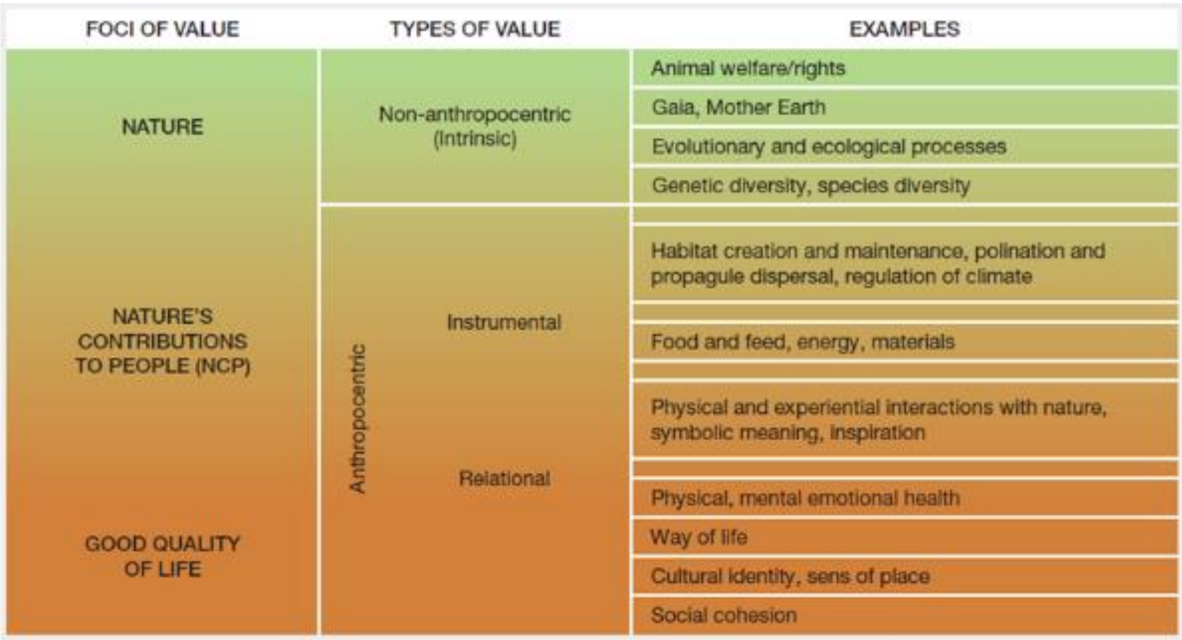


Figure 1.11 Types of value across nature's contributions to people. Source: Pascual *et al.* (2017)
Note: The grading in the colors indicate that both instrumental and relational values can be ascribed to the value of NCP, and to highlight that NCP are intertwined with nature and a good quality of life.

According to ***Principle 5***, this regional assessment draws and synthesises information from different knowledge systems such as ILK and modern scientific knowledge. In this respect it further recognises the constructive role that different worldviews and practices can play to promote evidence-based biodiversity conservation.

For the purpose of this assessment we understand ILK systems, as dynamic bodies of integrated and holistic social-ecological knowledge. This includes among others practices and beliefs about the relationship of living beings (including humans) with their environment (Section 1.1.3.2). ILK systems are highly diverse and context-specific, produced collectively and reproduced at the interface of ecological and socio-cultural systems. ILK systems include different types of knowledge (e.g. written, oral, tacit, practical, scientific) and continuously evolve through the interaction and experience among indigenous people and local communities, with their environments. The Asia-Pacific Regional Assessment views the loss of heritage and ILK systems as one of the major constraints to the conservation and sustainable use of Nature and NCP in the region.

IPBES has been developing guidance for the effective integration of ILK into its assessments that respects not only the diversity and value of ILK systems, but also the rights of indigenous and local communities to share and access the benefits of knowledge gained through these assessments (Section 1.4.1). IPBES has appointed experts in ILK issues to contribute to the this process by building on a substantial body of previous international work, including the Millennium Ecosystem Assessment (Reid *et al.*, 2006), the CBD (and especially adoption of the Nagoya Protocol) (Segger & Phillips, 2015; Zhao *et al.*, 2013) and the IPCC (Nakashima *et al.*, 2012). The critical review of the relevant outcomes of these initiatives has identified the need for greater facilitation of Indigenous and local peoples' institutions and collaboration in shaping the engagement of their knowledge systems in order for their contributions to influence the science-dominated agendas (Järvholm & Bohlin, 2014).

Within the regional assessment (and more broadly within IPBES processes), these diverse sources of knowledge are not considered as mutually exclusive, but as complementary whose synergy is very important for the quality of the end result (Díaz, Demissew, Carabias, *et al.*, 2015; Thaman *et al.*, 2013). However, their compatibility is not always self-evident, so their integration requires careful consideration (Kohsaka *et al.*, 2015). The use of appropriate approaches, procedures and participatory mechanisms proposed by the IPBES Task Force on ILK have been useful in accessing both the *in-situ* and *ex-situ* ILK as a basis for building synergies between ILK and modern science within this assessment (IPBES, 2015; Thaman *et al.*, 2013).

Specifically, the Asia-Pacific Regional Assessment uses key outcomes of the ILK dialogue workshops that were organized by the ILK Task Force (see below). These outcomes were extracted in the form of stories, anecdotes and practices that were made available during this series of ILK workshops organized by IPBES, UNESCO and IGES in three different subregions of the Asia-Pacific region (Alangui *et al.*, 2017a; IGES, 2017; Karki *et al.*, 2017). The outcome documents of these workshops contain information from case studies and success stories written jointly by ILK holders and experts, and validated through a peer-reviewed process used in scientific paper publications (Alangui *et al.*, 2017a; IGES, 2017; Karki *et al.*, 2017). Apart from the outcomes of these workshops, the authors of the regional assessment have used online repositories of ILK practices such as the Traditional Knowledge Digital Library, an repository of ILK practices for Indian medicinal plants and related practices.

We believe that the integration of insights from diverse fields of knowledge and practice can catalyse the sustainable management of biodiversity and ecosystem services in the region (Aggarwal & Elbow, 2006; Kariuki, 2008; Swiderska, Roe, Siegele, & Grieg-Gran, 2008), and is described through specific policy options in Chapter 6. Integrating multiple sources of knowledge could incentivise 'experts' (i.e. scientists) and 'users' (i.e. local communities as land managers and decision-makers) to co-produce new knowledge through collaborative learning (Leimona, Lusiana, *et al.*, 2015; Roux *et al.*, 2006). This can be achieved through multidisciplinary, multi-scale, and multi-stakeholder collaboration that can enhance the salient, legitimate and credible evidence-based inputs from the different contributing knowledge systems (Bhatta *et al*., 2015; Karki & Adhikari, 2015; Leimona *et al.*, 2015; Paudyal *et al.*, 2015; Takeuchi, 2010; Zarandian *et al.*, 2016; Parikh, 2013)

1.3.6 Communication of uncertainty

In scientific assessments, and in relation to knowledge, confidence refers to the degree of certainty that experts have about their findings. Low confidence describes a situation of incomplete knowledge, when an outcome cannot be fully explained or reliably predicted. On the other hand high confidence conveys extensive knowledge and an ability to explain an outcome (or predict a future outcome) with much greater certainty. Low confidence signals the need for further research.

Communicating levels of confidence is particularly important for the Asia-Pacific Regional Assessment. To allow assessment users make informed decisions, the chapters within this report not only communicate the high-confidence findings, but also those that require further investigation. Each key finding in the assessment, including the summary for policymakers, is accompanied by a confidence language statement (IPBES, 2016).

As other IPBES assessments, we use four specific phrases known as "confidence terms" in order to categorise consistently the experts' level of confidence in the reported findings. The categories depend on expert judgement on the quantity and quality of the supporting evidence, and the level of scientific agreement regarding what that evidence shows.

The four IPBES confidence terms are visualised in a four-box model of confidence (Figure 1.12) and are expressed as:

- "well established" (robust evidence and high level of agreement),
- "unresolved" (robust evidence but low level of agreement),
- "established but incomplete" (low quantity and quality evidence but low level of agreement);
- "inconclusive" (low quantity and quality of evidence and low level of agreement).

Figure 1.12 The four-box model for the qualitative communication of confidence in the Asia-Pacific Regional Assessment.
Note: Confidence increases towards the top-right corner as suggested by the increasing strength of shading. Source: IPBES (2016b).

1.3.7 Limitations and knowledge gaps of the Asia-Pacific Regional Assessment

Despite its well-thought structure and policy relevance (Section 1.5), the Asia-Pacific Regional Assessment, as any other assessment of its kind, relies on secondary sources of information, with all their limitations. The completeness and timeliness of this information posed some substantial limitations for achieving perfectly the seven principles that guided this assessment (Section 1.3.1).

First of all, due to the variable quality and completeness of used datasets (as well as the political/security sensitivity that sometimes accompanied them), it has not been always possible to access reliable data from (and thus provide complete estimates for) all subregions. Some areas are particularly under-researched and data-deficient such as Western Asia, Hindu-Kush Himalayas and small Pacific Islands. Furthermore while we aimed to synthesize recent information (post-2010), this was not always feasible, as some key datasets are not compiled at regular intervals (e.g. Table 1.3, Figure 1.7).

While there were active efforts to integrate and synthesize ILK with modern scientific (Section 1.3.5) this was not always feasible. For example, several ILK practices and practical information generated through the implementation of local, participatory and community-led conservation/management approaches are not well-documented (Young *et al.*, 2014). In addition, many of these practices have been confined to their local contexts and have not been scaled up. As a result, the Asia-Pacific Regional Assessment might not do full justice to some of the successful community-based natural resources management models and practices encountered throughout the region.

As already discussed in Section 1.3.1 the Asia-Pacific Assessment Report has adopted a social-ecological systems approach and a multi-stakeholder perspectice in order to reflect the intricate linkages between biological and cultural diversity (Section 1.1.1-1.1.3). However due to time, funding and space constraints this was not entirely feasible. For example, while the assessment involved academics from several disciplines and countries across the region, practitioners from the private sector and civil society were under-represented.

Due to the lack of appropriate case studies, the assessment has also faced some limitations in stratifying and customizing policy options, policy mixes and institutional and governance frameworks for all subregional. Furthermore, while several nations have formed stronger trans-boundary partnerships (see Figure S1, Appendix) and bilateral and multilateral initiatives (Section 1.4.2), there is limited peer-reviewed literature about their status and effectiveness as most of these regional initiatives are relatively recent.

Finally, while there was a strong effort to include and synthesize knowledge from different sources (Section 1.3.4), most of the cited literature comes from peer-reviewed articles and reports written in English, which is the working language of the IPBES to target international audiences (Section 1.2). As not all chapters had representatives conversant in all major regional languages, we do acknowledge that this might have led to the under-representation of regional knowledge.

1.4 Institutional, policy and governance contexts and frameworks

According to ***Principle 6*** (Section 1.3.1) and the IPBES Conceptual Framework (Section 1.3.2), environmental governance and institutional frameworks are important indirect drivers of ecosystem change and biodiversity loss. They operate at different scales and can both drive biodiversity loss and catalyse its conservation and sustainable use (Collins, 2013). It is therefore important to describe, understand and analyse the existing policy environment, institutional arrangements and governance frameworks that affect the status, trends and future patterns of biodiversity in the Asia-Pacific region.

1.4.1 Global environmental policy instruments

Global policy discourse about the impacts of humans on the environment began in the late 1940s with the establishment of the International Union for Conservation of Nature (IUCN) in 1948, and continued with sporadic policy actions at the national level in the 1960s (Adger, Benjaminsen, Brown, & Svarstad, 2001; Kamieniecki, Gonzalez, & Vos, 1997). The Man and the Biosphere Programme of the UNESCO that started in 1971 (UNESCO-MAB) and the Ramsar Convention (signed in 1971, entered into force in 1975) were perhaps the first two major efforts to bring environmental issues at the forefront of international policy and development (UNESCO, 2017; Batisse, 1997) (Table 1.6).

Two very important milestones that enhanced the visibility of environmental issues in international policy discourses were achieved in 1972 (Kanie, 2014; Kamieniecki *et al*., 1997). The first was the publication of the Report of the Club of Rome titled "The Limits to Growth", which predicted that following the prevailing consumption rates at that point the world would be heading for irreversible environmental damage (Meadows *et al.*, 1972). The second was the United Nations Conference on the Human Environment (known as the Stockholm Conference) that took the first serious global steps towards addressing environmental challenges (Andronico, 1995). The conference created the United Nations Environment Programme (UNEP)[14] that has been instrumental in providing common principles and frameworks on nature conservation and environmental management to its member countries (Sohn, 1973). At roughly the same time, the UNESCO General Conference adopted the 1972 World Heritage Convention whose aim was to promote global cooperation for the protection of bio-cultural heritage with high cultural value (Lixinski, 2008). Within its first 10 years, the UNEP facilitated the development and adoption of major international multilateral environment agreements (MEAs) related to biodiversity conservation such as the 1973 Convention on International Trade in Endangered Species (CITES), and the 1979 Convention on Migratory Species (CMS).

In 1986 the Brundtland Commission Report solidified the interest of the international community in global environmental governance, popularising the concept of sustainable development (UNCSD, 2007; Holden *et al*, 2014). This catalysed the establishment of the World Commission on Environment and Development (WCED) and the organization of the first ever United Nations Conference on Environment and Development (UNCED) in 1992. Popularly known as the "Rio Earth Summit", this conference led to the adoption of a global sustainable development action plan, purposely called "Agenda 21" to symbolize its futuristic vision, by the more than 190 nations that signed it. The Rio Summit signalled the dawn of a 'human-centric' approach[15] to environmental conservation and sustainable development, which highlighted the highly interdependent relationship between humans and nature (Holden *et al.*, 2014).

The major achievement of the Rio Summit has been the adoption of three globally important multilateral environment agreements (MEAs)[16]-[17], collectively known as the Rio conventions:

a) The Convention on Biological Diversity (CBD) that addresses the loss and use of biodiversity;
b) The United Nations Framework Convention on Climate Change (UNFCCC) that addresses the threat of greenhouse gas (GHG) emissions;

[14] UNEP has universal membership. In 2012 it was upgraded by the UN General Assembly and renamed as UN Environment.

[15] The Rio Principle 1 emanates from the Agenda 21 document and unabashedly posits "human beings at the centre of concerns for sustainable development"

[16] MEAs are key environmental conventions and international agreements that uphold the principles of sustainable development based on international laws. They fall into: (a) legally binding agreements (e.g. treaties, conventions, agreements, protocols, accords, pacts and charters); and (b) non-legally binding agreements (e.g. resolutions, decisions, declarations, and recommendations) (UNEP, 2016a).

[17] Other key achievements of the Rio Summit have been the recognition of: (a) the gravity of escalating environmental problems including biodiversity loss; (b) the need to have global and transboundary co-operation and collaborative solutions for environmental problems such as biodiversity loss; and (c) the fact that human well-being is closely tied with the health of Nature.

c) The United Nations Convention to Combat Desertification (UNCCD) that addresses the accelerated pace of land degradation and desertification.

Collectively these global MEAs address serious global environmental issues. Between them, they have set key targets to achieve a sustainable development, and have developed various instruments and mechanisms to strengthen environmental conservation and management. They provide an institutional framework to guide environmental protection, biodiversity conservation, improve food security and promote the transition to a low carbon "green economy" (Jacobs, 2013).

Table 1.6 Overview of key global initiatives and events related to the conservation of biodiversity and ecosystems

Year	Initiative/event	Focus
1948	International Union for Conservation of Nature (IUCN)	Influence, encourage and assist societies to conserve nature and ensure the equitable and ecologically sustainable use of natural resources.
1971	Ramsar Convention on Wetlands	Address the increasing loss and degradation of wetland habitats for migratory water birds
1972	World Heritage Convention	Address the protection of cultural and natural heritage at the national level
1973	Convention on International Trade in Endangered Species (CITES)	Ensure that the international trade of wild animals and plants does not threaten their survival.
1979	Convention on Conservation of Migratory Species (CMS)	Boost and coordinate conservation efforts for terrestrial, marine and avian migratory species throughout their migratory range
1982	The Brundtland Commission	Published "Our Common Future", which defined sustainable development and offered a blueprint for future work on sustainability
1992	Agenda 21 and the adoption of CBD, UNFCCC and the UNCCD	Regarding CBD: promote the conservation and sustainable use of biodiversity. Safeguard access to and benefit sharing from the use of biodiversity.
2000	CBD-COP5, Nairobi	Opened for signature the Cartagena protocol on biosafety, which entered into force in 2003
2002	CBD-COP6, The Hague	Adopted first CBD strategic plan (VI/26) targeting to significantly reduce the rate of biodiversity loss by 2010
2002-2005	Millennium Ecosystem Assessment	Provided the first global assessment of biodiversity and ecosystem services. Popularised the ecosystem services approach and helped mainstream it into international environmental policies and discourses
2004	International Treaty on Plant Genetic Resources for Food and Agriculture	Adopted the Global Plan of Action and legally binding International Treaty on Plant Genetic Resources for Food and Agriculture
	CBD-COP7, Kuala Lumpur	Promote the Addis Ababa principles and guidelines on the sustainable use of biodiversity (VII/12)
2010	CBD-COP10, Nagoya	Drew a new CBD strategic plan 2010-2020, including the Aichi Biodiversity Targets. Adopted the Nagoya Protocol on Access and Benefit-sharing
2012	IPBES inception meeting, Panama	Approved the main functions of IPBES to conduct global, regional and thematic assessments, as well as provide support on policy tools and methodologies
2013	IPBES-2, Antalya	Decided the first IPBES work programme (2014-2018)

The Convention on Biological Diversity (CBD) is the dedicated MEA that aims to promote the conservation of the world's ecosystems and biodiversity. It obliges each nation to conserve and sustainably manage their biological resources (United Nations, 1992), and rests across three overarching goals:

- conservation of biological diversity;
- sustainable use of its components;

- fair and equitable sharing of the benefits arising out of the utilization of genetic resources.

The CBD holds a biannual Conference of Parties (COP) with 13 CBD-COP meetings held up to the writing if this regional assessment. CBD-COP10 (2010, Nagoya) was instrumental in ratifying the Aichi Biodiversity Targets that provide an overarching framework to "*to halt the loss of biodiversity in order to ensure that by 2020 ecosystems are resilient and continue to provide essential services* " (Box 1.3). The most recent CBD-COP was held in Mexico (2016), and called for mainstreaming of biodiversity conservation in achieving the Sustainable Development Goals (SDGs) (see below).

Box 1.3 Aichi Biodiversity Targets in the context of the Asia-Pacific region

The Aichi Biodiversity Targets entail five strategic goals:

- **Strategic Goal A**: "Address the underlying causes of biodiversity loss by mainstreaming biodiversity across government and society";
- **Strategic Goal B**: "Reduce the direct pressures on biodiversity and promote sustainable use";
- **Strategic Goal C**: "To improve the status of biodiversity by safeguarding ecosystems, species and genetic diversity";
- **Strategic Goal D**: "Enhance the benefits to all from biodiversity and ecosystem services";
- **Strategic Goal E**: "Enhance implementation through participatory planning, knowledge management and capacity building".

Between them, these five goals have 20 specific targets (See Box S3, Appendix). National Biodiversity Strategies and Action Plans (NBSAPs) are the major instruments for implementing the Aichi Biodiversity Targets (Prip, 2017). Almost all countries in the Asia-Pacific region have developed NBSAPs that have set national targets and indicators to achieve the related Strategic Goals and specific Aichi Biodiversity Targets. However, the national indicators can vary between countries both in definition and quality. Furthermore not all countries show the same commitment to reflect the Aichi Biodiversity Targets in their NBSAPS, with countries from North-East Asia generally showing the most commitment and countries from Oceania the least (Figure 1.13).

For example, Aichi BiodiversityTarget 2 compels that by 2020 at the latest "biodiversity values have been integrated into national and local development and poverty reduction strategies and planning processes and are being incorporated into national accounting, as appropriate, and reporting systems." To meet this target, Myanmar, Samoa, and Bhutan, for example, have planned to integrate the value of biodiversity into their respective development planning via natural capital accounting. This rests on relatively well-designed indicators to accomplish the Strategic Goal A and Target 2. Timor Leste aims to increase public awareness on biodiversity and participation in conservation activities by all sectors, which is indirectly connected to the socio-economic integration objectives of Aichi Biodiversity Target 2.

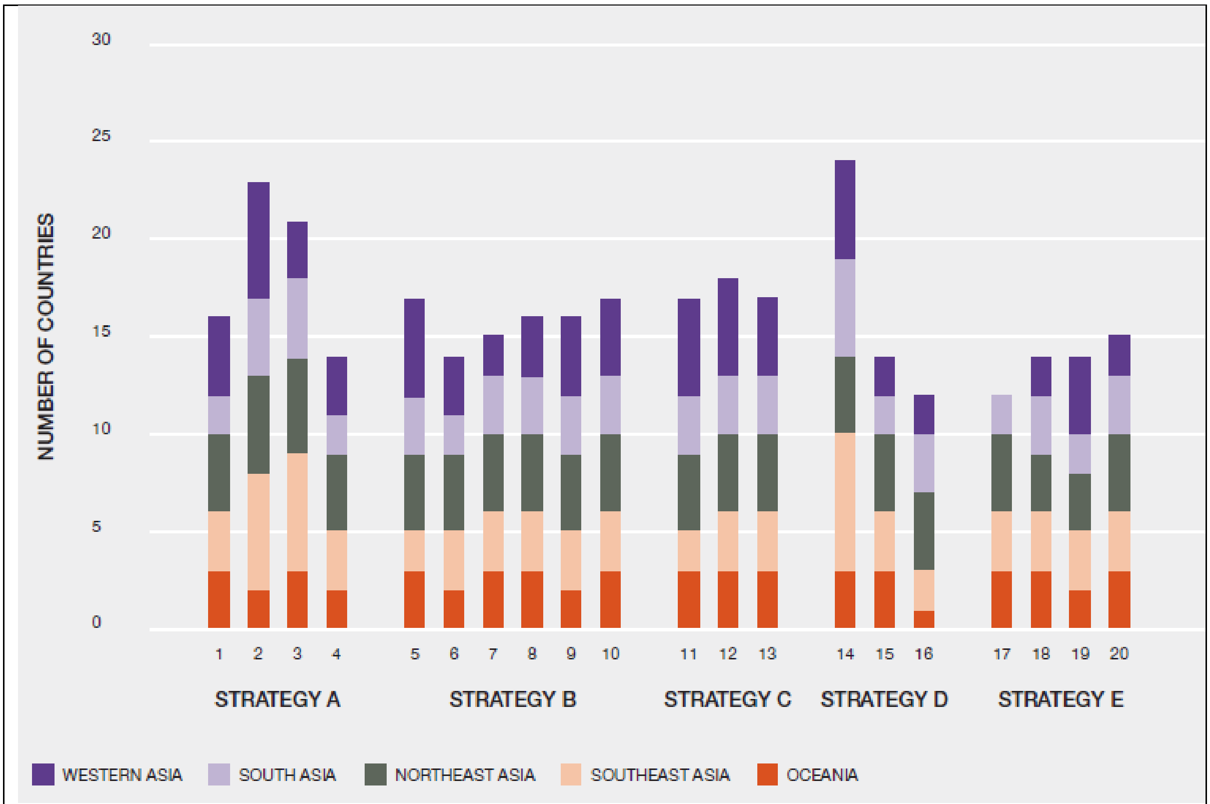


Figure 1.13 Number of countries in each region that reflect the Aichi Biodiversity Targets in their National Biodiversity Strategies and Action Plans (in October 2016)
Data source: Secretariat of the Convention on Biological Diversity (https://www.cbd.int/nbsap/)

In 2012, the United Nations Conference on Sustainable Development (UNCSD), also known as Rio+20, set another milestone for global environmental governance. The conference and its outcome document (i.e. "The Future we want") focused on two themes: (a) green economy in the context of sustainable development and poverty eradication; and (b) institutional frameworks for sustainable development. In a nutshell Rio+20 aimed to catalyse the transition to a low-carbon green economy through more inclusive and better-governed institutional frameworks. Rio+20 was also instrumental in proposing the Sustainable Development Goals (SDGs) as the successor to the Millennium Development Goals (MDGs). The SDGs were adopted by the United Nations in 2015, as a set of 17 goals to tackle by 2030 pressing sustainability challenges such as poverty, hunger, inequality, biodiversity loss and climate change, among several others (Box 1.4).

Box 1.4: Overview of the Sustainable Development Goals (SDGs)

The SDGs are an integral part of a global agenda to pursue a sustainable future and to end poverty by 2030. The 193 Member States of the United Nations unanimously adopted the SDGs during the 2015 Sustainable Development Summit. The SDGs consist of 17 Goals and 169 targets, several of which are directly and indirectly relevant to biodiversity, ecosystem services, and Nature's Contribution to People (NCP).

Goals 1-6 focus on the basic needs of social infrastructure, Goals 7-12 on socio-economic development, Goals 13-15 on the environment, and Goals16-17 on governance. In particular Goal 14 (Life below water) and Goal 15 (Life on land) have a very strong focus on biodiversity, with several other goals and targets having very strong linkages to biodiversity and ecosystem services.

SDGs exhibit strong interlinkages between them (ICSU, 2017). For example, reducing overfishing can contribute to the attainment of multiple others SDGs (Singh *et al.*, 2017). When it comes to ecosystem services, regulating and cultural services are relatively more frequently mentioned within the SDGs discourse compared to the Aichi Biodiversity Targets, while provisioning services come up with the same frequency (Geijzendorffer *et al.*, 2017).

In order to monitor the status of individual countries in attaining the SDGs, 227 Global SDG Indicators have been proposed and categorized into three groups. As of 20 April 2017 there are:

- 82 Tier I indicators, with internationally established methodology and high data availability;
- 61 Tier II indicators, with internationally established methodology and low data availability;
- 84 Tier III indicators, with no internationally established methodology.

The Paris Agreement was adopted during the UNFCCC-COP21 (2015, Paris) and came into force on October 5, 2016[18]. The Paris Agreements is the first universal agreement to curb anthropogenic climate change and prevent global temperature by the end of 21st century. The efforts focus on preventing temperature increase beyond 2 °C compared to pre-industrial levels (while making efforts to keep this increase below 1.5 °C) (UNFCCC, 2016). In a spirit of "common but differentiated responsibilities based on capabilities", the agreement gives equal weight to adaptation and mitigation. Through individual national commitments expressed in the form of "nationally determined contributions", the Paris Agreement aims to achieve climate mitigation and adaptation by providing finance, capacity development and technical support to developing countries. Developing countries can pursue adaptation through National Adaptation Plans and mitigation through diverse measures including ecosystem-based approaches such as REDD-plus that are much related to biodiversity and ecosystem conservation (Turnhout *et al.*, 2017).

The above developments suggest the significant interlinkages that are building up between the CBD and other MEAs in the context of the post-2015 development agenda. In fact, the successful implementation of the Paris Agreement and the SDGs in the Asia-Pacific region can potentially restore highly degraded ecosystems and reverse biodiversity loss. This illustrates the need to create greater complementarities and synergies between conventions that can minimize trade-offs in national efforts to pursue the Aichi Biodiversity Targets, Paris Agreement and the SDGs.

Concurrent to the proliferation and growing importance of environmental MEAs, there has been a steady demand to build a solid evidence base to inform these processes (Biermann *et al.*, 2014). For example, the CBD and UNCCD have identified the necessity of global scientific assessments that systematize and synthesize the knowledge about the status of biodiversity, and its contribution to human well-being. The Millennium Ecosystem Assessment (MA) was such a scientific assessment, which was the outcome of coordinated action from the global academic community (Millennium Ecosystem Assessment, 2005). Published in 2005, the MA concluded that human actions have been seriously degrading ecosystems globally, as well as their ability to sustain future generations (Millennium Ecosystem Assessment, 2005). Together with the periodic Assessment Reports of the Intergovernmental Panel on Climate Change (IPCC) that feed into the UNFCCC process, they have paved the way for appreciating the urgent need for substantial changes in environmental policies and implementation processes to reverse biodiversity loss, ecosystem degradation and anthropogenic climate change in the next 50 years (UNEP-WCMC, 2016).

The regional assessments commissioned by the IPBES, including the current Asia-Pacific Regional Assessment, aim to synthesise the existing evidence to inform activities related to the multiple goals of the above-described MEAs. Within the CBD work-plan, these assessments are subsumed under the Strategic Plan for Biodiversity 2011–2020, and its 2050 Vision and Aichi Biodiversity Targets. They

[18] The UNFCCC-COP22 (2016, Marrakesh) adopted the 2016 Marrakech Action Proclamation that signalled the commencement of the implementation of Paris Agreement showing the global community's "*highest political commitment to combat climate change, as a matter of urgent priority*" (UNFCCC, 2015; Castellas, 2016).

are also relevant for the successful implementation of NBSAPs that have the same timeframe with the Aichi Biodiversity Targets. The main focus is on the period between 2011 and 2030 that includes key deadlines related to the CBD Strategic Plan for Biodiversity (2011–2020) and the SDGs (2016-2030).

It is worth mentioning that as discussed above the Asia-Pacific Regional Assessment, acknowledges the importance of indigenous and local communities (and of their rich knowledge and practices) in achieving the Aichi Biodiversity Targets and the SDGs (Section 1.1.3, 1.3.5). Indigenous people are increasingly demanding the use of a universal standard known as the Free and Prior Informed Consent (FPIC), to access benefits from ILK and associated intellectual property under the United Nations Declaration on the Rights of Indigenous Peoples and the Nagoya Protocol on Access and Benefit-sharing of the CBD (AIPA, 2015; Zhao, Wu, & Xue, 2013). Different antecedents in the context of the CBD include Article 8j for involving indigenous people and local communities (and their knowledge/practices) in activities related to the conservation and sustainable use of biodiversity and “encourage the equitable sharing of the benefits arising from the utilization of such knowledge innovations and practices”.

1.4.2 Regional policy initiatives in the Asia-Pacific region

Countries in the Asia-Pacific region have accelerated and strengthened their environmental cooperation since the 1992 Rio Earth Summit (Schreurs, 2000). There are various regional, subregional and trans-boundary initiatives, alliances, and agreements that aim to achieve the multiple goals and targets related to biodiversity conservation in the region (Box 1.5) (see also Table S6 and Figure S1, Appendix).

Box 1.5 Major regional biodiversity initiatives in the Asia-Pacific region

The Heart of Borneo Initiative (HoB)
The Heart of Borneo (HoB) Initiative is a government-led and NGO-supported programme that was initiated by the governments of Brunei, Indonesia and Malaysia in 2007 and covers parts of the three countries. It aims to conserve and use sustainably the largest remaining rainforest in Asia, which contains highly biodiverse ecosystems with large carbon stocks. The vision of the HoB initiative has been agreed upon by the three countries, and includes a strong commitment to work together to improve the management of natural resources. The initiative has developed multi-level (i.e. regional, national and sub-national) plans and programs. It implements multi-sector, multi-stakeholder and coordinated activities to enhance the sustainable use of timber, non-timber forest products, water, minerals and other natural resources (Lim, 2016; WWF, 2017). For details visit: http://www.heartofborneo.org/

The Coral Triangle Initiative on Coral Reefs, Fisheries and Food Security (CTI-CFF)
CTI-CFF is a regional initiative that covers extensive seascapes in Indonesia, Malaysia, the Philippines, Papua New Guinea, Solomon Islands and Timor-Leste (collectively called the ‘CT6’). This regional multilateral partnership was launched in 2009 by the respective governments. It aims to protect one of the richest areas in the world in terms of marine biodiversity, also known as the “Amazon of the Seas” (Section 1.1.2). Key concerns of the CTI-CFF are the threats on marine biodiversity posed by overfishing, pollution, climate change, and other commercial activities. It has launched numerous initiatives to promote sustainable fishing, food security, and collaborative conservation networks. In 2016 CTI-CFF launched a 10-year plan (i.e. “CTI-CFF Regional Plan of Action”), whose key foci include the protection of critical seascapes, marine protected areas, and fisheries by applying ecosystem-based approaches (Christie *et al*., 2016; Hossain, *et al*. 2016). For details visit: www.coraltriangleinitiative.org

The Biodiversity Conservation Corridors Initiative (BCI) in the Greater Mekong Subregion (GMS)
BCI brings together the six Greater Mekong basin nations (i.e. Cambodia, China, Lao PDR, Myanmar, Vietnam and Thailand) to work jointly for the conservation and sustainable management

of the basins' resources (Balmford *et al.*, 2016) (Table 1.1). This is expected to be achieved through regional co-operation and collaboration to establish a Biodiversity Conservation Corridors Initiative (BCCI). This is the major program of the Core Environment Program of the GMS endorsed by political leaders at the Second GMS Summit (2005, Kunming). The intended outcome of implementing the BCCI is to promote by 2015 effective community-based natural resources management and climate resilience across the region (ADB, 2017). For details visit: http://www.gms-eoc.org/biodiversity-conservation-corridors-initiative

The Kailash Sacred Landscape Initiative (KSLCDI)
KSLCDI is a transboundary, multilateral programme established in 2010 between China, India and Nepal. The program aims to achieve the sustainable conservation of critical ecosystems, wildlife habitats and key biodiversity areas in the central Himalayan region. At the same time it aims to promote sustainable development, increase the resilience of communities against climate change, and protect cultural bonds among the three countries (Shakya *et al.*, 2012; Zomer *et al.*, 2014). KSLCDI has evolved through a series of stakeholder participation and engagement processes to form a transboundary conservation initiative. It involves concerned local, national and regional institutions, working in different capacities in the connected landscape areas of the three countries. The International Centre of Integrated Mountain Development (ICIMOD) facilitates KSLCDI, with the support of designated national bodies that are: the Chinese Academy of Sciences, China; the Ministry of Environment, Forests and Climate Change, India; and the Ministry of Forestry and Soil Conservation, Nepal. For details visit: http://www.icimod.org/?q=9456

Asia Protected Areas Partnership (APAP)
APAP brings together national institutions from 12 Asian countries (i.e. Bangladesh, Bhutan, Cambodia, India, Japan, Mongolia, Myanmar, Nepal, Pakistan, South Korea, Sri Lanka, and Vietnam). It was formally launched at the IUCN World Parks Congress in 2014. The Partnership aims to promote collaboration, co-operation, and sharing of best practices and innovative solutions for Asia's protected areas. APAP, is co-chaired by Japan and IUCN Asia Regional Office, and offers Country Membership and Associate Membership to other relevant institutions such as NGOs. It supports capacity building, training and knowledge exchange among its members. For detail visit: http://www.asiaprotectedareaspartnership.org

Pacific Oceanscape
Pacific Oceanscape was endorsed in 2010 by 23 Pacific Island nations and territories. It is a framework that aims to promote the conservation and sustainable management of a vast marine protected area shared between the participating nations and territories. The Framework aims "to catalyse action in support of the Pacific Islands Regional Oceans Policy (PIROP), to protect, manage and sustain the cultural and natural integrity of the ocean for present and future generations and for the broader global community". The overall goal is to foster regional co-operation for increasing the health and well-being of ocean and island populations (Pratt & Govan, 2010). For details visit: http://www.conservation.org/where/Pages/pacific-oceanscape.aspx

The initiatives highlighted in Box 1.5 are only a sample of on-going regional collaborative arrangements that promote cross-border co-operation for biodiversity conservation in the Asia-Pacific region. Chapter 6 outlines several other examples of regional and multinational partnerships. Their inception and work programmes have been largely influenced by the collective realization that the environmental impacts of socio-economic development and climate change in the region have far exceeded the capability of any individual country to handle.

This is particularly true for addressing transboundary issues related to illegal wildlife trade, pollution (e.g. Asian Haze, ocean littering, short-lived climate pollutants), use of freshwater/marine areas and disputes over commodity trade restrictions (International Maritime Organization, 2012; United Nations, 2017; Werschkun *et al.*, 2014). For example, 10 ASEAN countries have signed the ASEAN Agreement on Transboundary Haze Pollution; a legally binding environmental agreement to tackle forest fires and their associated air pollution that affects several countries in the region (ASEAN

Secretariat, 2015). Although the agreement lacks strong enforcement mechanisms and finance, the signatory ASEAN countries are engaged in discussions to come up with a long-term solution to this pressing environmental issue (Nair, 2015). Similarly, several Himalayan countries have been making efforts to develop mutually acceptable hydro-meteorological data-sharing protocols and transboundary biodiversity conservation mechanisms (Vasilijević *et al*, 2015) .

Countries in North-East Asia have devised some good models of regional co-operation on trans-boundary pollution through the North-East Asian Subregional Programme for Environmental Cooperation (NEASPEC) (Jung, 2016). ASEAN countries have also developed a comprehensive and strategic regional environmental plan on biodiversity conservation, illegal wildlife trade, and more recently on sustainable forest management (ASEAN Secretariat, 2015). Of particular relevance is also the collective commitment of small-island developing states in the Asia-Pacific region to implement the CBD work programme on conserving the uniqueness and fragility of island biodiversity (CBD-COP8 Decision VIII/1), with a good example being Pacific Oceanscape (Pratt & Govan, 2010) (see Box 1.5).

1.4.3 Globalization, liberalization and urbanization in the Asia-Pacific region

Globalization[19], economic liberalization, migration and urbanization have become some of the major indirect drivers of ecosystem change and biodiversity loss in the Asia-Pacific region (see Section 1.1.3, 1.3.2 and Chapter 4). Individually these phenomena shape policies, economic imperatives and consumption patterns in the region, which are also indirect drivers in their own right (Section 1.4.1-1.4.2, Chapter 4).

However, it is their interaction that can have even more pronounced ramifications for ecosystem change and biodiversity loss in the region. Despite the various regional initiatives discussed in Section 1.4.2, national policies such as NBSAPs and related transboundary co-operation policies are still the main biodiversity conservation instruments in the region. The interaction of these transformative forces in the Asia-Pacific region create a challenging environment for each country to tackle individually biodiversity loss.

1.4.3.1 The nexus of globalization, liberalization, urbanization and migration

Globalization and liberalisation processes have led to important productivity gains (especially in the agricultural sector), the emergence of the service sector, the expansion of tourism[20] and a general increase of the contribution of Asia-Pacific countries in international trade (FAO, 2009, 2010; Meyfroidt *et al.*, 2010; UNDESA, 2013). However not all countries have benefited the same from these processes (Gaston & Khalid, 2010). There are concerns about winners and losers in the region, especially in terms of the inequitable outcomes of the above discussed processes (Ehrenfeld, 2003; Kawai & Wignaraja, 2010).

The Asia-Pacific region also experiences very high urbanization rates (Section 1.1.3, Chapter 4). For some countries such as China, urbanization is highly interlinked with other socioeconomic processes related to economic liberalisation and globalisation (UNESCAP/ADB/UNDP, 2013). Migration is a key demographic process in several parts of the region, which is often strongly interlinked with urbanization and economic transformation (International Monetary Fund, 2017; International Organization for Migration, 2015; UNESCAP/ADB/UNDP, 2013).

[19] Globalization is defined as the increasing and intensified flows between countries of goods, services, capital, ideas, information and people (see Chapter 4).

[20] More than 300 million international tourists visited the Asia-Pacific region in 2016 (several of which came from within the region), with significant expected future growth (UNWTO, 2017).

There are about 50 million migrants in the Asia-Pacific region, with the intra-regional population mobility steadily increasing over the last decades (UNESCAP, 2015a). However there are several reasons behind the voluntary and involuntary migration within (and between) Asia-Pacific countries, as well as with regions outside the Asia-Pacific (International Organization for Migration, 2015). Most current migrants in the region are internal voluntary migrants, whose mobility has increased largely due to the economic opportunities emerging from labour market reforms and other economic circumstances in the wider region (International Organization for Migration, 2015; UNESCAP, 2015a). Poor households in rural, mountainous and outer island areas have often registered high migration rates to plains and urban areas for labour opportunities and education (ADB, 2012; Kollmair & Hoermann, 2011; UNESCAP, 2015b).

Still there is a substantial number of involuntary migrants that have been forced to leave their areas due to conflicts and large-scale infrastructure development such as hydropower development, roads and mines (Cernea & Mathur, 2008). Climate-induced migration is a key emerging challenge, especially in small island and least developed nations, some of which are extremely prone to natural disasters (Section 1.1.4) (ADB, 2012). It is worth noting, however, that migration (whether voluntary or involuntary), can increase the vulnerability of large segments of society to climatic shocks such as droughts (Sugden *et al.*, 2014).

1.4.3.2 Implications for biodiversity

The highly interconnected global trade and transport/communication systems can contribute to the loss of biodiversity, through a series of mechanisms including land use and cover change, the overexploitation of biological resources and the spread of invasive alien and exotic species (Section 1.1.4). For example, liberalisation and globalization have driven to a large extent the unprecedented demand for trade in species of economic importance, such as agricultural, forestry and fishery products, and wildlife (see Section 1.1.4) (Ehrenfeld, 2003; FAO, 2009; Lambin & Meyfroidt, 2011; Meyfroidt *et al.*, 2010; Tonts & Siddique, 2011; UNDESA, 2013). This can have significant negative effects to biodiversity hotspots across the Asia-Pacific region (Moran & Kanemoto, 2017).

Urbanization also intersects in multiple ways with biodiversity loss. On the one hand urban expansion can threaten ecosystems due to direct and indirect land use change (Section 1.1.4). However changes in the consumption preferences of urban residents can be equally important (Satterthwaite *et al.*, 2010). For instance, dietary transitions in the Asia-Pacific region can include strong shifts towards diets dominated by meat and vegetable/animal fats (Clonan *et al.*, 2016). The production of such food items can require more land and/or have damaging effects to ecosystems (Alexander, Brown, Arneth, Finnigan, & Rounsevell, 2016; Steinfeld, Gerber, Wassenaar, Castel, & de Haan, 2006) (see also Section 1.1.4). Such dietary transitions can catalyse the transformation of entire agri-food chains in the region, having ripple negative effects to biodiversity (e.g. Reardon & Timmer, 2014).

It is also worth mentioning that even though rural-urban urban migration is more prevalent in the Asia-Pacific region as a whole (International Organization for Migration, 2015), in some subregions such as South-East Asia there is significant migration to under-populated areas, which pushes agricultural frontier transforming forests into arable land (Section 1.1.4) (Elmhirst *et al.*, 2017).

The above processes can have important implications for the conservation of biodiversity. In this context many countries in the region find challenging to balance their economic growth and conservation goals (Chapter 6). It is thus absolutely critical to understanding better the complexity and dynamic nature of the interactions between economic development and the environment to reverse effectively biodiversity loss and ecosystem degradation in the region (Houdet *et al.*, 2012; OECD, 2014)

To strike a strategic balance between the goals of biodiversity conservation and socioeconomic development, there is a need to recognize the livelihood needs of the poor. In some contexts this might require the wise commercialization of natural products such as timber and non-timber forest products (e.g. aromatic and medicinal plants) (E. Marshall *et al.*, 2006). However in order to ensure transparency and equity, such efforts need to respect the prevailing national policies and regulatory frameworks, take an integrated view of value chains, and consider the implications of different production options (Belcher & Schreckenberg, 2007). Improving the regulation of natural product markets, through for example voluntary market instruments (e.g. certification standards), can possibly reduce the negative environmental and social outcomes of commercialisation (Burivalova *et al.*, 2017; Hansda, 2009). While some ASEAN countries have established social and environmental standards in intra-regional trade and commercial exchanges (IGES, 2015; Razal, 2016), it is necessary to put in place sufficiently stronger environmental and social safeguards.

In this era of economic liberalisation and globalisation it has become increasingly necessary to recognize and respect the intellectual and cultural property (ICP) of indigenous and local communities, especially as it relates to biodiversity and ecosystem services (Section 1.1.3 and 1.4.1). These include intangible heritage (e.g. human/genetic resources, seeds, traditional medicine), traditional and cultural expressions and practices (e.g. language, music, art), innovations and individual, collective, gendered and other types of property ownership systems (IPBES, 2016a; Janke, 2009). Across the Asia-Pacific region indigenous people and local communities are increasingly using a large array of instruments to protect their ICP rights, including patents, copyright, trademarks, confidentiality agreements and treaty settlement processes (Drahos, 2014; IGES, 2017). The accumulated experience during the application of Free, Prior and Informed Consent (FPIC) processes highlight the importance of indigenous and local communities to represent themselves through their own institutions and make decisions following procedures of their choosing during such processes (Cariño, J., & Colchester, 2010; Colchester, 2010). Regional agreements can often be essential towards protecting ICP since the alternate position is often the transfer of intellectual property rights to outsiders (IPBES, 2016; Janke, 2009). However, overall substantial national and international legal reforms and institutional arrangement will be needed to properly protect the ICP of indigenous and local communities related to biodiversity and ecosystem services, in this context of globalisation and economic liberalization.

1.4.4 Challenges and opportunities for biodiversity conservation in the Asia-Pacific region

There are both successes and failures related to the management and conservation of biodiversity and ecosystem services across the region. While some countries are on track to achieve the Aichi Biodiversity Targets (UNEP-WCMC, 2016), many countries have not been so successful in achieving most of the targets (see Chapter 6). This is due to various challenges (Section 1.4.4.1), not the least stemming from the fact that the multiple direct and indirect drivers of ecosystem change and biodiversity loss intersect to create complicated problems that are beyond the individual capacities of single countries (Section 1.1.3, 1.1.4, 1.4.3) (see below). However, local and national success stories in biodiversity conservation do exist (IGES, 2017). The current international policy landscape offers various opportunities to improve biodiversity conservation and its sustainable use throughout the region (Section 1.4.4.2).

1.4.4.1 Challenges

First and foremost there are considerable gaps in relevant knowledge, information and data in several Asia-Pacific countries. These gaps pose significant challenges for fully implementing NBSAPs, and achieving the Aichi Biodiversity Targets and the SDGs (Section 1.1.2, 1.3.7) (UNEP-WCMC, 2016; Amano & Sutherland, 2013). Despite noteworthy efforts in some developing and highly biodiverse countries in the region to establish biodiversity baselines, there are significant constraints due to knowledge, capacity, expertise, finance, and technology (Lira-Noriega & Soberón, 2015; Kohsaka *et al.*, 2015). These constraints can curtail their ability to carry out regular national biodiversity assessments and implement effectively the NBSAPs. Furthermore, there is a lack of expertise to fully gauge and analyse the interrelated effects of the direct and indirect drivers of ecosystem change and biodiversity loss (see Chapter 4), especially as new drivers such as climate change become more prevalent (Squires, 2013). There is an urgent need to support the development of a young generation of experts in relevant fields (e.g. taxonomy, physiology, climate science, system ecology) to fill in existing knowledge gaps and maintain monitoring in existing sites (Tengo Maria *et al*, 2017; Kohsaka *et al*., 2015).

In some countries there is inadequate technical, managerial and institutional capacity to define properly national guidelines for the effective conservation and sustainable use of biodiversity. In order to meet the different international commitments (Section 1.4.1-1.4.2), several countries in the region have to improve the quality, effectiveness and implementation of multiple relevant policies. However, the existing institutional and technical capacity is often fragmented, uncoordinated, incoherent, and weak in awareness raising, knowledge management, policy implementation, and mobilising private sector finance for conservation (Morand *et al.*, 2017). Policymakers and practitioners often lack access to off-the-shelf knowledge, manuals, guidelines and examples of good practices, to inform biodiversity-related decision-making. Such knowledge gaps can also be identified in other relevant sectors such as integrated watershed management, climate change adaptation, cross-sectoral management and integrated marine and costal management. These capacity gaps hamper to some extent the full deployment of monitoring programmes supported by the scientific community that are critical for the implementation of NBSAPs (Ferrari *et al.*, 2015; Nakano *et al.*, 2014; Vanhove *et al.*, 2017)

Several of these capacity constraints relate to declining international and national financing for conservation (UNEP-WCMC, 2016), and the generally high cost of developing and maintaining biodiversity-related information systems (Diego Juffe-Bignoli *et al*., 2016). Indeed the financial cost of meeting biodiversity conservation targets can be very high for some countries in the Asia-Pacific (McCarthy *et al.*, 2012), while the funding requirements to cope effectively with ongoing climate change can be much higher (e.g. Carozza, 2015). Many countries in the Asia-Pacific region are not in a position to mobilize effectively such resources, which poses further administrative challenges, slows progress and weakens momentum in biodiversity conservation efforts. However there is a growing realisation that improved financial security in the region and more realistic action plans may lead to the better implementation of biodiversity strategies. There are multiple financial institutions and instruments that can contribute fudning for such efforts such as the Green Climate Fund and the Asian Infrastructure Development Bank (ADB, 2017).

A second important challenge stems from the trans-boundary and regional nature of several of the biodiversity conservation and sustainable development challenges discussed throughout this Chapter (and the assessment as a whole) (e.g. Table 1.1, Section 1.4.2). For example, even though a specific country might have put in place strong policies and regulations to conserve species that are highly targeted for illegal trading, the weak implementation of similar measures in neighbouring countries might weaken the overall effectiveness in wildlife territories that span between countries. In such cases there is a need for “stronger” regional cooperation, but also for dealing with “softer” issues such as understanding better the drivers of the illegal trade between the different countries (Oldfield, 2003). Anthropogenic climate change and transboundary atmospheric pollution is a second example of transboundary environmental challenges that need stronger regional cooperation (see Section 1.4.2, and Chapter 4).

It is generally recognized that regional co-operation mechanisms can be successful in addressing issues that cannot be handled well through bilateral programmes (Chaudhary, 2014; Kato & Takahashi, 2000). Numerous attempts have been made to set up regional and transboundary initiatives in the Asia-Pacific region, however, with mixed success (Section 1.4.2). Some of the main challenges include the lack of coordination and mistrust between governments, economic/legal/administrative disparities, different perspectives and expectations on conservation, as well as different capacities (ASEAN, 2015; Edwardes, 2015; Lim, 2016; Parks for the Planet Forum, 2016; Vasilijević *et al.*, 2015). All of the above can collectively curtail the effectiveness of regional co-operation mechanisms.

A third major challenge are the pervasive inequalities in the Asia-Pacific region, related to poverty, gender, and exclusion of local and indigenous communities (Section 1.1.3-.1.1.4). The inclusion of marginalized groups especially women, and indigenous and poor communities, is particularly critical for the sustainable management of ecosystems (Lele *et al.*, 2010; UNEP, 2016b). However, closing the gender and poverty gaps in the Asia-Pacific region is a multi-faceted challenge. Evidence from different countries indicates that securing tenure, commercializing wisely non-timber forest products, and carefully implementing social forestry, agro-forestry, Payment for Ecosystem Services (PES) schemes (including REDD-plus), can help close some of these gaps and have positive biodiversity outcomes at the same time (ADB, 2010; FPP-IIFB-SCBD, 2016; Razal, 2016).

Another challenge that is linked to all of the above is the development of multi-scale and multi-sector governance systems that engage different actors, organizations and institutions in biodiversity conservation. There are several successful experiences across the region for managing forests, protected areas, watersheds, rangelands and wetlands through participatory, community-based and multi-stakeholder approaches (Gilmour, 2016; Sears *et al*, 2017; Rasolosofosan *et al*, 2017; Dahal & Capistrano, 2006; RECOFTC, 2013; Ojha, Subedi, Dhungana, & Paudel, 2008; Porter-Bolland *et al*., 2012;). Participatory decision-making and the equitable sharing of benefits from natural resources has provided positive biodiversity outcomes in several parts of the region (de Boef *et al.*, 2013). Community-based approaches are also important in transboundary and ridge-to-reef cooperation initiatives, especially considering the need for multiple sources of knowledge and good practices from member countries (Chaudhary, 2014). Such multi-stakeholder approaches can facilitate striking a balance between conservation and socioeconomic development (Laurance *et al.*, 2010; Leimona, van Noordwijk, *et al.*, 2015), but would require effective participation especially from indigenous peoples and local communities (Chaudhary, 2014). Other, major impediments include the lack of enabling policies, regulatory mechanisms and technical capacity of the institutions (Pasakhala *et al.*, 2017).

1.4.4.2 Emerging opportunities

Perhaps the biggest opportunity to boost biodiversity conservation in the Asia-Pacific region is to explore and enhance the synergies between the requirements of the major international environmental initiatives (Section 1.4.1-1.42). For example, the Paris Climate Agreement presents a major opportunity to boost biodiversity conservation efforts, as almost all countries in the region are signatories and have initiated steps to reduce their vulnerability to (and curb the impacts of) climate change (Section 1.4.1). To achieve this most countries in the region are currently implementing low carbon and green economic development strategies (UNESCAP *et al.*, 2012) (see below). Some of these can have strong climate mitigation/adaptation and biodiversity conservation synergies such as REDD-plus schemes (Turnhout *et al.*, 2017) and ecosystem-based adaptation (ICIMOD, 2017; Scarano, 2017).

A second opportunity is the proliferation of broader low-carbon efforts and green growth policies across the resion (Section 1.4.1) (ADB, 2017; Jacobs, 2013; UNESCAP *et al.*, 2012; WWF, 2014). Some of the green economic practices that can have positive biodiversity/ecosystem outcomes include eco-tourism, sustainable marketing of high-value natural products, sustainable forest management, climate smart agriculture, REDD-plus, Payment for Ecosystem Services (PES) schemes, and sustainable fishing, to name a few (UNEP, 2011). Several studies have also identified the large scope for promoting forest-based green economic interventions that can ultimately conserve biodiversity, but also contribute to poverty alleviation (ITTO/APNet/FAO, 2013; Razal, 2016). However, green growth strategies evolve according to national environmental, economic and social circumstances, and investment priorities (OECD, 2016; WWF, 2014). Yet, as ecosystems are often shared between countries there might be a scope for promoting green economic strategies through regional co-operation.

Finally, the absolute impacts of policies that promote multiple development and environmental objectives will most likely be larger in fast-growing economies such as China, India and Indonesia

(Johansson *et al.*, 2015). For example, the Chinese Grain-for-Green Program (the largest reforestation effort in the world) transformed more than 15 million hectares of degraded agricultural land and 17 million hectares of barren mountainous wasteland to natural vegetation (Delang & Zhen, 2015). Although the biodiversity value of this effort is not certain, there is evidence to suggest that there were substantial ecosystem service benefits related to carbon storage and water provision (Delang & Zhen, 2015).

1.5 Structure of the Asia-Pacific Regional Assessment

The Asia-Pacific Regional Assessment is a collective effort among more than 120 researchers, scientists, academics and ILK holders from 27 countries from within and outside the region. Collectively the author team represents several IPBES member governments, non-governmental organizations, academic institutions and private sector companies. The author team has carefully reviewed the available evidence to provide a state-of-art assessment of biodiversity, its contribution to people, and the benefits that its conservation will have for the good quality of life of the close to 4.5 billion people of the region.

This report builds on previous assessments and outlook reports, starting from the Millennium Ecosystem Assessment. It should be viewed as a building block towards the long-term goal of conserving and using sustainably the region's rich and threatened biological and cultural diversity. It identifies potential governance and institutional options to promote and support a more holistic approach towards achieving the CBD vision 2050 of "living in harmony with nature".

The Asia-Pacific Regional Assessment consists of six chapters organized in a logical sequence. The author team has made efforts to present the content in a coherent manner to reflect the interconnections between people and nature, as illustrated by the various components of the IPBES Conceptual Framework (Section 1.3.2).

Chapter 1 introduces the rationale, scope and the five policy relevant questions defined by the scoping report prepared by IPBES for this assessment. It also highlights the methodology for the entire assessment, and shows how it fits within the current policy discourse, regionally and globally.

Chapter 2 explores the multiple conceptualizations of the Value of Nature and its material and non-material benefits to people, especially from the perspectives of indigenous people and local communities. It also quantifies, where possible, the economic values of ecosystem services and NCP. It highlights current efforts across the region to account for and capture the true value of Nature and NCP, and its contribution to good quality life.

Chapter 3 reviews the current status of biodiversity and ecosystems in the region, and presents their future trends and conditions using scientific and indigenous local knowledge. The chapter also lays out the current picture of the bio-cultural diversity in the region.

Chapter 4 describes the main direct and indirect drivers of ecosystem change and biodiversity loss, including climate change, both anthropogenic and natural. It delves into the vulnerability and impacts that climate variability and change poses on the region's biodiversity in terrestrial (rural and urban), freshwater and marine systems. It also links climate vulnerability to different adaptation measures already being practiced by indigenous peoples, local communities, and national and sub-national governments.

Chapter 5 focuses on scenarios and models[21] in the context of biodiversity and ecosystem management. The chapter uses cross-scale, integrated and simulation models to explain the complex

[21] In this assessment models describe relationships between: (i) indirect and direct drivers; (ii) direct drivers and nature; and (iii) nature and nature's benefits to people (IPBES, 2016). Scenarios envisage possible futures for one or more components

interactions among the different direct and indirect drivers of biodiversity loss in the Asia-Pacific region. By using different scenario archetypes, the Chapter provides relevant decision support tools to policy-makers to evaluate the different implications that the synergistic effects of drivers, policies and actions can have for biodiversity and nature's contributions to people in different subregions of the Asia-Pacific.

Chapter 6 uses the scenarios outlined in Chapter 5 to identify existing challenges, opportunities and pitfalls for decision makers for the conservation and sustainable use of NCP at the subregional scale. Key foci include institutions, organizations, property rights, legal framework, enabling environment, multi-stakeholder governance approaches, public-private partnerships, and participatory and community-based processes. The chaper provides feasible and practical options for good ecosystem governance, across these multiple domains.

Table 1.6 illustrates how the evidence included in the different chapters of the Asia-Pacific Regional Assessment can contribute in achieving the five Aichi Strategic Biodiversity Goals. Table 1.7 highlights in more detail how each chapter relates to key topics within the CBD Strategic Plan for Biodiversity (2011-2020), the Aichi Biodiversity Targets and the Sustainable Development Goals (SDGs).

Table 1.6 Intended contributions of the Asia-Pacific Regional Assessment in meeting the Strategic Goals of the Aichi Biodiversity Targets

Strategic Goals of the Aichi Biodiversity Targets	Intended contributions	Relevant Chapters
A: Address the underlying causes of biodiversity loss by mainstreaming biodiversity across government and society	- Provides a state-of-art review of the status and management of biodiversity and NCP - Outlines policy, institutional and governance options and approaches, for mainstreaming biodiversity and NCP	Chapter 1,3, and 6
B:Reduce the direct pressures on biodiversity and promote sustainable use	- Identifies the role of direct and indirect drivers of ecosystem change and biodiversity loss - Outlines the status and trends of biodiversity and NCP at different ecosystems and scales, - Provides cross-scale analysis, scenarios and models for curbing the negative effects of the different drivers on biodiversity,	Chapter 4, 3 and 5
C: Improve the status of biodiversity by safeguarding ecosystems, species and genetic diversity	- Describes existing models, synthesises available scenarios and provides options for knowledge management and capacity development	Chapter 5, 1 and 6
D: Enhance the benefits to all from biodiversity and ecosystem services	- Identifies and assesses multiple and diverse source of values and valuation methods, and gathers multiple sources of knowledge	Chapter 2 , 6 and 1

of socio-ecological systems, especially for major drivers of change impacting biodiversity and nature's contributions to people under different alternative policy or management options.

Table 1.7 Linkages of chapters with specific Aichi Biodiversity Targets and SDGs

Chapter focus	Relevant Aichi Biodiversity Targets	Other relevant outcome goal
1. Introduction	-	-
2. Benefits, values and human well-being	14, 15, 16	Ecosystem Services, Access and Benefit Sharing. SDGs 1, 2, 3, 4 and 8.
3. Status, trends and future dynamics	11, 12, 13, 14 (parts)	Terrestrial, marine, freshwater, coastal ecosystems. SDGs 14 and 15.
4. Drivers and perspectives	4, 5, 6, 7, 8, 9, 10	Stakeholders, habitats, aquatic ecosystems, climate, pollution, invasive alien species, human pressure. SDGs 1, 2, 7, 12 and 13.
5. Scenarios and models	Long-term 2050 vision of the Strategic Plan for Biodiversity	Aichi Biodiversity Targets, SDGs 14, 15, 16 and 17.
6. Policy options, institutional framework, directions, possible actions	1, 2, 3, 4, 16, 17, 18, 19, 20	Policy instruments, knowledge (modern and ILK), finance, and Access and Benefit Sharing. SDGs 14, 15, 16 and 17.

1.6 References

ABC. (2008). Mortality Threats to Birds - Avian Malaria (Plasmodium relictum). American Bird Conservancy. Retrieved July 30, 2008, from http://www.abcbirds.orgconservationissues/threats/disease/avian_ malaria.html

ADB. (2012). *Addressing Climate Change and Migration in Asia and the Pacific*. https://doi.org/10.1126/science.323.5916.876b

ADB. (2017). Regional: Greater Mekong Subregion Biodiversity Conservation Corridors Project. Retrieved February 24, 2017, from https://www.adb.org/projects/40253-012/main#project-pds-collapse

Adger, W. N., Benjaminsen, T. A., Brown, K., & Svarstad, H. (2001). Advancing a Political Ecology of Global Environmental Discourses. *Development and Change*, *32*(4), 681–715. https://doi.org/10.1111/1467-7660.00222

Aggarwal, S., & Elbow, K. (2006). *The role of property rights in Natural Resource Management, Good governance and empowerment of the rural poor*.

AIPP. (2015). *Strenghtening Indigenous Peoples' Movements, AIPP Annual Report*. (L. Maranan, Ed.). Asia Indigenous Peoples Pact (AIPP).

Alangui, W. V., Ichikawa, K., & Takahashi, Y. (2017a). *IPBES-JBF Sub-regional Dialogue Workshop Report on Indigenous and Local Knowledge (ILK) for South-East and North-East Asia sub-region, Thailand*.

Alangui, W. V., Ichikawa, K., & Takahashi, Y. (Eds.). (2017b). *Report of the the IPBES-JBF Sub-regional Dialogue Workshop on Indigenous and Local Knowledge (ILK) for South-East and North-East Asia Sub-region (14-17 Oct. 2016 in Chiang Mai)*. Hayama, Japan: Institute for Global Environmental Strategies. Retrieved from https://pub.iges.or.jp/pub/ipbes-jbf-sub-regional-dialogue-workshop-0

Alexander, P., Brown, C., Arneth, A., Finnigan, J., & Rounsevell, M. D. A. (2016). Human appropriation of land for food: The role of diet. *Global Environmental Change*, *41*, 88–98. https://doi.org/10.1016/j.gloenvcha.2016.09.005

Almassy, D. (2014). *Handboook for ASEAn Govt. officials on climate change and the UN Sustainable Development Goals*. Vietnam: Hans Seidal Foundation.

Amano, T., & Sutherland, W. J. (2013). Four barriers to the global understanding of biodiversity conservation: wealth, language, geographical location and security. In *Proc. R. Soc. B* (Vol. 280, p. 20122649). The Royal Society.

Anderies, J. M., & Janssen, M. A. (2013). Robustness of social-ecological systems: Implications for public policy. *Policy Studies Journal*, *41*(3), 513–536. https://doi.org/10.1111/psj.12027

ASEAN. (2015). *Environment and Forestry ASEAN Cooperation on Environment: Natural Resources and Biodiversity, Coastal & Marine Environment, Transboundary Haze Pollution*.

ASEAN Secretariat. (2015). *Asean Integration Report 2015*. Jakarta: ASEAN Secretariat.

Asian Development Bank. (2013). *Regional Cooperation and Integration in a Changing World*. *Asian Development Bank*. Mandaluyong City, Philippines. Retrieved from http://www.adb.org/sites/default/files/publication/30224/regional-cooperation-changing-world.pdf

Bajpai, K. (2015). *China-India Relations: Cooperation and Conflict*. (K. M. Kanti P. Bajpai, Jing Huang, Ed.). Routledge (Taylor and Francis Group).

Balmford, A., Chen, H., Phalan, B., Wang, M., O'Connell, C., Tayleur, C., & Xu, J. (2016). Getting Road Expansion on the Right Track: A Framework for Smart Infrastructure Planning in the Mekong. *PLOS Biology*, *14*(12), e2000266. https://doi.org/10.1371/journal.pbio.2000266

Baral, H., Keenan, R. J., Fox, J. C., Stork, N. E., & Kasel, S. (2013). Spatial assessment of ecosystem goods and services in complex production landscapes: A case study from south-eastern Australia. *Ecological Complexity*, *13*, 35–45. https://doi.org/10.1016/j.ecocom.2012.11.001

Baral, H., Keenan, R. J., Sharma, S. K., Stork, N. E., & Kasel, S. (2014). Spatial assessment and mapping of biodiversity and conservation priorities in a heavily modified and fragmented production landscape in north-central Victoria, Australia. *Ecological Indicators*, *36*, 552–562. https://doi.org/10.1016/j.ecolind.2013.09.022

Batisse, M. (1997). Biosphere Reserves: A Challenge for Biodiversity Conservation & Regional Development. *Environment: Science and Policy for Sustainable Development*, *39*(5), 6–33. https://doi.org/10.1080/00139159709603644

Baumgartner, L., Zampatti, B., Jones, M., Stuart, I., & Mallen-Cooper, M. (2014). Fish passage in the Murray-Darling Basin, Australia: Not just an upstream battle. *Ecological Management & Restoration*, *15*(s1), 28–39.

Belcher, B., & Schreckenberg, K. (2007). Commercialisation of non-timber forest products: a reality check. *Development Policy Review*, *25*(3), 355–377.

Berkes, F. (2012). *Sacred ecology* (Third Edit). New York, USA: Routledge.

Berkes, F., Colding, J., & Folke, C. (2000). Rediscovery of Traditional Ecological Knowledge as Adaptive Management. *Ecological Applications*, *10*(5), 1251–1262.

Berkes, F., & Folke, C. (1998). *Linking Social and Ecological Systems: Management Practices and Social Mechanisms for Building Resilience*. *Ecological Economics* (Vol. 28).

Bhatta, L. D., van Oort, B. E. H., Stork, N. E., & Baral, H. (2015). Ecosystem services and livelihoods in a changing climate: Understanding local adaptations in the Upper Koshi, Nepal. *International Journal of Biodiversity Science, Ecosystem Services & Management*, *11*(2), 145–155. https://doi.org/10.1080/21513732.2015.1027793

Biermann, F., Stevens, C., Bernstein, S., Gupta, A., Kabiri, N., Kanie, N., Levy, M., Nilsson, M., Pintér, L., & Scobie, M. (2014). Policy Brief 3 - Integrating Governance into the Sustainable Development Goals. *POST2015/UNU-IAS Policy Brief*, (3). Retrieved from http://i.unu.edu/media/ias.unu.edu-en/project/2218/Post2015_UNU-IAS_PolicyBrief3.pdf%0Ahttp://www.post2015.jp/dl/result/seika_140520_3.pdf

Binder, C. R., Hinkel, J., Bots, P. W. G., & Pahl-Wostl, C. (2013). Comparison of Frameworks for Analyzing Social-ecological Systems. *Ecology and Society*, *18*(4), art26. https://doi.org/10.5751/ES-05551-180426

BirdLife International. (2016). Important Bird and Biodiversity Areas (IBAs). Retrieved September 5, 2015, from http://www.birdlife.org/worldwide/programmes/important-bird-and-biodiversity-areas-ibas

Bisht, N., Joshi, S., Shrestha, B. B., Yi, S., Chaudhary, R. P., Kotru, R., & Wu, N. (2016). *Manual on invasive alien plant species in Kailash; Sacred Landscape-Nepal*. Kathmandu.

Böhm, M., Collen, B., Baillie, J. E. M., Bowles, P., Chanson, J., Cox, N., Hammerson, G., Hoffmann, M., Livingstone, S. R., Ram, M., Rhodin, A. G. J., Stuart, S. N., van Dijk, P. P., Young, B. E., Afuang, L. E., Aghasyan, A., García, A., Aguilar, C., Ajtic, R., Akarsu, F., Alencar, L. R. V, Allison, A., Ananjeva, N., Anderson, S., Andrén, C., Ariano-Sánchez, D., Arredondo, J. C., Auliya, M., Austin, C. C., Avci, A., Baker, P. J., Barreto-Lima, A. F., Barrio-Amorós, C. L., Basu, D., Bates, M. F., Batistella, A., Bauer, A., Bennett, D., Böhme, W., Broadley, D., Brown, R., Burgess, J., Captain, A., Carreira, S., Castañeda, M. del R., Castro, F., Catenazzi, A., Cedeño-Vázquez, J. R., Chapple, D. G., Cheylan, M., Cisneros-Heredia, D. F., Cogalniceanu, D., Cogger, H., Corti, C., Costa, G. C., Couper, P. J., Courtney, T., Crnobrnja-Isailovic, J., Crochet, P.-A., Crother, B., Cruz, F., Daltry, J. C., Daniels, R. J. R., Das, I., de Silva, A., Diesmos, A. C., Dirksen, L., Doan, T. M., Dodd, C. K., Doody, J. S., Dorcas, M. E., Duarte de Barros Filho, J., Egan, V. T., El Mouden, E. H., Embert, D., Espinoza, R. E., Fallabrino, A., Feng, X., Feng, Z.-J., Fitzgerald, L., Flores-Villela, O., França, F. G. R., Frost, D., Gadsden, H., Gamble, T., Ganesh, S. R., Garcia, M. A., García-Pérez, J. E., Gatus, J., Gaulke, M., Geniez, P., Georges, A., Gerlach, J., Goldberg, S., Gonzalez, J.-C. T., Gower, D. J., Grant, T., Greenbaum, E., Grieco, C., Guo, P., Hamilton, A. M., Hare, K., Hedges, S. B., Heideman, N., Hilton-Taylor, C., Hitchmough, R., Hollingsworth, B., Hutchinson, M., Ineich, I., Iverson, J., Jaksic, F. M., Jenkins, R., Joger, U., Jose, R., Kaska, Y., Kaya, U., Keogh, J. S., Köhler, G., Kuchling, G., Kumlutaş, Y., Kwet, A., La Marca, E., Lamar, W., Lane, A., Lardner, B., Latta, C., Latta, G., Lau, M., Lavin, P., Lawson, D., LeBreton, M., Lehr, E., Limpus, D., Lipczynski, N., Lobo, A. S., López-Luna, M. A., Luiselli, L., Lukoschek, V., Lundberg, M., Lymberakis, P., Macey, R., Magnusson, W. E., Mahler, D. L., Malhotra, A., Mariaux, J., Maritz, B., Marques, O. A. V, Márquez, R., Martins, M., Masterson, G., Mateo, J. A., Mathew, R., Mathews, N., Mayer, G., McCranie, J. R., Measey, G. J., Mendoza-Quijano, F., Menegon, M., Métrailler, S., Milton, D. A., Montgomery, C., Morato, S. A. A., Mott, T., Muñoz-Alonso, A., Murphy, J., Nguyen, T. Q., Nilson, G., Nogueira, C., Núñez, H., Orlov, N., Ota, H., Ottenwalder, J., Papenfuss, T., Pasachnik, S., Passos, P., Pauwels, O. S. G., Pérez-Buitrago, N., Pérez-Mellado, V., Pianka, E. R., Pleguezuelos, J., Pollock, C., Ponce-Campos, P., Powell, R., Pupin, F., Quintero Díaz, G. E., Radder, R., Ramer, J., Rasmussen, A. R., Raxworthy, C., Reynolds, R., Richman, N., Rico, E. L., Riservato, E., Rivas, G., da Rocha, P. L. B., Rödel, M.-O., Rodríguez Schettino, L., Roosenburg, W. M., Ross, J. P., Sadek, R., Sanders, K., Santos-Barrera, G., Schleich, H. H., Schmidt, B. R., Schmitz, A., Sharifi, M., Shea, G., Shi, H.-T., Shine, R., Sindaco, R., Slimani, T., Somaweera, R., Spawls, S., Stafford, P., Stuebing, R., Sweet, S., Sy, E., Temple, H. J., Tognelli, M. F., Tolley, K., Tolson, P. J., Tuniyev, B., Tuniyev, S., Üzüm, N., van Buurt, G., Van Sluys, M., Velasco, A., Vences, M., Veselý, M., Vinke, S., Vinke, T., Vogel, G., Vogrin, M., Vogt, R. C., Wearn, O. R., Werner, Y. L., Whiting, M. J., Wiewandt, T., Wilkinson, J., Wilson, B., Wren, S., Zamin, T., Zhou, K., & Zug, G. (2013). The conservation status of the world's reptiles. *Biological Conservation*, *157*(Supplement C), 372–385. https://doi.org/https://doi.org/10.1016/j.biocon.2012.07.015

Borrini-Feyerabend, G., Kothari, A., & Oviedo, G. (2004). *Indigenous and Local Communities and Protected Areas: Towards Equity and Enhanced Conservation. IUCN. World Commission on Protected Areas. Best Practice Protected Area Guideline Series No. 11, Gland*. Switzerland and Cambridge, UK.

Braulik, G. T., Noureen, U., Arshad, M., & Reeves, R. R. (2015). Review of status, threats, and conservation management options for the endangered Indus River blind dolphin. *Biological Conservation*, *192*, 30–41.

Brooks, T. M., Butchart, S. H. M., Cox, N. A., Heath, M., Hilton-Taylor, C., Hoffmann, M., Kingston, N., Rodríguez, J. P., Stuart, S. N., & Smart, J. (2015). Harnessing biodiversity and conservation knowledge products to track the Aichi Targets and Sustainable Development Goals. *Biodiversity*, *16*(2–3), 157–174. https://doi.org/10.1080/14888386.2015.1075903

Burivalova, Z., Hua, F., Koh, L. P., Garcia, C., & Putz, F. (2017). A critical comparison of conventional, certified, and community management of tropical forests for timber in terms of environmental, economic, and social variables. *Conservation Letters*, *10*(1), 4–14.

Burke, L., Reytar, K., Spalding, M., & Perry, A. (2011). *Reefs at risk revisited*.

Burney, J., & Ramanathan, V. (2014). Recent climate and air pollution impacts on India agriculture. *Proceedings of the National Academy of Sciences*, *111*(46), 16319–16324. https://doi.org/10.1073/pnas.1317275111

Cariño, J., & Colchester, M. (2010). From dams to development justice: Progress with'free, prior and informed consent'since the World Commission on Dams. *Water Alternatives*, *3*(2), 423.

Carlson, K. M., Curran, L. M., Asner, G. P., Pittman, A. M., Trigg, S. N., & Marion Adeney, J. (2013). Carbon emissions from forest conversion by Kalimantan oil palm plantations. *Nature Climate Change*, *3*(3), 283–287. https://doi.org/10.1038/nclimate1702

Carpenter, K. E., & Springer, V. G. (2005). The center of the center of marine shore fish biodiversity: The Philippine Islands. *Environmental Biology of Fishes*, *72*(4), 467–480. https://doi.org/10.1007/s10641-004-3154-4

Castellas, P. (2016). *COP22 Key Takeaways: Climate Policy & Implications for Australian Business*. *Carbon Market Institute*.

Cernea, M. M., & Mathur, H. M. (2008). *Can Compensation Prevent Impoverishment?: Reforming Resettlement Through Investments*. Oxford University Press New Delhi.

Chan, K. M. a, Satterfield, T., & Goldstein, J. (2012). Rethinking ecosystem services to better address and navigate cultural values. *Ecological Economics*, *74*, 8–18. https://doi.org/10.1016/j.ecolecon.2011.11.011

Chaudhary, R. P. (2014). Conserving biodiversity and achieving the Millennium Development Goals in Nepal. In *Proceedings of the Sixth National Conference on Science and Technology* (p. 96-111).

Chou, L. M., Tuan, V. S., Reefs, P., Yeemin, T., Cabanban, A., Suharsono, & Kessna, I. (2002). Status of Southeast Asia coral reefs. In C. Wilkinson (Ed.), *Status of coral reefs of the world – 2002* (pp. 123–152).

Christie, P., Pietri, D. M., Stevenson, T. C., Pollnac, R., Knight, M., & White, A. T. (2016). Improving human and environmental conditions through the Coral Triangle Initiative: Progress and challenges. *Current Opinion in Environmental Sustainability*. https://doi.org/10.1016/j.cosust.2016.03.002

Clonan, A., Roberts, K. E., & Holdsworth, M. (2016). Socioeconomic and demographic drivers of red and processed meat consumption: implications for health and environmental sustainability. *The Proceedings of the Nutrition Society*, (July 2015), 1–7. https://doi.org/10.1017/S0029665116000100

Cochran, P. A. L., Marshall, C. A., Garcia-Downing, C., Kendall, E., Cook, D., McCubbin, L., & Gover, R. M. S. (2008). Indigenous ways of knowing: Implications for participatory research and community. *American Journal of Public Health*, *98*(1), 22–27.

Colchester, M. (2010). Free, Prior and Informed Consent: Making FPIC work for forests and peoples. *Research Paper*.

Collins, M. G. (2013). International Organizations and Biodiversity. In *Encyclopedia of Biodiversity* (pp. 324–331). Elsevier. https://doi.org/10.1016/B978-0-12-384719-5.00395-6

Como, S., Pais, A., Rumolo, P., Saba, S., Sprovieri, M., & Magni, P. (2016). Effects of an invasive mussel, Arcuatula senhousia, on local benthic consumers: a laboratory 13C-labeling study. *Marine Biology*, *163*(6), 140. https://doi.org/10.1007/s00227-016-2912-0

Conservation Synthesis - Center for Applied Biodiversity Science at Conservation International. (2004). Biodiversity Hotspots Revisited, Conservation International, 2004 | Data Basin. Retrieved July 12, 2018, from https://databasin.org/datasets/e5e1b415498249d0b511b0eef8625c12

Costello, M. J., Coll, M., Danovaro, R., Halpin, P., Ojaveer, H., & Miloslavich, P. (2010). A census of marine biodiversity knowledge, resources, and future challenges. *PLoS ONE*, *5*(8). https://doi.org/10.1371/journal.pone.0012110

Cox, C. B., & Moore, P. D. (2010). *Biogeography: An Evolutionary Approach (8th edition)*. New York: John Wiley.

CSIRO. (2016). State of the Climate, 2016. Retrieved from http://www.csiro.au/state-of-the-climate

Dahal, G. R., & Capistrano, D. (2006). Forest governance and institutional structure: an ignored dimension of community based forest management in the Philippines. *International Forestry Review*, *8*(4), 377–394.

Danielsen, F., Beukema, H., Burgess, N. D., Parish, F., Bruehl, C. A., Donald, P. F., Murdiyarso, D., Phalan, B., Reijnders, L., Struebig, M., & Fitzherbert, E. B. (2009). Biofuel Plantations on Forested Lands: Double Jeopardy for Biodiversity and Climate. *Conservation Biology*, *23*(2), 348–358. https://doi.org/10.1111/j.1523-1739.2008.01096.x

Danielsen, F., Sørensen, M. K., Olwig, M. F., Selvam, V., Parish, F., Burgess, N. D., Hiraishi, T., Karunagaran, V. M., Rasmussen, M. S., Hansen, L. B., Quarto, A., & Suryadiputra, N. (2005). The Asian tsunami: a protective role for coastal vegetation. *Science*, *310*(October), 643. https://doi.org/10.1126/science.1118387

De'ath, G., Fabricius, K. E., Sweatman, H., & Puotinen, M. (2012). The 27-year decline of coral cover on the Great Barrier Reef and its causes. *Proceedings of the National Academy of Sciences of the United States of America*, *109*(44), 17995–17999. https://doi.org/10.1073/pnas.1208909109

de Boef, W. S., Subedi, A., Peroni, N., Thijssen, M., & O'Keeffe, E. (2013). *Community Biodiversity Management: Promoting resilience and the conservation of plant genetic resources*. Routledge.

Deb, S., Lynrah, M. M., & Tiwari, B. K. (2013). Technological innovations in shifting agricultural practices by three tribal farming communities of Meghalaya, northeast India. *Tropical Ecology*, *54*(2), 133–148.

Delang, C. O., & Zhen, Y. (2015). *China's Grain for Green Program: A Review of the Largest Ecological Restoration and Rural Development Program in the World*. Switzerland: Springer International Publishing.

Díaz, S., Demissew, S., Carabias, J., Joly, C., Lonsdale, M., Ash, N., Larigauderie, A., Adhikari, J. R., Arico, S., Báldi, A., Bartuska, A., Baste, I. A., Bilgin, A., Brondizio, E., Chan, K. M., Figueroa, V. E., Duraiappah, A., Fischer, M., Hill, R., Koetz, T., Leadley, P., Lyver, P., Mace, G. M., Martin-Lopez, B., Okumura, M., Pacheco, D., Pascual, U., Pérez, E. S., Reyers, B., Roth, E., Saito, O., Scholes, R. J. R., Sharma, N., Tallis, H., Thaman, R., Watson, R., Yahara, T., Hamid, Z. A., Akosim, C., Al-Hafedh, Y., Allahverdiyev, R., Amankwah, E., Asah, T. S., Asfaw, Z., Bartus, G., Brooks, A. L., Caillaux, J., Dalle, G., Darnaedi, D., Driver, A., Erpul, G., Escobar-Eyzaguirre, P., Failler, P., Fouda, A. M. M., Fu, B., Gundimeda, H., Hashimoto, S., Homer, F., Lavorel, S., Lichtenstein, G., Mala, W. A., Mandivenyi, W., Matczak, P., Mbizvo, C., Mehrdadi, M., Metzger, J. P., Mikissa, J. B., Moller, H., Mooney, H. A., Mumby, P., Nagendra, H., Nesshover, C., Oteng-Yeboah, A. A., Pataki, G., Roué, M., Rubis, J., Schultz, M., Smith, P., Sumaila, R., Takeuchi, K., Thomas, S., Verma, M., Yeo-Chang, Y., & Zlatanova, D. (2015). The IPBES Conceptual Framework — connecting nature and people. *Current Opinion in Environmental Sustainability*, *14*, 1–16. https://doi.org/10.1016/j.cosust.2014.11.002

Díaz, S., Demissew, S., Joly, C., Lonsdale, W. M., & Larigauderie, A. (2015). A Rosetta Stone for nature’s benefits to people. *PLoS Biology*, *13*(1), e1002040. https://doi.org/10.1371/journal.pbio.1002040

Díaz, S., Pascual, U., Stenseke, M., Martín-López, B., Watson, R. T., Molnár, Z., Hill, R., Chan, K. M. A., Baste, I. A., Brauman, K. A., Polasky, S., Church, A., Lonsdale, M., Larigauderie, A., Leadley, P. W., van Oudenhoven, A. P. E., van der Plaat, F., Schröter, M., Lavorel, S., Aumeeruddy-Thomas, Y., Bukvareva, E., Davies, K., Demissew, S., Erpul, G., Failler, P., Guerra, C. A., Hewitt, C. L., Keune, H., Lindley, S., & Shirayama, Y. (2018). An inclusive approach to assess nature’s contributions to people. *Science*, *359*(6373). Retrieved from http://science.sciencemag.org/cgi/doi/10.1126/science.aap8826

Dinerstein, E., Olson, D. M., Joshi, A., Vynne, C., Burgess, N. D., Wikramanayake, E., Hahn, N., Palminteri, S., Hedao, P., Noss, R., Hansen, M., Locke, H., Ellis, E. C., Jones, B., Barber, C. V., Hayes, R., Kormos, C., Martin, V., Crist, E., Sechrest, W., Price, L., Baillie, J. E. M., Weeden, D., Suckling, K., Davis, C., Sizer, N., Moore, R., Thau, D., Birch, T., Potapov, P., Turubanova, S., Tyukavina, A., de Souza, N., Pintea, L., Brito, J. C., Llewellyn, O. A., Miller, A. G., Patzelt, A., Ghazanfar, S. A., Timberlake, J., Klöser, H., Shennan-Farpón, Y., Kindt, R., Lillesø, J.-P. B., van Breugel, P., Graudal, L., Voge, M., Al-Shammari, K. F., & Saleem, M. (2017). An Ecoregion-Based Approach to Protecting Half the Terrestrial Realm. *Bioscience*, *67*(6), 534–545. https://doi.org/10.1093/biosci/bix014

Drahos, P. (2014). *Intellectual Property, Indigenous People and their Knowledge. Cambridge Intellectual Property and Information Law*. Cambridge, UK: Cambridge University Press. https://doi.org/10.1017/CBO9781107295230

Duraiappah, A., Nakamura, K., Takeuchi, K., Watanabe, M., & Nishi, M. (Eds.). (2012). *Satoyama-satoumi ecosystems and human well-being: socio-ecological production landscapes of Japan*. Japan: UNU Tokyo.

EANET. (2015). *Review on the State of Air Pollution in East Asia*.

Edwardes, A. (2015). *Transboundary Cooperation for Nature Conservation: World Trends and Ways Forward in Northeast Asia*. *NEASPEC WORKING PAPER*.

Edwards, D. P., Tobias, J. A., Sheil, D., Meijaard, E., & Laurance, W. F. (2014). Maintaining ecosystem function and services in logged tropical forests. *Trends in Ecology and Evolution*, *29*(9), 511–520. https://doi.org/10.1016/j.tree.2014.07.003

Ehrenfeld, D. (2003). Globalisation: effects on biodiversity, environment and society. *Conservation and Society*, *1*(1), 99.

Elmhirst, R., Siscawati, M., Basnett, B. S., & Ekowati, D. (2017). Gender and generation in engagements with oil palm in East Kalimantan, Indonesia: insights from feminist political ecology. *The Journal of Peasant Studies*, *44*(6), 1135–1157. https://doi.org/10.1080/03066150.2017.1337002

Estes, J. G., Othman, N., Ismail, S., Ancrenaz, M., Goossens, B., Ambu, L. N., Estes, A. B., & Palmiotto, P. A. (2012). Quantity and Configuration of Available Elephant Habitat and Related Conservation Concerns in the Lower Kinabatangan Floodplain of Sabah, Malaysia. *PLoS ONE*, *7*(10). https://doi.org/10.1371/journal.pone.0044601

Ewers, R. M., Boyle, M. J. W., Gleave, R. a, Plowman, N. S., Benedick, S., Bernard, H., Bishop, T. R., Bakhtiar, E. Y., Chey, V. K., Chung, A. Y. C., Davies, R. G., Edwards, D. P., Eggleton, P., Fayle, T. M., Hardwick, S. R., Homathevi, R., Kitching, R. L., Khoo, M. S., Luke, S. H., March, J. J., Nilus, R., Pfeifer, M., Rao, S. V, Sharp, A. C., Snaddon, J. L., Stork, N. E., Struebig, M. J., Wearn, O. R., Yusah, K. M., & Turner, E. C. (2015). Logging cuts the functional importance of invertebrates in tropical rainforest. *Nature Communications*, *6*(April 2016), 6836. https://doi.org/10.1038/ncomms7836

FAO. (2009). *THE FUTURE OF FORESTS IN ASIA AND THE PACIFIC: OUTLOOK FOR 2020 16–18 October 2007*. (R. N. Leslie, Ed.). Bangkok, Thailand: FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, REGIONAL OFFFICE FOR ASIA AND THE PACIFIC.

FAO. (2010). *ASIA-PACIFIC FORESTS AND FORESTRY TO 2020, The Second Asia-Pacific Forestry Sector Outlook Study*. Bangkok, Thailand.

FAO. (2017). *THE STATE OF FOOD AND AGRICULTURE LEVERAGING FOOD SYSTEMS FOR INCLUSIVE RURAL TRANSFORMATION*. Rome, Italy. Retrieved from http://www.fao.org/3/a-I7658e.pdf

FAO, & ITPS. (2015). *The Status of the World's Soil Resources (Main Report)*. Rome, Italy. https://doi.org/ISBN 978-92-5-109004-6

Ferrari, M. F., de Jong, C., & Belohrad, V. S. (2015). Community-based monitoring and information systems (CBMIS) in the context of the Convention on Biological Diversity (CBD). *Biodiversity*, *16*(2–3), 57–67.

Fisher, B., & Christopher, T. (2007). Poverty and biodiversity: Measuring the overlap of human poverty and the biodiversity hotspots. *ECOLOGICAL ECONOMICS*, *62*, 93–101.

Fitzherbert, E. B., Struebig, M. J., Morel, A., Danielsen, F., Brühl, C. A., Donald, P. F., & Phalan, B. (2008). How will oil palm expansion affect biodiversity? *Trends in Ecology and Evolution*. https://doi.org/10.1016/j.tree.2008.06.012

Gaston, N., & Khalid, A. M. (2010). Globalization and integration in the Asia-Pacific: Prospects and risks. In N. Gaston & A. M. Khalid (Eds.), *Globalization and economic integration: Winners and losers in the Asia-Pacific* (pp. 3–21). Cheltenham, UK: Edward Elgar Publishing Limited. Retrieved from https://www.e-elgar.com/shop/globalization-and-economic-integration

GCRMN. (2009). *Status of corral reefs of the world: 2008*. Townsville.

Geijzendorffer, I. R., Cohen-Shacham, E., Cord, A. F., Cramer, W., Guerra, C., & Martín-López, B. (2017). Ecosystem services in global sustainability policies. *Environmental Science & Policy*, *74*(Supplement C), 40–48. https://doi.org/https://doi.org/10.1016/j.envsci.2017.04.017

Gibbs, H. K., & Salmon, J. M. (2015). Mapping the world's degraded lands. *Applied Geography*, *57*, 12–21. https://doi.org/10.1016/j.apgeog.2014.11.024

Giri, C., Ochieng, E., Tieszen, L. L., Zhu, Z., Singh, A., Loveland, T., Masek, J., & Duke, N. (2011). Status and distribution of mangrove forests of the world using earth observation satellite data. *Global Ecology and Biogeography*, *20*(1), 154–159. https://doi.org/10.1111/j.1466-8238.2010.00584.x

Gorenflo, L. J., Romaine, S., Mittermeier, R. A., Walker-Painemilla, K., LJ, G., S, R., RA, M., & Walker-Painemilla K. (2012). Co-occurrence of linguistic and biological diversity in biodiversity hotspots and high biodiversity wilderness areas. *Proceedings of the National Academy of Sciences*, *109*(21), 8032–8037. https://doi.org/10.1073/pnas.1117511109

Govan, H. (2009). Achieving the potential of locally managed marine areas in the South Pacific. *SPC Traditional Marine Resource Management and Knowledge Information Bulletin*, *25*, 16–25.

Grantham, H. S., Wilson, K. A., Moilanen, A., Rebelo, T., & Possingham, H. P. (2009). Delaying conservation actions for improved knowledge: how long should we wait? *Ecology Letters*, *12*(4), 293–301.

Hall, D., & Bouapao, L. (2010). Social Impact Monitoring and Vulnerability Assessment. *MRC Technical Paper*, (30), 202.

Hall, G., & Patrinos, H. (Eds.). (2012). *Indigenous peoples, poverty, and development*. New York: Cambridge University Press. Retrieved from https://books.google.co.jp/books?hl=ja&lr=&id=amWM1iuimsQC&oi=fnd&pg=PR1&dq=hall+patrinos+2012+indigenous+people&ots=CJe8NDWopU&sig=kla2g3vuMmQ4xGtOifsHkw_iwqA#v=onepage&q=hall patrinos 2012 indigenous people&f=false

Hansda, R. (2009). The outlook for non-wood forest products in Asia and the Pacific. *Asia-Pacific Forestry Sector Outlook Study II Working Paper Series*.

Hayasaka, D., Goka, K., Thawatchai, W., & Fujiwara, K. (2012). Ecological impacts of the 2004 Indian Ocean tsunami on coastal sand-dune species on Phuket Island, Thailand. *Biodiversity and Conservation*, *21*(8), 1971–1985. https://doi.org/10.1007/s10531-012-0288-0

Heather, C., & Jeffrey, S. D. (2007). Impacts of Invasive Species on Ecosystem Services. In *Biological Invasions* (Vol. 193, pp. 217–237). https://doi.org/10.1007/978-3-540-36920-2_13

Heiner, M., Higgins, J., Li, X., & Baker, B. (2011). Identifying freshwater conservation priorities in the Upper Yangtze River Basin. *Freshwater Biology*, *56*(1), 89–105.

Hernández-Morcillo, M., Hoberg, J., Oteros-Rozas, E., Plieninger, T., Gómez-Baggethun, E., & Reyes-García, V. (2014). Traditional Ecological Knowledge in Europe: Status Quo and Insights for the Environmental Policy Agenda. *Environment: Science and Policy for Sustainable Development*, *56*(1), 3–17. https://doi.org/10.1080/00139157.2014.861673

Heron, S. F., Maynard, J. A., van Hooidonk, R., & Eakin, C. M. (2016). Warming Trends and Bleaching Stress of the World's Coral Reefs 1985–2012. *Scientific Reports*, *6*(November), 38402. https://doi.org/10.1038/srep38402

Holden, E., Linnerud, K., & Banister, D. (2014). Sustainable development: our common future revisited. *Global Environmental Change*, *26*, 130–139.

Hossain, M. S., Bujang, J. S., Zakaria, M. H., & Hashim, M. (2016). Marine and human habitat mapping for the Coral Triangle Initiative region of Sabah using Landsat and Google Earth imagery. *Marine Policy*, *72*, 176–191. https://doi.org/10.1016/j.marpol.2016.07.003

Houdet, J., Trommetter, M., & Weber, J. (2012). Understanding changes in business strategies regarding biodiversity and ecosystem services. *Ecological Economics*, *73*, 37–46.

Hughes, A. (2017). Understanding the drivers of Southeast Asian biodiversity loss. *Ecosphere*, *8*(January), DOI: 10.1002/ecs2.1624. https://doi.org/10.1002/ECS2.1624

HuiJun, R., HaiJun, W., WeiHua, Z., YaQiang, S., Yong, W., & XiaoKe, Z. (2010). Fishes in the mainstream of the Yellow River: assemblage characteristics and historical changes. *Biodiversity Science*, *18*(2), 169–174.

Ibisch, P. L., Hoffmann, M. T., Kreft, S., Pe'er, G., Kati, V., Biber-Freudenberger, L., DellaSala, D. A., Vale, M. M., Hobson, P. R., & Selva, N. (2016). A global map of roadless areas and their conservation status. *Science*, *354*(6318), 1423–1427. https://doi.org/10.1126/science.aaf7166

Ichikawa, K. (2012). *Socio-ecological production landscapes in Asia*. *United Nations University Institute of Advanced Studies*. Yokohama.

ICIMOD. (2011). Glacial Lakes and Glacial Lake Outburst Floods in Nepal, 1–109. https://doi.org/978 92 9115 193 6

ICIMOD. (2017). Building Partnerships for Conservation and Development in HKH: Exploring Complementary Opportunities for Improving HKPL Transboundary Cooperation from One Belt, One Road Initiative, 1–12 December 2016, Lanzhou, China, *2017/4*. Retrieved from http://lib.icimod.org/record/32608

ICSU. (2017). *A Guide to SDG Interactions: from Science to Implementation*. Retrieved from https://www.icsu.org/cms/2017/05/SDGs-Guide-to-Interactions.pdf

IGES. (2015). *Greening Integration In Asia: How Regional Integration Can Benefit People And The Environment*. Tokyo, Japan. Retrieved from http://pub.iges.or.jp/modules/envirolib/upload/6046/attach/IGESWhitePaperV2015_eng_web.pdf%5Cnhttp://pub.iges.or.jp/modules/envirolib/view.php?docid=6046

IGES. (2017). IPBES-JBF Sub-regional Dialogue Workshop Report on Indigenous and Local Knowledge (ILK) for South and West Asia sub-region March 2017 Institute for Global Environmental Strategies (IGES), (March).

ILO. (2013). *Global Employment Trends for Youth 2013: A generation at risk*. Geneva, Switzerland. Retrieved from http://www.ilo.org/wcmsp5/groups/public/---dgreports/---dcomm/documents/publication/wcms_212423.pdf

IMO (International Maritime Organization). (2012). *Methodology for information gathering and conduct of work of the GESAMP-BWWG, BWM.2/Circ.13/Rev.1*.

International Monetary Fund. (2017). *Regional Economic Outlook. Asia and Pacific: Preparing for Choppy Seas*.

International Organization for Migration. (2015). *World Migration Report 2015. Migrants and Cities: New Partnerships to Manage Mobility*. https://doi.org/1561-5502

IPBES. (2015). *Preliminary guide regarding diverse conceptualization of multiple values of nature and its benefits, including biodiversity and ecosystem functions and services (deliverable 3 (d))* (No. IPBES/4/INF/13). Bonn. Retrieved from http://www.ipbes.net/sites/default/files/downloads/IPBES-4-INF-13_EN.pdf

IPBES. (2016a). *Guide on the production and integration of assessments from and across all scales (deliverable 2 (a))* (No. IPBES/4/INF/9). Retrieved from http://www.ipbes.net/sites/default/files/downloads/IPBES-4-INF-9_EN_1.pdf

IPBES. (2016b). *Summary for policymakers of the assessment report of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services on pollinators, pollination and food production*. (S. G. Potts, V. L. Imperatriz-Fonseca, H. T. Ngo, J. C. Biesmeijer, T. D. Breeze, L. V. Dicks, L. A. Garibaldi, R. Hill, J. Settele, A. J. Vanbergen, M. A. Aizen, S. A. Cunningham, C. Eardley, B. M. Freitas, N. Gallai, P. G. Kevan, A. Kovács-Hostyánszki, P. K. Kwapong, J. Li, X. Li, D. J. Martins, G. Nates-Parra, J. S. Pettis, R. Rader, & B. F. Viana, Eds.). Bonn, Germany: secretariat of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. Retrieved from www.ipbes.net/sites/default/files/downloads/pdf/spm_ deliverable_3a_pollination_20170222.pdf

IPBES. (2017a). *Update on the classification of nature's contributions to people by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services*. *IPBES/5/1/Rev.1*.

IPBES. (2017b). *Update on the work on knowledge and data (deliverables 1 (d) and 4 (b)). Fifth session pf the Plenary of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services*. *IPBES/5/INF/5*. Bonn, Germany.

IPBES. (2018). *Summary for policymakers of the assessment report on land degradation and restoration of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services*. (R. Scholes, L. Montanarella, A. Brainich, N. Barger, B. ten Brink, M. Cantele, B. Erasmus, J. Fisher, T. Gardner, T. G. Holland, F. Kohler, J. S. Kotiaho, G. Von Maltitz, G. Nangendo, R. Pandit, J. Parrotta, M. D. Potts, S. Prince, M. Sankaran, & L. Willemen, Eds.). Bonn, Germany: IPBES secretariat.

IPCA. (2017). Biological and Cultural Diversity in the Indo-Pacific.

IPCC. (2012). *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change*. (and P. M. M. Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, Ed.). Cambridge, UK, and New York, NY, USA: Cambridge University Press.

IPCC. (2014). *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. (R. K. P. and L. A. M. Core Writing Team, Ed.). Geneva, Switzerland: IPCC.

ITTO/APNet/FAO. (2013). *Proceedings of the Workshop on Forest Products Statistics in China*. Hainan, China.

IUFRO. (2014). *Forests under pressure : Local responses to global*. (G. M. Pia Katila, Glenn Galloway, Wil de Jong, Pablo Pacheco, Ed.), *IUFRO World Series (Vol. 32)*. International Union of Forest Research Organizations (IUFRO). Retrieved from http://www.cifor.org/library/5027/management-of-natural-tropical-forests-in-the-past-and-present-and-projections-for-the-future/

Izuta, T. (Ed.). (2017). *Air Pollution Impacts on Plants in East Asia*. Tokyo: Springer Japan. https://doi.org/10.1007/978-4-431-56438-6

Jackson, J. B. C., Kirby, M. X., Berger, W. H., Bjorndal, K. A., Botsford, L. W., Bourque, B. J., Bradbury, R. H., Cooke, R., Erlandson, J., & Estes, J. A. (2001). Historical overfishing and the recent collapse of coastal ecosystems. *Science*, *293*(5530), 629–637.

Jacobs, M. (2013). Green Growth. In R. Falkner (Ed.), *The Hanbook of Global Climate and Environment Policy* (pp. 197–214). Oxford, UK: John Wiley & Sons, Inc. Retrieved from http://www20.iadb.org/intal/catalogo/PE/2012/10496.pdf

Jambeck, J. R., Geyer, R., Wilcox, C., Siegler, T. R., Perryman, M., Andrady, A., Narayan, R., & Law, K. L. (2015). Plastic waste inputs from land into the ocean. *Science*, *347*(6223), 768–771. https://doi.org/10.1126/science.1260352

Janke, T. (2009). *Report on the Current Status of Indigenous Intellectual Property*. Canberra: Terri Janke and Company Pty Ltd, National Centre for Indigenous Studies Australian National University and Jumbunna Indigenous House of Learning University of Techn.

Järvholm, B., & Bohlin, I. (2014). Evidence-based evaluation of information: the centrality and limitations of systematic reviews. *Scandinavian Journal of Public Health*, *42*(13 suppl), 3–10.

Jenkins, C. N., & Van Houtan, K. S. (2016). Global and regional priorities for marine biodiversity protection. *Biological Conservation*, *204*, 6–12. https://doi.org/10.1016/j.biocon.2016.10.005

Johansson, D. J. A., Lucas, P. L., Weitzel, M., Ahlgren, E. O., Bazaz, A. B., Chen, W., den Elzen, M. G. J., Ghosh, J., Grahn, M., Liang, Q.-M., Peterson, S., Pradhan, B. K., van Ruijven, B. J., Shukla, P. R., van Vuuren, D. P., & Wei, Y.-M. (2015). Multi-model comparison of the economic and energy implications for China and India in an international climate regime. *Mitigation and Adaptation Strategies for Global Change*, *20*(8), 1335–1359. https://doi.org/10.1007/s11027-014-9549-4

Johnston, R. M., Hoanh, C., Lacombe, G., Noble, A., Smakhtin, V., Suhardiman, D., Kam Suan, P., & Choo, P. (2010). *Rethinking agriculture in the Greater Mekong Subregion: how to sustainably meet food needs, enhance ecosystem services and cope with climate change*. IWMI.

Joppa, L. N., Visconti, P., Jenkins, C. N., & Pimm, S. L. (2013). Achieving the convention on biological diversity’s goals for plant conservation. *Science*, *341*(6150), 1100–1103.

Juffe-Bignoli, D., Brooks, T. M., Butchart, S. H. M., Jenkins, R. B., Boe, K., Hoffmann, M., Angulo, A., Bachman, S., Böhm, M., Brummitt, N., Carpenter, K. E., Comer, P. J., Cox, N., Cuttelod, A., Darwall, W. R. T., Di Marco, M., Fishpool, L. D. C., Goettsch, B., Heath, M., Hilton-Taylor, C., Hutton, J., Johnson, T., Joolia, A., Keith, D. A., Langhammer, P. F., Luedtke, J., Nic Lughadha, E., Lutz, M., May, I., Miller, R. M., Oliveira-Miranda, M. A., Parr, M., Pollock, C. M., Ralph, G., Rodríguez, J. P., Rondinini, C., Smart, J., Stuart, S., Symes, A., Tordoff, A. W., Woodley, S., Young, B., & Kingston, N. (2016). Assessing the Cost of Global Biodiversity and Conservation Knowledge. *PLoS ONE*, *11*(8), e0160640. https://doi.org/10.1371/journal.pone.0160640

Juffe-Bignoli, D., Burgess, N. D., Bingham, H., Belle, E. M. S., De Lima, M. G., Deguignet, M., Bertzky, B., Milam, A. N., Martinez-Lopez, J., & Lewis, E. (2014). *Protected planet report 2014. Cambridge, UK: UNEP-WCMC*. Retrieved from http://wdpa.s3.amazonaws.com/WPC2014/protected_planet_report.pdf

Jung, W. (2016). Environmental Challenges and Cooperation in Northeast Asia. Retrieved March 29, 2017, from http://isdp.eu/publication/environmental-challenges-cooperation-northeast-asia/

Jupiter, S., Mangubhai, S., & Kingsford, R. T. (2014). Conservation of biodiversity in the Pacific Islands of Oceania: challenges and opportunities. *Pacific Conservation Biology*, *20*(2), 206–220.

Kamieniecki, S., Gonzalez, G. A., & Vos, R. O. (Eds.). (1997). *Flashpoints in environmental policymaking: controversies in achieving sustainability*. SUNY Press.

Kanie, N. (2014). Governance with Multilateral Environmental Agreements: A Healthy or Ill-equipped Fragmentation? *Green Planet Blues: Critical Perspectives on Global Environmental Politics*, 137.

Kariuki, J. W. (2008). The governance of biodiversity in Kakamega Forest, Kenya. Dortmund, Technische Universität, Diss., 2008.

Karki, M., & Adhikari, J. R. (2015). Integrating indigenous, local and modern knowledge for sustainable conservation and management of forest ecosystems in Nepal. Retrieved from http://www.forestrynepal.org/publications/article/6307

Karki, M., Chaudhary, R. P., Shrestha, K. K., Sakurai, Y., & Pandey, D. P. (Eds.). (2017). *IPBES-JBF Sub-regional Dialogue Workshop Report on Indigenous and Local Knowledge (ILK) for South and West Asia sub-region, Nepal (29 November - 2 December 2016, Dhulikhel (Kathmandu), Nepal)*. Hayama, Japan: Institute for Global Environmental Strategies. Retrieved from https://pub.iges.or.jp/pub/ipbes-jbf-sub-regional-dialogue-workshop

Katayama, N., Baba, Y. G., Kusumoto, Y., & Tanaka, K. (2015). A review of post-war changes in rice farming and biodiversity in Japan. *Agricultural Systems*, *132*, 73–84. https://doi.org/10.1016/j.agsy.2014.09.001

Kato, K., & Takahashi, W. (2000). *An Overview of Regional/Subregional Environmental Cooperation In Asia and the Pacific*. Retrieved from https://pub.iges.or.jp/system/files/publication_documents/pub/discussionpaper/923/overview_asia_pacific.pdf

Kawai, M., & Wignaraja, G. (2010). *Asian FTAs : Trends, Prospects, and Challenges* (ADB Economics Working Paper Series).

Keener, V. W., Marra, J. J., Finucane, M. L., Spooner, D., & Smith, M. H. (2012). *Climate Change and PaCifiC islands: indiCators and imPaCts Pacific Islands Regional Climate Assessment (PIRCA)*. Island Press. Retrieved from www.EastWestCenter.org/PIRCA.

Kiel, S. (Ed.). (2010). *The Vent and Seep Biota* (Topics of). New York: Springer.

Kier, G., Kreft, H., Lee, T. M., Jetz, W., Ibisch, P. L., Nowicki, C., Mutke, J., & Barthlott, W. (2009). A global assessment of endemism and species richness across island and mainland regions. *Proceedings of the National Academy of Sciences*, *106*(23), 9322–9327. https://doi.org/10.1073/pnas.0810306106

Koetz, T., Bridgewater, P., van den Hove, S., & Siebenhüner, B. (2008). The role of the Subsidiary Body on Scientific, Technical and Technological Advice to the Convention on Biological Diversity as science–policy interface. *Environmental Science & Policy*, *11*(6), 505–516.

Koh, L. P., Miettinen, J., Liew, S. C., & Ghazoul, J. (2011). Remotely sensed evidence of tropical peatland conversion to oil palm. *Proceedings of the National Academy of Sciences of the United States of America*, *108*(12), 5127–5132. https://doi.org/10.1073/pnas.1018776108

Koh, L. P., & Wilcove, D. S. (2008). Is oil palm agriculture really destroying tropical biodiversity? *Conservation Letters*, *1*(2), 60–64. https://doi.org/10.1111/j.1755-263X.2008.00011.x

Kohsaka, R. (2010). Developing biodiversity indicators for cities: Applying the DPSIR model to Nagoya and integrating social and ecological aspects. *Ecological Research*, *25*(5), 925–936. https://doi.org/10.1007/s11284-010-0746-7

Kohsaka, R., Tomiyoshi, M., Saito, O., Hashimoto, S., & Mohammend, L. (2015). Interactions of knowledge systems in shiitake mushroom production: a case study on the Noto Peninsula, Japan. *Journal of Forest Research*, *20*(5), 453–463.

Kollmair, M., & Hoermann, B. (2011). Labour migration in the Himalayas: opportunities and challenges. *Sustainable Mountain Development*, *59*, 3–8.

Kumar, R., Horwitz, P., Milton, G. R., Sellamuttu, S. S., Buckton, S. T., Davidson, N. C., Pattnaik, A. K., Zavagli, M., & Baker, C. (2011). Assessing wetland ecosystem services and poverty interlinkages: a general framework and case study. *Hydrological Sciences Journal*, *56*(8), 1602–1621.

Ladle, R.J. and Whittaker, R. J. (Ed.). (2011). *Conservation Biogeography*. Wiley-Blackwell, Oxford.

Lambin, E. F., & Meyfroidt, P. (2011). Global land use change, economic globalization, and the looming land scarcity. *Proceedings of the National Academy of Sciences*, *108*(9), 3465–3472.

Laurance, W. F., Clements, G. R., Sloan, S., O'Connell, C. S., Mueller, N. D., Goosem, M., Venter, O., Edwards, D. P., Phalan, B., Balmford, A., Van Der Ree, R., & Arrea, I. B. (2014). A global strategy for road building. *Nature*, *513*(7517), 229–232. https://doi.org/10.1038/nature13717

Laurance, W. F., Koh, L. P., Butler, R., Sodhi, N. S., Bradshaw, C. J. A., Neidel, J. D., Consunji, H., & Mateo Vega, J. (2010). Improving the performance of the Roundtable on Sustainable Palm Oil for nature conservation. *Conservation Biology : The Journal of the Society for Conservation Biology*, *24*(2), 377–381. https://doi.org/10.1111/j.1523-1739.2010.01448.x

Lavides, M. N., Molina, E. P. V, Gregorio Jr, E., Mill, A. C., Rushton, S. P., Stead, S. M., & Polunin, N. V. C. (2016). Patterns of coral-reef finfish species disappearances inferred from fishers' knowledge in global epicentre of marine shorefish diversity. *PloS One*, *11*(5), e0155752.

Leimona, B., Lusiana, B., van Noordwijk, M., Mulyoutami, E., Ekadinata, A., & Amaruzaman, S. (2015). Boundary work: Knowledge co-production for negotiating payment for watershed services in Indonesia. *Ecosystem Services*, *15*, 45–62. https://doi.org/10.1016/j.ecoser.2015.07.002

Leimona, B., van Noordwijk, M., de Groot, R., & Leemans, R. (2015). Fairly efficient, efficiently fair: Lessons from designing and testing payment schemes for ecosystem services in Asia. *Ecosystem Services*, *12*, 16–28. https://doi.org/http://dx.doi.org/10.1016/j.ecoser.2014.12.012

Lele, S., Wilshusen, P., Brockington, D., Seidler, R., & Bawa, K. (2010). Beyond exclusion: alternative approaches to biodiversity conservation in the developing tropics. *Current Opinion in Environmental Sustainability*, *2*(1), 94–100.

Lim, M. (2016). Governance criteria for effective transboundary biodiversity conservation. *International Environmental Agreements: Politics, Law and Economics*, *16*(6), 797–813. https://doi.org/10.1007/s10784-015-9296-3

Lira-Noriega, A., & Soberón, J. (2015). The relationship among biodiversity, governance, wealth, and scientific capacity at a country level: Disaggregation and prioritization. *Ambio*, *44*(5), 391–400.

Liu, X., Zhang, Y., Han, W., Tang, A., Shen, J., Cui, Z., Vitousek, P., Erisman, J. W., Goulding, K., Christie, P., Fangmeier, A., & Zhang, F. (2013). Enhanced nitrogen deposition over China. *Nature*, *494*(7438), 459–462. https://doi.org/10.1038/nature11917

Lixinski, L. (2008). World Heritage and the Heritage of the World – Book Review; F. Francioni And F. Lenzerini, The 1972 World Heritage Convention: A Commentary, Oxford, Oxford University Press, 2008. *European Journal of Legal Studies*, *2*(1), 371–386.

Long, J., Giri, C., Primavera, J., & Trivedi, M. (2016). Damage and recovery assessment of the Philippines' mangroves following Super Typhoon Haiyan. *Marine Pollution Bulletin*, *109*(2), 734–743. https://doi.org/10.1016/j.marpolbul.2016.06.080

Luo, T., Maddocks, A., Iceland, C., Ward, P., & Winsemius, H. (2015). World's 15 Countries with the Most People Exposed to River Floods. Retrieved April 5, 2016, from http://www.wri.org/blog/2015/03/world's-15-countries-most-people-exposed-river-floods

Ma, Z., Wang, Y., Gan, X., Li, B., Cai, Y., & Chen, J. (2009). Waterbird population changes in the wetlands at Chongming Dongtan in the Yangtze River estuary, China. *Environmental Management*, *43*(6), 1187–1200.

Maddocks, A., & Reig, P. (2014). World's 18 Most Water-Stressed Rivers. Retrieved from http://www.wri.org/blog/2014/03/world's-18-most-water-stressed-rivers

Maffi, L. (2007). Biocultural Diversity and Sustainability. In *The SAGE Handbook of Environment and Society* (pp. 267–278). 1 Oliver's Yard, 55 City Road, London EC1Y 1SP United Kingdom: SAGE Publications Ltd. https://doi.org/10.4135/9781848607873.n18

Marshall, E., Schreckenberg, K., & Newton, A. C. (2006). *Commercialization of non-timber forest products: factors influencing success: lessons learned from Mexico and Bolivia and policy implications for decision-makers*. UNEP/Earthprint.

Marshall, N. A., Bohensky, E., Curnock, M., Goldberg, J., Gooch, M., Nicotra, B., Pert, P., Scherl, L. M., Stone-Jovicich, S., & Tobin, R. C. (2016). Advances in monitoring the human dimension of natural resource systems: an example from the Great Barrier Reef. *Environmental Research Letters*, *11*(11), 114020. https://doi.org/10.1088/1748-9326/11/11/114020

Martín-López, B., Gómez-Baggethun, E., García-Llorente, M., & Montes, C. (2014). Trade-offs across value-domains in ecosystem services assessment. *Ecological Indicators*, *37*(PART A), 220–228. https://doi.org/10.1016/j.ecolind.2013.03.003

McCarthy, D. P., Donald, P. F., Scharlemann, J. P. W., Buchanan, G. M., Balmford, A., Green, J. M. H., Bennun, L. A., Burgess, N. D., Fishpool, L. D. C., Garnett, S. T., Leonard, D. L., Maloney, R. F., Morling, P., Schaefer, H. M., Symes, A., Wiedenfeld, D. A., & Butchart, S. H. M. (2012). Financial Costs of Meeting Global Biodiversity Conservation Targets: Current Spending and Unmet Needs. *Science*. Retrieved from http://science.sciencemag.org/content/early/2012/10/10/science.1229803.abstract

McCartney, M., Rebelo, L.-M., Senaratna Sellamuttu, S., & De Silva, S. (2010). *Wetlands, agriculture and poverty reduction* (Vol. 137). IWMI.

McDonald, R. I., Forman, R. T. T., Kareiva, P., Neugarten, R., Salzer, D., & Fisher, J. (2009). Urban effects, distance, and protected areas in an urbanizing world. *Landscape and Urban Planning*, *93*(1), 63–75. https://doi.org/10.1016/j.landurbplan.2009.06.002

McGinnis, M. D., & Ostrom, E. (2014). Social-ecological system framework: initial changes and continuing challenges. *Ecology and Society*, *19*(2), 30.

Meadows, D. H., Meadows, D. L., Randers, J., & Behrens, W. . I. (1972). *The Limits to Growth: A report for the Club of Rome's project on the predicament of mankind*. New York: Universe Books.

Mendiratta, U., Sheel, V., & Singh, S. (2017). Enforcement seizures reveal large-scale illegal trade in India's tortoises and freshwater turtles. *Biological Conservation*, *207*, 100–105. https://doi.org/10.1016/j.biocon.2017.01.023

Meyer, C., Kreft, H., Guralnick, R. P., & Jetz, W. (2015). Global priorities for an effective information basis of biodiversity distributions. *Nature Communications*, *6*, 8221. https://doi.org/10.1038/ncomms9221

Meyfroidt, P., Rudel, T. K., & Lambin, E. F. (2010). Forest transitions, trade, and the global displacement of land use. *Proceedings of the National Academy of Sciences*, *107*(49), 20917–20922. https://doi.org/10.1073/pnas.1014773107

Mihoub, J.-B., Henle, K., Brotons, L., Brummitt, N., Titeux, N., & Schmeller, D. S. (2017). Setting temporal baselines for biodiversity: the limits of available monitoring data for capturing the full impact of anthropogenic pressures. *Scientific Reports*, *in press*(December 2016), 1–11. https://doi.org/10.1038/srep41591

Millenium Ecosystem Assessment. (2005). *Ecosystems and Human Well-Being: Biodiversity Synthesis*. *World Resources Institute*. Washington, DC. https://doi.org/10.1057/9780230625600

Millennium Ecosystem Assessment. (2005). *Ecosystems and Human Well-Being Vol. 5* (Vol. 5). Washington, DC: Island Press.

Mittermeier, R. A., Robles-Gil, P., Hoffmann, M., Pilgrim, J. D., Brooks, T. B., Mittermeier, C. G., Lamoreux, J. L., & Fonseca, G. A. B. (2004). *Hotspots Revisited: Earth's Biologically Richest and Most Endangered Ecoregions*. Mexico City, Mexico: CEMEX.

Mittermeier, R. A., Turner, W. R., Larsen, F. W., Brooks, T. M., & Gascon, C. (2011). Global biodiversity conservation: the critical role of hotspots. In *Biodiversity hotspots* (pp. 3–22). Springer.

Moran, D., & Kanemoto, K. (2017). Identifying species threat hotspots from global supply chains. *Nature Ecology & Evolution*, *1*(1). https://doi.org/10.1038/s41559-016-0023

Morand, S., Lajaunie, C., & Satrawaha, R. (2017). *Biodiversity Conservation in Southeast Asia: Challenges in a Changing Environment*. Taylor & Francis. Retrieved from https://books.google.co.jp/books?id=UpcuDwAAQBAJ

MRGI. (2003). Report on Intellectual and Cultural Property Rights of Indigenous and Tribal Peoples in Asia. Retrieved from http://www.ecologyandsociety.org/vol17/iss1/art23/

Nadon, M. O. (2017). Stock Assessment of the Coral Reef Fishes of Hawaii, 2016.

Nair, D. (2015). Saving the states' face: an ethnography of the ASEAN secretariat and diplomatic field in Jakarta. The London School of Economics and Political Science (LSE).

Nakano, S., Yahara, T., & Nakashizuka, T. (Eds.). (2014). *Integrative Observations and Assessments*. Tokyo: Springer Japan. https://doi.org/10.1007/978-4-431-54783-9

Nakashima, D., Galloway, K., McLean, K., Thulstrup, H., Castillo, A., & Rubis, J. (2012). *Weathering Uncertainty: Traditional Knoweldge for Climate Change Assessment and Adaptation.* UNESCO and UNU, Paris and Darwin.

Noss, R. F., Platt, W. J., Sorrie, B. A., Weakley, A. S., Means, D. B., Costanza, J., & Peet, R. K. (2015). How global biodiversity hotspots may go unrecognized: Lessons from the North American Coastal Plain. *Diversity and Distributions*, *21*(2), 236–244. https://doi.org/10.1111/ddi.12278

Nuuhiwa, K., Lilly, O., Nobrega-Olivera, M., & Huihui, M. (2016). Aimalama: E Mauliauhonua ? Readapting to Ancestral Knowledge for Survival,Aimalama. Retrieved November 26, 2016, from http://www.aimalama.org/wp-content/uploads/'Aimalama-—-E-Mauliauhonua.pdf

OECD. (2014). *Green Growth Indicators 2014, OECD Green Growth Studies*. OECD Publishing. https://doi.org/10.1787/9789264202030-en

Ojha, H. R., Subedi, B., Dhungana, H., & Paudel, D. (2008). Citizen participation in forest governance: Insights from community forestry in Nepal. In *Conference on "Environmental Governance and Democracy," May* (pp. 10–11).

Oldfield, S. (Ed.). (2003). *The Trade in Wildlife: Regulation for Conservation*. London: Earthscan Publications Ltd.

Oliver, J., & Noordeloos, M. (2002). ReefBase: A global information system oncoral reefs.

Olson, D. M., Dinerstein, E., Wikramanayake, E. D., Burgess, N. D., Powell, G. V. N., Underwood, E. C., D'amico, J. a., Itoua, I., Strand, H. E., Morrison, J. C., Loucks, C. J., Allnutt, T. F., Ricketts, T. H., Kura, Y., Lamoreux, J. F., Wettengel, W. W., Hedao, P., & Kassem, K. R. (2001). Terrestrial Ecoregions of the World: A New Map of Life on Earth. *BioScience*, *51*(11), 933. https://doi.org/10.1641/0006-3568(2001)051[0933:TEOTWA]2.0.CO;2

Ostrom, E. (2009). A General Framework for Analyzing Sustainability of Social-Ecological Systems. *Science, New Series*, *325*(5939), 419–422. https://doi.org/10.1126/science.1172133

Oteros-Rozas, E., Ontillera-Sánchez, R., Sanosa, P., Gómez-Baggethun, E., Reyes-García, V., & González, J. A. (2013). Traditional ecological knowledge among transhumant pastoralists in Mediterranean Spain. *Ecology and Society*, *18*(3), 33. https://doi.org/10.5751/ES-05597-180333

Pandit, R., & Bevilacqua, E. (2011). Social heterogeneity and community forestry processes: reflections from forest users of Dhading District, Nepal. *Small-Scale Forestry*, *10*(1), 97–113.

Parks for the Planet Forum. (2016). Session 571 The Next Frontier: Transboundary Cooperation for Biodiversity and Peace Report. In C. Odenigbo (Ed.), *Salzburg Global Seminar*. Salzburg.

Pasakhala, B., Rucha, G., & Kotru, R. (2017). *Integrating Conservation and Development in Transboundary Landscapes: Looking Back to Move Forward*.

Pascual, U., Balvanera, P., Díaz, S., Pataki, G., Roth, E., Stenseke, M., Watson, R., Dessane, E., Breslow, S., Islar, M., Kelemen, E., Keune, H., Maris, V., Pengue, W., Quaas, M., Subramanian, S., Wittmer, H., Mohamed, A., Al-Hafedh, Y., Asah, S., Berry, P., Bilgin, E., Bullock, C., Cáceres, D., Golden, C., Gómez-Baggethun, E., González-Jiménez, D., Houdet, J., Kumar, R., May, P., Mead, A., O'Farrell, P., Pacheco-Balanza, D., Pandit, R., Pichis-Madruga, R., Popa, F., Preston, S., Saarikoski, H., Strassburg, B., Verma, M., Yagi, N., Ahn, S., Amankwah, E., Daly-Hassen, H., Figueroa, E., Ma, K., van den Belt, M., & Wickson, F. (2017). Valuing nature's contributions to people: The IPBES approach. *Current Opinion in Environmental Sustainability*, *26*, 7–16. https://doi.org/10.1016/j.cosust.2016.12.006

Paudyal, K., Baral, H., Burkhard, B., Bhandari, S. P., & Keenan, R. J. (2015). Participatory assessment and mapping of ecosystem services in a data-poor region: Case study of community-managed forests in central Nepal. *Ecosystem Services*, *13*, 81–92.

Phelps, J., & Webb, E. L. (2015). "Invisible" wildlife trades: Southeast Asia's undocumented illegal trade in wild ornamental plants. *Biological Conservation*, *186*, 296–305. https://doi.org/10.1016/j.biocon.2015.03.030

Piao, S., Ciais, P., Huang, Y., Shen, Z., Peng, S., Li, J., Zhou, L., Liu, H., Ma, Y., Ding, Y., Friedlingstein, P., Liu, C., Tan, K., Yu, Y., Zhang, T., & Fang, J. (2010). The impacts of climate change on water resources and agriculture in China. *Nature*, *467*(7311), 43–51. https://doi.org/10.1038/nature09364

Porter-Bolland, L., Ellis, E. A., Guariguata, M. R., Ruiz-Mallén, I., Negrete-Yankelevich, S., & Reyes-García, V. (2012). Community managed forests and forest protected areas: An assessment of their conservation effectiveness across the tropics. *Forest Ecology and Management*, *268*(Supplement C), 6–17. https://doi.org/https://doi.org/10.1016/j.foreco.2011.05.034

Pratchett, M. S., Bay, L. K., Gehrke, P. C., Koehn, J. D., Osborne, K., Pressey, R. L., Sweatman, H. P. A., & Wachenfeld, D. (2011). Contribution of climate change to degradation and loss of critical fish habitats in Australian marine and freshwater environments. *Marine and Freshwater Research*, *62*(9), 1062–1081.

Pratt, C., & Govan, H. (2010). *Our Sea of Islands Our Livelihoods Our Oceania. Framework for a Pacific Oceanscape: a catalyst for implementation of ocean policy*. *Framework for a Pacific Oceanscape: a catalyst for implementation of ocean policy. Suva*. Suva. Retrieved from http://www.sprep.org/att/publication/000937_684.pdf

Prip, C. (2017). The Convention on Biological Diversity as a legal framework for safeguarding ecosystem services. *Ecosystem Services*, (August 2016), 1–6. https://doi.org/10.1016/j.ecoser.2017.02.015

Quammen, D. (1996). The song of the dodo: island biogeography in an age of extinction. *Hutchinson, London*.

Ramankutty, N., Evan, A. T., Monfreda, C., & Foley, J. A. (2008). Farming the planet: 1. Geographic distribution of global agricultural lands in the year 2000. *Global Biogeochemical Cycles*, *22*(1), n/a-n/a. https://doi.org/10.1029/2007GB002952

Razal, R. A. (2016). *Early analysis report on "Impact of the asean economic community (aec) on social forestry and forest products trade"; Auhtors: Ramon A. Razal, Anna Floresca F. Firmalino, and Maria Cristina S. Guerrero; NTFP-EP*.

Reardon, T., & Timmer, C. P. (2014). Five inter-linked transformations in the Asian agrifood economy: Food security implications. *Global Food Security*, *3*(2), 108–117. https://doi.org/10.1016/j.gfs.2014.02.001

Reid, W., Berkes, F., Wilbranks, T., & Capistrano, D. (Eds.). (2006). *Bridging Scales and Knowledge Systems. Concepts and Applications in Ecosystem Assessment / Millenium Ecosystem Assessment*. Washington DC, USA: Island Press.

Revenga, C., & Tyrrell, T. (2016). Major River Basins of the World. In *The Wetland Book* (18 August, pp. 1–16).

Reyes, M., Engel, M., May, S. M., Brill, D., & Brueckner, H. (2015). Life and death after super typhoon Haiyan. *Coral Reefs*, *34*(2), 419.

Roberts, C. M., McClean, C. J., Veron, J. E. N., Hawkins, J. P., Allen, G. R., McAllister, D. E., Mittermeier, C. G., Schueler, F. W., Spalding, M., Wells, F., Vynne, C., & Werner, T. B. (2002). Marine biodiversity hotspots and conservation priorities for tropical reefs. *Science*, *295*(5558), 1280–1284. https://doi.org/10.1126/science.1067728

Roux, D. J., Rogers, K. H., Biggs, H., Ashton, P. J., & Sergeant, A. (2006). Bridging the science-management divide: Moving from unidirectional knowledge transfer to knowledge interfacing and sharing.

Sanciangco, J. C., Carpenter, K. E., Etnoyer, P. J., & Moretzsohn, F. (2013). Habitat Availability and Heterogeneity and the Indo-Pacific Warm Pool as Predictors of Marine Species Richness in the Tropical Indo-Pacific. *PLoS ONE*, *8*(2). https://doi.org/10.1371/journal.pone.0056245

Satterthwaite, D., McGranahan, G., & Tacoli, C. (2010). Urbanization and its implications for food and farming. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *365*(1554), 2809 LP-2820. Retrieved from http://rstb.royalsocietypublishing.org/content/365/1554/2809.abstract

Scarano, F. R. (2017). Ecosystem-based adaptation to climate change: concept, scalability and a role for conservation science. *Perspectives in Ecology and Conservation*, *15*(2), 65–73. https://doi.org/https://doi.org/10.1016/j.pecon.2017.05.003

Schipper, J., Chanson, J. S., Chiozza, F., Cox, N. A., Hoffmann, M., Katariya, V., Lamoreux, J., Rodrigues, A. S. L., Stuart, S. N., & Temple, H. J. (2008). The status of the world's land and marine mammals: diversity, threat, and knowledge. *Science*, *322*(5899), 225–230.

Schreurs, M. A. (2000). An Analytic Framework for a Comparative Study of Environmental Governance in Asia. *IGES Environmental Governance (1999)*.

Segger, M. C. C., & Phillips, F.-K. (2015). Indigenous traditional knowledge for sustainable development: the biodiversity convention and plant treaty regimes. *Journal of Forest Research*, *20*(5), 430–437.

Selig, E. R., Turner, W. R., Troëng, S., Wallace, B. P., Halpern, B. S., Kaschner, K., Lascelles, B. G., Carpenter, K. E., & Mittermeier, R. A. (2014). Global priorities for marine biodiversity conservation. *PLoS ONE*, *9*(1), 1–11. https://doi.org/10.1371/journal.pone.0082898

Senaratna Sellamuttu, S., de Silva, S., & Nguyen-Khoa, S. (2011). Exploring relationships between conservation and poverty reduction in wetland ecosystems: lessons from 10 integrated wetland conservation and poverty reduction initiatives. *International Journal of Sustainable Development & World Ecology*, *18*(4), 328–340.

Seto, K. C., Güneralp, B., & Hutyra, L. R. (2012). Global forecasts of urban expansion to 2030 and direct impacts on biodiversity and carbon pools. *Proceedings of the National Academy of Sciences of the United States of America*, *109*(40), 16083–16088. https://doi.org/10.1073/pnas.1211658109

Shakya, B., Chettri, N., & Rawat, G. S. (2012). Transboundary landscape management framework for ecological and socioeconomic resilience. *ICIMOD Working Paper*, (2012/7), 32 pp.-32 pp.

Shan, X., Sun, P., Jin, X., Li, X., & Dai, F. (2013). Long-term changes in fish assemblage structure in the Yellow River Estuary ecosystem, China. *Marine and Coastal Fisheries*, *5*(1), 65–78.

Short, F., Carruthers, T., Dennison, W., & Waycott, M. (2007). Global seagrass distribution and diversity: a bioregional model. *Journal of Experimental Marine Biology and Ecology*, *350*(1), 3–20.

Singh, G. G., Cisneros-Montemayor, A. M., Swartz, W., Cheung, W., Guy, J. A., Kenny, T. A., McOwen, C. J., Asch, R., Geffert, J. L., Wabnitz, C. C. C., Sumaila, R., Hanich, Q., & Ota, Y.

(2017). A rapid assessment of co-benefits and trade-offs among Sustainable Development Goals. *Marine Policy*, (March). https://doi.org/10.1016/j.marpol.2017.05.030
Sloan, S., Jenkins, C. N., Joppa, L. N., Gaveau, D. L. A., & Laurance, W. F. (2014). Remaining natural vegetation in the global biodiversity hotspots. *Biological Conservation*, *177*, 12–24. https://doi.org/10.1016/J.BIOCON.2014.05.027
Sohn, L. B. (1973). Stockholm Declaration on the Human Environment, The. *Harv. Int'l. LJ*, *14*, 423.
Spalding, M. ., Fox, H. ., Allen, G. ., Davidson, N., Ferdana, Z. A., Finlayson, M., Halpern, B. ., Jorge, M. ., Lombana, A. ., Lourie, S. A., Martin, K. ., McManus, E., Molnar, J., Rechhia, C. ., & Robertson, J. (2007). Marine Ecoregions of the World: A Bioregionalization of Coastal and Shelf Areas. *BioScience*, *57*(7), 573. https://doi.org/10.1641/B570707
Spalding, M. D., Ravilious, C., & Green, E. P. (2001). *World Atlas of Coral Reefs. Prepared at the UNEP World Conservation Monitoring Centre.* University of California Press, Berkeley, USA.
Squires, D. (2013). Biodiversity Conservation in Asia. *Asia & the Pacific Policy Studies*, *1*(1), 144–159. https://doi.org/10.1002/app5.13
Squires, D. (2014). Biodiversity conservation in Asia. *Asia & the Pacific Policy Studies*, *1*(1), 144–159.
Srinivas, H. (2015). The Indian Ocean Tsunami and its Environmental Impacts. Retrieved from https://www.gdrc.org/uem/disasters/disenvi/tsunami.html
Stattersfield, A. J., Crosby, M. J., Long, A. J., & Wege, D. C. (1998). Global directory of endemic bird areas. *BirdLife International, Cambridge, United Kingdom*.
Stavi, I., & Lal, R. (2015). Achieving Zero Net Land Degradation: Challenges and opportunities. *Journal of Arid Environments*, *112*(PA), 44–51. https://doi.org/10.1016/j.jaridenv.2014.01.016
Steinfeld, H., Gerber, P., Wassenaar, T., Castel, V., & de Haan, C. (2006). *Livestock's Long Shadow: Environmental Issues and Options*. Rome, Italy.
Stepp, J. R., Cervone, S., Castaneda, H., Lasseter, A., Stocks, G., & Gichon, Y. (2004). Development of a GIS for Global Biocultural Diversity. *Policy Matters*, *13*(November), 267–270. https://doi.org/Policy Matters
Stibig, H. J., Achard, F., Carboni, S., Raši, R., & Miettinen, J. (2014). Change in tropical forest cover of Southeast Asia from 1990 to 2010. *Biogeosciences*, *11*(2), 247–258. https://doi.org/10.5194/bg-11-247-2014
Stuart, S. N., Lynx Edicions, Conservation International, & International Union for Conservation of Nature and Natural Resources. (2008). *Threatened amphibians of the world* (1st ed). Lynx Edicions ; Gland, Switzerland : IUCN ; Arlington, Virginia : Conservation International, Barcelona.
Sugden, F., Maskey, N., Clement, F., Ramesh, V., Philip, A., & Rai, A. (2014). Agrarian stress and climate change in the Eastern Gangetic Plains: Gendered vulnerability in a stratified social formation. *Global Environmental Change*, *29*, 258–269.
Sullivan, C. A., Dudgeon, D., Bunn, S. E., Davies, P. M., Gessner, M. O., Glidden, S., Green, P., McIntyre, P. B., Prusevich, A., & Liermann, C. R. (2011). Saving the world's rivers: what must be done? *World Rivers Review*, *26*(4).
Swiderska, K., Roe, D., Siegele, L., & Grieg-Gran, M. (2008). *The governance of nature and the nature of governance: policy that works for biodiversity and livelihoods* (Vol. 8). IIED.
Takeuchi, K. (2010). Rebuilding the relationship between people and nature: the Satoyama Initiative. *Ecological Research*, *25*(5), 891–897. https://doi.org/10.1007/s11284-010-0745-8
Tangjang, S., & Nair, P. K. R. (2015). Rice+ fish farming in homesteads: sustainable natural-resource management for subsistence in Arunachal Pradesh, India. *J Environ Sci Eng A*, *4*, 545–557.
TEEB. (2010). *The Economics of Ecosystems and Biodiversity: Ecological and economic foundation*. Earthscan, Cambridge.
Thaman, R. R. (2008). Atolls–the "biodiversity cool spots" vs hot spots: a critical new focus for research and conservation. *Micronesica*, *40*(1/2), 33–61.
Thaman, R. R. (2009). Samoa and the Black Tuesday Tsunami 2009: Part 1. *Mai Life*, (Nov), 54–57.
Thaman, R. R. (2011). The silent invasion. *Mai Life*, *55(Dec)*, 64–65.
Thaman, R. R. (2013a). Ethno-biodiversity, Taxonomy and Bioinformatics for All Ages: Engaging and Educating the Next Generation of Taxonomists as a Foundation for Sustainable Living on Planet earth–Challenges and Opportunities. In *Tracking Key Trends in Biodiversity Science and*

Policy: Based on the Proceedings of a UNESCO International Conference on Biodiversity Science and Policy, edited by LA Brooks and S. Aricò (pp. 23–25).

Thaman, R. R. (2013b). *Islands on the frontline against the winds and waves of global change: Emerging environmental issues and actions to build resilience in Pacific small island developing states (PSIDS). Proceedings of the IGU Commission on Islands International Conference on Island Development: Local Economy, Culture, Innovation and Sustainability*. Makong, Penghu Archipelago Taiwan.

Thaman, R. R. (2013c). Silent alien invasion of our islands and seas: A call for action against invasive alien species (IAS). In H.-M. Tsai (Ed.), *2013 Proceedings of the IGU Commission on Islands International Conference on Island Development: Local Economy, Culture, Innovation and Sustainability. National Penghu University, Makong, Penghu Archipelago,Taiwan, October 1 – 5, 2013* (p. 2–D–3–1 – 6.).

Thaman, R. R. (2014). Agrodeforestation and the loss of agrobiodiversity in the Pacific Islands: a call for conservation. *Pacific Conservation Biology*, *20*(2), 180–192.

Thaman, R. R., Lyver, P., Mpande, R., Perez, E., Cariño, J., & Takeuchi, K. (Eds.). (2013). *The contribution of Indigenous and local knowledge systems to IPBES: Building synergies with science. IPBES Expert Meeting Report*. *IPBES Expert Meeting Report*. Paris.

Thompson, I. D. (2015). An overview of the science–policy interface among climate change, biodiversity, and terrestrial land use for production landscapes. *Journal of Forest Research*, *20*(5), 423–429.

Todd, P. A., Ong, X., & Chou, L. M. (2010). Impacts of pollution on marine life in Southeast Asia. *Biodiversity and Conservation*, *19*(4), 1063–1082. https://doi.org/10.1007/s10531-010-9778-0

Tonts, M., & Siddique, M. A. B. (2011). *Globalisation, agriculture and development: Perspectives from the Asia-Pacific*. Edward Elgar Publishing.

Turnhout, E., Gupta, A., Weatherley-Singh, J., Vijge, M. J., De Koning, J., Visseren-Hamakers, I. J., Herold, M., & Lederer, M. (2017). Envisioning REDD+ in a post-Paris era: between evolving expectations and current practice. *Wiley Interdisciplinary Reviews: Climate Change*, *8*(1).

Turvey, S. T., & Pettorelli, N. (2014). Spatial congruence in language and species richness but not threat in the world's top linguistic hotspot. *Proceedings of the Royal Society B: Biological Sciences*, *281*(1796), 20141644. https://doi.org/10.1098/rspb.2014.1644

UN-Habitat, & UNESCAP. (2015). *The State of Asian and Pacific Cities 2015, Urban transformations Shifting from quantity to quality*. Retrieved from http://www.unescap.org/sites/default/files/The State of Asian and Pacific Cities 2015.pdf

UNCSD. (2007). *Framing Sustainable Development; The Brundtland Report – 20 Years On; Sustainable Development Action*. New York.

UNDESA. (2013). *World Economic and Social Survey 2013: Sustainable Development Challenges*. *United Nations, Department for Economic and Social Affairs*. New York. https://doi.org/10.1016/j.compind.2010.10.001

UNDESA. (2015). *World Population Prospects: The 2015 Revision, Methodology of the United Nations Population Estimates and Projections*.

UNEP-WCMC. (2016). *The State of Biodiversity in Asia and The Pacific: A mid-term review of progress towards the Aichi Biodiversity Targets*. Cambridge, UK: UNEP-WCMC.

UNEP. (2011). *Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication*. Retrieved from www.unep.org/greeneconomy

UNEP. (2014). *Emerging issues for Small Island Developing States. Results of the UNEP/UN DESA Foresight Process.* Nairobi, Kenya.

UNEP. (2016a). *Enhancing cooperation among the seven biodiversity related agreements and conventions at the national level using national biodiversity strategies and action plans*. Nairobi, Kenya.

UNEP. (2016b). *Global Gender and Environment Outlook*. Nairobi, Kenya.

UNESCAP/ADB/UNDP. (2013). *Asia-Pacific Aspirations: Perspectives for a Post-2015 Development Agenda*. *Asia-Pacific Regional MDGs Report 2012/13*.

UNESCAP. (2015a). *Asia-Pacific Migration Report 2015. Migrants' Contributions to Development*. https://doi.org/10.1017/CBO9781107415324.004

UNESCAP. (2015b). *Economic and Social Survey of Asia and the Pacific 2015: Making Growth More Inclusive for Sustainable Development*. Bangkok. Retrieved from http://www.unescap.org/sites/default/files/Economic and Social Survey of Asia and the Pacific 2015.pdf

UNESCAP. (2017). *Statistical Yearbook for Asia and the Pacific 2016: SDG Baseline Report*. Bangkok. Retrieved from http://www.unescap.org/sites/default/files/ESCAP_SYB2016_SDG_baseline_report.pdf

UNESCAP, ADB, & UNEP. (2012). *Green Growth, Resources and Resilience: Environmental Sustainability in Asia and the Pacific*.

United Nations, Department of Economic and Social Affairs, P. D. (2015). *World Urbanization Prospects: The 2014 Revision, (ST/ESA/SER.A/366)*. New York. Retrieved from http://esa.un.org/unpd/wup/Publications/Files/WUP2014-Report.pdf

United Nations. (1992). Convention on biological diversity. Rio de Janeiro, Brazil.: Earth Summit.

United Nations. (2014). *World Economic Situation and Prospectus 2014*. Retrieved from http://www.un.org/en/development/desa/policy/wesp/wesp_archive/wesp2014.pdf

United Nations. (2015). *State of the World's Indigenous Peoples 2015*. Retrieved from http://www.un.org/esa/socdev/unpfii/documents/2015/sowip2volume-ac.pdf

United Nations. (2017). *Global Marine Litter Campaign*.

University of Florida. (2015). *Technical Report: Follow-up Project from the Risk Interpretation and Action Fellows Seminar; Developing an International Network on Indigenous Peoples and Disaster Risk Reduction* (No. Principal Investigator: Dr. Simone Athayde). Retrieved from www.indigenousknowledgenetwork.org

UNWTO. (2017). UNWTO Annual Report 2016, 74. Retrieved from http://cf.cdn.unwto.org/sites/all/files/pdf/annual_report_2016_web_0.pdf

Van Hinsbergen, D. J. J., Lippert, P. C., Dupont-Nivet, G., McQuarrie, N., Doubrovine, P. V, Spakman, W., & Torsvik, T. H. (2012). Greater India Basin hypothesis and a two-stage Cenozoic collision between India and Asia. *Proceedings of the National Academy of Sciences*, *109*(20), 7659–7664.

van Oort, B., Bhatta, L. D., Baral, H., Rai, R. K., Dhakal, M., Rucevska, I., & Adhikari, R. (2015). Assessing community values to support mapping of ecosystem services in the Koshi river basin, Nepal. *Ecosystem Services*, *13*, 70–80.

Vanhove, M. P. M., Rochette, A.-J., & Janssens de Bisthoven, L. (2017). Joining science and policy in capacity development for monitoring progress towards the Aichi Biodiversity Targets in the global South. *Ecological Indicators*, *73*, 694–697. https://doi.org/10.1016/j.ecolind.2016.10.028

Vasilijević, M., Zunckel, K., Mckinney, M., Erg, B., Schoon, M., & Michel, T. R. (2015). *Transboundary Conservation: A systematic and integrated approach*. *Best Practice Protected Area Guidelines Series No. 23*. https://doi.org/10.2305/IUCN.CH.2015.PAG.23.en

Vijay, V., Pimm, S. L., Jenkins, C. N., & Smith, S. J. (2016). The Impacts of Oil Palm on Recent Deforestation and Biodiversity Loss. *PLoS Biology*, 1–19. https://doi.org/10.1371/journal.pone.0159668

Vincent, P. (2008). *Saudi Arabia: an environmental overview*. Taylor & Francis.

Werner, T., & Allen, G. (1998). *A rapid biodiversity assessment of the coral reefs of Milne Bay Province, Papua New Guinea.* (No. RAP Working Papers 11). Washington, DC.

Werschkun, B., Banerji, S., Basurko, O. C., David, M., Fuhr, F., Gollasch, S., Grummt, T., Haarich, M., Jha, A. N., Kacan, S., Kehrer, A., Linders, J., Mesbahi, E., Pughiuc, D., Richardson, S. D., Schwarz-Schulz, B., Shah, A., Theobald, N., von Gunten, U., Wieck, S., & H??fer, T. (2014). Emerging risks from ballast water treatment: The run-up to the International Ballast Water Management Convention. *Chemosphere*, *112*, 256–266. https://doi.org/10.1016/j.chemosphere.2014.03.135

Wilkinson, C. (2002). *Status of coral reefs of the world – 2002*. Australian Institute of Marine Science, Townsville.

Wohlfart, C., Liu, G., Huang, C., & Kuenzer, C. (2016). A River Basin over the Course of Time: Multi-Temporal Analyses of Land Surface Dynamics in the Yellow River Basin (China) Based on Medium Resolution Remote Sensing Data. *Remote Sensing*, *8*(3), 186. https://doi.org/10.3390/rs8030186

WWF. (2014). *Green Growth in the Greater Mekong Subregion*. *WWF*. Gland, Switzerland.
WWF. (2017). Heart of Borneo. Retrieved February 24, 2017, from http://wwf.panda.org/what_we_do/where_we_work/borneo_forests/
Xu, J., Grumbine, R. E., Shrestha, A., Eriksson, M., Yang, X., Wang, Y. U. N., & Wilkes, A. (2009). The melting Himalayas: cascading effects of climate change on water, biodiversity, and livelihoods. *Conservation Biology*, *23*(3), 520–530.
Young, J. C., Waylen, K. A., Sarkki, S., Albon, S., Bainbridge, I., Balian, E., Davidson, J., Edwards, D., Fairley, R., Margerison, C., McCracken, D., Owen, R., Quine, C. P., Stewart-Roper, C., Thompson, D., Tinch, R., Van den Hove, S., & Watt, A. (2014). Improving the science-policy dialogue to meet the challenges of biodiversity conservation: having conversations rather than talking at one-another. *Biodiversity and Conservation*, *23*(2), 387–404. https://doi.org/10.1007/s10531-013-0607-0
Zarandian, A., Baral, H., Yavari, A. R., Jafari, H. R., Stork, N. E., Ling, M. A., & Amirnejad, H. (2016). Anthropogenic Decline of Ecosystem Services Threatens the Integrity of the Unique Hyrcanian (Caspian) Forests in Northern Iran. *Forests*, *7*(3), 51.
Zhang, B., Zhang, L., Guo, H., Leinenkugel, P., Zhou, Y., Li, L., & Shen, Q. (2014). Drought impact on vegetation productivity in the Lower Mekong Basin. *International Journal of Remote Sensing*, *35*(8), 2835–2856. https://doi.org/10.1080/01431161.2014.890298
Zhao, F., Wu, J., & Xue, D. (2013). Background, progress and prospect of traditional knowledge under the Convention on Biological Diversity. *Biodiversity Science*, *21*(2), 232–237. https://doi.org/10.3724/SP.J.1003.2013.06215
Ziegler, A. D., Phelps, J., Yuen, J. Q., Webb, E. L., Lawrence, D., Fox, J. M., Bruun, T. B., Leisz, S. J., Ryan, C. M., Dressler, W., Mertz, O., Pascual, U., Padoch, C., & Koh, L. P. (2012). Carbon outcomes of major land-cover transitions in SE Asia: Great uncertainties and REDD+ policy implications. *Global Change Biology*, *18*(10), 3087–3099. https://doi.org/10.1111/j.1365-2486.2012.02747.x
Ziv, G., Baran, E., Nam, S. S., Rodriguez-Iturbe, I., Levin, S. A., Rodríguez-Iturbe, I., & Levin, S. A. (2012). Trading-off fish biodiversity, food security, and hydropower in the Mekong River Basin. *Proceedings of the National Academy of Sciences*, *109*(15), 5609–5614. https://doi.org/10.1073/pnas.1201423109
Zomer, R. J., Trabucco, A., Metzger, M. J., Wang, M., Oli, K. P., & Xu, J. (2014). Projected climate change impacts on spatial distribution of bioclimatic zones and ecoregions within the Kailash Sacred Landscape of China, India, Nepal. *Climatic Change*. https://doi.org/10.1007/s10584-014-1176-2

Appendix

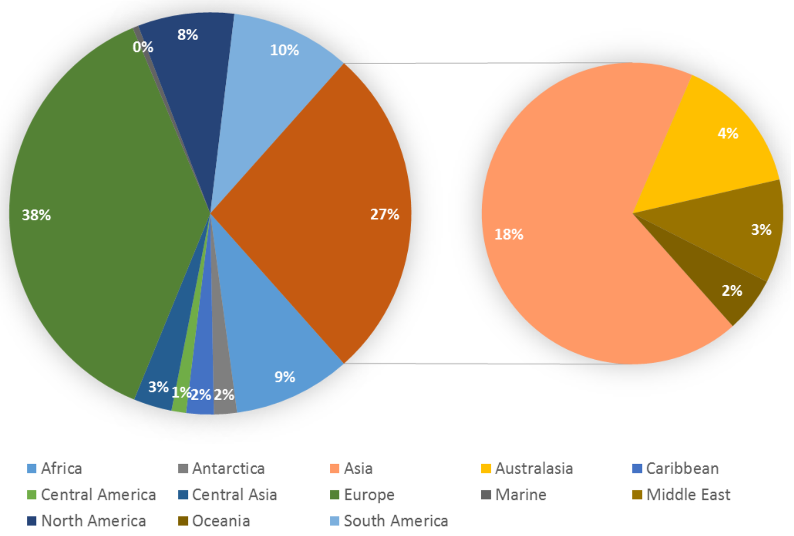
Table S1 Subregions, countries and territories of the Asia-Pacific region within the geographical focus of the Asia-Pacific regional assessment

Subregion	Country or Territory
Oceania (26)	American Samoa*, Australia, Commonwealth of the Northern Mariana Islands*, Cook Islands, Fiji, French Polynesia*, Guam*, Hawai'i*, Kiribati, Marshall Islands, Federated States of Micronesia, Nauru, New Caledonia*, New Zealand, Niue*, Palau, Papua New Guinea, Pitcairn Island*, Samoa, Solomon Islands, *Tokelau, Tonga, Tuvalu, Vanuatu, Wallis and Futuna, and oceanic and sub-Antarctic islands in the Pacific and Indian Oceans*
South-East Asia (11)	Brunei Darussalam, Cambodia, Indonesia, Lao People's Democratic Republic, Malaysia, Myanmar, Philippines, Singapore, Thailand, Timor-Leste, and Viet Nam
North-East Asia (5)	China, Democratic People's Republic of Korea, Japan, Mongolia, and Republic of Korea
South Asia (9)	Afghanistan, Bangladesh, Bhutan, India, Iran (Islamic Republic of), Maldives, Nepal, Pakistan and Sri Lanka
Western Asia (12)	Bahrain, Iraq, Jordan, Lebanon, Kuwait, Oman, Palestine (State of), Qatar, Saudi Arabia, Syrian Arab Republic, United Arab Emirates, and Yemen

Note: This list includes full UN member states as well as observer states, territories and other entities; (e.g., American Samoa, Guam, Hawai'i, New Caledonia, French Polynesia, State of Palestine) that are not fully recognised nation states or territories of nations under other regions such as USA, France and the UK; but they clearly fall under the geographical scope of the Asia-Pacific Assessment and existing subregional biodiversity assessments. Non-full UN member states are indicated with an asterisk*.

Table S2 Globally listed Birdlife International Important Bird and Biodiversity Area (IBAs)

No.	BirdLife Region	Number of IBAs
1	Africa	1,255
2	Antarctica	245
3	**Asia**	2,427
4	**Australasia**	532
5	Caribbean	294
6	Central America	155
7	Central Asia	410
8	Europe	4,982
9	Marine	62
10	**Middle East**	396
11	North America	1,030
12	**Oceania**	212
13	South America	1,283
	Asia-Pacific (3+4+10+12)	3,567
	TOTAL	13,283



Note: Asia-Pacific region bolded. Western Asia does not include Russia and Middle East does not include Israel. Source: Data downloaded from Birdlife International Data Zone (http://datazone.birdlife.org/site/search).

Table S3 Number of disasters and deaths by subregion in the Asia-Pacific region between 1900

and 2016 (as of October 1st 2016)

	Asia-Pacific region	Australia New Zealand	Central Asia	Eastern Asia	Melanesia	Micronesia	Polynesia	Southern Asia	Western Asia
Complex Disasters	610,000 (5)	0 (0)	0 (0)	610,000 (1)	0 (0)	0 (0)	0 (0)	0 (2)	0 (2)
Drought	9,664,084 (144)	600 (12)	0 (4)	3,503,534 (50)	84 (9)	0 (3)	0 (3)	6,150,518 (47)	0 (16)
Earthquake	1,618,408 (624)	471 (13)	189 (22)	1,088,044 (233)	2,751 (33)	0 (1)	197 (6)	435,515 (222)	91,241 (94)
Epidemic	6,527,700 (252)	6,700 (3)	261 (12)	1,562,080 (27)	451 (9)	42 (3)	8 (4)	4,957,089 (164)	1,069 (30)
Extreme temperature	27,017 (170)	509 (7)	31 (8)	1,211 (28)	0 (0)	0 (0)	0 (0)	25,085 (111)	181 (16)
Flood	6,786,130 (1,473)	350 (98)	1,680 (45)	6,619,962 (422)	206 (34)	0 (5)	6 (2)	159,629 (718)	4,297 (149)
Industrial accident	31,096 (778)	40 (6)	144 (6)	18,649 (560)	11 (1)	0 (0)	0 (0)	9,381 (155)	2,871 (50)
Insect infestation	0 (10)	0 (2)	0 (1)	0 (1)	0 (0)	0 (0)	0 (0)	0 (3)	0 (3)
Landslide	18,794 (285)	28 (3)	686 (22)	7,226 (103)	495 (12)	0 (0)	23 (3)	9,690 (124)	646 (18)
Mass movement (dry)	1,254 (19)	0 (0)	13 (2)	500 (7)	86 (2)	0 (0)	0 (0)	374 (6)	281 (2)
Miscellaneous accident	34,369 (504)	106 (9)	293 (13)	14,408 (190)	0 (0)	1 (1)	18 (2)	9,604 (211)	9,939 (78)
Storm	1,060,076 (1,430)	296 (116)	116 (5)	243,492 (657)	1,354 (103)	82 (22)	448 (65)	813,741 (412)	547 (50)
Transport accident	80,442 (1,736)	1,157 (29)	521 (18)	22,615 (383)	432 (11)	228 (1)	95 (2)	47,003 (1,044)	8,391 (248)
Volcanic activity	4,249 (42)	150 (2)	0 (0)	578 (16)	3,515 (21)	0 (1)	0 (1)	0 (0)	6 (1)
Wildfire	947 (104)	501 (39)	0 (1)	292 (45)	0 (1)	0 (0)	0 (1)	94 (7)	60 (10)
Total	26,455,218 (7576)	10,908 (339)	3,934 (159)	13,692,591 (2,723)	9,385 (236)	353 (37)	795 (89)	12,617,723 (3,226)	119,529 (767)

5.

Table S4 Core indicators for IPBES Assessments. Source: IPBES (2017b)

Aichi Target	Specific Indicator	DPSIR*	CF**	GA Chapter	RA Chapter	Origin***	BIP****	Source
4	Ecological Footprint	P	DD	2,3,4	4	CBD	B	Global Footprint Network
4	Percentage of Category 1 nations in CITES	R	IGID	2,3,6	4,6	CBD	BP	Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
4	Water Footprint (Human appropriation of fresh water)	P	DD	2,3,4	4	CBD		Water Footprint Network
5	Biodiversity Habitat Index	S	DD, BEF	2,3,4	3,4	CBD		GEO BON - CSIRO
5	Forest area as a percentage of total land area	S	DD, BEF	2,3,4	3,4	CBD	B	FAO
5	Trends in forest extent (tree cover)	S	DD, BEF	2,3,4	3,4	CBD		Hansen *et al*., 2013
5, 11, 12	Protected area coverage of Key Biodiversity Areas (including Important Bird and Biodiversity Areas, Alliance for Zero Extinction sites)	R	IGID, DD	2,3,4,6	4,6	CBD	BP	BirdLife International, IUCN, Alliance for Zero Extinction (AZE)
5, 12	Species Habitat Index	P, S	DD, BEF	2,3,4	3,4	CBD		GEO BON - Map of Life
5, 7, 14	Total wood removals	S,I	DD, NCP	2,3,4,5,6	2,4,5	Future Earth	BP	FAO
6	Estimated fisheries catch and fishing effort	P	DD, BEF	2,3,4	3,4	CBD		Sea Around Us
6	Marine Trophic Index	S	DD, BEF	2,3,4	3,4	Future Earth	B	Sea Around Us
6	Proportion of fish stocks within biologically sustainable levels	S	BEF	2,3	3	CBD	B	FAO
6	Trends in fisheries certified by the Marine Stewardship Council	R	IGID	2,3,4	3,4	CBD		Marine Stewardship Council
6, 14	Inland fishery production	S, I	BEF, NCP	2,3,4	2,4	Future Earth	BP	FAO
7	Nitrogen + Phosphate Fertilizers (N+P205 total nutrients)	P	DD	2,3,4	4	Future Earth	BP	FAO
7	Nitrogen Use Efficiency	P	DD	2,3,4	4	EPI		Lassaletta *et al*. (2014) from Environmental Performance Index (EPI)
7	Proportion of area of forest production under FSC and PEFC certification	R	IGID, DD	2,3,4,6	4,6	CBD	B	Forest Stewardship Council (FSC), Programme for the Endorsement of Forest Certification (PEFC)
8	Trends in nitrogen deposition	P	DD	2,3,4	4	CBD	B	International Nitrogen Initiative
8	Trends in pesticide use	P	DD	2,3,4	4	CBD	BP	FAO
11	Percentage of areas covered by protected areas - marine, coastal, terrestrial, inland water	R	IGID	2,3,6	4,6	CBD	B	UNEP-WCMC, IUCN
11	Protected Area Connectedness Index	R	DD, IGID	2,3,4,6	4,6	CBD		GEO BON - CSIRO
11	Protected area management effectiveness	R	IGID	2,3,6	4,6	IPBES	BP	UNEP-WCMC
11	Species Protection Index	P, R	IGID, DD	2,3,4,6	4,6	CBD		GEO BON - Map of Life
12	Red List Index	S	BEF	2,3	3	CBD	B	IUCN, BirdLife International and other Red List Partners
12, 14	Biodiversity Intactness Index	P, S	DD, BEF	2,3,4,5	4,5	CBD		GEO BON - PREDICTS

13	Proportion of local breeds, classified as being at risk, not-at-risk or unknown level of risk of extinction	S	BEF, NCP	2,3,4	2,3	CBD	B	FAO
14	Percentage of undernourished people	I	GQL	2,3,4	2	Future Earth	BP	FAO
17	Number of countries with developed or revised NBSAPs	R	IGID	2,3,6	4,6	CBD	B	Secretariat of the Convention on Biological Diversity (CBD)
19	Proportion of known species assessed through the IUCN Red List	R	IGID	2,3,6	4,6	CBD	BP	IUCN
19	Species Status Information Index	R	IGID, BEF	2,3,6	4,6	CBD		GEO BON - Map of Life

Note

* DPSIR - D: Drivers, P: Pressure, S: Status, I: Impact, R: Response

** CF (Conceptual Framework) - DD: direct driver, NCP: nature's contributions to people/ ecosystem goods and services, BEF: nature/biodiversity and ecosystem functions, IGID: institutions, governance and other indirect drivers, GQL: good quality of life/human well-being

*** CBD: Convention of Biological Diversity SBSTTA 20 draft indicator list; Future Earth: recommended by Future Earth indicator group; EPI: used in the Yale Environmental Protection Index; IPBES: added by the IPBES Task Force for Data and Knowledge

**** BIP (Biodiversity Indicator Partnership): B: indicators in BIP global suite, BP: data/indicator holder in BIP partnership

Table S5 Socio-economic indicators for IPBES Assessments. IPBES (2017b)

Aichi Target	Specific Indicator	DPSIR*	CF**	GA Chapter	RA Chapter	Origin***	BIP****	Source
	Total human population	P	IGID	2,3,6	4,6	Future Earth (S)		World Bank
	GDP	S	IGID	2,3,4	4,6	Future Earth (S)		World Bank
14	*Food security*: Countries requiring external assistance for food (famine relief)	S	GQL	2,3,4	2	Future Earth (S)	BP	FAO
14	*Food security*: Calorie supply per capita (kcal/capita.day)	S	GQL	2,3,4	2	Future Earth (S)	BP	FAO
14	*Water security*: Proportion of population using safely managed drinking water services (SDG 6.1.1)	S	GQL	2,3,4	2	CBD		UNICEF/WHO
14	*Water security*: Freshwater consumption as per cent of total renewable water resources/watershed	S	GQL	2,3,4	2	Future Earth (S)	BP	FAO
	Equity: GINI index	S	GQL	2,3,4	2	Future Earth (S)		World Bank
14	*Food*: World grain production by type/capita.year	S	NCP	2,3,4	2	Future Earth (S)	BP	FAO
18	*Non-material NCP*: Index of Linguistic Diversity (ILD)	S,P	NCP, IGID	2,3,4,6	2,4,6	CBD	B	UNESCO

Note

* DPSIR - D: Drivers, P: Pressure, S: Status, I: Impact, R: Response
** CF (Conceptual Framework) - DD: direct driver, NCP: nature's contributions to people/ ecosystem goods and services, BEF: nature/biodiversity and ecosystem functions, IGID: institutions, governance and other indirect drivers, GQL: good quality of life/human well-being
*** CBD: Convention of Biological Diversity SBSTTA 20 draft indicator list; Future Earth (S): recommended by Future Earth socio-ecological indicator group
**** BIP (Biodiversity Indicator Partnership): B: indicators in BIP global suite, BP: data/indicator holder in BIP partnership

Table S6 Examples of environmental cooperation agreements in the Asia-Pacific region

Regional Initiative	Source
The Association of Southeast Asian Nations (ASEAN)	
ASEAN Cooperation on Global Environmental Issues	http://environment.asean.org/asean-working-group-on-multilateral-environmental-agreements-awgmea/
ASEAN Agreement on Transboundary Haze Pollution	http://environment.asean.org/asean-cooperation-on-transboundary-haze-pollution/ http://haze.asean.org
ASEAN Cooperation on Environmental Education	http://environment.asean.org/asean-cooperation-on-environmental-education/
ASEAN Cooperation on Environmentally Sound Technologies (EST)	http://environment.asean.org/asean-cooperation-on-environmentally-sound-technologies-est/
ASEAN Cooperation on Environmentally Sustainable City	http://environment.asean.org/asean-working-group-on-environmentally-sustainable-cities/
ASEAN Cooperation on Nature Conservation and Biodiversity	http://environment.asean.org/asean-working-group-on-nature-conservation-and-biodiversity/
ASEAN Working Group on Coastal and Marine Environment	http://environment.asean.org/46-2/
ASEAN Cooperation on Water Resources Management	http://environment.asean.org/asean-working-group-on-water-resources-management-awgwrm/
ASEAN Cooperation on Climate Change	http://environment.asean.org/climate-change-page/
ASEAN Regional Centre for Biodiversity Conservation—now ASEAN Centre for Biodiversity	http://www.aseanbiodiversity.org/
The South Asian Association for Regional Corporation (SAARC)	
South Asia Environment Outlook (SAEO) 2009	http://www.saarc-sec.org/areaofcooperation/detail.php?activity_id=28
SAARC Meteorological Research Centre (SMRC)	http://www.saarc-sec.org/areaofcooperation/cat-detail.php?cat_id=46
Secretariat of the Pacific Regional Environment Programme (SPREP)	
The Pacific Adaptation to Climate Change The Pacific Climate Change Roundtable The Pacific Islands Framework for Action on Climate Change The Council of Regional Organizations in the Pacific (CROP) CEOs Working Group on Climate Change	https://www.sprep.org/pacc http://www.pacificclimatechange.net/ https://www.sprep.org/attachments/Publications/PIFACC-ref.pdf http://www.brookings.edu/~/media/research/files/reports/2013/07/pacific-regional-organizations-disasters/brookings_regional_orgs_pacific_july_2013.pdf
Biodiversity and Ecosystem Management	https://www.sprep.org/Biodiversity-and-Ecosystems-Management/bem-overview
Waste Management and Pollution Control	https://www.sprep.org/Waste-Management-and-Pollution-Control/wmp-overview
Environmental Monitoring and Governance	https://www.sprep.org/Environmental-Governance-Monitoring/overview
North-East Asian Subregional Programme for Environmental Cooperation (NEASPEC)	http://www.neaspec.org/
The Cooperation Council for the Arab States of the Gulf - known as Gulf Cooperation Council (GCC)	https://www.gcc-sg.org/ http://sites.gcc-sg.org/DLibrary/index-eng.php?action=ShowOne&BID=176
The Arab League -- or League of Arab States (LAS)	http://www.lasportal.org/Pages/Welcome.aspx http://www.al-bab.com/arab/docs/league.htm
The Environment Outlook for the Arab Region	https://www.unige.ch/gepp/files/6314/4890/1821/EOAR_brochure_eng2.pdf
The Council of Arab Ministers Responsible for the Environment (CAMRE)	http://web.cedare.org/
The Sustainable Development Initiative in the Arab region (SDIAR)	http://www.un.org/esa/sustdev/partnerships/activities_initiate/101202_sd_initiative_arab_region.pdf

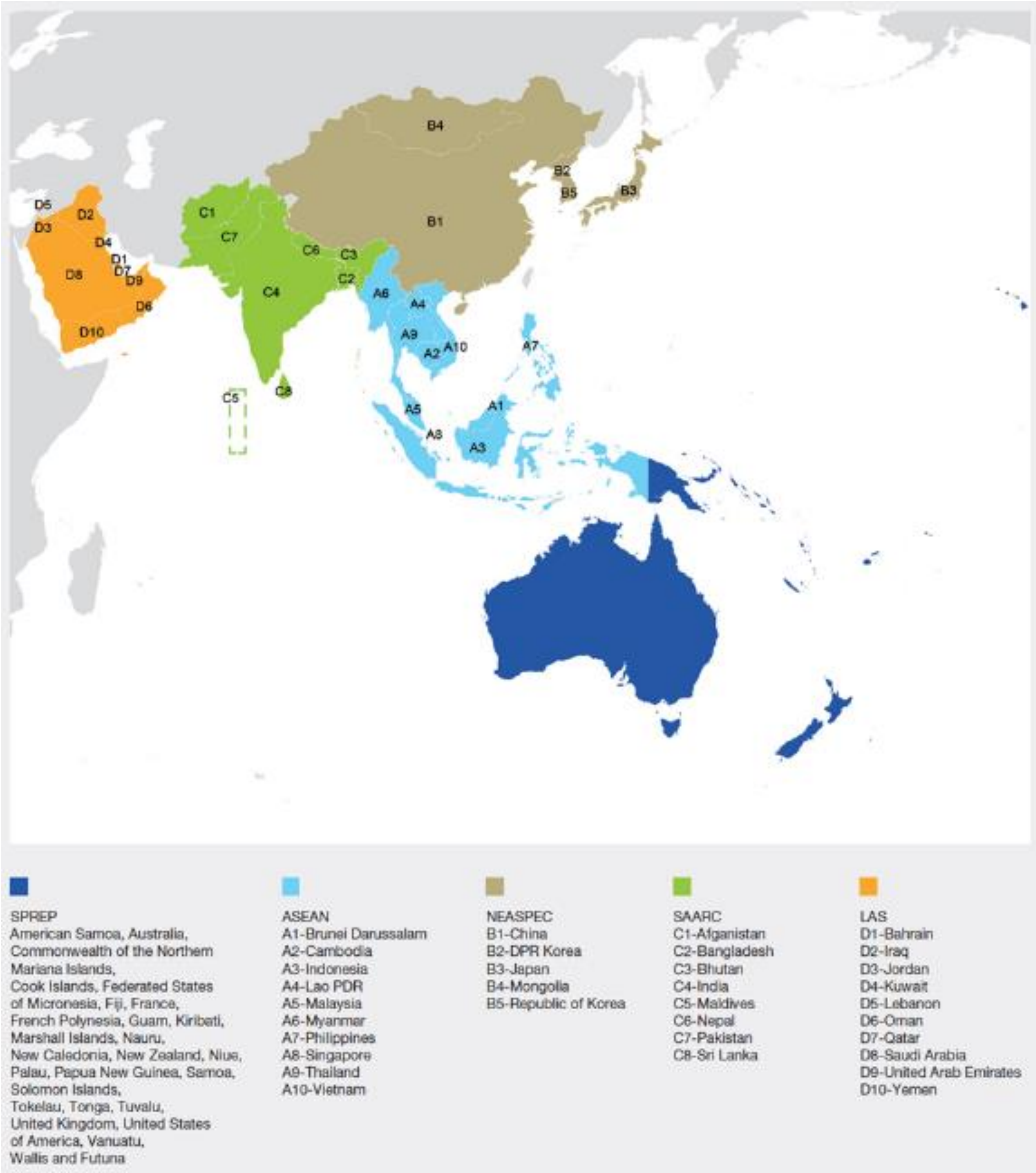


Figure S1 Regional associations and member countries in the Asia-Pacific region

6.

Box S1 Audience of the Asia-Pacific Regional Assessment

Examples include:

- regional initiatives such as ASEAN Biodiversity Initiative, Asia-Pacific Economic Cooperation,
- Pacific Island regional bodies such as the Pacific Community (SPC), the Secretariat of the Pacific Environment Programme (SPREP) and the Pacific Island Roundtable on Nature Conservation in the Pacific;
- UN agencies such as UNEP, UNDP, UN-ESCAP;
- conservation organizations such as IUCN, WWF, WI, CI, WCS, WWT;
- scientific and research bodies such as the Asia-Pacific Biodiversity Observation Network, CGIAR centres (e.g. IWMI, ICRAF, CIFOR, World Fish and Biodiversity), Asian Forum for Indigenous Nationalities, the Mekong River Commission;
- international organization such as ICIMOD, International Network for Bamboo and Rattan
- many NGOs and civil society organizations that are active in the region.

7.

Box S2 Data sources of the Asia-Pacific Regional Assessment

These include among several others the Clearing-House Mechanism (CHM) of the CBD, the Global Biodiversity Outlook, National Specimen Information Infrastructure (NSII), the Global Biodiversity Information Facility, the Indian Bio-resource Information Network, the Group on Earth Observations Biodiversity Observation Network with regional components, the Asia-Pacific Biodiversity Observation Network and subregional or national components, the Japanese Biodiversity Observation Network and the Korea Biodiversity Observation Network; regional initiatives: the Economics of Ecosystems and Biodiversity for South-East Asia; regional research institutes: Bioversity International (Asia-Pacific Oceania division), Ocean Bio geographic Information System, the World Resources Institute, the CGIAR Consortium for Spatial Information, the International Centre for Integrated Mountain Development, the International Union for Conservation of Nature

Box S3 Strategic Goals and Aichi Biodiversity Targets of the Strategic Plan for Biodiversity 2011-2020

Strategic Goal A: Address the underlying causes of biodiversity loss by mainstreaming biodiversity across government and society

Target 1: By 2020, at the latest, people are aware of the values of biodiversity and the steps they can take to conserve and use it sustainably.

Target 2: By 2020, at the latest, biodiversity values have been integrated into national and local development and poverty reduction strategies and planning processes and are being incorporated into national accounting, as appropriate, and reporting systems.

Target 3: By 2020, at the latest, incentives, including subsidies, harmful to biodiversity are eliminated, phased out or reformed in order to minimize or avoid negative impacts, and positive incentives for the conservation and sustainable use of biodiversity are developed and applied, consistent and in harmony with the Convention and other relevant international obligations, taking into account national socio economic conditions.

Target 4: By 2020, at the latest, Governments, business and stakeholders at all levels have taken steps to achieve or have implemented plans for sustainable production and consumption and have kept the impacts of use of natural resources well within safe ecological limits.

Strategic Goal B: Reduce the direct pressures on biodiversity and promote sustainable use

Target 5: By 2020, the rate of loss of all natural habitats, including forests, is at least halved and where feasible brought close to zero, and degradation and fragmentation is significantly reduced.

Target 6: By 2020 all fish and invertebrate stocks and aquatic plants are managed and harvested sustainably, legally and applying ecosystem based approaches, so that overfishing is avoided, recovery plans and measures are in place for all depleted species, fisheries have no significant adverse impacts on threatened species and vulnerable ecosystems and the impacts of fisheries on stocks, species and ecosystems are within safe ecological limits.

Target 7: By 2020 areas under agriculture, aquaculture and forestry are managed sustainably, ensuring conservation of biodiversity.

Target 8: By 2020, pollution, including from excess nutrients, has been brought to levels that are not detrimental to ecosystem function and biodiversity.

Target 9: By 2020, invasive alien species and pathways are identified and prioritized, priority species are controlled or eradicated, and measures are in place to manage pathways to prevent their introduction and establishment.

Target 10: By 2015, the multiple anthropogenic pressures on coral reefs, and other vulnerable ecosystems impacted by climate change or ocean acidification are minimized, so as to maintain their integrity and functioning.

Strategic Goal C: To improve the status of biodiversity by safeguarding ecosystems, species and genetic diversity

Target 11: By 2020, at least 17 per cent of terrestrial and inland water, and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes.

Target 12: By 2020 the extinction of known threatened species has been prevented and their conservation status, particularly of those most in decline, has been improved and sustained.

Target 13: By 2020, the genetic diversity of cultivated plants and farmed and domesticated animals and of wild relatives, including other socio-economically as well as culturally valuable species, is maintained, and strategies have been developed and implemented for minimizing genetic erosion and safeguarding their genetic diversity.

Strategic Goal D: Enhance the benefits to all from biodiversity and ecosystem services

Target 14: By 2020, ecosystems that provide essential services, including services related to water, and contribute to health, livelihoods and well-being, are restored and safeguarded, taking into account the needs of women, indigenous and local communities, and the poor and vulnerable.

Target 15: By 2020, ecosystem resilience and the contribution of biodiversity to carbon stocks has been enhanced, through conservation and restoration, including restoration of at least 15 per cent of degraded ecosystems, thereby contributing to climate change mitigation and adaptation and to combating desertification.

Target 16: By 2015, the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization is in force and operational, consistent with national legislation.

Strategic Goal E: Enhance implementation through participatory planning, knowledge management and capacity building

Target 17: By 2015 each Party has developed, adopted as a policy instrument, and has commenced implementing an effective, participatory and updated national biodiversity strategy and action plan.

Target 18: By 2020, the traditional knowledge, innovations and practices of indigenous and local communities relevant for the conservation and sustainable use of biodiversity, and their customary use of biological resources, are respected, subject to national legislation and relevant international obligations, and fully integrated and reflected in the implementation of the Convention with the full and effective participation of indigenous and local communities, at all relevant levels.

Target 19: By 2020, knowledge, the science base and technologies relating to biodiversity, its values, functioning, status and trends, and the consequences of its loss, are improved, widely shared and transferred, and applied.

Target 20: By 2020, at the latest, the mobilization of financial resources for effectively implementing the Strategic Plan for Biodiversity 2011-2020 from all sources, and in accordance with the consolidated and agreed process in the Strategy for Resource Mobilization, should increase substantially from the current levels. This target will be subject to changes contingent to resource needs assessments to be developed and reported by Parties.

Chapter 2. Nature's contributions to people and quality of life

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Table of Contents

Executive summary

The Asia-Pacific region's rich biodiversity and valuable ecosystem services provide vital support for human well-being and sustainable development (*well established*) {2.3.1, 2.3.3, 2.4.4, 2.4.3}. The biodiversity of the Asia-Pacific region is important for providing food, water, energy, and health security, as well as cultural and spiritual fulfilment to its 4.5 billion inhabitants. Ample evidence demonstrates that human well-being in the region is deeply connected with nature, although there is much variation in dependency across the region (*well established*) {2.2.4.1, 2.3.1.2, 2.4.6.3}.

The declining status and trends of nature's provisioning goods and services threaten the sustainable livelihoods of future generations across the Asia-Pacific (*well established*) {2.1.1, 2.1.5, 2.1.6, 2.1.7, 2.2.2, 2.3, 2.4, 2.5.2, 2.5.2.5, 2.5.3, 2.5.3.3}. These trends are driven by factors such as: environmental degradation {2.3, 2.4}, migration {2.1.5}, changing values {2.2.2}, inadequate laws, policy and governance {2.5.2, 2.5.3.4}, conflicts {2.4.1}, rapid population growth {2.1.1}, urbanization {2.1.3}, pollution {2.1.7} and the impacts of climate change {2.1.6}. Significant and persistent barriers exist in terms of protecting nature to sustain future generations. Simultaneously, there is an increasing trend to address these issues through: legal, policy and management responses surrounding intra and inter-generational equity and justice, all of which aim to secure and protect the environmental rights of future generations (*well established*) {2.5.2, 2.5.2.5, 2.5.3, 2.5.3.3, 2.5.2.8}.

Subregional institutional initiatives have resulted in opportunities for managing transboundary ecosystems and sustaining, or improving, the flow of ecosystem services. Some of these initiatives include: reduced climate change induced vulnerabilities, improved adaptation capacities, and promoting green growth and inclusive development (*established but incomplete*) {2.3.4, 2.3.4.1, 2.3.4.2, 2.3.4.3, 2.3.4.4, 2.5.1.2}. Persistent regional transboundary issues require urgent solutions, such as haze pollution, largely attributable to forest fires that are having detrimental effects on human health (*well established*) {2.3.4.3}. Many ecosystem resources, such as water from transboundary river systems, are used and managed at multiple scales (local, national, and regional) and governed by diverse stakeholders. The increasing anthropogenic pressure on surface and groundwater for multiple human uses (agriculture, urban and industrial purposes) across national borders leads to persistent water insecurity in the region, particularly environmental water insecurity which is crucial for ecosystem functions {2.4.2}. The transboundary landscape management approach makes it possible to address the conservation and sustainable use of natural resources (biodiversity, rangelands, farming systems, forests, wetlands, and watersheds) in landscapes defined by ecosystems rather than administrative boundaries {2.3.4.1, 2.3.4.2, 2.3.4.3, 2.5.1.1, 2.5.1.2, 2.5.1.3}. However, the value of nature's contributions to people from transboundary areas has not been optimally utilised by regional, national and sub-national governments (*established but incomplete*) {2.3.4.3}.

The impacts of climate change and geo-political instability in some areas of the Asia- Pacific have led to large scale human migration, which has resulted in localised and transboundary pressures on nature to provide ecosystem goods and services to support these changes in population distributions. These pressures are predicted to escalate in the future (*well established*) {2.1.5, 2.5.3.4, 2.6.3}. The region is predicted to experience some of the highest human impacts, globally, due to global warming {2.1.5}. For example: There may be up to 150 million climate change refugees, this century, in the Asia-Pacific *(2.1.5).* Mass migration has direct impacts on nature. For example, changes in landuse and increased demand for provisioning services, such as food, water and materials {2.1.5, 2.5.3.4, 2.6.3}. Protection, conservation, preservation and rehabilitation of transboundary conservation areas, in the context of increased migration and changes in settlement patterns, depend strongly on governance {2.5.1} and initiatives involving multi-level institutions and stakeholders (*established but incomplete*) {2.1.5, 2.3.4}.

The impacts of waste on terrestrial, freshwater and marine ecosystems are of significant concern for the current, and future, health of nature, and people, across the Asia-Pacific *(well established*) {2.17, 2.2.2.3, 2.2.4.4, 2.3.2, 2.4.1, 2.3.4.3}. Rapid population growth {2.1.1}, changing values {2.2.2}, shifting socio-economic status {2.1.6}, technological and industrial capabilities {2.5.3.1} and urbanization trends {2.1.3} across the region are some of the factors resulting in an increase in the consumption of natural resources and the production of waste. For example, quantities of household hazardous waste, e-waste and food waste are rising with the growth of urbanization across the Asia-Pacific {2.1.7}. An estimated 870 million tonnes of municipal solid waste was produced within the region in 2014, and is projected to increase to possibly 1.4 billion tonnes per year by 2030 {2.1.7}. Construction and demolition waste linked to rapid industrialisation and urbanization is also increasing {2.1.7}. Of particular concern is plastic waste. For example, studies on plastic waste have found that eight of the top 10 rivers globally carrying the highest amounts of plastic waste are located in Asia {2.1.7}. This waste accounts for 88 to 95 per cent of the total global load of plastics in the oceans {2.1.7}. Water pollution {2.4.1}, air pollution {2.2.2.3, 2.3.4.3}, soil contamination, and chemical waste pose ongoing threats to human and environmental health (*well established*) {2.2.4.4, 2.2.2.3, 2.3.4.3}.

The diverse values and value systems across the Asia-Pacific region shape interactions between people and nature (*established but incomplete*) {2.2.1; 2.2.2, 2.3.1, 2.3.2}. There are some significant valuation data gaps {2.3.3.3} so caution needs to be applied during interpretation. While people across the region value nature for its contributions to their spiritual, cultural and physical well-being, these contributions have been measured to different extent with respect to their economic value. Studies of valuation estimates of nature's contributions to people in the Asia-Pacific region show that, in addition to provisioning services, regulating services are also significantly valued, and their contribution to a good quality of life is acknowledged. However, the number of such studies is small, and drawn only from North-East Asia and Oceania (*established but incomplete*) {2.2.2, 2.3, 2.3.2, 2.3.3.2}.

The rich biodiversity of the region keeps options open for future benefits for people in the Asia-Pacific. The value of biodiversity is evidenced by recent scientific reports of unanticipated uses of a diversity of species in the region. However, there is predicted to be significant loss of these options, based on the expected loss of biodiversity (well established) {2.3.1.3}. Measures of the maintenance of options draw upon effective measures of biodiversity, including phylogenetic diversity. The portion of imperilled phylogenetic diversity found within the Asia-Pacific region is estimated as 38 per cent of the global imperilled phylogenetic diversity (unresolved) {2.3.1.3}.

Although the Asia-Pacific region is succeeding in reducing poverty, mass poverty persists in some subregions (*well established*) {2.1.2, 2.4.5, 4.2.2.2}. Sustaining the viability of and access to ecosystem services will contribute to poverty alleviation. The Asia-Pacific region has the world's largest number of people living below the poverty line – 400 million of the world's 767 million poor people live in Asia and the Pacific – although trends are improving. Eradicating poverty requires multiple strategies, including the sustainable management of food production systems (such as agriculture and aquaculture) that remain the main source of income and nutrition in the region. Similarly, natural terrestrial, freshwater and marine ecosystems also offer goods and services that people need to secure their livelihoods. Sustaining these provisioning services will assist in poverty alleviation (*well established*) {2.3.2, 2.4.2, 2.4.3, 2.4.4, 2.5.1.1, 2.5.2.3, 2.5.2.4, 2.5.3.3, 2.5.3.4, 2.6.3}.

Participatory approaches, volunteer programs, indigenous and local knowledge, co-management, and technological solutions, for the management of natural resources have resulted in positive outcomes in the conservation of biodiversity and ecosystem services (*well established*) {2.2.2.2, 2.5.1.2, 2.5.2.3, 2.5.3.3}, and enhanced contributions to people (*established but incomplete*) {2.2.2.2, 2.5.1.2, 2.5.2.5, 2.5.3.3}. Many community based participatory {2.2.2.2, 2.2.3.2, 2.5.1.2, 2.5.2.6, 2.5.2.8}, and co-management {2.5.2.3} systems across the region have benefitted through the support of government and non-government agencies. These often include the adoption of: science-based decision-making processes, technology {2.5.3.1}, innovative tools, information sharing and capacity development. Conversely the one size fits all policy and management approaches have led to failed or less successful outcomes (*well established*) {2.5.1, 2.5.2.6}. Knowledge, innovations and the practices of indigenous peoples and local communities have been especially useful for overcoming some of the governance deficits associated with the top-down approach, including adapting to the impacts of climate change {2.2.4.5, 2.2.4.6, 2.3.1.2, 2.4.5, 2.5.2.4, 2.6}. Important positive trends include increased volunteerism and citizen science activities (*established but incomplete*) {2.5.2.6}.

The Asia-Pacific holds distinctive knowledge and cultural heritage values and practices that are in harmony with nature, particularly in areas that have been inhabited by indigenous peoples and local communities over long periods of time (*well established*) {2.2.4.5, 2.2.4.6, 2.3.1.2, 2.4.5, 2.5.2.4, 2.5.2.8, 2.6}. These systems and practices can provide the foundation of biodiversity and ecosystem resource management strategies that support a good quality of life for some of the regional community (*established but incomplete*) {2.2.4.5, 2.2.4.6, 2.3.1.2, 2.5.2.3, 2.5.3.3}. Adopting indigenous and local knowledge and practices as a platform for management strategies accommodates the unique characteristics of local ecosystems and communities, that may lead to increased local ownership and engagement (*established but incomplete*) {2.2.4.6, 2.5.2.3, 2.5.3.3}. Incorporating the values and beliefs of indigenous peoples is crucial to the understanding, knowing and being of place, people and spirit within complex natural and cultural landscapes while combining traditional practices with western understandings of landscapes {2.2.4.5, 2.2.4.6, 2.3.1.2, 2.4.5, 2.5.2.4, 2.5.2.8, 2.6}. Where indigenous peoples and local communities are engaged in the design and implementation of culturally appropriate, participatory, and cost-effective ecosystem resource management strategies there is a high likelihood of successful outcomes. For example, proven strategies for multiple species cropping, rotation and landscape management (*established but incomplete*) {2.3.1.2, 2.5.2.2, 2.5.2.3, 2.5.2.4}.

Exemplary models of legislation, policies and their implementation, exist in some nations across the Asia-Pacific (*established but incomplete*) {2.5.2, 2.5.2.2, 2.5.2.3}. However, gaps exist and in some cases, a lack of appropriate legislation, policy and practices is evident {2.5.2}. These gaps are adversely affecting some citizens, with respect to their rights {2.5.2.1}, including access to ecosystem services (*well established*) {2.1.2, 2.4.5, 4.2.2.2}. In addition inadequate governance mechanisms may limit community capacity to conserve nature (*well established*) {2.2.3.4, 2.2.4.1, 2.2.4.5, 2.5.2, 2.5.2.1, 2.5.2.2}. In many Asia- Pacific countries, vulnerable people, such as: women, indigenous peoples, young people, the elderly and ethnic minorities, lack adequate representation or the opportunity for participation in local and national decision-making processes {2.5.2.5}. These groups require a voice in the governance of nature which sustains their lives and well-being (*established but incomplete*) {2.2.3.4, 2.2.4.1, 2.2.4.5}. There is some evidence of this changing trend. For example, customary law {2.5.2.3, 2.5.1.2, 2.5.2.2} and rights to land and natural resources are increasingly being recognised under statutory law (*established*) {2.5.2.2, 2.5.2.4}. Additionally legislative and trends incorporating co-management approaches are becoming increasingly evident across the region (*established but incomplete*) {2.5.2.3, 2.5.3.4}.

2.1 Introduction

Chapter two addresses policy question one of the Asia and Pacific Regional Assessment[22]: "How do biodiversity and ecosystem functions and services contribute to the economy, livelihoods, food security, and good quality of life in the Asia-Pacific region and subregions, and what are the interdependences and synergies among them?" (IPBES, 2015). It responds to this question by assessing the different impacts of changes in nature's contributions to people with regard to: water, food, energy, livelihood, and health security. The IPBES Conceptual Framework boxes of 'Nature's contributions to people', 'Good quality of life', and 'Nature's gifts to people', provide the architecture for this chapter. It adopts a thematic values-based approach, highlighting key characteristics of the five Asia-Pacific subregions of: Oceania, South-East Asia, North-East Asia, South Asia and Western Asia.

'Nature's contributions to people' (NCP) is not simply another term for ecosystem services. Pascual *et al*. (2017) refer to it as "a more encompassing term than the one of ecosystem services". In this assessment, we follow the IPBES classification of nature's contributions to people. This classification system builds on the Millennium Ecosystem Assessment (2005), and the Economics of Ecosystems and Biodiversity (TEEB, 2011) systems. For this assessment, three categories of nature's contributions to people, namely provisioning services, regulating services, and cultural services are divided into two groups – material (provisioning services) and non-material (regulating and cultural services).

Questions addressed in Chapter 2 are:

- What are the key contributions of nature to people?
- How does nature's contributions to people relate to the quality of life in the region?
- What are the key issues for sustaining the benefits of contributions from nature to people for a good quality of life?
- What are the emerging threats and challenges in nature's contributions to people and their contributions for a good quality of life?
- What are the key underlying factors changing nature's contributions to people?

Sections 2 and 3 of this chapter are focused on human values and nature's benefits to people. Geographical differences in the production and use of ecosystem goods and services are also explored. Sections 4 and 5 investigate the influences of governance on nature's contributions and quality of life through the roles of Institutions, equity, justice and fairness, connections and access to nature, innovation, vulnerability and adaptation, community participation and conflict. Section 6 concludes this chapter with a summary of the policy implications.

This chapter identifies aspects of biodiversity and ecosystem functions and services that are critical in supporting human well-being such as: the current and changing values, spirituality and cultural identity. In summary, this chapter highlights key aspects of nature's contributions to people. It identifies constraints, challenges and opportunities, as well as successful and failed stories. A limitation to comprehensively capturing these narratives is the diversity and number of nations and territories that constitute the Asia-Pacific. These differ significantly from many perspectives, including: social profiles, cultural landscapes, and environmental assets. These differing compositions result in unique strengths and challenges that cannot be fully captured in a regional assessment. Chapter 2 has addressed this limitation by highlighting key considerations across the region and subregions, illustrated through a rich diversity of case studies.

[22] This chapter interacts closely with the thematic assessments in Deliverable 3 (b) which are: (i) land degradation and restoration, (ii) invasive alien species, and (iii) sustainable use. It reflects Goal D of the Strategic Plan for Biodiversity and addresses issues related to the three Aichi Targets under this goal (14, 15 and 16) as well as Target 18 of Goal E and the 2015 Sustainable Development Goals.

Some key attributes and trends across the Asia-Pacific community that will inform this chapter are set out below.

2.1.1 Population trends

There are increasing pressures on nature to provide for an expanding population across the region. For example, by 2050 China, India, Pakistan and Indonesia are predicted to have populations in excess of 300 million (United Nations, 2015c, p. 4). However, these trends are country specific, as the overall growth rate for Asia-Pacific was 0.98 per cent per year for 2010–2015, which is lower than the global rate of 1.14 per cent, and it is likely to fall to 0.01 per cent by 2045–2050 (United Nations, 2016a). China’s population is expected to reduce from 2031 onwards and Japan’s current population of 127 million is likely to drop to about 107 million by 2040 (UNESCAP, 2014; United Nations, 2016a).

2.1.2 Economic trends

The regions share in the world economy increased from 14 per cent in 2000, to 25 per cent in 2012 (UNESCAP, 2014). The pertinent social considerations include: income and opportunity inequality, disparities in health outcomes between geographic locations, resource depletion and gender inequality (UNESCAP, 2015). The range of geo-political and economic landscapes can be seen through the presence of liberal, wealthy democratic nations such as Australia and New Zealand, and the war torn nations of Western Asia.

The overall economic growth of the region is highlighted in the declining poverty level. In 1990, 1.6 billion people, or 51 per cent of the Asia-Pacific population, were living in extreme poverty, and by 2011 the level of extreme poverty had dropped to approximately 18 per cent of the population (UNESCAP, 2015). However, as of 2013 there were 400 million people in the region still living under the international poverty line of $1.90 per person per day, using 2011 purchasing power parity. This corresponds to 52 per cent of the world’s 767 million poor (UNESCAP, 2017). Continuing to support the trend of lifting people out of poverty is a significant consideration for this assessment.

2.1.3 Urbanization trends

Urbanization within the region has been a rapidly increasing trend, with approximately 200 million people moving to urban areas within East Asia between 2000 to 2010 (World Bank, 2015). Urbanization rates tend to vary among subregions across the Asia-Pacific. Over 70 per cent of the population in the Pacific live in urbanized areas, whilst in South West Asia it is only 34 per cent (UNESCAP, 2013). The estimated future growth rate across the region is up to 63 per cent living in urban areas (UN-Habitat & UNESCAP, 2015). These trends present changing scenarios for the future management of ecosystem services and their provisions.

2.1.4 Cultural diversity

The cultural diversity of the Asia-Pacific influences the ways in which communities interact with nature. For example, the region has a highly diverse religious profile that includes, Hindus, Muslims, Buddhists, traditional religions and members of other world religions (89 per cent), together with those who are religiously unaffiliated (Pew Research Center, 2012).

The region’s cultural diversity is further illustrated by its (approx.) 70 common languages and innumerable traditional languages (United Nations, 2015a). The indigenous cultural landscape is one of a long standing history that has been interspersed with the colonial context.

Indigenous inhabitants across the Asia-Pacific offer a diverse range of cultural practices, customary law and traditional ecological knowledge that is particularly relevant to contemporary environmental protection (K. Davies, 2015). Indigenous people within the large nations of Asia, and the smaller island nations of the Pacific, generally have a lower life expectancy compared to non-indigenous people, whilst also suffering higher rates of malnutrition, child mortality and infectious diseases (United Nations, 2015a).

2.1.5 Migration trends and nature

The impacts of climate change and geo-political instability in some areas of the Asia- Pacific region, such as Western Asia, have created large-scale humanitarian and environmental challenges that have increased local and trans-boundary pressures on nature to provide for these people. The link between environmental degradation and migration is widely acknowledged and land degradation is an important factor, especially in short-term migration (Shah, 2005). Land degradation-induced migration is projected to increase in Asia in the years to come (United Nations, 2016a).

These pressures on nature are predicted to escalate in the future. "Global warming will drive increasingly severe humanitarian crises, forced migration, political instability and conflict. The Asia–Pacific region…. is considered to be "Disaster Alley" where some of the worst impacts will be experienced" (Dunlop & Spratt, 2017). It has been proposed that there may be up to 150 million climate change refugees, this century, in the Asia region (Dunlop & Spratt, 2017). Mass migration has a direct impact on nature, such as through land use, and/or an indirect impact, through increased demand for provisioning services (United Nations, 2016a). Of particular concern is the ongoing energy and water security of the region. For example, rural to urban migration tends to cause changing patterns of consumption and energy use, and also increases pressures on water supply and waste management (United Nations, 2016a). This could ultimately deteriorate urban environments and intensify land pressures in productive rural areas (United Nations, 2016a).

Additionally, the Asia-Pacific is host to more than 30 million migrant workers, of whom, in contrast with the past, women constitute approx. half. The main source countries are Bangladesh, Cambodia, China, India, Indonesia, Lao PDR, Myanmar, Nepal, Pakistan, Philippines, Sri Lanka and Viet Nam (United Nations, 2016a).

There has been increasing attention on the linkage between the environment and international migration, where there is a need to improve the limited knowledge on the complex two-way relationship involving environmental change as both a cause, and a consequence of migration (Graeme Hugo, 2008). This is particularly the case where: (1) Increasing population pressures and low levels of technology result in intense pressure on natural resources, especially land and forests. (2) Work-related migration and related remittances help to moderate pressures on natural resources, especially if there are no efforts to improve human resources and infrastructure (FAO, 2011b). These contextual characteristics have received least focus within migration research (Hunter & Nawrotzki, 2011). However some studies have researched the migration impact on the environment and biodiversity, specifically comparing migrants' and non-migrants' knowledge and technical skills of using natural resources (Sierra, 1999). Other studies have investigated livelihood insecurity related to a scarcity of natural resources and found that a household is likely to diversify their livelihood strategies. This might involve national or international migration for entire families or one family member (Massey *et al.*, 2010).

At destination areas, migrants differ from non-migrants in their livelihood strategies (e.g. consumption pattern, use of firewood, agricultural intensification), which leads to distinct environmental outcomes. For example, changes in land quality, soil erosion and forest re-growth (Qin, 2010).

Shrestha and Bhandari (2005) examined changes in environmental security resulting from declining access to forestry resources due to deforestation as a major factor shaping labour migration. The study found that a decrease in access to forest resources increased the likelihood of domestic and international migration to seek work of individuals regardless of destination. In recent years concern has increased over whether the rising demand for natural resources, such as food, water and land, will reach supply limits thereby causing increased violent conflict over scarce resources – particularly, but not exclusively, due to the projected impacts of climate change. While climate change is generally acknowledged as a threat to the region, it is not yet collectively prepared to manage the increasing demand for natural resources, which is predicted to lead to future conflict over scarce resources (Blondel, 2012).

2.1.6 Impacts of climate change on nature and communities

The 2014 report of the Intergovernmental Panel on Climate Change (IPCC) stated that "Human influence on the climate system is clear, and recent anthropogenic emissions of greenhouse gases are the highest in history. Recent climate changes have had widespread impacts on human and natural systems" (IPCC, 2014, p. 2). It proceeded to warn that climate change will exacerbate existing risks and create new ones for human- nature systems, these risks will not be evenly distributed, and will mostly affect the disadvantaged. The report stressed the importance of the dual approach of mitigation and adaptation, coupled with "Effective decision-making to limit climate change and its effects…" (IPCC, 2014, p. 7).

These trends in a changing climate, present profound and unprecedented mitigation and adaptation challenges for nature and communities across the region. For example, recent studies have documented the on-going impacts of climate change on terrestrial ecosystems. Observations suggest that climate change is causing many flora and fauna species, to shift their geographical ranges, distributions and phenologies at faster rates than previously thought (I.-C. Chen *et al.*, 2011; Staudinger *et al.*, 2012; United Nations, 2016a). Crop productivity is highly sensitive to the distribution of rainfall during the cropping season. Expected intense rainfall during the harvest or post-harvest stage is extremely damaging to crops and hence the livelihoods of farmers. Additionally there is an increased probability of drought, especially over the semi-arid regions of India (Gore *et al.*, 2010; United Nations, 2016a). These changing climatic patterns of fires, floods and droughts, including the predicted weakened of monsoons in South East Asia, may add stress on farming communities and the production of crops, which will impact food availability and prices (United Nations, 2016a, p. 39).

The growing threats of climate change, such as increasing global temperatures, brings risks, to not only the direct human impacts, such as those related to public health, but also indirect impacts, for example influencing food production, together with rates of conflict and migration (United Nations, 2016a, p. 38). From a public health dimension, an increase in vector borne diseases, such as malaria, is of concern to the region (IPCC, 2014; United Nations, 2016a). Another example is rising heat stress that holds risks for vulnerable community members, such as the elderly, very young, the poor and those with mental illness or chronic diseases (United Nations, 2016a, p. 38). Disaster losses are increasing due to escalating climate-driven risks and exposure to higher degrees of urbanization (United Nations, 2016a, p. 153). To date the Asia-Pacific has suffered from more losses due to disasters than any other region, and this trend is expected to continue due to demographic growth and socio-economic expansion (United Nations, 2016a, p. 153).

2.1.7 Consumption and waste

The rapid population growth and urbanization across the region is resulting in an increase in the consumption of resources and the production of waste. For example, quantities of household hazardous waste, e-waste and food waste are rising. An estimated 870 million tonnes of municipal solid waste was produced within the Asia-Pacific in 2014 (United Nations, 2016a, p. 100), and this is projected to increase to possibly 1.4 billion tonnes per year by 2030 (United Nations, 2016a, p. 101). Construction and demolition waste, linked to rapid industrialisation and urbanization, is also increasing (United Nations, 2016a, p. 101). There are examples of poor waste management systems within the region, such as uncontrolled landfill sites that are contributing to increasing greenhouse emissions (United Nations, 2016a, p. 107). Additionally, the inadequate treatment of waste causes further pollution and environmental degradation (United Nations, 2016a, p. 106).

The quantity of generated municipal solid waste has a strong correlation with a country's income level, with higher income countries producing more waste per person than lower income countries. For example, across North-East and South-East Asia and the Pacific, the rate of municipal solid waste was approx. 1.4 kilograms per person per day in 2010. This rate was much lower than in the Organization for Economic Co-operation and Development (OECD) countries (approx. 2.4 kilograms per person per day) (United Nations, 2016a).

With rising consumption rates, especially by the middle-income class, food waste is a major concern, especially in the more developed economies of the region, such as: China, Japan, the Republic of Korea and Singapore (FAO, 2011a; United Nations, 2016a). On average, approximately 11 kilograms of food are wasted per person per year in developing Asian countries, and around 80 kilograms per person in developed countries such as Japan and the Republic of Korea (APO & FAO, 2006). It has been estimated that half of all food is wasted in the Republic of Korea and Indonesia (United Nations, 2016a).

The impacts of climate change coupled with the frequency of natural disasters are forecast to increase. These events destroy property and create 'disaster waste'. As one of the most vulnerable regions to climate change and natural disasters, the Asia-Pacific is facing an increase in this type of waste and challenges pertaining to its impact on ecosystems and provisioning services. The Haiyan typhoon, for example, created 1 million tonnes of waste in the Philippines in 2013. The 2011 earthquake in Japan resulted in 28 million tonnes of waste, and the accompanying tsunami, produced an estimated 6.15 million tonnes of debris in Ishinomaki alone, equivalent to 103 years of the city's solid waste production in normal circumstances (UNEP, 2012; United Nations, 2016a).

The impact of waste and its management on freshwater and marine ecosystems is of significant concern for the region. For example, studies on plastic waste that have sampled sites along 57 rivers globally have found that the mismanagement of plastic waste is related to the amount of plastic in rivers. Of the top 10 rivers globally carrying the highest amounts of plastic waste, eight are located in Asia. This waste accounts for 88 to 95 per cent of the total global load of plastics in the oceans (Lebreton *et al.*, 2017).

2.2 Living in harmony with nature, values and value systems

This section explores values and value systems in relation to naturein the Asia-Pacific. Values are critical to consider in this assessment because they underpin human decision-making and behavior.

2.2.1 What are values and value systems?

A "value" can be defined in multiple ways. It can be a measure, perceived importance or preference someone has for something/a particular state of the world, a principle associated with a given worldview or cultural context, the *importance* of something for itself or for others, or simply a *measure* (Pascual *et al.*, 2017). Value orientations are important for decision-making, and include the intrinsic values of nature (non-anthropocentric) and instrumental and relational values (anthropocentric), where relationships are linked to people's sense of identity and spirituality (Pascual *et al.*, 2017). Values have direct and indirect effects on human behaviour. They underpin world views, beliefs and norms (Stern, 2000). Indigenous people's values and worldviews recognise that nature and people are inseparable and thus socio-ecological systems are interpreted as one (N. J. Turner *et al.*, 2000).

A value system is a set of values through which people, societies and organizations regulate their behaviour and function as individuals and in social groups (Pascual *et al.*, 2017). Value systems can be considered as a part of an informal institution that also includes unwritten rules and codes of conduct (UNEP, 2012). Additionally, value systems can be interpreted as the shared values of communities, manifesting in collective decision-making processes (G. C. Daily *et al.*, 2000). For example, value systems underpin legal, political, governance and religious systems and therefore significantly influence human- nature interactions. Value systems are influenced by the multiple knowledge systems and differing world views which people hold, including scientific, technical, practitioner and indigenous and local knowledge systems (Brondízio *et al.*, 2010).

2.2.2 Changes in value systems and values

The IPBES Conceptual Framework is inclusive of benefits, stakeholders, knowledge systems and worldviews and so requires the consideration of multiple value systems, which are wide ranging and highly variable across the Asia-Pacific. Within the region, value systems vary among individuals and across groups on temporal and spatial scales. For example, some nations tend to be more dominated by value systems that prioritise individual rights, while others by value systems that prioritise collective and/or community-level values (Díaz, Demissew, Carabias, *et al.*, 2015).

Value systems are influenced by the interconnections of rapidly changing events across the Asia-Pacific such as migration, intergenerational change and shifting political situations. These transitions are accompanied by changing ecological, and value states, all of which influence policy development. Establishing policy linked to the Sustainable Development Goals provides an opportunity to incorporate these rapidly changing values as drivers of change.

Changes in human values and behaviour are an important aspect of understanding the benefits of biodiversity and ecosystem services to people (Tisdell, 2014). Changes in values and value systems will bring societal challenges and opportunities that could affect the status of biodiversity and ecosystem services positively and/or negatively.

Webb *et al*. (2008) examined shifting forest value orientations in recent decades in Australia, demonstrating the increasing importance of non-anthropocentric, moral/spiritual/aesthetic value orientations, relative to commodity values. Accordingly, nature's contributions to people in the Asia-Pacific are expected to change for reasons including: political state, globalisation, urbanization, education, communication, technology, migration, economic conditions, social structures and lifestyles. Nonetheless, the ways in which value orientations and beliefs influence people's perceived benefits and actual behaviours are also likely to vary across different cultural contexts (Boeve-de Pauw & Van Petegem, 2013). Changing values and components of value systems are evidenced in many studies across the region, some examples are provided below.

2.2.2.1 Values influencing seasonal traditional calendars and measuring change

The use of traditional calendars, some very ancient, based on diverse lunar and solar astronomic observations and an holistic use of values are used across all subregions of the Asia-Pacific, for example: South Asia (Fuller, 1980); Western Asia (Heydari-Malayeri, 2004; Ioh, 2014); South-East Asia (Proudfoot, 2006); North-East Asia (Marin, 2010); and Oceania (see Figure 2.1). Diverse seasonal and traditional calendars provide critical representations of the holistic incorporation of values which define interlinkages between nature, people and the good quality of life across the Asia-Pacific region, and evidence of change over time (Marin, 2010).

China's "Twenty four solar terms" calendar was developed to assist the timing of agricultural activities and is tightly related to daily life, values, festivals, traditional customs and the religious ceremonies of Chinese people. The calendar uses the movement of the sun around the earth, with every fifteen degrees equating to one term. The calendar was officially recorded during the early years of the Western Han Dynasty (179 B.C.-121 B.C.) (Government of China, 2015). The names of the terms reflect seasonal indicators associated with natural phenomena in the Yangtze River, where it originated, such as the "Waking of the insects".

Holistic seasonal calendars, based on indigenous local knowledge values and worldviews are also used in the management of biodiversity and ecosystem services across the Asia-Pacific, including in Australia (Prober *et al.*, 2011), Indonesia (H. Chan, 2007) and the Pacific Islands (McMillen *et al.*, 2014). The holistic approach is influenced by values as evidenced by seasonal indicators of change. It uses phenological indicators that link natural phenomena to one another, as well as to the position of the sun or the moon, to social behaviours, and to cosmology and spirituality (Armatas *et al.*, 2016). Among the Arrentye people of central Australia, dozens of distinct animals and plants are used as indicators of the availability of food and water, influencing peoples' values and health, some of which have associated event chains, such as the fresh shoots of the *tatye-tatye* plant as an indicator of kangaroo health (Turpin *et al.*, 2013).

The decreasing reliability of indicators provides evidence to indigenous local knowledge holders that their environments are changing in ways that are of great concern (Leonard *et al.*, 2013; Maclean, 2015).

Figure 2.1 Mingayooroo-Manyi Waranggiri Yarrangi, the Gooniyandi seasons calendar
Note: This was developed by key knowledge-holders of the Gooniyandi language group from the Fitzroy Valley in the Kimberley region of Western Australia and CSIRO. Source: Davis *et al.* (2011).

2.2.2.2 Changing values and practices - India

In India, both productive and protective roles of forests were emphasised during the Vedic period (Circa 4500 - 1800 BCE). The religious texts such as Aranyakas (“forest” works), the Upanishad ‘Brhadaranyaka’ (Great Forest Text), and Smriti Vedas, or the Vedas for Kali Yuga, contain many descriptions on the uses and management of forests. According to the Vedic traditions, every village will attain wholeness only when certain types of forest are present. Some of these are, however, equivalent to the ‘protected areas’ and ‘production forests’ of today.

Participatory forest management, an important approach today, was not alien to ancient Indians, for instance, village committees overseeing the maintenance of forests. During the late Vedic period (Circa 500 BCE) with the emergence of agriculture as the dominant economic activity, the concept of cultural landscapes such as sacred forests and groves, sacred corridors, and a variety of ethno forestry practices evolved, which continued to the post-Vedic period (Circa 1000 to 200 BCE).

Emperor Ashoka, a great Indian ruler (273–232 BCE), encouraged a system of arbori-horticulture of: plantains, mango, jackfruit and grapes. The second of the 14 Rock Edicts of Ashoka (257 BCE), planting of medicinal herbs and trees along the roads, and fruit plants on the wastelands was an accepted norm – analogous to social forestry and agroforestry programs of the present (B. M. Kumar *et al.*, 2012). Ancient historical chronicles from the period of King Vijaya of Sri Lanka (Circa 543 BCE) such as “Maha-Wamsa”, “Rajaratnacari” and “Rajawali” also exemplify that the village communities lived in harmony with the neighbouring forest environment (Maddugoda, 1991).

India’s two most important religions, Jainism, which advocates ‘kindness and sympathy for all living creatures at every step of daily life’, and Buddhism, which ‘believes that all things, including humans, exist by their interrelationships with all other parts of nature’, promote principles of harmony with nature, respect for other creatures and welfare of all living beings (R. Sharma *et al.*, 2014).

Coastal traditional (*neythal*) values ensure that *Kadalamma* (Mother Ocean) is worshipped, looked after and conserved sustainably. Coastal fishermen’s values and indigenous local knowledge of the Mukkuva Community (South India) influence their skepticism that modern technology, such as bottom trawling and harbour dredging, destroys underwater marine ecosystems. “They considered the sea and open beaches as their common livelihood areas, so they did not own them as private [areas] as they commonly say that [the] ocean would be there always and they were too” (Panipilla & Jament, 2016, p. 60). These values are rapidly changing and the protectors of the *Kadalamma* are largely disappearing.

2.2.2.3 Changing values and pollution

Along with the expanding migration of people to urban areas across the Asia-Pacific, and demands from a growing middle class for greater services, pollution has become a major issue influencing health and changing values across the region (Abasolo *et al.*, 2007, 2008; Bickerstaff, 2004; C. K. Chan & Yao, 2008; Clark *et al.*, 2014; State of the Tropics, 2014; Zheng *et al.*, 2008). Values have been affected by community perceptions of the health risks from pollution in the region (UNESCAP, 2005). Slovic *et al*. (1980) identified two psycho-social factors that characterise those risks most commonly impacting on individuals’ views. The first is the “dread factor”: risks perceived as uncontrollable, potentially catastrophic, dangerous to future generations and involuntary. The second is the “unknown factor” or risks perceived as difficult to observe, unfamiliar and not fully known to science. Nuclear power scores highly for both factors, while air pollution scores highly on the first (Bickerstaff, 2004).

Perceived risks can lead people to fear rather than value the environment as a source of benefits. For example, where smog occurs in China, both visitors and residents perceive places as less attractive (C. K. Chan & Yao, 2008; Li *et al.*, 2015). Where radioactive exposure has occurred in Japan and the Pacific (Barker, 2012; Huang *et al.*, 2013), people are reluctant to eat local foods, fear for their children living in the environment, and devalue the worth of land near nuclear facilities, even where radioactive exposure has not occurred (Zhu *et al.*, 2016). Where transboundary haze occurs in Singapore, Malaysia and Indonesia, public concern rises about air pollution impacts on health, with risks linked to the expansion of palm-oil plantations and burning of forests (T. Forsyth, 2014).

This regional level of concern is supported by the World Health Organization (WHO), which found that of the 3.7 million premature deaths globally attributable to outdoor air pollution, 2.67 million (72 per cent) occur in the Asia-Pacific (WHO, 2014). This estimate reflects the very significant role of air pollution in cardiovascular illness and premature deaths (United Nations, 2016b).

2.2.3 Living in harmony with nature

The concept of ‘living in harmony with nature’ has, throughout history, been fundamental to the culture and livelihoods of indigenous peoples. ‘Animism’ is an integral worldview of many indigenous peoples, where it is believed that ‘soul’ or ‘spirit’ is attributed to all things (Harvey, 2005). Animism can also comprise a substratum of popular religion in many societies, such as Buddhism, Confucianism, Daoism, Hinduism, or Islam (Sponsel, 2012). Animism emphasises that humans, nature and the supernatural comprise a functional, spiritual and moral unity through their interconnectedness and interdependence. People hold respect, reverence and reciprocity with nature, as expressed in symbols, myths, and rituals (Sponsel, 2012). Rituals and ceremonies occur at various stages of people’s lives (e.g. birth, marriage, building of a new house, death) and during stages of agricultural practices, as people appreciate nature’s bounty, demonstrating their care for nature and their ancestors.

This concept of ‘living in harmony with nature’ first appeared in formal international documents in the *World Charter for Nature* at the United Nations General Assembly (United Nations, 1982). This charter explicitly recognised that humans are a part of nature and depend on the functions and benefits from natural systems. This Charter and the concept of harmony with nature were excluded from major UN conferences and international agendas until 2005 (Bandot, 2012). However, in 2005, the United Nations General Assembly resolved to dedicate 2008 as the International Year of Planet Earth, and in 2009 one day was designated as International Mother Earth Day, which now falls on 22 April each year. In 2009, the General Assembly adopted a resolution on harmony with nature, recalling the 1982 World Charter for Nature (United Nations, 2009). Responding to this resolution in 2010, at the 10th Conference of Parties (COP) in Nagoya, Aichi, there was agreement to establish the Aichi Targets with the Convention on Biological Diversity (CBD) vision: ‘Living in Harmony with Nature’. Following this new vision, the United Nations General Assembly adopted further resolutions on harmony with nature. These resolutions recognised that many ancient civilisations and indigenous cultures have a deep understanding of the interconnections between people and nature (United Nations, 2011a, 2011b).

Some examples illustrating ‘living in harmony with nature’, by subregion and a selection of countries, are set out below.

2.2.3.1 North-East Asia

China

The ancient Chinese concept of Feng-shui or Tian Ren Heyi (天人合一), reflects conservation-oriented practices of nature characterised by people as part of their worldview “human-as-part-of-nature world view” (Berkes *et al.*, 1995).

Japan

The concept of “Shizen tono Kyosei” (自然との共生), or ‘Living in harmony with nature’, was put forward by the Japanese government as a translation for a concept of ‘Shizen tono Kyosei’ (Díaz, Demissew, Carabias, *et al.*, 2015). ‘Shizen’ can be translated to mean ‘nature’. Additionally it refers to all things in the universe, including humans. ‘Kyosei’ literally means living together, or symbiosis. The concept stems from a Buddhist thought of co-living and an ecological concept of symbiosis (Kurokawa, 1996). In Buddhism, everything is codependent and exists because of the provisions of others. Thus humans and other living and non-living entities are considered equal (Abe, 2010). The concept is also grounded in a traditional Japanese animistic world view, where every entity in nature e.g. the sun, winds, animals, plants, mountains, rivers, rocks etc., is believed to host a deity. People worship natural entities and treat them with awe and respect. Based on the view that people are a part of nature, a society in harmony with nature is considered as one where people live together with other biological organisms and the surrounding environment in a harmonious, respectful, and sustainable manner.

2.2.3.2 South Asia

India

The Indian Vedic philosophy emphasises the human connection with nature. Vedism is a way of life based on scriptures called Aranyakas, or forest books, written by sages who lived in the forest. The scriptures Mahabharata, Ramayana, Vedas, Upanishads, Bhagavad Gita, Puranas and Smriti contain some of the earliest messages on ecological balance and the need for people’s ethical treatment of nature. They emphasise harmony with nature and recognise that all natural elements hold divinity (Hind, 2007).

The Indian philosophic tradition of the ‘Prakriti-Purus’ concept dates back (approx.) 3,500 years, to the days of the Upanishads (a collection of philosophical texts for the Hindu religion). These describe how nature and man are complementary and one is incomplete without the other. In ancient Hindu scriptures and seers, a Hindu way of life allows the use of natural resources but does not support control, or dominion over nature, and its elements, and so the exploitation of nature for selfish gain is considered as sacrilegious (Dwivedi, 1990). Thus living in harmony and respect for nature is ingrained in the society through traditional values and religious belief systems that helped shape peoples attitudes towards nature.

Nature and its manifestations are a part of the Sanatana Dharma belief system. The importance of flora in Hindu religion is reflected through tree worship, water as the media of purification and the source of energy, and rivers as holy mothers. The prohibition of eating meat resonates with the idea of non-violence towards domesticated and protected animals (Dwivedi, 1990). Different wild animals are considered as the companion of Hindu gods and goddesses which signify their values. For examplethe: tiger, white swan, rat and snake are the companions of Goddess Durga, Goddess Saraswati, God Ganesh, and Lord Shiva, respectively.

Iran

Farhadi (1997, 2009, 2014) provides examples of how traditional Iranians lived in harmony with nature by showing holy respect. For example, traditional local people respected water and peacefully collaborated on irrigation and farming. They selected a Mirab (who managed water) to distribute the amount of available water to all areas (Farhadi, 1997, 2009, 2014). Beneath Iran's arid desert lies a network of ancient water tunnels, known as ‘Qanat’, an ingenious system for tapping underground water invented in Iran (approx.) 3,000 years ago (Wulff, 1968). This ancient water infrastructure was developed in response to the prevalent arid and semi-arid conditions, and consists of underground channels that transfer extra water from underground reservoirs located in the highlands to the plains by using gravity (Motiee *et al.*, 2006).

Another example Farhadi (1997, 2009, 2014) highlights is the role of women’s organizations, known as ‘Vareh’, that were engaged in activities ranging from: dairy production and animal husbandry to local participatory management. These women’s organizations were distributed across Iran’s villages and nomadic communities. Farhadi (1997) estimated that at least two million Iranian women were active members in approximately 400,000 Vareh organizations across Iran in 1955. Vareh had social and economic functions for Iranian women, by providing opportunities for them to contribute to supporting their families.

2.2.3.3 South-East Asia

Thailand

In Thailand, the Karen people's reverence and connection with the forests is expressed through the tying of the umbilical cord of a newborn baby to a tree to establish a mutual connection between them and nature. It is prohibited to cut down that tree, resulting in at least the number of the village's population of trees being protected. These forest-centered values are represented in their local saying "No forest, no life", demonstrating their recognition that their life depends on the ecosystem functions and services of the forests, including foods, soil conservation and water provision (Rattanakrajangsri *et al.*, 2017).

Indonesia

The 'Dayak Jalai' people have coexisted in harmony with nature for thousands of years, in the forbidden rainforests (Tana Olen) of East Kalimantan, Borneo. They believe that the entire universe is ruled by God, who has a soul and spirit that must be maintained and respected. Thus, human beings are required to request permission from God for the use of nature (Lakon *et al.*, 2013). This approach has led to the effective maintenance of human and nature relationships, including people in this area rarely selling their land.

Philippines

In the Philippines a large population follows the Catholic religion. Pope Francis's Laudato Si (2015) refers to the earth as a common home like our sister and our mother. This text refers to harming the environment as being equivalent to damaging familial relationships, while forgetting our interconnectedness with the earth (Pope Francis, 2015).

2.2.3.4 Western Asia

Iraq

Eastern civilisations have historically prioritised living in harmony with nature (Özensel, 2013). Iraq has been inhabited for thousands of years by humans who lived in harmony with nature, alongside countless human developments. Over the last decades, 90 per cent of the Iraqi marshlands located in the area that flows into the Persian Gulf were turned into barren drylands because of unsustainable policy decisions, unsustainable urbanization and development projects, war, conflicts, local situations, and Turkey's Southeastern Anatolia Project (Adriansen, 2006; Ünver & Olcay, 2001).

2.2.3.5 Oceania

Australia

At the time of colonisation of Australia, in 1788, indigenous peoples had lived there for tens of thousands of years. They spoke (approx.) 260 distinct languages and 500 dialects (Horton, 1996). Generally indigenous Australians, often known as Aboriginal and Torres Strait Islanders, were semi-nomadic, living in small family groups with a defined territory which they moved across following seasonal changes. They believed that the physical environment of each local area was created and shaped by the actions of spiritual ancestors who travelled across the landscape. Living and non-living things existed as a consequence of the actions of the 'dreaming ancestors' (Dudgeon *et al.*, 2010). Milroy (2008) spoke about the importance of land as part of the Dreaming: "We are part of the Dreaming. We have been in the Dreaming for a long time before we are born on this earth and we will return to this vast landscape at the end of our days. It provides for us during our time on earth, a place to heal, to restore purpose and hope, and to continue our destiny" (Milroy, 2008, p. 414).

2.2.4 Drivers affecting changes in values and value systems

Changing values and value systems are influenced by a diverse range of drivers across the Asia-Pacific. Drivers of value change can be categorized as: economic, biophysical, socio-cultural, holistic approaches and health (Pascual *et al.*, 2017). These drivers often interact and vary across the Asia-Pacific. The World Values Survey[23] (1981-2015) involved a global network of social scientists who investigated changes in values and their impact in 100 countries (Inglehart & Welzel, 2005). The survey found that norms related to marriage, family, gender and sexual orientation have changed significantly, with almost all advanced industrial societies moving in the same direction and at a similar speed. Simultaneously, the survey found a growing divergence between the prevailing values in low-income countries and those in high-income countries. This result is highly relevant to the Asia-Pacific which has a mix of high income countries, such as Australia, Japan and New Zealand and low-income countries located in the South-East Asia, North-East Asia and South Asia subregions. This divergence in drivers affecting responses to changes in values, highlights the complexities of interactions across the region that influence the provisioning services of nature (Inglehart & Welzel, 2005).

2.2.4.1 Economic drivers of value change

Myanmar (formerly Burma)
The challenges of rapid political and economic change are driving biophysical and community values changes in Myanmar (South-East Asia). For example, many subsistence communities rely heavily on mangroves for their primary protein in the form of shellfish, prawns and fish (Bandaranayake, 1998; H. T. Chan, 1986; Spalding *et al.*, 2010). Mangroves provide key nursery habitats, food and timber, waste water treatment, nutrient cycling, erosion and sediment control and coastal stabilisation (Linden & Jernelov, 1980). Analyses after the 2004 Asian tsunami found that dense mangrove and coastal forests greatly mitigated wave damage in many areas (Alongi, 2008), thus improving the likelihood of human survival.

Rapid political, economic and policy reforms that promote private and foreign investment are impacting Myanmar’s mangrove forests, such as the Ayeyarwady Delta and the critically endangered sub-population of the Ayeyarwady dolphin. Additionally they impact important natural resources which maintain rural livelihoods, fertile farmland and fisheries for an estimated 7.7 million people. For example, between 1978 and 2011 there has been an estimated mangrove loss of 64 per cent (E. L. Webb *et al.*, 2014). These reforms have increased interest from overseas investors and multi-national companies and begun transforming Myanmar’s biophysical resources. The mangrove forests of the Ayeyarwady Delta are among the areas targeted with agro-industrial companies expressing an interest in purchasing land for large-scale plantations. For example replacing forests with sugar planations for the export market. These drivers of economics, policy and incentives have negatively influenced the values of those relying on the mangroves for survival, bringing profound social, political and economic changes (State of the Tropics, 2014).

Japan
As Japan has become wealthier, citizens’ values have been shown to change from valuing material goods, to values which prioritise non-material well-being. Increasingly Japanese people are preferring a sense of fulfillment, as opposed to material wealth. In an annual opinion poll by the Cabinet Office, Japanese citizens were asked whether they would place more value on material richness, or non-material well-being, such as a sense of fulfillment and a relaxed lifestyle. The results of the poll, conducted in 2017 (Cabinet Office Government Of Japan, 2017) found that 62.6 per cent of respondents, indicated that they preferred non-material well-being, while 29.2 per cent responded that they prioritised material richness. This result represents a changing trend in values. In the 1970s survey, more people indicated that they aspired to material richness. Then in the 1980 survey, the number of people preferring non-material well-being, exceeded those preferring material richness. It

[23] www.worldvaluessurvey.org

should be noted that many Japanese people tend to prioritise non-material well-being, as they have satisfied their material wealth needs (Cabinet Office Government Of Japan, 2017).

2.2.4.2 Biophysical drivers of value change

The Asia-Pacific is renowned for its wide variation of cultures and values. Examples of biophysical drivers responsible for value changes in rapidly urbanizing areas can be seen in Japan and the Philippines. Abasolo *et al*. (2008) utilised a questionnaire (*n*=167) to measure people's values, perceptions and attitudes towards ecosystem services in urban areas of Japan and the Philippines, with differences found in perceptions and attitudes between these two cultures. The Filipino respondents assigned the highest importance, from 1-5, to air pollution, greenhouse gas reduction, habitat provision, food provision and flood protection. Japanese respondents allotted higher importance, 1-5, to air pollution, water supply, greenhouse gas reduction, water pollution control and the mitigation of heat island effect. The common ecosystem services of concern that were common to the Philippines and Japan were: air pollution control, greenhouse gas reduction, water pollution control, and heat island mitigation. Differing levels of importance allocated to value systems have been shown between these two countries, with some of these differences being attributed to culture, while others may be influenced by the environment itself (Abasolo *et al.*, 2008).

2.2.4.3 Economic, biophysical and socio-cultural interacting drivers of value change

Values and their interpretation depend on valuation contexts and whose values are elicited. Tisdell *et al*. (2005) studied the value of endangered mahogany gliders in Brisbane (Australia) and estimated the willingness of the community to pay to maintain a viable glider population and habitat for 100 years. On average, the respondents of the study were willing to pay one-off donations to conserve the glider at a range of AU$24.99 to AU$35.66. Using the same sample (*n*= 204) of Brisbane residents, Tisdell *et al*. (2007) studied the relative influence of the degree of species endangerment and stated likeability on individual's allocation of funds to conserve 24 Australian wildlife species (mammals, birds, and reptiles). Their results suggest that the public allocation of funds to conserve wildlife species is sensitive to information about the conservation status of species rather than to factors related to species likeability. Tisdell & Wilson (2006) also found that respondent's willingness to allocate funds to conserve species is not related to their economic values but to the policy context, suggesting that a poorly known species in remote areas may obtain much less conservation support than they deserve. Pandit *et al*. (2015) reviewed 76 studies of non-market valuations of threatened species and cited the Jakobsson & Dragun (2001) study that estimated the value of the Leadbeater's possum (*Gymnobelideus leadbeateri*) in Victoria, Australia. The value of the Leadbeater's possum was found to be three times higher than the value generated from timber sales found in its habitats.

Economic value changes have been demonstrated by local community actions motivated by socio-cultural and biophysical changes to the urban landscape. These drivers of change have led to increases in the economic value of properties in urban areas. For example in Australia, a local community restored the ecological function of urban drainage systems by developing a 'Living Stream'. They incorporated biodiverse structural plant communities, which supported a meandering river ecosystem (J. Fisher, 1998). This restoration work has increased the economic value of the properties in comparison to other areas within the region. Incorporated into the development of the 'Living Streams' were consultations with indigenous people who valued the project as it provided habitat for culturally significant turtles (J. Fisher, 1998). The increase in property values demonstrates that people value, and are willing to pay, more to live in habitat-rich environments, which not only improve the natural environment but also provide a healthier environment for the waterway and those living in the area (Polyakov *et al.*, 2016).

In an attempt to value the economic benefit of nature to residents in Perth, Pandit *et al*. (2014) found that higher tree canopy cover on street verges, compared to any other areas surrounding the property, increases the property price. These results signify the importance of a particular form of urban environment and its physical location in generating or changing economic value.

2.2.4.4 Human health as a driver of value change

Managing the effects of hazardous substances on people and the environment are, at times poorly developed, in some areas of the region. Information is neither available nor accessible about "the safety of tens of thousands of chemicals on the market; the potential sources of exposure to substances with known and unknown hazards; the amount of human exposure to hazardous substances; and the impacts of exposure to a large number of hazardous substances starting from conception" (Tuncak, 2015, pt. 98).

For example, the nuclear cycle in the Asia-Pacific drives changes in values, away from perceived benefits towards perceived risks from the environment, across the region. Nuclear pollution has occurred at numerous sites as a result of weapons use and testing (Cordonnery, 2014; Leschine, 2014); uranium mining (Hart *et al.*, 2015; Marsh, 2013); and accidents and incidents in nuclear power plants (Marui & Gallardo, 2015; Wheatley *et al.*, 2016). The nuclear cycle drives other activities that are perceived as high risk, including ocean transport of radioactive material (Van Dyke, 2014) and waste disposal (Hinman *et al.*, 1993). Community anxiety surrounding nuclear pollution occurs in many parts of the region including: Taiwan, China (J.-C. Ho *et al.*, 2014); Hong Kong, SAR (Mah *et al.*, 2014); Japan and the USA (Hinman *et al.*, 1993), Pacific Islands (Barker, 2012) and has been exacerbated by the 2011 Fukushima accident, particularly among women (Aldrich, 2013; Morioka, 2014).

The Asia-Pacific contains nine of the fourteen main sites where over 500 atomic weapons were tested between 1945 and 1980 (Simon & Bouville, 2015). All sites, except Monte Bello, are the traditional homelands of indigenous peoples who were affected by fallout, including: Uygur at Lop Nor, Australian Aborigines at Maralinga, and Pacific Islanders in the Marshall, Christmas, Johnston and Malden Islands.

From 1977 to 1980 the United States government conducted a partial clean-up in the Marshall Islands, including stockpiling topsoil within a concrete dome, Enewetak Atoll, that has since cracked (T. Hamilton, 2013; Okney, 2014). Additionally they sunk 24 vessels that were tested for durability during explosions in the lagoon of Bikini Atoll, these are an ongoing source of pollution (Wang *et al.*, 2011). The Marshall Islands people continue their struggle to restore contaminated lands and recover the legacy of impacts of the 67 tests on their health, their lands, their social and cultural lifeways, and their livelihoods, including through inventing an entire new vocabulary to describe birth defects (Barker, 2012). The safety of local foods is still not trusted and the US Government continues to provide food parcels to Bikini and Enewetak (Office of the Law Revision Council of the House of Representatives, 2007) (Case Study Box 2.1).

Box 2.1 Case study, Marshall Islanders: struggling to survive on homelands devastated by nuclear weapons. (Takala, 2017)

Location: Enewetak Atoll, Republic of the Marshall Islands
Indigenous traditional leader: Mores Abraham, oral presentation, February 2017

"Right now on Enewetak, we are living in a very sad situation. Remaining on our homeland, islands inhabited by our ancestors for thousands of years, means sleeping with poison[24] and eating poisoned foods. We have no opportunities to support our families as the local copra processing plant refuses to accept our coconuts because of the bomb tests. Things are getting worse and the US[25] does not think about us and our hardships."

[24] There is no word in the Marshallese language for radiation caused by nuclear bombs. The word 'poison' refers to radiation.

[25] The United States conducted 67 nuclear and thermonuclear bomb tests in the Marshall Islands between 1946 and 1958, with 43 bombs detonated at Enewetak Atoll.

"The most fertile fishing grounds on the atoll have always been at Runit Island. Yet this island now holds [the] Cactus Dome[26], a concrete tomb full of nuclear waste. The fishing grounds are still fertile, but now the tomb is leaking. Are the fish safe to eat? We don't know. We don't have a choice but to fish there, as fishing is very difficult on the southern islands where we are forced to live[27]."

"The United States provides us with quarterly food shipments. We used to receive enough to survive but now the food assistance is less and less each quarter. Now, the white rice, white flour, and tinned meats only last for a month or so. When that food runs out, we have no choice but to gather local foods from the northern islands."

"We are very sick. In the past three months, nine of our family members have passed away including my twelve-year-old nephew. We have to take matters into our own hands. Recently we appealed to a Japanese NGO to conduct health check-ups. They came to our island and found many people with swollen thyroids, and high readings of poison, even in our homes."

2.2.4.5 Indigenous peoples and local communities' as drivers of value change

Indigenous peoples and local communities often hold different knowledge systems that involves perspectives and values based on local learning-by-doing practices of managing resource use. There is a diversity of local or traditional practices for bio-diversity and eco-system management. These include multiple species management, resource rotation, succession management and landscape patch management (Berkes *et al.*, 2000), where they can enable local communities and institutions to adapt strategies and develop and apply plans and actions. Indigenous peoples and local communities' values can be integrated and adapted, for example, with scientific knowledge, tools, sustainable policy and actions. This can lead to modifying or transforming existing behaviours and norms towards adaptive actions and so changing peoples' values (*see* previous Asian case studies).

For example, understanding the values and beliefs of Australian indigenous peoples has been found to be crucial prior to the commencement of any ecosystem management activities. This includes their knowing and being of place, customs and spirituality within complex natural and cultural landscapes. Environmental programs often involve combining traditional with western practices that expand understandings and valuing of landscapes (Ens *et al.*, 2015).

Women in Business, Samoa, provides an example of changing values and social structures developed to empower and equip rural families to cultivate sustainable businesses while honoring indigenous tradition[28]. Women weaving mats from the *Pandanus* plant have developed into small businesses. These provide a role for everyone in the family to sustain the business starting with the planting of the crop, then harvesting and cleaning of the *Pandanus*. This has empowered rural families to sustain ventures which maximise farm-based resources (IGES, 2017).

Local knowledge-based industrial innovation is emerging in many Asian developing countries. For example, approaches are being trialed to connect small scale producers with supermarkets. Some are unique to Asia, for example government-sponsored interfaces and services that link farmers to modern markets. This model has been demonstrated to be environmentally friendly and eco-efficient and is leveraging off community values and knowledge (United Nations, 2016a).

[26] The United States considers Cactus Dome to be a low-level nuclear waste storage site.

[27] The US 'cleaned' three of the southern islands with the northern islands remaining off-limits due to excessive contamination.

[28] http://www.womeninbusiness.ws/

2.2.4.6 Utilising the benefits of traditional medicines to support health and well-being

Many communities have been shifting towards more nature based products, such as health foods and traditional medicines. The use of traditional knowledge for herbal medicines among regions of the Asia-Pacific is rich, for example, the Kani tribes of the forests of the Western Ghats region of India possess knowledge of a large number of wild plants that have helped them to survive for generations (Matsuoka, 2015)[29]. The use of traditional medicines for health outcomes is practiced across the Asia-Pacific e.g. Chinese traditional medicinal practices (S.-L. Chen *et al.*, 2016).

Increasingly, Western societies, such as Australia, have come to value traditional medicines. However, high level debates are occurring across policy developers and the western medical fraternities questioning the benefits and the large scale uses of traditional medicines amongst the general population (Baggoley, 2015).

2.2.5 Implications of changes in value systems to public policy

Value systems are influenced by the interconnections of rapidly changing events occurring across the Asia-Pacific. Migration, intergenerational change and political situations are just some of the influences on changing values. As such shifts occur they trigger changes in ecological and cultural states, all of which influence public policy.

Change in value systems does act as a driver of change for public policy development. The evolution of community-based natural resource governance in the Asia-Pacific is an example of the growing recognition of local norms, values and beliefs in managing natural resources. It is the reflection of higher values being placed on local knowledge and practices by private enterprise, governments and decision makers. The growing evidence of the influence of these values can be seen in the rise of the consumer demand for process and products that are ‘certified organic’,’ fair-trade’ and ‘green- eco-friendly’ (Commonwealth of Australia, 2016; D’Souza *et al.*, 2006). Such emerging trends are observed more in countries such as Japan, Australia, New Zealand, South Korea, indicating higher values being placed by consumers on pro-social and environmental production processes. These consumer sentiments are then reflected in national or international policies that materialise the changed value system. For example, Japan and New Zealand developed a policy in 2006 to purchase certified wood products (European Union, 2010).

Another implication for public policy on changing value systems, is in relation to agreements or commitments made by the governments in international forums regarding ecosystem, biodiversity, and local knowledge systems. To implement such commitments, national governments revise or introduce new policy measures. In this respect, it is believed that the government represents the society and their changed positions or values. The increasing multilateral environmental agreements at regional and international levels in recent decades are some examples. More recently, establishing policy linked to the Sustainable Development Goals provides an opportunity to incorporate these rapidly changing value systems in a consistent way across the region and internationally.

2.3 Nature’s contributions to people

This section assesses nature’s contributions to people in terms of biodiversity and ecosystem goods and services provided by key ecosystems (marine, coastal and terrestrial) in the Asia-Pacific. It builds on the IPBES framework to provide interlinkages between nature’s contributions and people.

Here, we define different categories and types of ecosystem goods and services associated with marine, coastal and terrestrial ecosystems in the region. Table 2.1 presents the 18 categories of nature’s contributions to people (NCP) used in this IPBES assessment (IPBES, 2017). There has been

[29] http://www.wipo.int/ipadvantage/en/details.jsp?id=2599

an array of classification systems for ecosystem benefits or contributions, such as those of the Millenium Assessment (MA), The Economics of Ecosystems and Biodiversity (TEEB), and the Common International Classification of Ecosystem Services (CICES). The NCP approach of IPBES grows on the overall scientific knowledge that has evolved through these efforts. The most influential classification has been the MA system: supporting, provisioning, regulating and cultural. Later in the TEEB and CICES systems, supporting services were treated as properties of ecosystems, and habitat maintenance services that were associated with provisioning services (Haines-Young & Potschin, 2013) or placed as a separate category (TEEB, 2010). The NCP classification focuses on "contributions" in lieu of "benefits" to people, involving three broad groups: regulating, material (e.g., formerly provisioning services) and non-material (e.g., formerly cultural services). The 18 inclusive NCP categories might be associated with more than one group. For detailed descriptions for individual categories, please refer to IPBES/5/INF/24 (IPBES, 2017).

We assess the status and heterogeneity of ecosystem goods and services in the Asia-Pacific. In order to demonstrate the heterogeneity of ecosystem goods and services across the region, we provide case studies that highlight geographical and cultural differences in the production and use of ecosystem goods and services. We conclude this section by providing a summary of economic values of these contributions to the people.

Table 2.1 The 18 categories of nature's contributions to people used in IPBES assessments

	Reporting categories of nature's contributions to people	**Brief explanation and some examples**	**Type of contribution**
1	Habitat creation and maintenance	The formation and continued production, by ecosystems or organisms within them, of ecological conditions necessary or favourable for organisms important to humans to live in. E.g. nesting, feeding, and mating sites for birds and mammals, resting and overwintering areas for migratory mammals, birds and butterflies, nurseries for juvenile stages of fish and refuge for fish and invertebrates	Regulating service
2	Pollination and dispersal of seeds and other propagules	Facilitation by animals of movement of pollen among flowers, and dispersal of seeds, larvae or spores of organisms important to humans	Regulating service
3	Regulation of air quality	Regulation (by impediment or facilitation) by ecosystems, of CO_2/O_2 balance, O_3 for UV-B absorption, levels of sulphur oxide, nitrogen oxides (NOx), volatile organic compounds (VOC), particulates, aerosols . Filtration, fixation, degradation or storage of pollutants that directly affect human health or infrastructure	Regulating service
4	Regulation of climate	Climate regulation by ecosystems (including regulation of global warming) through: . Positive or negative effects on emissions of greenhouse gases (e.g. biological carbon storage and sequestration; methane emissions from wetlands) . Positive or negative effects on biophysical feedbacks from vegetation cover to atmosphere, such as those involving albedo, surface roughness, long-wave radiation, evapotranspiration (including moisture-recycling) . Direct and indirect processes involving biogenic volatile organic compounds . Regulation of aerosols and aerosol precursors	Regulating service
5	Regulation of ocean acidification	Regulating, by photosynthetic organisms (on land or in water), of atmospheric CO_2 concentrations and so seawater pH, which affects associated calcification processes by many marine organisms important to humans (such as corals)	Regulating service
6	Regulation of freshwater quantity,	Regulation, by ecosystems, of the quantity, location and timing of the flow of surface and groundwater used for	Regulating service

	flow and timing*	drinking, irrigation, transport, hydropower, and as the support of non-material contributions (NCP 15, 16, 17) Regulation of flow to water-dependent natural habitats that in turn positively or negatively affect people downstream, including via flooding (wetlands including ponds, rivers, lakes, swamps) Modifying groundwater levels, which can ameliorate dryland salinization in unirrigated landscapes	
7	Regulation of freshwater and coastal water quality	Regulation – through filtration of particles, pathogens, excess nutrients, and other chemicals – by ecosystems or particular organisms, of the quality of water used directly (e.g. drinking) or indirectly (e.g. aquatic foods, irrigated food and fibre crops, freshwater and coastal habitats of heritage value)	Regulating service
8	Formation, protection and decontamination of soils and sediments	Sediment retention and erosion control, soil formation and maintenance of soil structure and processes (e.g. such as decomposition and nutrient cycling) that underlie the continued fertility of soils important to humans. Filtration, fixation, degradation or storage of chemical and biological pollutants (pathogens, toxics, excess nutrients) in soils and sediments that are important to humans	Regulating service
9	Regulation of hazards and extreme events	Amelioration, by ecosystems, of the impacts on humans or their infrastructure caused by e.g. floods, wind, storms, hurricanes, seawater intrusion, tidal waves, heat waves, tsunamis, high noise levels Reduction, by ecosystems of hazards like landslides, avalanches	Regulating service
10	Regulation of organisms detrimental to humans	. Regulation, by ecosystems or organisms, of pests, pathogens, predators, competitors, etc. that affect humans, plants and animals, including e.g.: . Regulation by predators or parasites of the population size of non-harmful important animals (e.g. large herbivore populations by wolves or lions) . Regulation (by impediment or facilitation) of the abundance or distribution of potentially harmful organisms (e.g. venomous, toxic, allergenic, predators, parasites, competitors, disease vectors and reservoirs) over the landscape or seascape . Removal of animal carcasses and human corpses by scavengers (e.g. vultures in Zoroastrian and some Tibetan Buddhist traditions) . Regulation (by impediment or facilitation) of biological impairment and degradation of infrastructure (e.g. damage by pigeons, bats, termites, strangling figs to buildings)	Regulating service
11	Energy	Production of biomass-based fuels, such as biofuel crops, animal waste, fuelwood, agricultural residue pellets	Material
12	Food and feed	Production of food from wild, managed, or domesticated organisms, such as fish, beef, poultry, game, dairy products, edible crops, mushrooms, bushmeat and edible invertebrates, honey, edible wild fruits and tubers Production of feed for domesticated animals (e.g. livestock, work and support animals, pets) or for aquaculture, from the same sources	Material
13	Materials and assistance	. Production of materials derived from organisms in crops or wild ecosystems, for construction, clothing, printing, ornamental purposes (e.g. wood, fibres, waxes, paper, resins, dyes, pearls, shells, coral branches). . Direct use of living organisms for decoration (i.e. ornamental plants in parks and households, ornamental fish), company (i.e. pets), transport, and labor (including herding, searching, guidance, guarding)	Material
14	Medicinal, biochemical and	. Production of materials derived from organisms (plants, animals, fungi, microbes) used for medicinal and veterinary	Material

	genetic resources	purposes . Production of genes and genetic information used for plant and animal breeding and biotechnology	
15	Learning and inspiration	Provision, by landscapes, seascapes, habitats or organisms, of opportunities for the development of the capabilities that allow humans to prosper through education, acquisition of knowledge and development of skills for well-being, scientific information, and inspiration for art and technological design (e.g. biomimicry)	Non-material
16	Physical and psychological experiences	Provision, by landscapes, seascapes, habitats or organisms, of opportunities for physically and psychologically beneficial activities, healing, relaxation, recreation, leisure, tourism and aesthetic enjoyment based on the close contact with nature. E.g. hiking, recreational hunting and fishing, birdwatching, snorkeling, gardening	Non-material
17	Supporting identities	Landscapes, seascapes, habitats or organisms being the basis for religious, spiritual, and social-cohesion experiences Provisioning of opportunities by nature for people to develop a sense of place, purpose, belonging, rootedness or connectedness, associated with different entities of the living world (e. g. cultural and heritage landscapes, sounds, scents and sights associated with childhood experiences, iconic animals, trees or flowers) Basis for narratives and myths, rituals and celebrations provided by landscapes, seascapes, habitats, species or organisms (e.g. sacred groves, sacred trees, totem animals) Source of satisfaction derived from knowing that a particular landscapes, seascape, habitat or species exist in the present	Non-material
18	Maintenance of options	Capacity of ecosystems, habitats, species or genotypes to keep human options open in order to support a later good quality of life. Examples include: . Benefits (including those of future generations) associated with the continued existence of a wide variety of species, populations and genotypes . Future benefits (or threats) derived from keeping options open for yet unknown discoveries and unanticipated uses of particular organisms or ecosystems that already exist (e.g. new medicines or materials) . Future benefits (or threats) that may be anticipated from on-going biological evolution (e.g. adaptation to a warmer climate, to emergent diseases, development of resistance to antibiotics and other control agents by pathogens and weeds)	Non-material

8. *Hydrological NCP are fundamentally conceived as regulating NCP, because the primary impact of ecosystems on water is the modification of its flows, not the creation or breakdown of water molecules.

2.3.1 Status and trends of biodiversity and ecosystem goods and services

2.3.1.1 Nature's contributions to people for environmental regulation

Material benefits (or provisioning services) are included as the products of nature. For example, food, milk, fibre, timber etc. from terrestrial ecosystems, fish and other seafood from marine and coastal regions. These material benefits fulfil basic human needs for nutrition, shelter, energy and safety. Regulating and cultural services are less tangible than 'provisioning'. Regulating services are essential to the production of provisioning goods and services. Regulating services are as important as provisioning services to the livelihoods of people. They also provide direct benefits such as flood mitigation and reduce risks/impacts from natural disasters. Cultural services fulfil aesthetic needs and provide recreational opportunities.

Forest management for the protection of soil and water

Estimating the trends and status of hydrological ecosystem services across the Asia-Pacific is difficult and complex, partly because of the lack of disaggregated data that is available on different categories of hydrological services. Brauman *et al*. (2007) proposed that hydrologic ecosystem services include five broad categories: improvement of extractive water supply, improvement of in-stream water supply, water damage mitigation, provision of water related cultural services, and water-associated supporting services. Among these, water damage mitigation is the ‘hydrological regulating services’, which includes ecosystem mitigation of flood damage, of sedimentation of water bodies, of saltwater intrusion into groundwater, and of dryland salinization (Brauman *et al.*, 2007). Precipitation, soil moisture, and total water storage (TWS) in river basins are vitally important for sustaining ‘hydrological regulating services’. Extreme climatic events (such as precipitation and drought), and increasing demand for fresh water affects the hydrological services in the region. For example, in the Ganges and Brahmaputra-Meghna river basins in South Asia, Khandu *et al*. (2016) found, that despite the lack of long-term statistically significant precipitation trends, there has been a significant decline in rainfall (9.0 ± 4.0 mm/decade) over the Brahmaputra-Meghna River Basin from 1998 to 2014. Both river basins exhibit a rapid decline of TWS from 2002 to 2014 with some upward trend in the Ganges Basin from 2010 onward (Figure 2.2). The impact of human water consumption on TWS appears to be considerably higher in the Ganges, when compared to Brahmaputra-Meghna river basin.

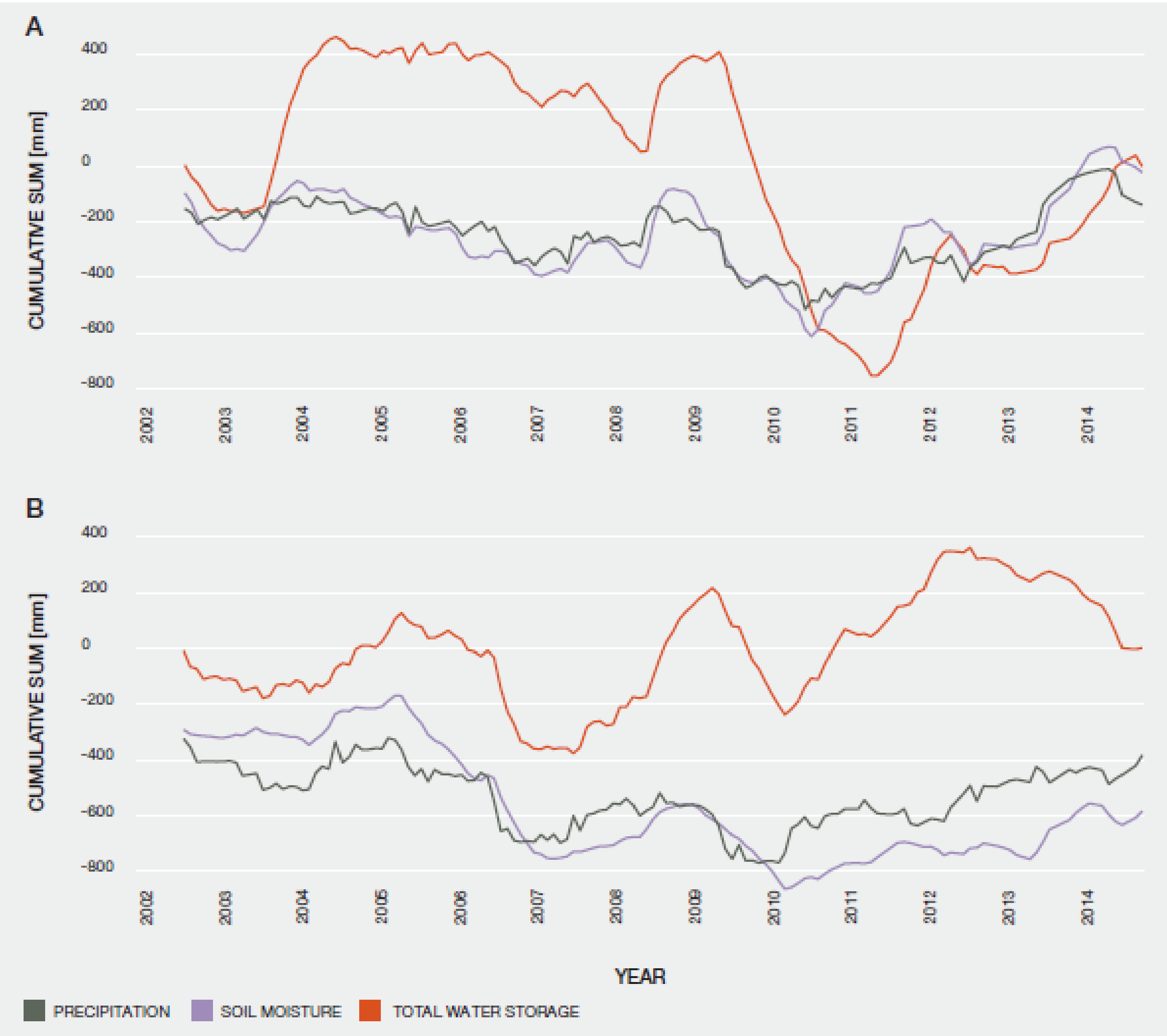

Figure 2.2 Cumulative sums of basin-averaged monthly rainfall, soil moisture, and Gravity Recovery and Climate Experiment total water storage changes in the (a) Ganges, and (b) Brahmaputra River Basins. Source: Khandu *et al.* (2016).

Figure 2.3 presents the proportion of forest area managed for soil and water protection by the amount of forested area (forests + woodlands, Panel A) and by the total land area of the country (Panel B) for a set of countries in the Asia-Pacific. In Panel A, the proportion of forest area managed for soil and water over the years is weighted using forested area reported for 2015, hence if there has been reduction in total forested area in 2015, compared to earlier years in a specific country (e.g. Cambodia), the proportion of forested area allocated for soil and water protection exceeded 100 per cent. It reflects the fact that the forested area in those countries have reduced sharply over the years. These figures have clearly shown the trend in forest management with an emphasis on soil and water protection in these countries, however the trend is not encouraging for all countries. For example, Japan and China have shown steady progress in managing increasingly more forest areas to protect soil and water, while Cambodia and Timor-Leste have shown the opposite trends.

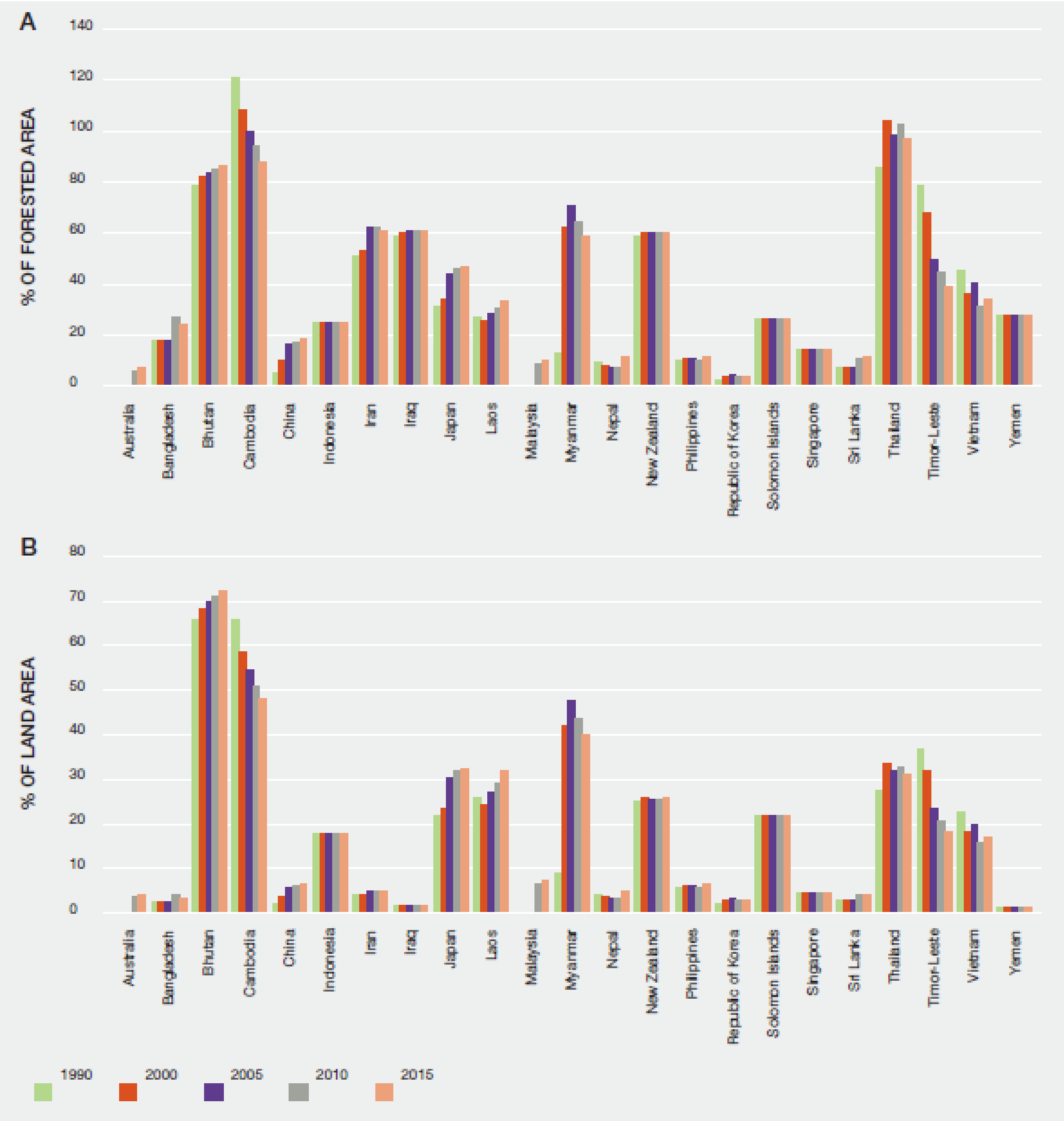

Figure 2.3 Panel A: Proportion of forest area managed for soil and water protection in different years compared to forested area (forests + woodlands) in 2015 for selected countries; Panel B: Proportion of forest area managed for soil and water protection in different years compared to total land area in selected countries

Notes: The graph in Panel A uses the total forest area in 2015 as the baseline. Thus the percentages are greater than 100 in 1990, 2000 and 2005 for Cambodia, and in 2000 and 2010 for Thailand, when the forest area managed for soil and water protection was greater than the total forest area in 2015. Source: FAO (2015a).

Regulation of climate

Climate regulating services are among the basic life-supporting services. They do not appear on conventional balance sheets, but they are equally essential for the survival of modern economies. Quantifying climate services remains an ongoing challenge. The value of climate regulation services' contribution to the maintenance of ecosystems depends on existing carbon stocks and ongoing ecosystem–atmosphere greenhouse gases (GHGs) exchange (Anderson-Teixeira *et al.*, 2012).

Emissions of methane (CH4) as a greenhouse gas contributing to global warming is a side-effect of agricultural activities and land use changes (Garnett, 2011). Figure 2.4 and 2.5 represent the methane emissions from two sources – agriculture and land use changes, respectively. The emission of methane in the southern Asia region is mainly attributed to agriculture. Moreover, The Food and Agriculture Organization of the United Nations (FAO) statistics on emissions of methane due to land use change, do not show a clear trend in the Asia-Pacific. This could reflect unstable development pathways in land use. A study by Hergoualc'h and Verchot (2012) found that land use change resulted in a significant decrease in methane emissions when peat swamp forests were converted for agriculture, with the exception of rice cultivation, where emissions remained high. However, the decrease in methane emissions is not large enough to offset the carbon emissions that occur from increased peat decomposition that also occurs with land use change.

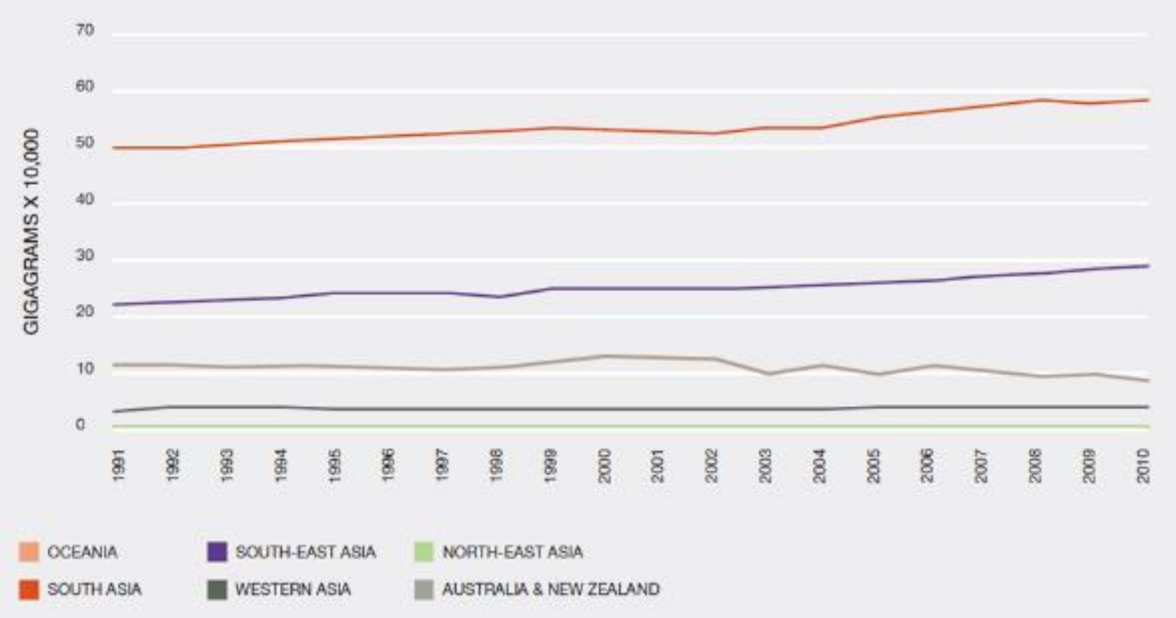

Figure 2.4 Emissions of methane (CO2eq) from agriculture in the Asia-Pacific subregions from 1991-2010. Source: FAO (2016c).

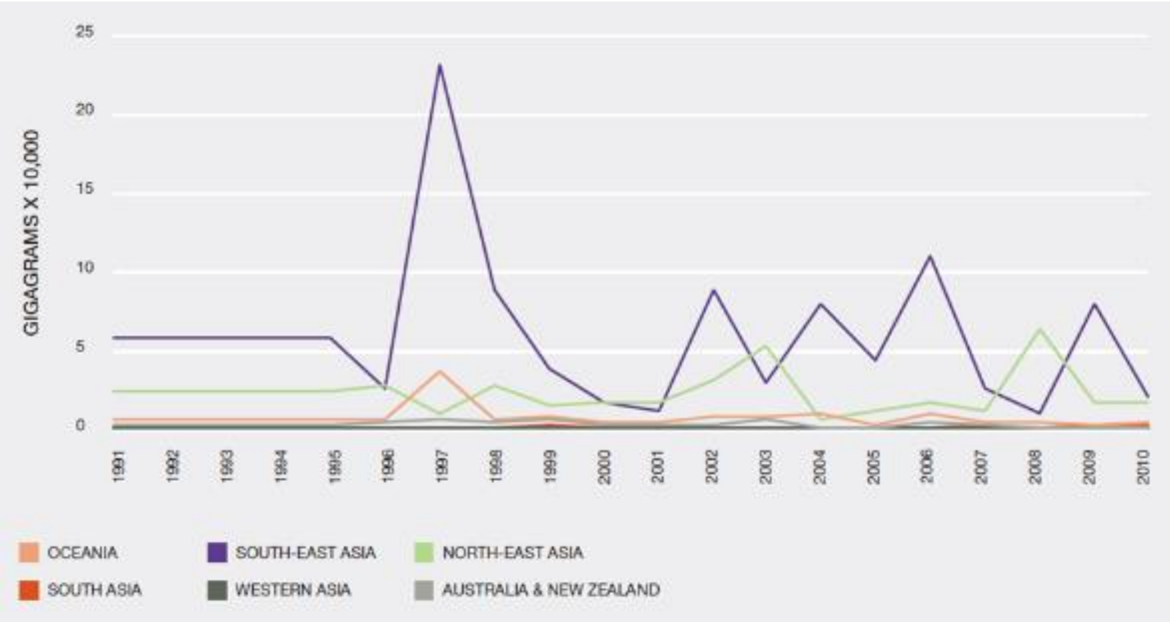

Figure 2.5 Emissions of methane (CO_2eq) from land use change in the Asia-Pacific subregions from 1991-2010. Source: FAO (2017).

Regulation of freshwater quantity, flow and timing

Global freshwater use was predicted to increase, from 2000- 2010 by 10 per cent from 2000 to 2010 (Millennium Ecosystem Assessment, 2005).This increase in usage has arisen largely due to: population growth, economic development, and changes in water use efficiency. Water withdrawal was estimated as 25 per cent of the continental runoff to which the majority of the population had access during the year .Regional variations from differential development pressures and efficiency changes during 1960–2000 produced increases in water use of 15– 32 per cent per decade (Millennium Ecosystem Assessment, 2005).

Determining the allocated water for human uses, without loss of ecosystem integrity, is central to an understanding of how freshwater ecosystems support human well-being through the range of provisioning, supporting and regulating services. Water availability varies significantly across the Asia- Pacific. For example, some areas of Western Asia are amongst the driest regions in the world. The Arabian Peninsula receives rainfall of just 85 mm/year, and the total annual actual renewable water resources per inhabitant is below 10, 000 m3/inhab/yr. Across the subregion there is a declining trend of renewable water resources (Figure 2.6) (FAO, 2016a).

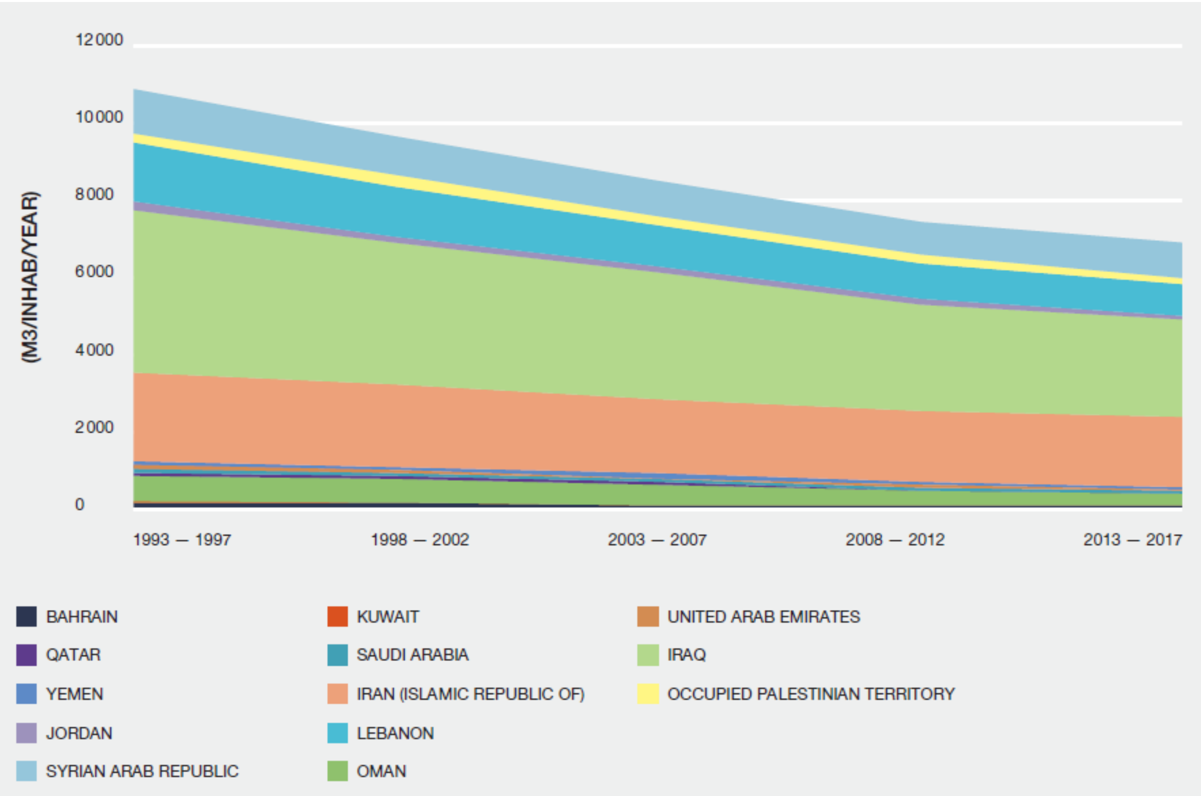

Figure 2.6 Total renewable water resources per capita (m^3/year) for some countries in Western Asia from 1997 to 2017. Source: FAO (2016a).

According to the FAO's (2016a) analysis of renewable freshwater resources in the Asia-Pacific, Oceania is the driest subregion with only 2 per cent of the world's annual renewable freshwater resources. It is, however, the region where renewable freshwater per person is the largest—81,000 litres per day—due to a low population density. However, there are large differences regionally and within countries. In Australia, the population is often concentrated in areas where water is already scarce. By comparison, the Asian subregions have some of the lowest volumes of renewable freshwater resources per person: 7,550 litres per day. China uses 5,500 litres per person per day, but with notable differences between the dry north and the humid south. India uses only 4 200 litres per person per day, again with significant differences between the dry northwest and the wetter east.

The total exploitable water resources (also called manageable water resources or water development potential) are those considered to be available for development, taking into consideration factors such as: the economic and environmental feasibility of storing flood water behind dams, extracting groundwater, the physical possibility of storing water that naturally flows out to the sea, and minimum flow requirements (navigation, environmental services, aquatic life, etc) (Figure 2.7) (FAO, 2016a). Lebanon and the occupied Palestinian territory are among the driest countries in Western Asia (El-Fadel *et al.*, 2000).

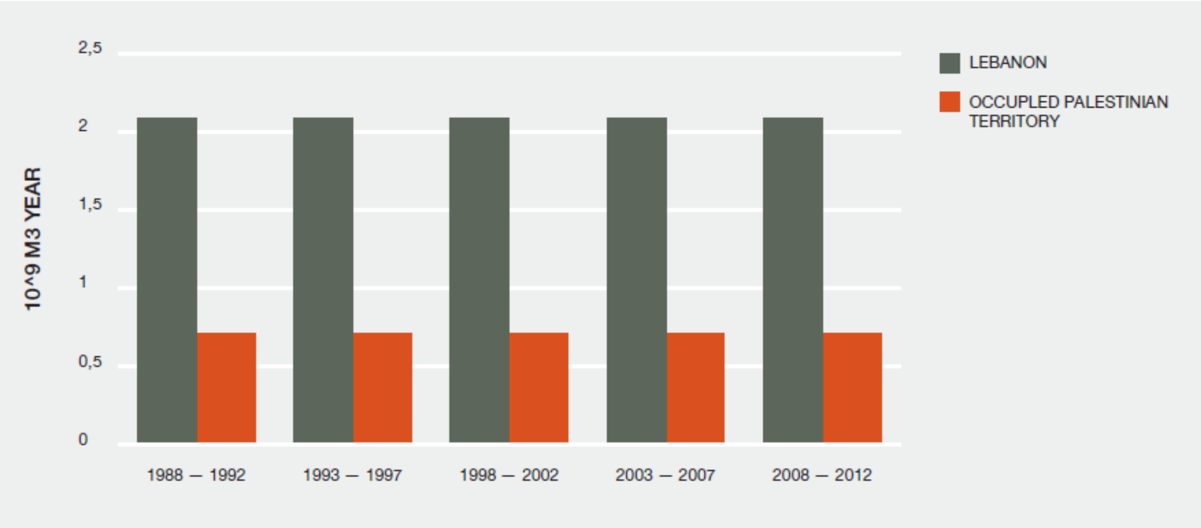

Figure 2.7 Annual total exploitable water resources for Lebanon and Occupied Palestinian Territory from Western Asia region from 1997 to 2012. Source: FAO (2016a).

2.3.1.2 Production of food, fuel, medicine, and materials

Production of grain and livestock

Agricultural productivity in the Asia-Pacific has increased a little faster than population growth in recent decades, resulting in an increase in per capita food availability (FAO, 2014). In the past 50 years, crop production and animal production have expanded across the region. Figure 2.8 shows the improvement of crop productivity in Asia-Pacific subregions (FAO, 2016b). The adoption of intensive cropping practices, such as multiple cropping with reduced fallow periods and the expansion of arable land, positively resulted in the growth of crop production (FAO, 2014). In the Asia-Pacific, the annual growth rate of crop productivity is most evident in Eastern Asia (2.6 per cent), while that of Oceania is 0.7 per cent. Meanwhile, Oceania and South-Eastern Asia have expanded harvested areas of crops with an annual average growth rate of 1.8 per cent and 1.6 per cent, respectively (FAO, 2016b). Such an expansion of agricultural land and highly intensive production systems may have caused significant declines of species habitat and biodiversity loss, while it increases food and rural livelihood security (Polasky *et al.*, 2011; Reidsma *et al.*, 2006).

Figure 2.8 Crop productivity in the Asia-Pacific region, 1961-2014. Source: FAOSTAT (2016b).

Cereals (eg. rice, wheat, maize) are important source of energy for human beings. Eastern Asia is the largest supplier of cereals in the world, and cereal production has increased from 1961 to 2014 (Figure 2.9). The largest cereal production was delivered by China, with Cambodia, Mongolia, Lao PDR and Sri Lanka expanding their cereal cropland (FAO, 2014). Trade has played an important role in meeting the demands for cereals and improving food security in the region. Oceania produced the largest amount of cereal per person and has exported the largest amount of cereal among Asia-Pacific subregions, while Eastern Asia, with a low production of cereals per person, imported the largest amount of cereals (Figure 2.10).

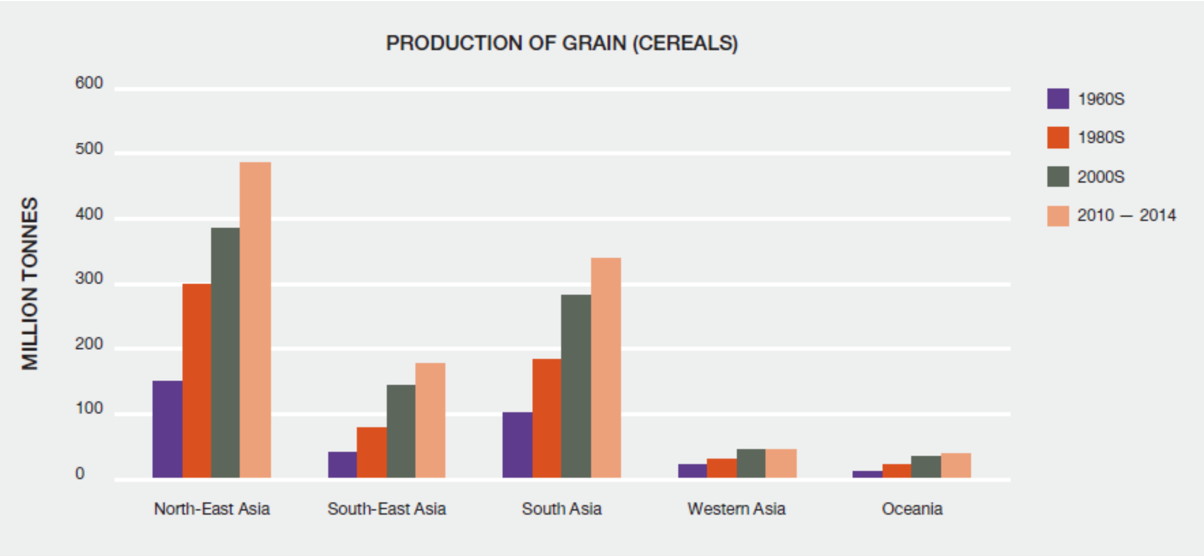

Figure 2.9 Production of grain (cereals) in the Asia-Pacific region during 1961-2014. Source: FAOSTAT (2016b).

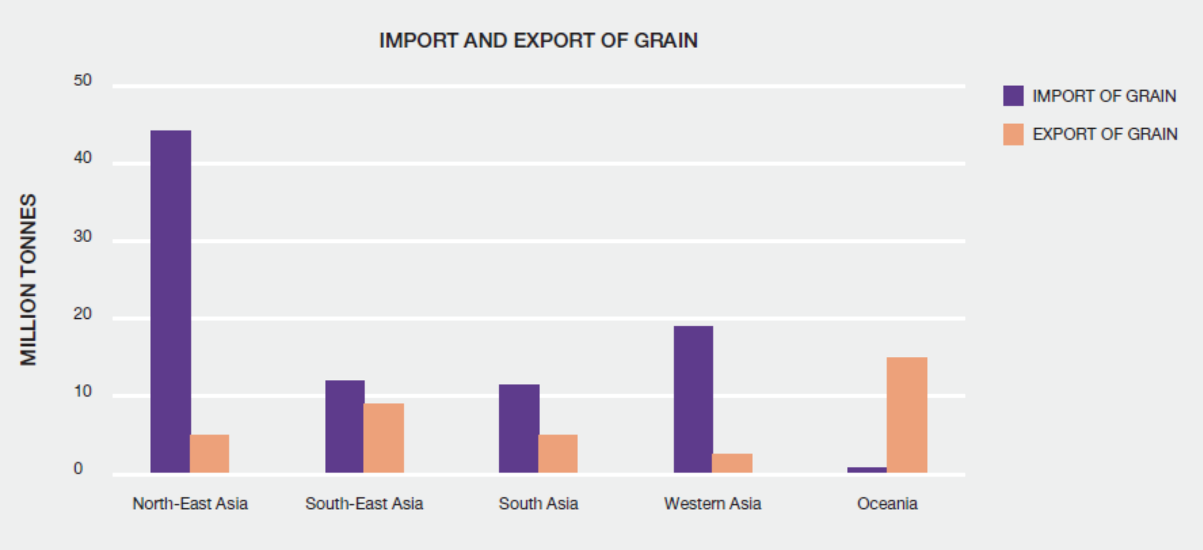

Figure 2.10 Import and export of grain in the Asia-Pacific region on average from 1961 to 2013. Source: FAOSTAT (2016b).

Production of livestock primary products (eg. meat, milk, eggs, skin) has increased in all regions of the Asia-Pacific, and especially rapidly in Eastern and Southern Asia over the past 20 years (Figure 2.11). In particular, the dairy sector has been expanding rapidly in reponse to the increasing demand and consumption of milk (FAO, 2014).

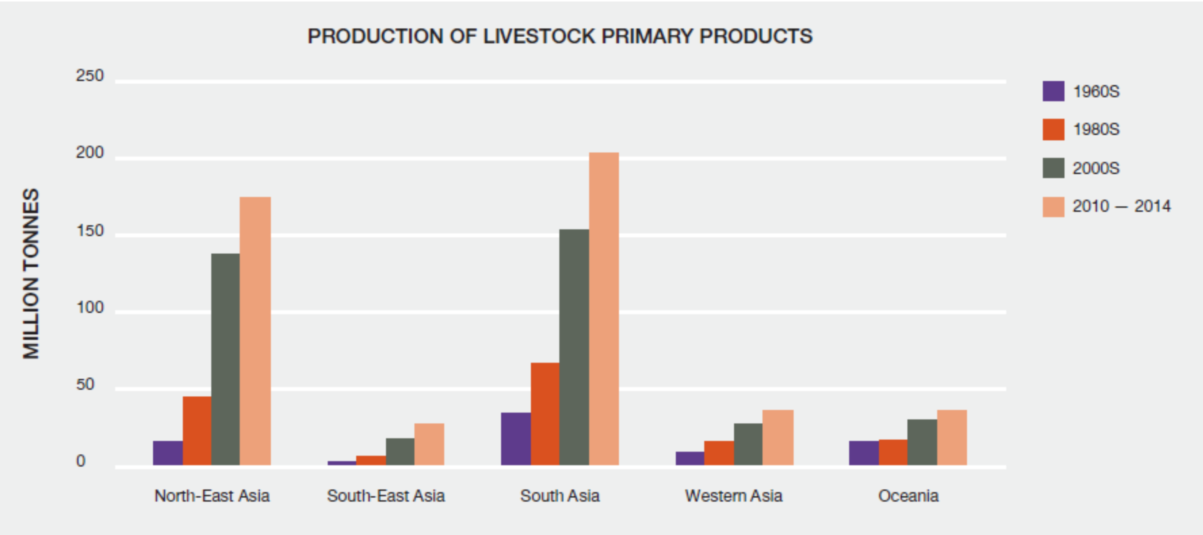

Figure 2.11 Production of livestock primary products in the Asia-Pacific region during 1961-2014. Source: FAOSTAT (2016b).

Figure 2.12 shows the trade quantity of livestock products on average from 1961 to 2013. Eastern Asia imported the largest amount followed by Western Asia, and Oceania exported the largest amount of livestock products. Oceania produced the largest amount of livestock products per person and exported the largest amount of livestock products among Asia-Pacific subregions. Eastern Asia, with its low production of livestock products per person, imported the largest amount of livestock products.

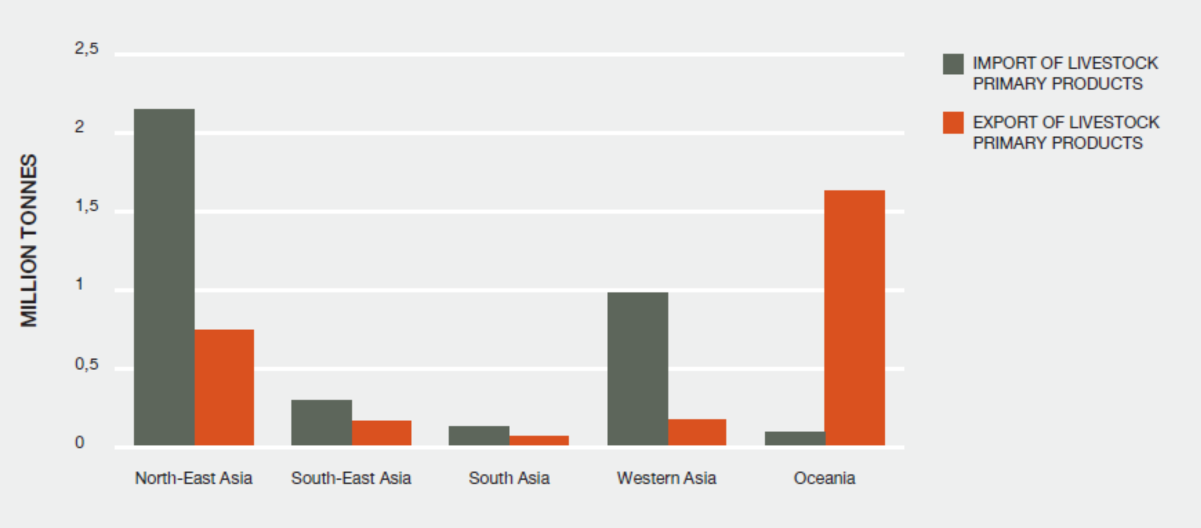

Figure 2.12 Import and export of livestock primary products in the Asia-Pacific region on average from 1961 to 2013. Source: FAOSTAT (2016b).

Fish production

The production of fisheries from ecosystems (capture fisheries) in the Asia-Pacific was 6.38 megatonnes in 1950 and increased to 52.45 megatonnes in 2015 (Figure 2.13) (FAO, 2016b). The average annual growth of capture fisheries during the period was 2.8 per cent. Throughout the period 1950-2015, the East Asian countries of: China, Japan and the Republic of Korea were the major contributors to capture fisheries. The share of East Asian countries in 2015 is 46.56 per cent of the total production in the region. The South and South-East Asia subregions cover the most productive ecosystems of the region, where the contribution comes to around 32.98 per cent. In these subregions, more than 10 million people are engaged in the fisheries sector; of which (approx.) 90 per cent are small-scale fishermen. The South Asia share is 15.77 per cent of the total production in 2015 while the contribution of Western Asia is low at 2.07 per cent. The subregion of Oceania encompasses vast areas of marine waters but accounted for only 2.6 per cent of the total catch for the Asia-Pacific (FAO, 2016b).

Fish and fisheries products play a major role in food and nutritional security of the people living in the region. It is reported that fish consumption varies from 110.7 kg per capita per year in the Pacific Island of Tuvalu to 0.18 kg per capital per year in Magnolia and parts of western China (Needham & Funge-Smith, 2014).

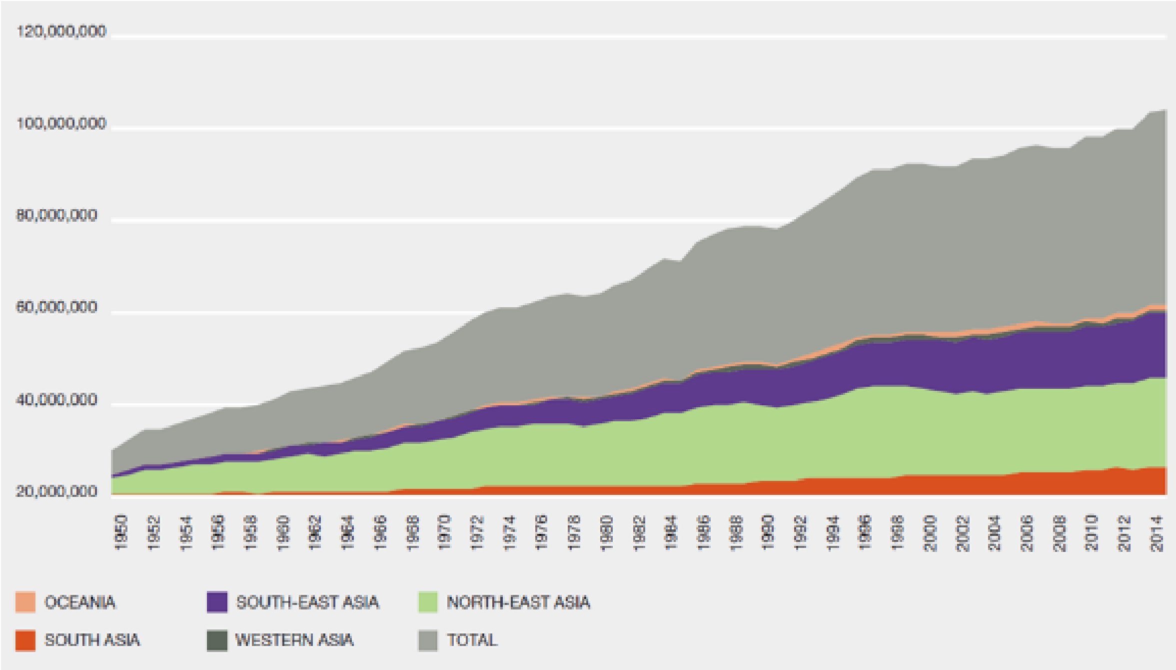

Figure 2.13 Capture Fish Production in the Asia-Pacific region. Source: FAOSTAT (2016b).

Production of industrial round wood and wood fuel

Forest area in the Asia-Pacific accounts for 18.1 per cent of the global area (Yasmi *et al.*, 2010). Despite the per capita forest area being high in some countries, the overall region has 0.18 hectares of forest per person (FAO, 2011b). The total regional population accounts for more than half of the global population, and the consumption of industrial round wood is increasing because of moderate growth in population and rapid growth in the economy (FAO, 1997). Trends of production, export and import of industrial round wood and wood fuel from 1961 to 2016 are illustrated in Figure 2.14. The overall trends show a rising production and import and export of industrial round wood.

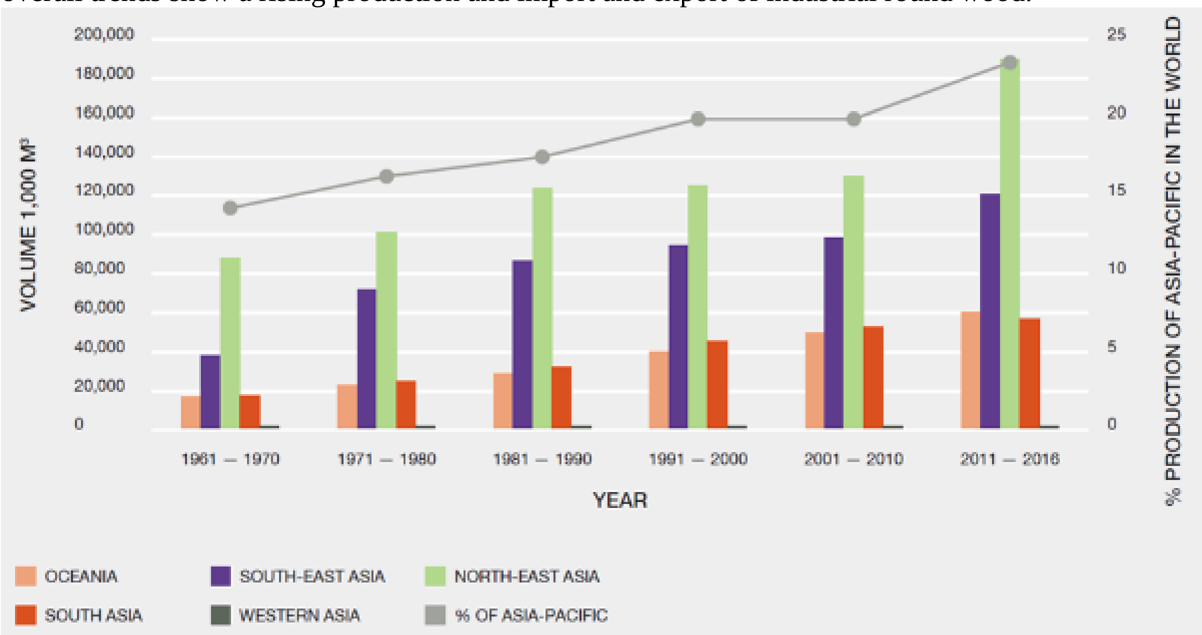

Figure 2.14 Production of industrial round wood in the Asia-Pacific region and its percentage in the world production during 1961-2016. Source: FAOSTAT (2016b).

Almost 25 per cent of the global industrial round wood production is in the Asia-Pacific, and this percentage has been increasing gradually (FAOSTAT). This increased production is accounted for by the largest producers, such as: China, Indonesia, New Zealand, Australia and India, while Japan and Malaysia's production has been decreasing gradually.

The consumption of wood fuel in this region was (approx.) 56 per cent of the total world wood fuel consumption during 1the 960s and 1970s (Figure 2.15). Since this time, its share has decreased to 40 per cent, in 2016. This declining trend in the production is found mainly in South-East Asia and North-East Asia. While South-Asia has been increasing their production and imports. Wood fuel is significantly contributing, as the main source of energy for almost two thirds of the population in this region (FAOSTAT).

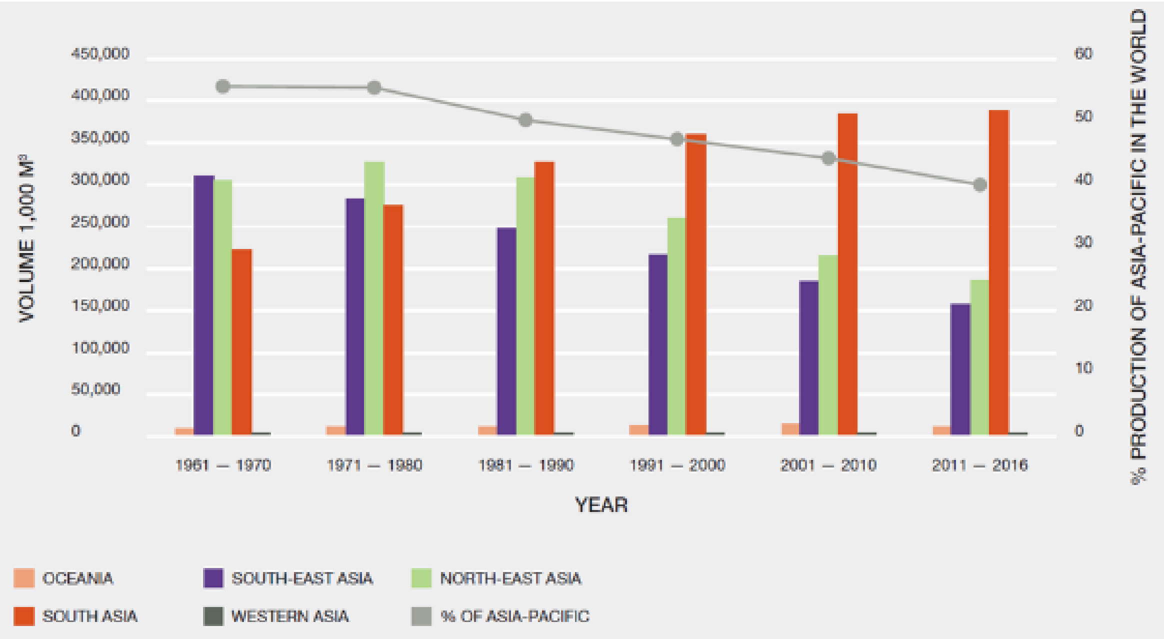

Figure 2.15 Production of wood fuel in the Asia-Pacific region and its percentage in the world production, 1961-2016. Source: FAOSTAT (2016b).

The Asia-Pacific continues to increase in importance as a producer and consumer of forest products. Oceania's increasing export of industrial round wood was mainly attributable to New Zealand. The export of forest products in South-East Asia is decreasing, even though the absolute amount is still higher than other Asia-Pacific countries. Being the world's leading exporter of tropical wood (Yasmi *et al.*, 2010), the Asia-Pacific's forestry sector continues to grow with the wood, forest products and non-wood forest products trade (Figures: 2.16 and 2.17).

Figure 2.16 Industrial round wood export and import in the Asia-Pacific region, 1961-2016. Source: FAOSTAT (2016b).

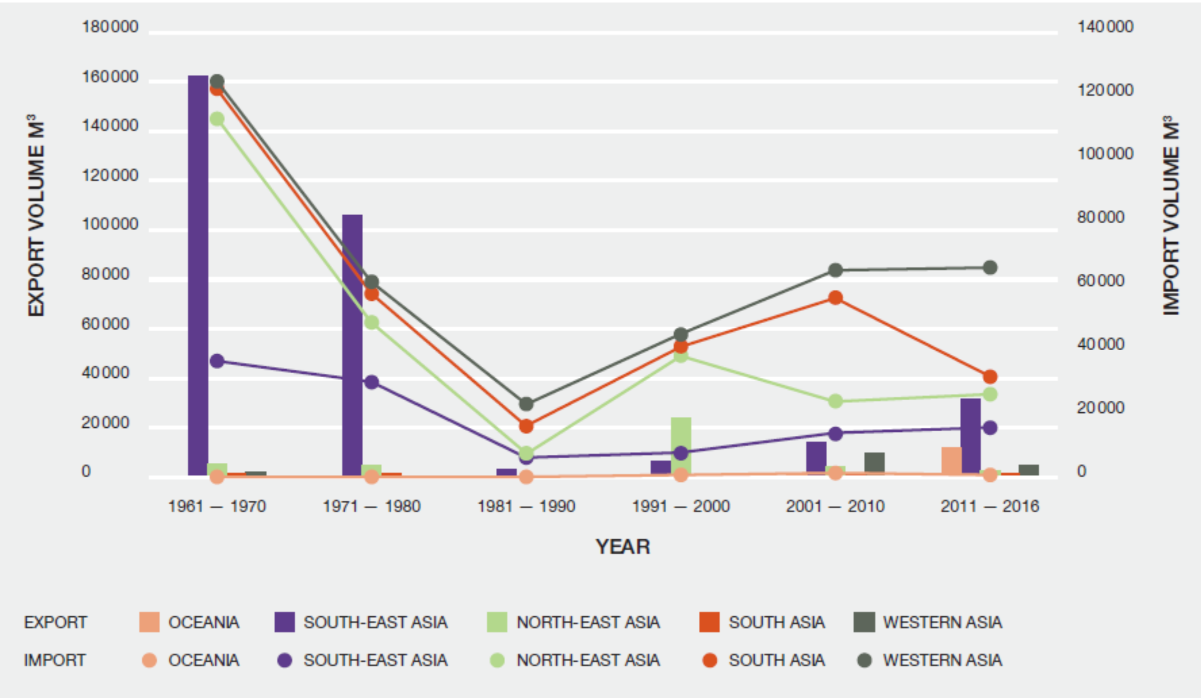

Figure 2.17 Wood fuel export and import in the Asia-Pacific region during 1961-2016. Source: FAOSTAT (2016b).

Provisioning medicinal and food resources

Plants have long been used for improving health and well-being, as well as for healing and treating diseases and sicknesses. Medicinal plants are defined as plants which have part(s) that contain substance(s) that can be utilized for therapeutic purposes, or, as precursors for the synthesis of useful drugs (M. R. Kumar & Janagam, 2011). The International Trade Centre defines medicinal and aromatic plants as botanical raw materials or herbal drugs that are predominantly used as components of cosmetics, medicinal products, health foods and other natural health products.

An estimated 70-80 per cent of people worldwide rely mainly on traditional, largely herbal, medicine to meet their basic healthcare needs (Ramawat & Merillon, 2008). The global demand for herbal medicine is large and growing. There has been a substantial growth in herb and herbal products since the 1970s and this worldwide interest in these products is evidenced by the increase in exports in medicinal plants. The rising interest in MAPs also indicates the increase in opportunities for income generation by rural populations. As many of MAPs are gathered from the wild, rural communities obtain additional income from the collection and sale of MAPs. In a study on Nepal, the average daily income gained from commercial MAP collection was revealed to be competitive with other income generating activities, constituting about 15-30 per cent of the annual income of poor households (Olsen, 1998). In Pakistan, almost all medicinal plants are collected from the wild and are an important source of income for poor people (Shinwari, 2010).

Despite the high value of the final products, the primary collectors of MAPs generally receive a small share of the final value of the unprocessed plant material. This may be because the primary collectors are not well-informed of the real value of the goods, are incapable of marketing it in the form desired by consumers, and/or are unable to market them to the consumers directly (FAO, 2005b). The processing of the raw plant material commonly takes place in consumer countries.

Based on information from the International Union for Conservation of Nature and the World Wildlife Fund, between 50,000 and 80,000 flowering plant species are being used for medicinal purposes globally (Medicinal Plant Specialist Group, 2007; Schippmann *et al.*, 2006). Among these, approximately 15,000 species are threatened with extinction due to overharvesting and habitat destruction, and 20 per cent of their wild resources are close to depletion due to rising human population and plant consumption (Motaleb, 2010). The distribution of medicinal plants is not uniform across the world (Figure 2.18) and China and India, the largest medicinal plant users, contain 11,146 and 7,500 species respectively (S.-L. Chen *et al.*, 2016; Verma & Singh, 2008).

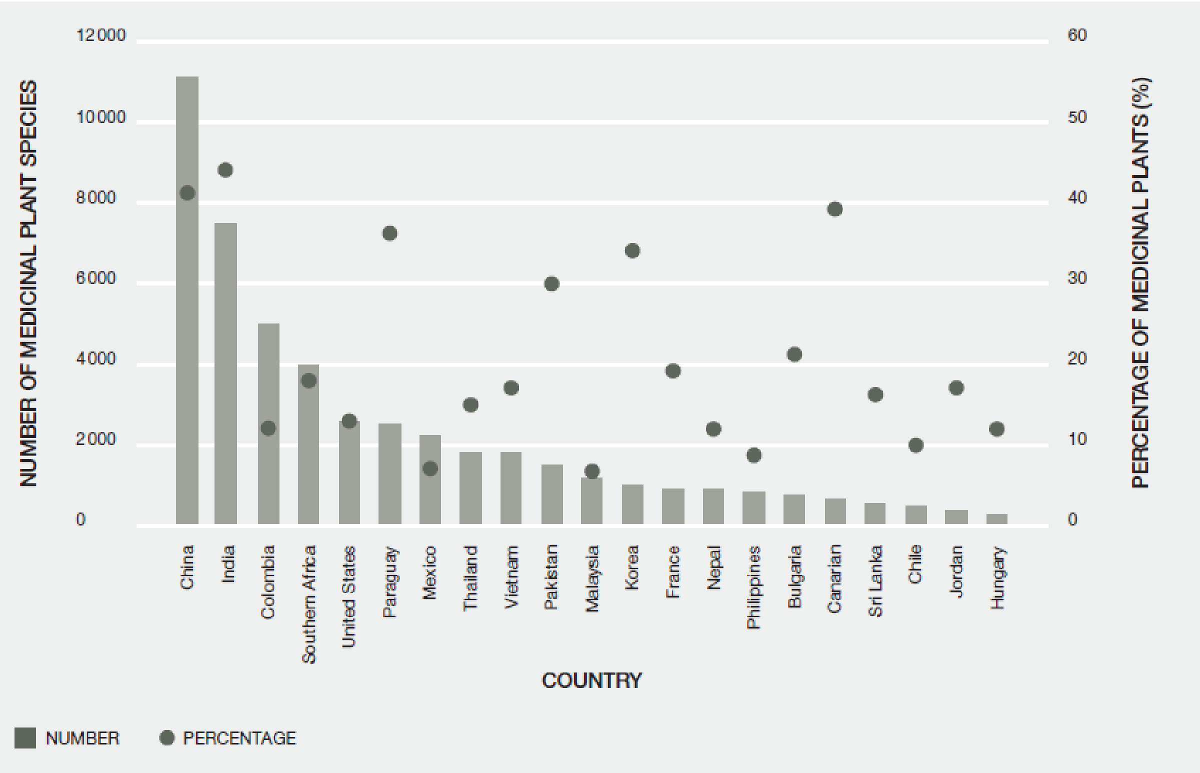

Figure 2.18 Number and percentage of plant species globally

Note: The bars show the number of medicinal plant species, and the dots show the percentage of medicinal plants compared with the total number of plant species in the country. Source: Chen *et al*. (2016)

The conservation and sustainable use of medicinal plants is important as they contribute significantly to people's lives by providing health support and maintenance, sources of income, as well as livelihood security and cultural preservation (A. C. Hamilton, 2004; U. R. Sharma *et al.*, 2004).

In many rural areas of the Asia-Pacific, animals are harvested for food, medicinal and subsistence uses, and/or trade (E. L. Bennett & Rao, 2002; Clayton *et al.*, 1997; Corlett, 2007; Lee *et al.*, 2014; Scheffers *et al.*, 2012; Shairp *et al.*, 2016; Wadley & Colfer, 2004). A wide range of taxa may be harvested, including primates, ungulates, pigs, bats, turtles, snakes, lizards, and birds. Wild meat (legal or illegal, often termed "bushmeat") can be very important for food security (Nasi *et al.*, 2008) and plays an integral part in the livelihoods, cultural and spiritual lives of many indigenous peoples and local communities (Lee *et al.*, 2014). Much wild meat hunting in the region is considered illegal, especially when carried out in protected areas. On the other hand, this region also has one of the world's largest regulated commercial harvests of meat, which is also aimed at culling high numbers (such as kangroos in Australia) and agricultural conflicts (Pople & Grigg, 1999).

Due in part to the illegal nature of much wildmeat harvesting, there is minimal reliable information on the scale of harvesting (Lee *et al.*, 2014; Milner-Gulland & Bennett, 2003; Swamy & Pinedo-Vasquez, 2014). However, the overexploitation of wild animals is clearly driving declines of many species (Corlett, 2007; Ripple *et al.*, 2016), and these impacts are escalating due to decreasing forest areas and increased human populations (Lee *et al.*, 2014). Wild meats are sometimes sold cheaper than domestic meats in rural markets in many remote areas of South-East Asia (Swamy & Pinedo-Vasquez, 2014). In some urban areas, wild meats are consumed in sizable quantities, generally more as a luxury than a staple food source (E. L. Bennett & Rao, 2002; Shairp *et al.*, 2016). In some cases, harvesting is driven by the demand from international trade e.g. frog legs (Kusrini & Alford, 2006; Warkentin *et al.*, 2009)

2.3.1.3 Nature's non-material contributions to people

Links between physical and mental health and exposure to natural environments have been identified in international literature. A systematic review of the literature, (van den Bosch & Ode Sang, 2017) found positive associations between green spaces/natural environments and: stress reduction; mental health and well-being; affect (the emotional tone expressed by an individual) and reduced levels of anger and sadness; and increased levels or motivation for physical activity. These positive associations have led to secondary impacts such as improved mental health, reductions in cardiovascular disease mortality, mental disorders, and a decrease in reduced birth weights and/or preterm births. These international trends are echoed by research across the Asia-Pacific, especially North-East Asia, where there is much research on links between mental and physical health such as the concept of 'forest bathing'. Research in this region correlates exposure (such as viewing, walking and/ or camping) to forest environments to therapeutic effects on human hypertension (Mao *et al.*, 2012; Song *et al.*, 2017), happiness and reduced negative emotions (Morita *et al.*, 2007; Shin *et al.*, 2013) and reduced stress, as observed in both psychological and physiological measures (Jung *et al.*, 2015; B. J. Park *et al.*, 2010; Tsunetsugu *et al.*, 2013). A forest environment was also found to be superior to a hospital environment in treatment of major depressive disorders in patients undergoing treatment through pharmacotherapy and psychotherapeutic interventions (W. Kim *et al.*, 2009).

While it would be very difficult to reliably quantify the impacts of BES exposure on human health and how this has changed over time, an approximation can be made by examining data on exposure of, or access to, green areas and/or natural environments such as urban parks and national parks. While data on visits to national parks in some countries in the Asia-Pacific is available, there is generally limited accessible data on visitation rates to parks across the region. We present here two sets of data from New Zealand and the Republic of Korea to give an indication of visitation trends.

Figure 2.19 shows data from the New Zealand Department of Conservation on the percentage of New Zealanders who have visited at least one Department of Conservation recreation area (national parks and heritage areas maintained by the Department, most of which are set in natural environments) in the past 12 months. Figure 2.20 shows the number of visitors in 18 national parks in Republic of Korea from 1988-2016.

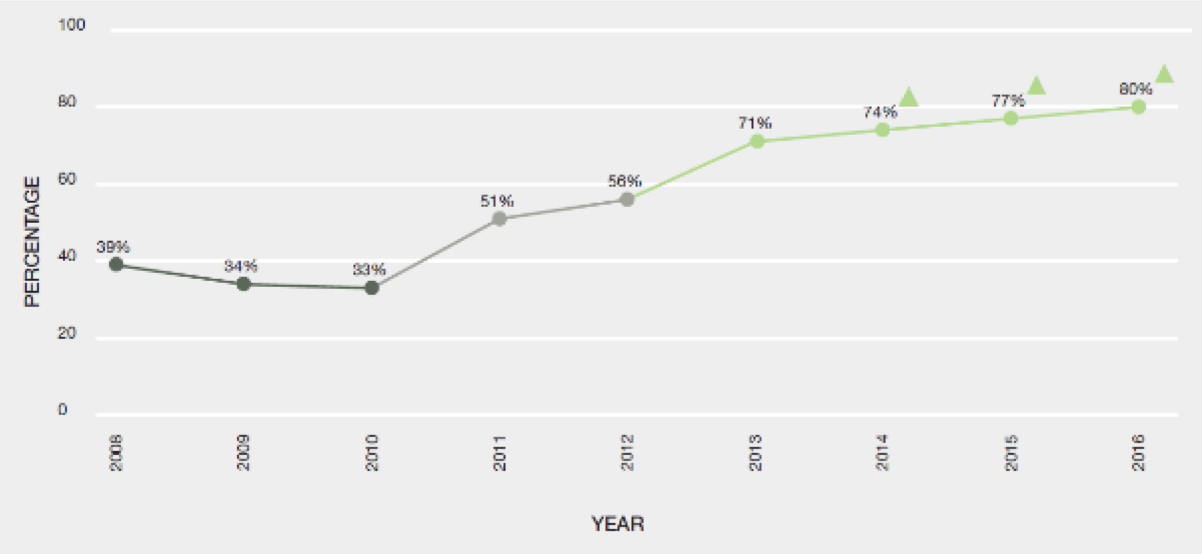

Figure 2.19 Proportion of New Zealanders who have visited recreation areas operated by the Department of Conservation in the past 12 months
Note: Change in line colour represents the shift in methodology. Source: "Survey of New Zealanders" by IPSOS, Department of Conservation New Zealand (2016).

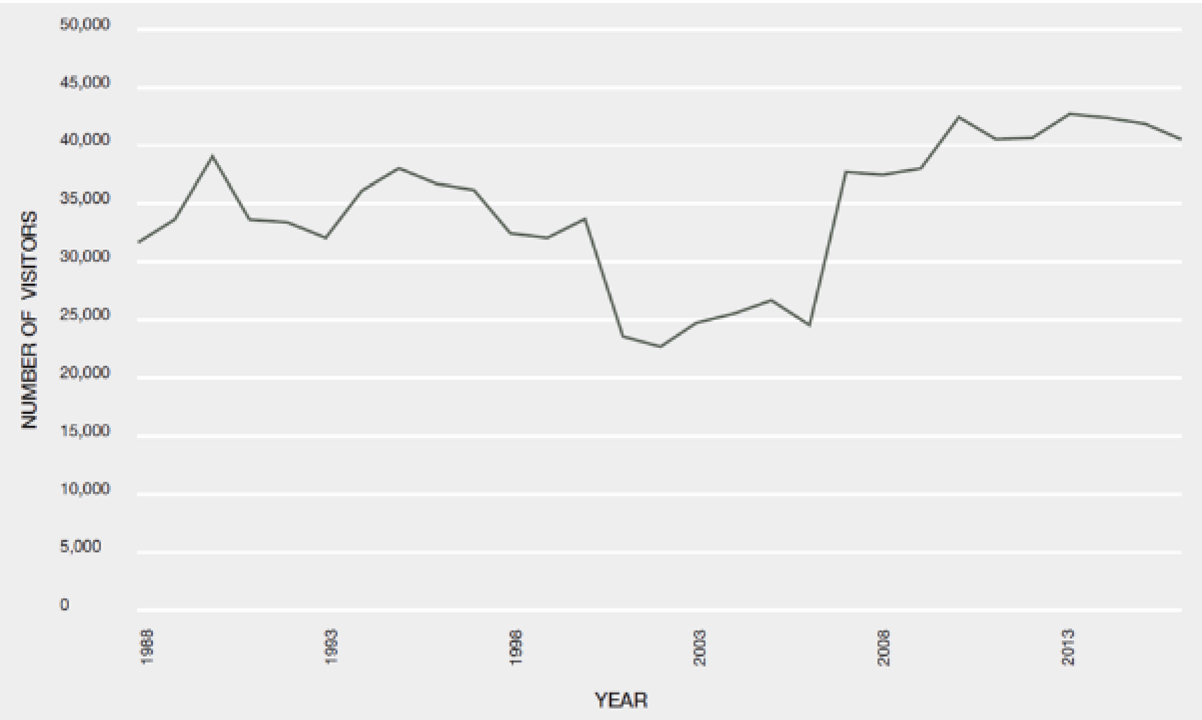

Figure 2.20 Visitors to 18 National Parks in the Republic of Korea. Source: Korea National Statistical Office, statistical database (KOSIS, 2014).

Forest management for provision of ecosystem services, cultural and spiritual values

In recent years, countries in the Asia-Pacific have started to manage their forest areas for specific ecosystem services, including hydrological regulating services. The FAO Global Forest Assessment report 2015 highlights that forests are managed broadly for two purposes: protecting soil and water. This includes areas managed for the production of clean water, coastal stabilization, desertification control, avalanche control, erosion and flood protection. Additionally for ecosystem services, cultural or spiritual values that include areas managed for public recreation, carbon sequestration/storage, and spiritual or cultural services (FAO, 2015a). The areas allocated for these purposes are mutually inclusive, providing an indication of trends towards management approaches, adopted by the countries, for ecosystem service provisions. Figure 2.21 presents the trend in proportion of forest areas allocated for the specific provision of ecosystem services, cultural and spiritual values from 1990 to 2015 for countries that have data available. Panel A is based on total forested area (forests + woodlands) and Panel B is based on total land area. There is clearly an increasing trend for some countries and a decreasing trend for others. Additionally some countries indicate no specific trend on forest area managed for ecosystem services, cultural or spiritual values over the years.

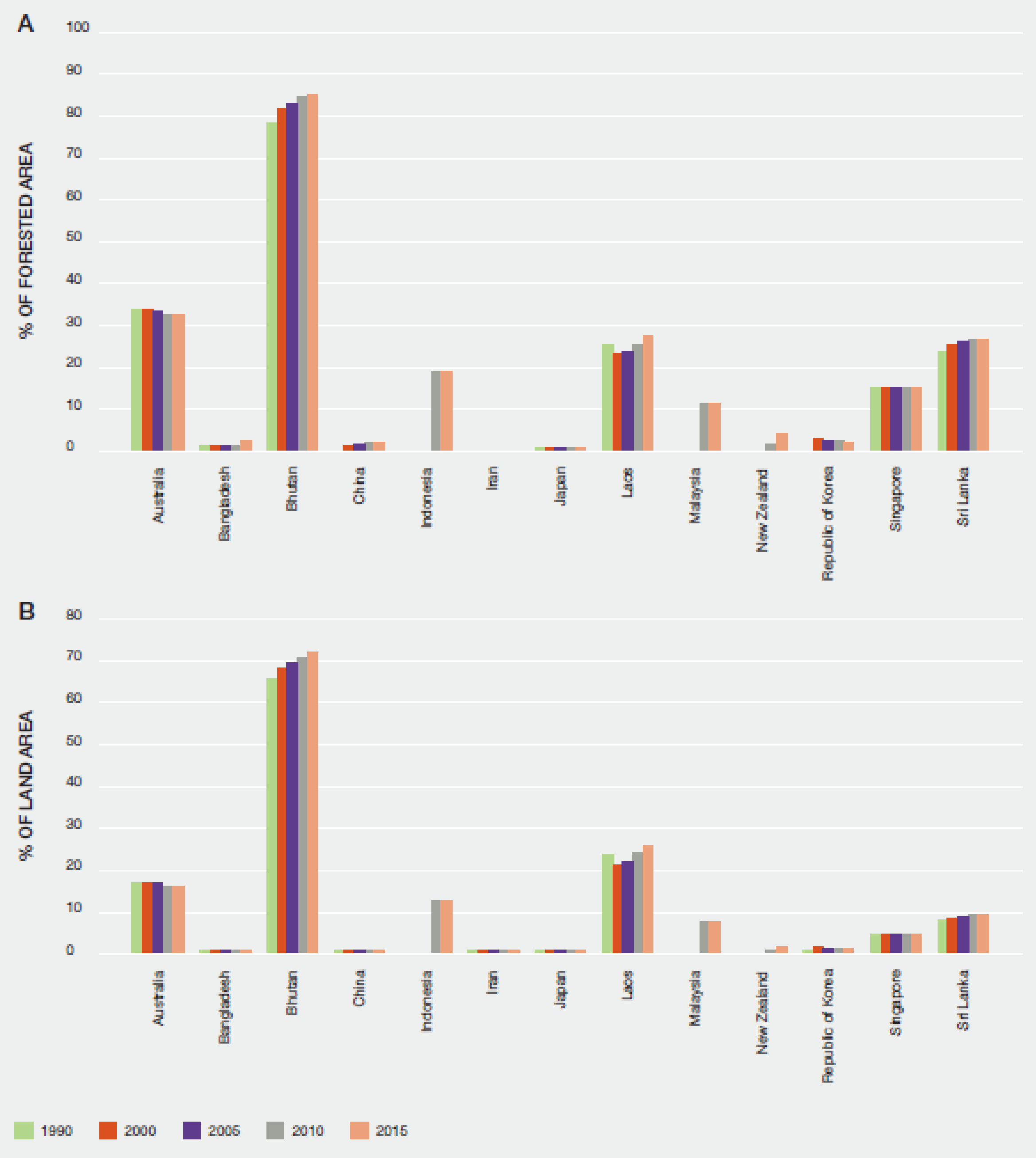

Figure 2.21 Panel A: Proportion of forest area managed for ecosystem services, cultural or spiritual values in different years compared to forested area (forests + woodlands) in 2015 for selected countries; Panel B: Proportion of forest area managed for ecosystem services, cultural or spiritual values in different years compared to land area for selected countries. Source: FAO (2015a).

Maintenance of options

The NCP "Maintenance of options" (NCP18) accords well with the IPBES Conceptual Framework listing of anthropocentric values including "the option values of biodiversity as a reservoir of yet-to-be discovered uses from known and still unknown species and biological processes" (Díaz, Demissew, Carabias, *et al.*, 2015). Because these benefits are typically global, they are distinguished from others within-ecosystem benefits (Faith *et al.*, 2017).

NCP 18 refers to "Benefits (including those of future generations) associated with the continued existence of a wide variety of species, populations and genotypes". "Wide variety" is another way of saying "biodiversity". Thus, this statement echoes early discussions that identified biodiversity itself as providing a benefit corresponding to maintenance of options (Faith *et al.*, 2017; Haskins, 1974).

The Millennium Ecosystem Assessment evaluated society's value of such maintenance of options: "the value individuals place on keeping biodiversity for future generations— the option value—can be significant." (Millennium Ecosystem Assessment, 2005, p. 32). Society's appreciation of the importance of biodiversity in maintaining options for the future also is revealed in the popularity of reports in the media of recent surprising discoveries and benefits that have emerged from the "maintenance of options". Many of these include discoveries in the Asia-Pacific that offer new benefits for society in general. For example, Chassagnon *et al*. (2017) reported this year that the venom of the 'Darling Downs' (Queensland, Australia) funnel web spider (*Hadronyche infensa*) is the unlikely source for a drug to ward off brain damage caused by strokes. Also this past year, Peel *et al*. (2016) reported that the milk from Tasmanian devils surprisingly provides a weapon against antibiotic-resistant bacteria. These stories and others have been reported in the popular press, reinforcing people's relational value linking biodiversity to the welfare of future generations (Faith *et al.*, 2017). A consortium of IUCN and 8 conservation NGOs (Gascon *et al.*, 2015) argued for the value of biodiversity as maintaining options and provided many examples of past , unpredicted benefits from biodiversity.

This societal value is documented indirectly in the Biodiversity Barometer (2015). The Asia-Pacific has the top global scores for countries regarding the percentage of people who have heard of "biodiversity" (China 96 per cent; Vietnam 94 per cent). Biodiversity awareness in India more than doubled between 2012 and 2015 (from 19 per cent to 40 per cent). However respondents from these countries had low scores when asked to define 'biodiversity' demonstrating their lack of understanding that it means 'living variation'. Understanding the definition is foundational for a community appreciation of the idea that biodiversity provides maintenance of options. The shift in focus by IPBES from 'ecosystem services' to NCP helps to overcome the neglect of the typically global-scale option values of biodiversity (Faith *et al.*, 2017).

Over the past decade or more, a strong case (Faith *et al.*, 2017) has been made for an indicator of "maintenance of options" as the estimate, over multiple taxonomic groups, of the status of phylogenetic diversity (Faith, 1992). Phylogenetic diversity is informative about the maintenance of options because it reflects the total relative 'feature diversity' of sets of species The IPBES catalogue[30] of assessments illustrates the link of phylogenetic diversity to features and to option value, based on the many foods and medicines discovered in plants . Many published studies corroborate the link between phylogenetic diversity and feature diversity, using available data on taxa and their features (Slowinski & Crother, 1998; Wilkinson *et al.*, 2002).

The status and trends of phylogenetic diversity, over multiple taxonomic groups, can be assessed by linking phylogeny to the IUCN red list status of species. Such assessment of imperiled phylogenetic diversity is well-established in the global EDGE of Existence program[31]. Many related regional and global studies (Daru *et al.*, 2013; Safi *et al.*, 2013; Tonini *et al.*, 2016; Yessoufou *et al.*, 2017) also provide existing data useful for the assessment of NCP18. 'Evolutionary Distinctiveness' measures the proportion of phylogenetic diversity (measured as branch lengths in millions of years) by giving the species credit for a branch inverse-weighted by the number of species sharing that branch. Available information includes tabulated published lists of 'Evolutionary Distinctiveness' values associated with good phylogenies, and IUCN red list assessments of the corresponding species. The sum of the tabulated Evolutionary Distinctiveness values of the threatened species within a given

[30] http://catalog.ipbes.net/assessments/144

[31] https://www.edgeofexistence.org/

taxonomic group approximates its total threatened or "imperiled" phylogenetic diversity (an estimate of the expected loss of phylogenetic diversity and corresponding loss of maintenance of options).

Table 2.2 shows these assessments for multiple taxonomic groups. There is expected serious loss of the maintenance of options based on the large fractions of phylogenetic diversity that is imperilled. The imperilled phylogenetic diversity allocated to the Asia-Pacific is a portion of the overall tabulated global imperilled PD for the given group. The region has approximately 38 per cent of the assessed global threatened species (Brooks *et al.*, 2016). However, the maintenance of options NCP for the Asia-Pacific depends not only on its own biodiversity but also that of the other regions.

Table 2.2 Status of NCP18 maintenance of options as indicated by amounts of imperilled phylogenetic diversity, for six taxonomic groups.

Taxonomic group	**Cycads**	**Amphibians**	**Corals**	**Mammals**	**Birds**	**Squamates**
Global non-imperilled PD	3,081	105,803	4,164	30,970	67,537	112,301
Imperilled PD, species in Asia-Pacific	2,195	16,775	611	4,025	3,653	3,867
Imperilled PD, species not in Asia-Pacific	3,581	27,370	996	6,566	5,960	6,310
Total imperilled PD / total PD	0.652	0.294	0.278	0.255	0.125	0.083

Note: The units of phylogenetic diversity (Faith, 1992) are millions of years. Taxonomic groups are ordered from left to right by the magnitude of their total imperilled phylogenetic diversity as a fraction of the total phylogenetic diversity of the group. The estimate of the fraction of imperilled phylogenetic diversity represented by species in the Asia-Pacific is approximated by the fraction of all threatened species found in the region. Global "non-imperilled" phylogenetic diversity includes both those assessed as non-threatened and portions that cannot be identified as imperilled because the associated species are Data Deficient (DD). Data sources: Brooks *et al*. (2016); EDGE of Existence, Safi *et al*. (2013); Tonini *et al*. (2016); Yessoufou *et al*. (2017); Daru *et al*. (2013).

2.3.2 Geographical heterogeneity of nature's contributions to people

This section includes case studies from five subregions within the Asia-Pacific that highlights geographical differences in the production and use of different ecosystem goods and services. The cases are from: Japan, China, Indonesia, Singapore, Jordan, Bhutan, India, Australia, Fiji and New Zealand (Table 2.3).

Table 2.3 Summary of case studies

Subregion	**Country**	**Type of nature's contributions**	**Ecosystem type/Biome**	**Value Type**
North-East Asia	Japan	Non-material benefits (Cultural)	Shinto Shrines and Satoyama Landscapes	Socio-economic
	China	Material and non-material benefits	All ecosystems	Economic
South-East Asia	Indonesia	Material and non-material benefits	Forests	Economic and socio-cultural
	Singapore	Material and non-material benefits	Coastal	Relational
	Philippines	Non-material (traditional)	All ecosystems	Socio-economic
	Vietnam	Material and non-material benefits	Forest, crop	Socio-economic

Western Asia	Jordan	Material and non-material benefits	Forests and Oases	Economic
		Regulating water flows	Range	Economic
South Asia	India	Material and non-material benefits	Lakes	Biophysical and socio- cultural
	Bhutan	Material and non-material benefits	All ecosystems	Economic
Oceania	New Zealand	Material and non-material benefits	Freshwater fisheries and Maori values	Socio-economic

The value of nature's contributions to people in China

In response to ecosystem degradation from rapid economic development, China began investing heavily in protecting and restoring natural ecosystems from 2000. A recent study reports on China's first national ecosystem assessment (2000–2010), designed to quantify and help manage ecosystems reflecting changes in value of ecosystem services. All ecosystem services evaluated increased between 2000 and 2010, with the exception of habitat provision for biodiversity. Thus 'maintenance of options' (NCP18), which depends on the region's biodiversity, is likely to have decreased. Food production had the largest increase (38.5 per cent), followed by carbon sequestration (23.4 per cent), soil retention (12.9 per cent), flood mitigation (12.7 per cent), sandstorm prevention (6.1 per cent), and water retention (3.6 per cent), whereas habitat provision decreased slightly (–3.1 per cent).The Chinese Government designated its priority areas for securing these ecosystem services in its National Biodiversity Strategies and Action Plan (NBSAP). The study indicated that they provide 83.4 per cent of carbon sequestration services, 77.7 per cent of soil retention services, 59.1 per cent of sandstorm prevention services, 80.4 per cent of water retention services, and 56.3 per cent of natural habitats, although they make up only 37.0 per cent of the area of China (Ministry of Environmental Protection of China & Chinese Academy of Sciences, 2015).

The changes in the provision of ecosystem services from 2000 to 2010 are the result of natural capital investment policies, changes in biophysical factors, and socio-economic development. Overall, results from the study suggest that China's national conservation policies contributed significantly to the increases in four key ecosystem services (Ouyang *et al.*, 2016).

Shinto shrines and Satoyama landscapes

In Japan, Shinto shrines are usually surrounded by trees and often by extensive thick forests including sacred trees (Ono & Woodard, 1962). Many Buddhist temples and monasteries in Japan, China, Korea and South-East Asia have carefully tended gardens, including trees that can be described as 'sacred groves' (Frazer, 1935; Yin, 1994). Traditional agricultural management practices created and maintained specific ecosystems (Moonen & Marshall, 2001). Paddy fields cultivated the culture and landscapes of Japan (Iiyama *et al.*, 2005).

More than a decade ago, the Satoyama began to be recognized as a hub of biodiversity (Fujii & Shibata, 1981; Fujii & Zinnai, 1979; Hamada & Kuramoto, 1994; Hayama *et al.*, 1996; Ishii, 2005). The secondary forest attached to agricultural villages, which provided wood, charcoal and organic fertilizer is known as the Satoyama Proper. It was later revealed that constant human intervention had provided an environment well suited to native Japanese species that had adapted to constant natural disturbances such as earthquakes, storms and volcanic activity (Washitani, 2001). However, in the modern Japanese context the Satoyama has only a limited economic influence in providing provisional services for various industries, and most Japanese rural landscapes have lost their function and been abandoned or incorporated into urban fringes as a result (Brown & Yokohari, 2003). The importance of cultural services which provide the feeling of 'homeland' has increased significantly, compared to the past when the Satoyama's value was recognised predominantly for its provisioning services.

Value of nature's contributions to people in New Zealand

Use of and respect for freshwater fisheries are key aspects of Māori culture in New Zealand. Rivers, wetlands and lakes sustain fisheries of indigenous species and introduced salmonids (trout and salmon), and support waterfowl that are valued for hunting and bird watching. They also provide a range of resources that are used in Māori cultural and spiritual practices, including wetland and riparian plants that are used in weaving and medicine (Tipa & Teirney, 2006). They support a wide range of recreational activities and provide the backdrop to many key tourist attractions (Robb & Bright, 2004), which, in the 2012/13 financial year, attracted 2.64 million international visitors who spent $5,491 million (MBIE, 2013).

Māori have particularly strong cultural and historic links to freshwaters. Some tribes consider their river as an ancestor (tīpuna) (NIWA, 2010). Some waters are considered to be tapu (or tabu or sacred), while other water bodies have special taonga value because of special uses that are not restricted by the prohibitions of tapu. The tapu or taonga status of a waterway is dependent on the preservation of its purity and the avoidance of unprotected contact with humans (MfE, 2001).

Value of nature's contributions to people in Bhutan

Of the total value of ecosystem services, 47 per cent of the benefits accrue to people inside the country of Bhutan - 15 per cent at the national level, and 32 per cent at the local level. Based on this, and a population of 700,000, Bhutan's combined per capita annual benefits is estimated at $15,400/capita/yr. Of this, $5,000 is from goods and services captured in GDP and $10,400 is from ecosystem services. This is, of course, only a partial estimate that omits many other sources of benefits to the people, including social and cultural values (Kubiszewski *et al.*, 2013).

Wular Lake in India

Wular Lake is the largest freshwater lake in India, with an area of 11,277 ha (National Wetland Atlas, 2013) and provides a range of ecosystem services including: fish, aquatic plants and water supply. Wular Lake provides livelihoods to a population of 10,964 households in 31 villages along the shoreline (Wetlands International, 2007). Over 60 per cent of fish for the Kashmir Valley comes from this lake (National Wetland Atlas, 2013). The aquatic plants within the lake are extensively utilized for different purposes including food and fodder. Seeds of water chestnut (*Trapa natans*) and the lotus root (*Nelumbo nucifera*), are consumed as food while *Nymphoides peltata* and *Phragmites australis* are dominant fodder plants. The lake with its associated wetlands supports rich biodiversity and is an important habitat for migratory waterbirds within the Central Asian Flyway, including several species that are globally threatened (Wani, 2009). The coniferous forests and alpine pastures in the lake catchment add to the natural beauty and biodiversity of the wetland area. Wular and its associated marshes regulate the water regime in the valley by absorbing water during peak periods (summers) and releasing it during low flows (winters). This regulation not only helps in flood control by absorbing excess water and preventing fast run offs, but also assists the functioning of hydroelectric power stations, downstream. Wular Lake was designated as a Wetland of International Importance under the Ramsar Convention in 1990 for its biodiversity and socio economic values.

The lake has witnessed several changes over the decades affecting all its natural functions and ecosystem services. A recent study of land cover changes within a 5km buffer zone around Wular Lake between 1992 and 2008 (Mushtaq & Pandey, 2014), revealed a decrease in *forest* from 93 to 32 km^2, the area of *built up* land increased from 7 to 52km^2, and marshy wetland area decreased from 85 to 5km^2. This has resulted in a significant quantity of silt being deposited in the lake reducing its volume substantially and therefore its absorption capacity. Willow plantations to meet the fuel wood requirements, have further compounded the siltation process and altered the hydrological regimes.

The direct discharge of solid and liquid wastes in to the lake has degraded its water quality, creating a major health hazard, not only for the people but also for the lake ecosystem. The main sources of pollution include domestic wastewater, agricultural activities and runoff (Figure 2.22) (Bhat & Pandit, 2014). Invasive macrophytes (e.g. *Azolla cristata* and *Alternanthera philoxeroides)* are an emerging threat (Masoodi & Khan, 2012b, 2012a). The number of tourists visiting the lake has lowered drastically over the decades. Decline in the resource base and limited opportunities for livelihood diversification have led to poverty and a reduced quality of life for communities living around the lake. The prevalence of poverty is between 41 per cent – 52 per cent within these communities, higher than the state average of 3.91 per cent (WUCMA, 2016). Many of these people have migrated to urban areas in search of livelihoods.

Figure 2.22 Harvesting nutlets of *Trapa natans* from the lake sediment during winter, for use as food. Photograph by Ather Masoodi.

Sacred groves in Asia

In Asia, the tradition of nature worship and the religious respect to nature is an important aspect of sacred customs and practices often with small patches of native vegetation traditionally protected and managed by indigenous peoples and local communities. The local communities protect and maintain a particular region as a 'sacred grove' as a part of their religious and cultural values and practices. The sacred groves are pockets of more, or less, climax vegetation preserved on religious grounds, often in remote areas. Scattered throughout India, these patches of vegetation are dedicated to the Gods or other deities, ancestral spirits and are revered by local inhabitants as the deity's sacred territory (Gadgil & Vartak, 1973, 1981; Ramakrishnan *et al.*, 1998; Vartak & Suryanarayana, 1995). Even the removal of dead parts of trees may be a taboo in some cases (Vartak, 1996). At least 13,720 sacred groves have been reported to date in India, which represents only an indication of the extent and magnitude of the presence of sacred groves in the country. In view of the known presence and pattern of the distribution of sacred groves, the number in India is estimated to be between 100,000 and 150,000 (Malhotra, 1998; Malhotra *et al.*, 2001).

Philippines

Biodiversity and ecosystems are closely linked to the culture and spirit of indigenous people in the Asia- Pacific. Often nature is represented in rituals and ceremonies. For example, for Kankana- ey People in Sagada, Northern Philippines, various elements of a landscape are related to rituals called *begnas* that are practiced to support community welfare and personal well-being. These rituals include birds and other animals of which their behavior is observed as important omens. Mountain peaks are utilized for calling ancestor spirits. Freshwater species from rice paddies, rivers and streams and different rice varieties are used for the *begnas* ceremony. Rivers and streams are for purifying participants in the rituals. A particular *begnas* is then performed under certain trees or within sacred groves (Anacio, 2017). In the pre-colonial times crocodiles were worshiped as the embodiment of the ancestors, spirits or gods, and this still remains in the beliefs of some people such as the:Magindanaon, Tagbanwa and Kalinga (van der Ploeg *et al.*, 2011).

Vietnam

While the forest is a source of provisioning services (foods and other materials) to ethnic minority groups in Vietnam, it also used as a venue for spiritual activities; rituals, traditional games and songs are held within the forest (Hien *et al.*, 2011). In the H're ethnic community in Vietnam, certain traditional rice varieties are especially used and connected with rituals, ceremonies, making special wine and special cake (local specialty) (Anacio, 2017; Dang, 2017).

Singapore

Singapore is one of the most densely populated countries in the world. Despite this, it still has rich biodiversity throughout the country. One of the signigicant attributes of Singapore's biodiversity is its harbors and coastline. Coastal management is a very important aspect of Singapore's response to the constant pressures of: pollution, transport and industrialization. Tourism is a predominant industry in Singapore. The government has used tourism to the benefit of supporting biodiversity and sustaining ecosystems through education and nature-based tourism. The current state of biodiversity shows some trends of improving, as there have been noted increases in the numbers of species of certain groups of plants and animals. (National Parks Board Singapore, 2015)

Western Asia

Only a few sub-systems have been valued for their contibutions to people (i.e. ago-ecosystems, dry land, steep and forests). Mashayekhi *et al*. (2010) estimated the economic value of the water storage function of forest ecosystems in Zagros, Iran, by calculating the cost of replacing this function with other artificial methods, the water retention value was estimated at $43 per hectare. Several studies have estimated the value of forest ecosystems in Western Asia. Following the contingent valuation method (method to elicit people's choices based on hypothetical survey questions), the social value of the northern forested area in Jordan was estimated to be $1,158,414.8 per year (Al-Assaf, 2015). This amount covers the value of services: soil conservation, aesthetic purposes, medicinal and herbal plants, biodiversity conservation, firewood and animal feed. Meanwhile the cedar forests in Lebanon had a total economic value based on the difference in value for users and non-users, which was approximately $20 per household for both villagers and city dwellers (Sattout *et al.*, 2007).

Oases in Western Asia have been under continuous threat in terms of water availability, where water is diverted to high-value uses at the expense of irrigation. The estimated value for the recreational use of an oasis can be exemplified by the Misfat Al-Abryeen oasis in Oman, which has been valued at $104.74 per individual, per trip. The total social benefit from this oasis is estimated at $366,590 per year (Zekri *et al.*, 2011).

A study by the IUCN (2011) estimated some of the potential economic benefits that could be accrued from protecting and restoring the rangelands of Jordan using the traditional Hima system tool following the Total Economic Value (TEV) to derive the rangeland's benefits to local people. Local communities derived substantial amounts of forage material from Mujib Natural Reserve in Jordan, which represents three bio-geographical regions that accounted to $147,000. Thus, the annual economic value of rangelands in Jordan would amount to $191.6 million (IUCN, 2011).

2.3.3 Economic valuation of ecosystem goods and services

2.3.3.1 Rationale for economic valuation

Although there are diverse definitions of values (e.g. principles, preferences, importance and measures) and there exist multiple valuation methods, human decision-making largely depends on anthropocentric, instrumental values and in particular, economic values (Díaz, Demissew, Joly, *et al.*, 2015; Pascual *et al.*, 2017). One of the rationales for economic valuation is that assessment results are expressed in a “common metric” (i.e. money) across various ecosystem services, which is essential for informed decision-making (Millennium Ecosystem Assessment, 2005). This utilitarian interpretation of human preferences can be useful when societies face trade- offs between different ecosystem services or between different policy options.

Studies of economic valuation can be largely divided into two approaches: one aims to estimate a total economic value for entire jurisdictional boundaries (e.g. global values) (e.g. Costanza *et al.* (1997, 2014)) and the other a welfare value for a change in ecosystem services due to a change in ecosystems (e.g. TEEB (2010); UKNEA (2011)). It is important to recognize the differing purposes of the two approaches. The total valuation approach might be limited to awareness-raising, whereas the change-based approach is more applicable for specific policy questions or decisions (Costanza *et al.*, 2014). A priority of this assessment is to offer policy relevant information for decision makers. Therefore the following subsection offers a brief overview of valuation studies in terms of ecosystem types (or biomes) and NCP in the region. Value estimates are reviewed to reveal which ecosystem types and services are prioritised by the people in this region.

Need for valuation of ecosystem services in decision-making

The Republic of Korea has experienced frequent damage from landslides and flooding due to deforestation, up until 1960s. The investment of the nation in reforestation, in 1960s and 1970s, is ‘paying back’, in terms of the ecosystem services being delivered from the recovery of the forests. A recent study by UNDP revealed that the reforestation investment took at least one decade in returning its payoffs as shown in Figure 2.23. The annual benefits were converted to present values (PV) in 2010. The NPV level shown each year is the sum of accumulated annual PV until that year. In the case of Republic of Korea, the most significant benefits of reforestation was regulating the services of forests, controlling water flows with increased water yield, and reduced floods. The study relied on the results of research on valuation of ecosystem services of forests carried out by scientists e.g. Kim *et al.* (1994) and Markandya *et al.* (2017). Cost benefit analyses such as Markandya *et al.* (2017) require a prior valuation of ecosystem services to be conducted.

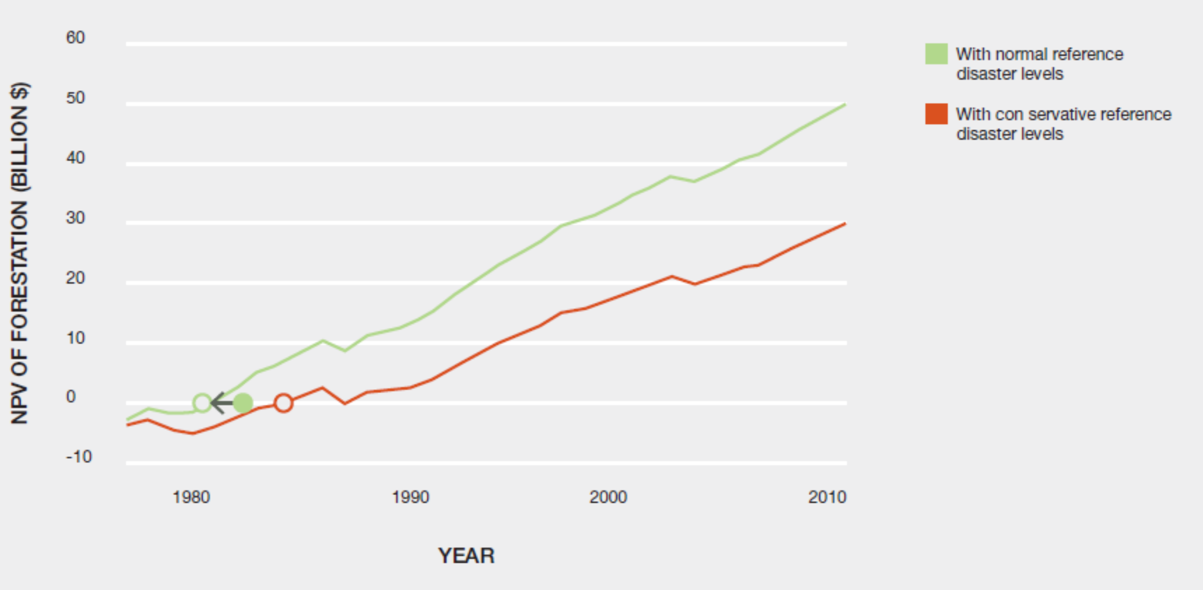

Figure 2.23 Total cumulative Net Present Value (NPV) of forestation in the Republic of Korea
Note: The annual benefits were converted to present values (PV) in 2010. The NPV level shown each year is the sum of accumulated annual PV until that year using discount rate of 3 per cent per year. Source: Markandya *et al*. (2017).

2.3.3.2 Methodology for the review

A systematic review (SR) approach is used to extract the relevant information from existing literature following the guidelines developed by Khan *et al*. (2003) and D'Amato *et al*. (2016). A SR protocol, which includes key research questions, search strategies, study inclusion criteria and data extraction strategies, was developed. The key research questions can be summarized as to examine:

1) spatial and temporal trends of valuation studies in the Asia-Pacific
2) number of studies and value estimates by ecosystem types and NCP
3) magnitude of values by ecosystem types and NCP

In order to identify relevant studies, we defined search strings and language. We limited our search to the published articles in English and designed 'search strings' which are combinations of (monetary) values, ecosystem services, NCP, subregions of the Asia-Pacific, and the name of countries in the region. We chose an online-database, Web of Science, for the publication search and located 684 journal articles through the search process.

Criteria of study inclusion were constructed for the data extraction. We excluded the studies where the information on monetary value, name of country, ecosystem type, and ecosystem service were not clearly reported or specified. As a result, only 92 studies, from a possible 684 studies were included, indicating that 86 per cent of the articles are eliminated through the screening process. Relevant information for the analysis was extracted from these 92 studies[32], and the categories of ecosystem types and ecosystem services were re-coded based on the classification of 11 ecosystem types (biomes) and the 18 NCP in the Asia-Pacific Regional Assessment. A single study can provide multiple value estimates, we were therefore able to assemble 1,131 observations from the 92 studies. For the comparisons, monetary values were standardized into 2010 international dollars using GDP deflators of each country and purchasing power parity conversion factors provided by the World Bank.

[32] The list of publications used in the analysis can be seen in the supporting document.

2.3.3.3 Trends of valuation studies

According to the review results, there were 1,131 value estimates that were studied between 1980 and 2015, and reported in 92 journal articles published between 2000 and 2017. There is a time lag for recent studies to be published.

As shown in Figure 2.24, the annual number of estimates involving eighteen NCP has been continuously increasing, particularly since 2000. Regulating NCP received more study estimates than material and non-material NCP, which showed a particularly rapid increase in the areas of climate regulation and soil quality. In terms of the total quantity of estimates for particular NCP, the majority of estimates were related to foods and materials for material NCP; climate regulation and soil quality, followed by habitat and water quantity, for regulating NCP; and amenities for non-material for NCP.

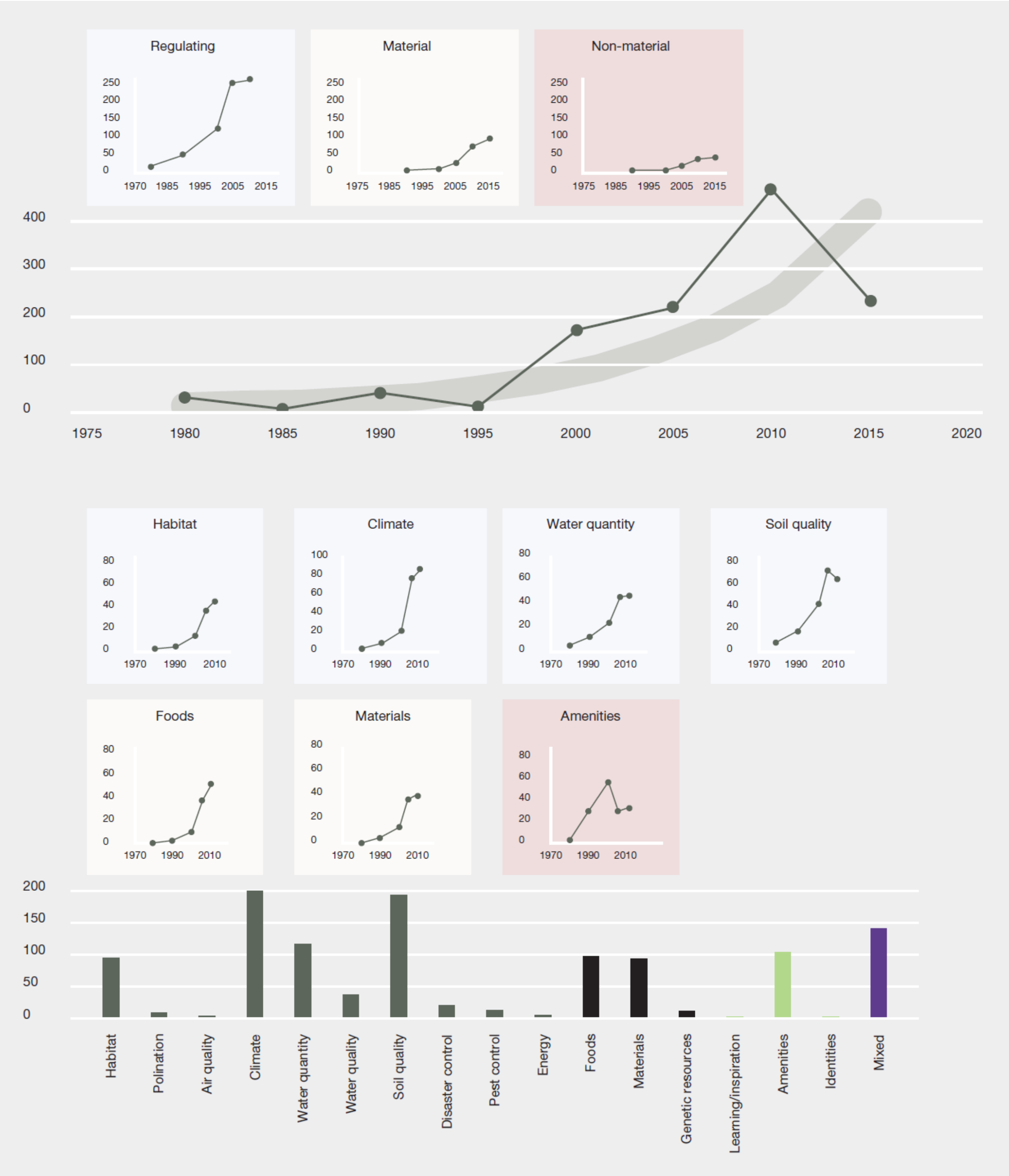

Figure 2.24 Distribution of studies on the economic valuation of ecosystem services by year and by type of nature's contributions to people

These valuation estimates showed varying levels of concentration across the eleven ecosystem types or biomes, and across the five Asia-Pacific subregions. As shown in Figure 2.25, (approx.) 24 per cent of the total estimates were related to productive systems (e.g. cultivated areas), followed by wetlands (16 per cent), freshwater (13 per cent), temperate and boreal forests (13 per cent), urban (9 per cent), grasslands (9 per cent), deserts (4 per cent), and coastal (2 per cent). The other ecosystem types received less than 1 per cent coverage. The overall concentration levels of ecosystem types (i.e.their value estimates) were dominated by those of North-East Asia, while Oceania had less for temperate forests; South-East Asia had more for temperate forests and coastal; South Asia had more for temperate forests; and Western Asia had more for grasslands.

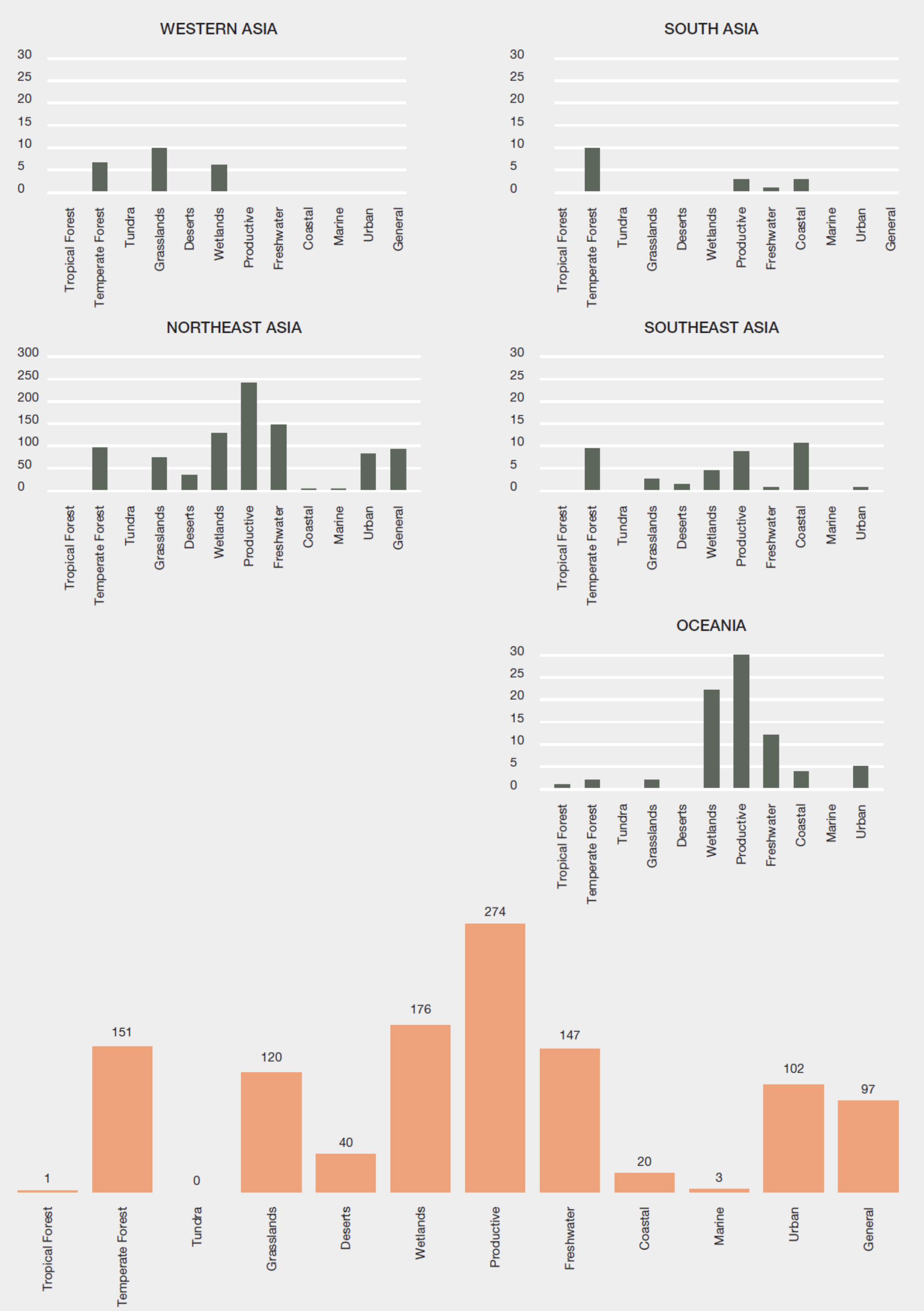

Figure 2.25 Distribution of studies on the economic valuation of ecosystem services across eleven ecosystem types in the Asia-Pacific region and in the five subregions

Five subregions showed disproportionate estimation numbers and coverages of NCP. As depicted in Figure 2.26, the majority of value estimates (983 estimates; 87 per cent of the total) involved NCP in North-East Asia, in particular China (966 estimates; 98 per cent of North-East Asia).The next subgroup is Oceania, including 78 estimates (7 per cent), followed by South-East Asia (42 estimates; 4 per cent), and South Asia (28 estimates; 3 per cent).Within each subgroup, about 60~65 per cent of the estimates were related to regulating NCP in North-East Asia, and Oceania, while Material NCP received more research interests in South Asia and South-East Asia. There are several countries that took a dominant position in valuation studies within their own subregions: China in North-East Asia; Australia and New Zealand in Oceania; Indonesia in South-East Asia; and Nepal in South Asia.

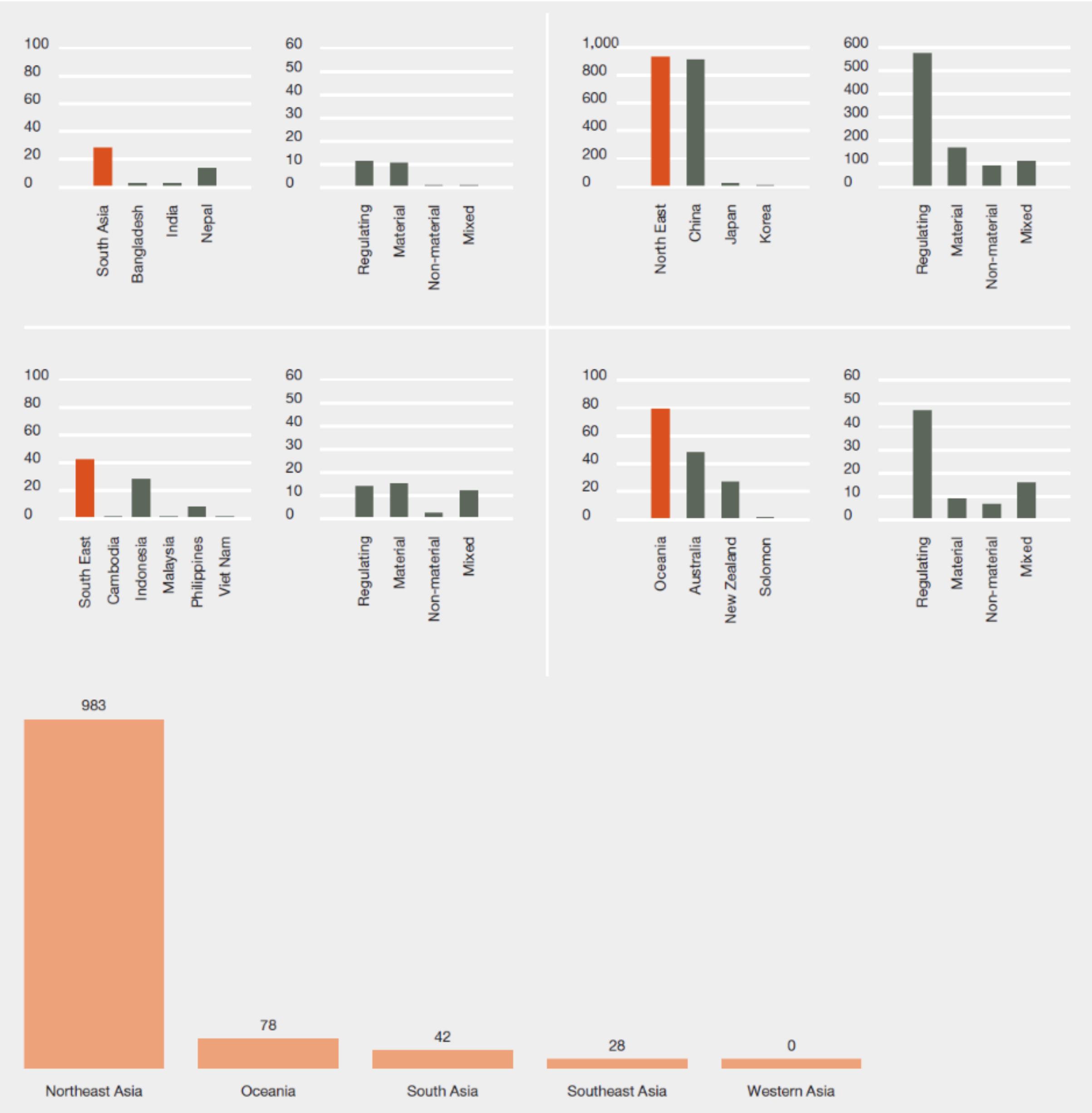

Figure 2.26 Distribution of studies on the economic valuation of ecosystem services by subregion and across three groups of nature's contributions to people

2.3.3.4 The monetary values of ecosystem goods and services in the Asia-Pacific region

Table 2.4 shows a summary of monetary values, in medians with minimum and maximum figures in parentheses and the number of estimates used for calculation in the next row, of 18 NCP categories by 11 ecosystem types (biomes) in the Asia-Pacific. We report medians, not averages, due to the skewed distribution of value estimates and the small number of observations for each cell of Table 2.4. Note that only 802 value estimates with the same measurement unit (i.e. currencies per hectare per year) out of 1,131 were used to create the Table 2.4.

Although the data is limited in terms of the number of estimates used to compute the median values per ha per year for particular NCP and types of ecosystems, some implications can be derived based on median and range of values. Regarding the types of ecosystems, relatively high values are found for: wetlands, inland surface waters and temperate forest. In terms of NCP, relatively high values are observed for the regulation of: water quantity and quality of both freshwater and coastal water, habitat creation and maintenance, and regulating climate. These results indicate that people in region acknowledge and highly appreciate the regulating services of ecosystems. Among provisioning services, providing food and materials received relatively high values. The category of physical and psychological experiences, mainly in forms of recreation and eco-tourism, also received high values.

Empirical studies in the Asia-Pacific have found that temperate forest ecosystem are valued more for habitats ($864 per hectare per year[33]), carbon store ($760 per hectare per year) and water reserve ($544 per hectare per year) than materials ($434 per hectare per year) or energy source ($31 int $/hr/yr) based on the median of estimates. Wetlands are most highly valued for their water regulating services ($3,957 per hectare per year for regulating water flows, $6,485 per hectare per year for regulating water quality). Inland surface waters and water bodies are also highly valued for their water regulating services ($4,371 per hectare per year for regulating water flows, $3,899 per hectare per year for regulating water quality). Although these value estimates of NCP by ecosystem types can provide some sense of economic values perceived by the people in the region, the interpretations should be cautious because the number of studies is limited and they tend to represent only some subregions, namely North-East Asia and Oceania.

[33] These monetary values have been standardized to a common currency (the international dollar – $) and base year (2010). The standardization procedure adjusts values elicited in a particular currency and year to a standard currency and year using appropriate gross domestic product deflators and purchasing power parity exchange rates.

Table 2.4 Distribution of estimated values by ecosystem type and by type of nature's contributions to people in the Asia-Pacific region[34]

	Median monetary values of nature's contributions to people in the Asia-Pacific region (2010 international$/ha/year)																	
	Nature's contributions to people																	
Biome	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**
1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	**864**	**8**	**-**	**760**	**-**	**544**	**12**	**534**	**32**	**13**	**31**	**38**	**434**	**15**	**-**	**282**	**-**	**-**
	(5-12,400)	8	-	(9-11,878)	-	(2-11,245)	12	(2-11,053)	(12-52)	13	(2-59)	(1-907)	(5-8,193	15	-	(1-5,719)	-	-
	14	1	-	28	-	17	1	27	2	1	2	13	16	1	-	17	-	-
3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	**409**	**199**	**-**	**308**	**-**	**300**	**440**	**392**	**2**	**113**	**-**	**106**	**24**	**76**	**-**	**28**	**-**	**-**
	(60-5,141)	199	-	(48-4,289)	-	(3-4,179)	(346-534)	(42-6,159)	2	113	-	(14-1,182)	(8-990)	76	-	(7-2,392)	-	-
	10	1	-	21	-	12	2	20	1	1	-	10	10	1	-	11	-	-
5	**667**	**-**	**-**	**183**		**182**	**-**	**350**	**-**	**-**	**-**	**64**	**43**	**-**	**-**	**330**	**-**	**-**
	(129-1,842)	-	-	(92-358)	-	(162-1,561)	-	(7-2,208)	-	-	-	(54-479)	(11-110)	-	-	(9-660)	-	-
	4	-	-	6	-	4	-	8	-	-	-	5	3	-	-	4	-	-
6	**641**	**113**	**3,021**	**726**	**-**	**3,957**	**6,485**	**513**	**5,811**	**192**	**-**	**163**	**63**	**79**	**1,019**	**1,506**	**-**	**-**
	(27-14,817)	(79-115)	3,021	(1-101,350)	-	(101-91,866)	(94-107,750)	(5-10,135)	(1,762-10,362)	(133-195)	-	(49-1,778)	(5-2,588)	(70-81)	(198-1,577)	(637-32,894)	-	-
	14	3	1	26	-	15	11	18	4	3	-	11	13	3	3	14	-	-
7	**278**	**73**	**-**	**158**	**-**	**326**	**9,538**	**333**	**101**	**93**	**-**	**342**	**43**	**1,259**	**-**	**35**	**-**	**-**
	(18-4,208)	(70-57,951)	-	(5-5,275)	-	(25-4,371)	(9,031-13,063)	(2-9,720)	101	(57-128)	-	(12-5,927)	(2-593)	(966-3,284)	-	(2-136,132)	-	-
	22	3	-	46	-	25	3	58	1	2	-	23	17	4	-	22	-	-
8	**536**	**-**	**-**	**116**		**4,371**	**3,899**	**4**	**-**	**4,574**	**1**	**40**	**4**	**-**	**-**	**1,047**	**-**	**-**
	(110-14,758)	-	-	(0-3,667)	-	(600-120,908)	(475-107,869)	(2-367)	-	(2,620-8,474)	1	(16-593)	(2-92)	-	-	(142-25,748)	-	-
	11	-	-	18	-	11	11	11	-	3	1	12	11	-	-	10	-	-
9	**71,741**	**-**	**-**	**808**	**-**	**-**	**-**	**2,185**	**271**	**-**	**4**	**4**	**5,656**	**154**	**-**	**-**	**-**	**-**
	(2,246-141,236)	-	-	808	-	-	-	2,185	271	-	(2-5)	(2-30)	(5-8,018)	154	-	-	-	-
	2	-	-	1	-	-	-	1	1	-	2	3	3	1	-	-	-	-
10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11	**44**	**-**	**2**	**6**	**-**	**9**	**-**	**5**	**-**	**-**	**-**	**2**	**4**	**-**	**-**	**5**	**-**	**-**

[34] These results are based on limited data pertaining to some regions and are not transferable to the Asia-Pacific region as a whole

	(0-810)	-	2	(0-739)	-	9	-	(0-795)	-	-	-	(0-97)	(0-424)	-	-	(0-506)	-	-
	6	-	1	8	-	6	-	12	-	-	-	6	4	-	-	7	-	-

Note:

1) '-' indicates that no data is available
2) Figures in the parentheses are minimum and maximum values of the corresponding category and the figures in numbers in the third row of each category are the numbers of estimates used for the calculation of the median values
3) Monetary values are standardized into 2010 International dollars per ha per year using GDP deflators of each country and purchasing power parity conversion factors provided by the World Development Indicator (World Bank)
4) A total of 802 estimates are used and the data cover the period of 1990-2015

Key to table above:

Ecosystem Types (Biome)		Categories of nature's contributions to people	
1	Tropical and subtropical dry and humid forests	1	Habitat creation and maintenance
2	Temperate and boreal forests and woodlands	2	Pollination and dispersal of seeds and other propagules
3	Heath lands, scrubs and tundra	3	Regulation of air quality
4	Savannas and Grasslands	4	Regulation of climate
5	Dry lands and Desert	5	Regulation of ocean acidification
6	Wetlands including peat land, mires and bogs	6	Regulation of freshwater quantity, flow and timing
7	Productive systems such as cultivated areas	7	Regulation of freshwater and coastal water quality
8	Inland Surface Waters and Water Bodies/Freshwater -rivers, lakes and estuaries	8	Formation, protection and decontamination of soils and sediments
9	Coastal Habitats/Coastal and Near shore Marine/inshore ecosystems	9	Regulation of hazards and extreme events
10	Marine/Deepwater/Offshore ecosystems	10	Regulation of organisms detrimental to humans
11	Urban/Semi-urban	11	Energy
		12	Food and feed
		13	Materials and assistance
		14	Medicinal, biochemical and genetic resources
		15	Learning and inspiration
		16	Physical and psychological experiences
		17	Supporting identities
		18	Maintenance of options

Prospects of ecosystem service values

Following on from the global trends in decline in value of ecosystem services (Costanza *et al.*, 2014), the value of ecosystem goods and services in the Asia-Pacific is likely to decline. With the rapid increase in population, there is pressure on agricultural land, forests and grasslands which are being converted into urban areas. If the current trends of land use change continue, there could be decline of 34 per cent in value of total ecosystem services in the Asia-Pacific by 2050 (Kubiszewski *et al.*, 2016). For example, Afghanistan shows the greatest potential losses as it is more susceptible to desertification. On the other hand, countries such as Japan and New Zealand, are highly developed and potentially have more stability for t ecosystem goods and services.

2.3.4 Transboundary flow of ecosystem services

2.3.4.1 Definition and typology

The transboundary landscape concept makes it possible to address the conservation and sustainable use of natural resources defined by ecosystems, rather than administrative boundaries. The Millennium Ecosystem Assessment (MEA) Framework can be applied to: (1) elucidate how drivers of environmental change in one country can affect the delivery of nature's contributions to people and human welfare in another country (or in both countries), and (2) develop cross-border collaborations to protect shared ecosystem services (G. C. Daily, 1997b; G. C. Daily *et al.*, 1997; López-Hoffman *et al.*, 2009; Millennium Ecosystem Assessment, 2005).

Box 2.2 Features of transboundary flow of ecosystem services

- Neighbouring countries share ecosystem services
- Actions and policies in one country can affect ecosystem services and human well-being in another
- Countries in the Asia-Pacific share provisioning services (such as water), regulating services (such as crop pollination), and cultural services of migratory species.
- The transboundary services shared by the countries in Asia extend far beyond the border region
- The Millennium Ecosystem Assessment framework can be used as an organizing principle for transboundary conservation policy

Typology of transboundary conservation areas (TBCAs)
Transboundary conservation areas can be considered in three categories (IUCN WCPA, 2011; Vasilijević *et al.*, 2015):

Type 1: Transboundary Protected Areas
Type 2: Transboundary Conservation Landscape and/or Seascape
Type 3: Transboundary Conservation Migration area
Special designation: Park for Peace

2.3.4.2 Roles of transboundary areas

The transboundary approach for conservation may help to bring a large number of ecosystem services for the benefit of the residents of the Asia-Pacific. These benefits include:
(1) Conserving threatened plant and animal populations that require large territorial boundaries for their habitat requirements

(2) Ensuring the survival of migratory marine and avian populations, particularly migratory bird fly ways that stretch across 22 countries of the region, as well as other continents
(3) Reintroduction and recolonization of threatened floral and faunal species that are presently increasing in isolated patches in different transboundary areas
(4) Building greater capacity for ensuring ecological integrity in the Asia-Pacific, by addressing fragmentation, drivers of biodiversity and loss issues in transboundary areas
(5) Ensuring ecological resilience against the climate led variabilities and vulnerabilities in transboundary areas (Carroll *et al.*, 2010; Claudet *et al.*, 2008; N. Dudley *et al.*, 2010; Ervin *et al.*, 2010; Prugh *et al.*, 2008; Thompson *et al.*, 2009).

Additionally the transboundary approach across the region presents significant opportunities to promote and enhance opportunities for building peace and political stability, together with developing economic opportunities through enhanced trade and socio cultural sharing with neighbouring transboundary nations.

2.3.4.3 Challenges and constraints

With limited land resources, increasing energy demand, and growing water stress, the Asia-Pacific faces the challenge of providing water and energy to grow enough food for the burgeoning population. Nature in general, and TBCAs in particular, are under continual pressure either to deliver tangible benefits for people or to yield to other priorities (Vasilijević *et al.*, 2015).

Based on United Nations estimates, approximately 40 per cent of the world's population lives in one of 263 transboundary river basins and many are located in the Asia-Pacific (World Water Assessment Programme, 2009). The issues and challenges in the food, air, water, and energy sectors are interwoven in many complex ways and cannot be managed effectively without cross-sectoral integration (P. C. Tiwari, 2000). The challenge is especially great in the South Asian countries where more than 40 per cent of the world's poor live and some 51 per cent of the population is food-energy deficient (Ahmed *et al.*, 2007).

Illegal wildlife trade in TBCAs is an issue with major challenges to be addressed. The efforts of CITES and the ASEAN Wildlife Enforcement Network (WEN) have generated legislative headway in the region (Rose, 2015). The UNODC suggests that the illegal wildlife trade in the East Asia and Pacific region is, conservatively, worth around $2.5 billion annually, while a Brookings Institute report suggests that the value for South-East Asia alone is closer to $8-10 billion (Felbab-Brown, 2011).

In the Mongolian plateau of Inner Asia, dust storms are recurring events (Y. Chen & Tang, 2005; Middleton, 1991) and the changing frequency of these storms along the northern China-Mongolian corridor (Natsagdorj *et al.*, 2003) affects land degradation and desertification processes in both countries (Wesche & Retzer, 2005). Dust from this desert region has became an international transboundary concern as it also affects Japan and Korea, and moves out to the Pacific Ocean as well as in a southwesterly direction towards Taiwan China. Rosenfeld *et al*. (2001) identified that the effect of dust on cloud properties can be sufficient to inhibit precipitation causing drier soil, potentially intensifing drought conditions.

South-East Asian countries, particularly: Indonesia, Singapore, Malaysia, Brunei and Thailand suffered from transboundary haze, resulting from forest fires, in 1997, 2005, 2013 and 2016. The causes of such transboundary haze have changed from a discussion of the potential health and economic impacts of fires resulting partly naturally from El Niño-induced droughts, toward an increasing vilification of Indonesia for not ratifying the 2002 Association of Southeast Asian Nations (ASEAN) Agreement on Transboundary Haze Pollution; plus criticism of Singaporean and Malaysian companies investing in palm oil plantations (T. Forsyth, 2014). From the perspective of the economic value of the health impacts of transboundary smoke haze pollution, the average annual economic loss due to the inpatient health impact of haze was valued at $91,000 in the case of 14 haze-related illnesses in Kuala Lumpur and adjacent areas in the state of Selangor, Malaysia (Othman *et al.*, 2014). Among others, providing economic incentives in managing forest fires through the principle of "polluter-pays" can become part of the solution to solve the transboundary haze (Quah, 2002).

2.3.4.4 Case studies of transboundary conservation areas

Countries in the Asia-Pacific have a share of many TBCAs in different ecosystems and regions that range from terrestrial, inland, water, ocean/marine, coastal etc. (Figure 2.27).

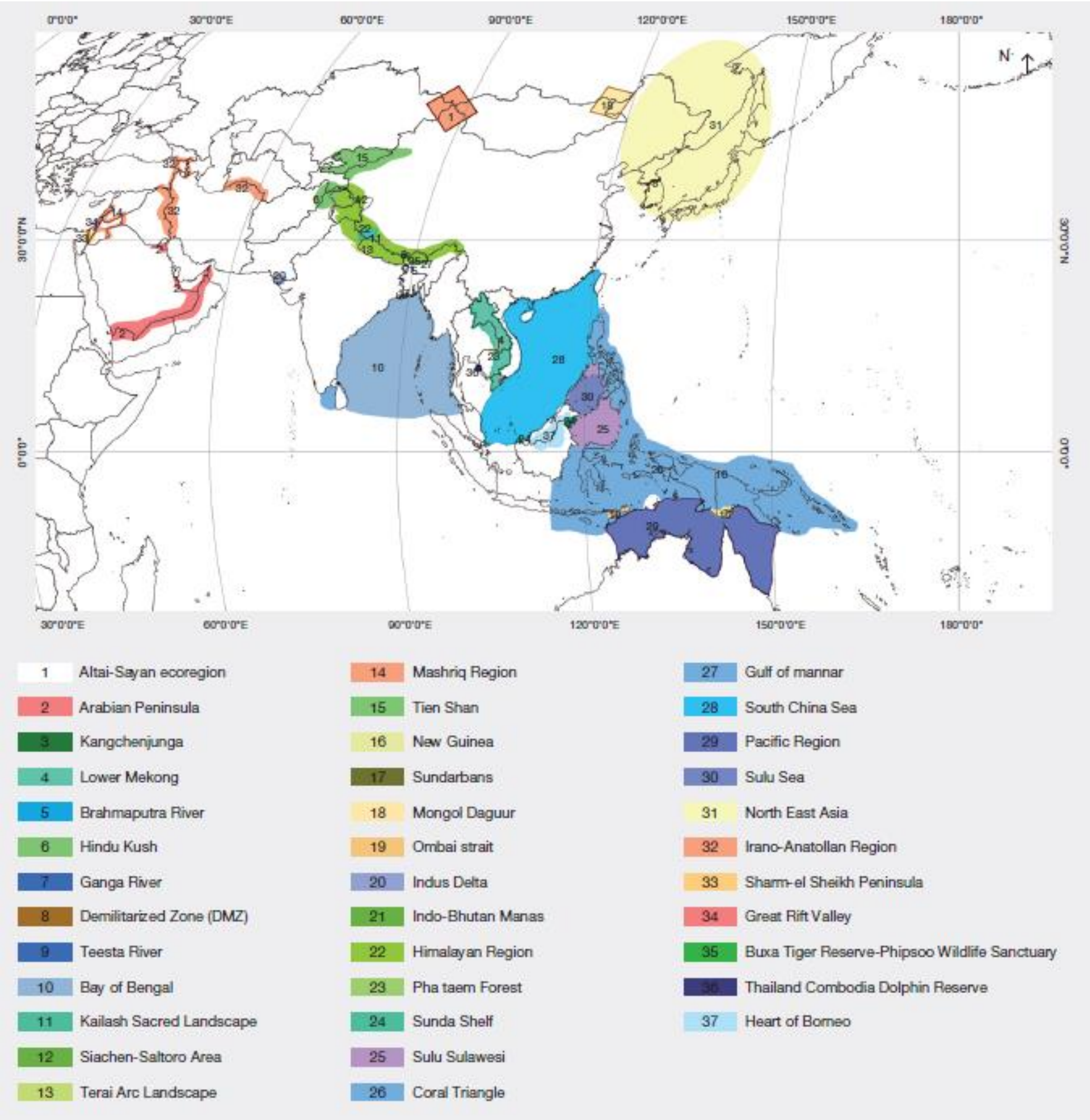

Figure 2.27 Important transboundary conservation areas (protected areas, conservation landscapes/seascapes, conservation migration area and Peace Parks) in different ecosystems and subregions of the Asia-Pacific region

Type 1: Transboundary protected areas

Mountain case study: sacred landscape of Kailash and Mansarover (India, China, and Nepal)

The sacred landscape of Kailash Mansarover, located in the Hindukush Himalayas, is unique for it's natural, cultural and spiritual values and also because it serves as the water tower for downstream communities dwelling in three Asian countries.

The Conservation and Development initiative for this area, as a regional TBA conservation programme started in 2012 -2017. Mount Kailash supports water requirements of millions of people dwelling down stream. Additionally, it has importance for its sacred and spiritual importance to pilgrims and communities across Asia. TBA has RAMSAR sites and serves as the habitat for many threatened flora and fauna of significant importance.

The Kailash Sacred Landscape Conservation and Development Initiative is a regional transboundary conservation programme (2012-2017) in the Hindu Kush Himalaya that emphasizes the importance of sacred sites and the preservation and management of biocultural diversity. There are many natural and cultural values of this landscape:

- *Natural significance*: Biogeographic areas, Ramsar Sites and habitats for endangered species;
- *Tangible evidence of cultural significance*: pilgrimage, transhumance, sacred sites, sacred mountains, cultural routes, sacred groves;
- *Uniqueness and spiritual significance*: pilgrims visit Mount Kailash and Lake Manasarovar from five religions (Hinduism, Buddhism, Bonism, Jainism and Sikhism);
- *Natural beauty*: the landscape is of aesthetic importance;
- *Water Tower:* Kailash supplies water to millions living within the landscape and downstream.

Inland water systems: Mekong region (Cambodia, China, Lao PDR, Myanmar, Thailand and Vietnam)

The Mekong Region (MR) is a relatively pristine river ecosystem and is the major and longest watercourse in South-East Asia, shared by six countries. There is a rush, by riparian states, to acquire sources of alternative energy and other benefits to meet growing demands for water and energy (Do & Dinar, 2014). The MR shares 110 international rivers and lakes and is home to most of Asia's great rivers that flow into 18 downstream countries (He *et al.*, 2014). China's total transboundary water resources are (approx.) 800 billion m^3 and most originate in the southwest of China, mainly from the 'Asian Water Towers' on the Tibetan-Qinghai Plateau. Among these are four biodiversity hotspots: the mountains of Central Asia and Southwest China, the Himalayas and the Indo-Burma region (Myers *et al.*, 2000). Similarly, 11 of the 14 World Wildlife Fund (WWF) Global 200 Priority Ecoregions (Olson & Dinerstein, 2002) are also located in this region.

The Mekong River Commission (MRC) was established in 1995 (Jacobs, 2002). With an estimated annual harvest of 2.2 million tonnes of wild fish, the Mekong River supports the world's largest inland fishery, annually worth $2.4-4.3 billion wholesale (Hortle, 2007). WWF-Greater Mekong in Cambodia, Lao PDR, Myanmar, Thailand and Vietnam is working to conserve the region's biodiversity and has assessed the retail value of Mekong River fisheries to be more than US$4 billion annually. The Lower Mekong River provides the main source of food for 60 million people. All forms of payments for ecosystem services are very much at an incipient stage in the Lower Mekong countries which suggests that they are not capturing the full value being delivered by the region's ecosystems (WWF, 2013).

Rainforest initiative: Heart of Borneo (HoB initiative) (Indonesia, Malaysia, Brunei)

The 'Heart of Borneo' is the only remaining place in South-East Asia that still holds huge tracts of pristine forest. Borneo, accounts for just 1 per cent of the world's land yet holds approximately 6 per cent of global biodiversity in its rich, tropical forests. Made up of 3 countries in 746,000 sq km of land, Borneo's forests are home to 221 species of mammals, 620 species of birds, and over 150 species of dipterocarp trees with 1,000 insect species per tree. 35 per cent of its 15,000 plant species that are not found nowhere else in the world. Borneo has already lost over half its forests. The declaration on the *Heart of Borneo Initiative (HoB)* was signed in 2007 by the three nations that constitute the island of Borneo to ensure the shared responsibility for protecting this ecosystem. HoB is also a source of providing ecological services for at least 11 million Borneans, and a million indigenous Dayaks. More modern sectors of Borneo's economy depend heavily on ecosystem goods and services produced by the area.

Some of the strengths and challenges faced by Borneo include: Liquefied natural gas extraction in Brunei requires large quantities of water for processing, derived from Borneo. Hydroelectric power plants in Sarawak benefits from Borneo forests. The sustainable production of palm oil requires healthy ecosystems and associated ecosystem services. Mining companies in Borneo rely on river-based transport. Mining also benefits from the capacity of ecosystems to detoxify pollutants (Heart of Borneo Rainforest Foundation, 2013; WWF, 2017).

Jordan transboundary watershed Great Rift Valley (Syria, Israel, Jordan, Lebanon, Palestine)

The Jordan River, one of the most endangered rivers in the world is highly dependent on water flow from upstream with five neighboring states dependent on the waters of the basin. The river's location in the Great Rift Valley, at the meeting point of Asia, Africa, and Europe, creates a lush wetland ecosystem, rich in biodiversity and one of the most important migratory flyways on the planet with an estimated 500 million birds (M. Turner *et al.*, 2005). The Jordan River Basin in Southwest Asia illustrates the complexity of cross-border water resources management. The Jordan River Basin has multiple stakeholders, a complex physical geography, and conflicts in the resolution process. The Jordan River Basin lies in a region of high political tensions and decreasing precipitation (Young, 2015). The Jordan River has approximately 9 more major tributaries, adding to its volume before it empties into the Dead Sea at 395 m below sea level. This low point in the Rift Valley is the world's lowest terrestrial elevation, and, this being an arid region, these rivers are critical sources of water.

Type 2: Transboundary conservation landscape and/or seascape

Marine: Coral Triangle (Indonesia, Malaysia, Philippines, Timor Leste, Salomon Island, PPNG)

The Coral Triangle (CT), the global center of marine biodiversity, is a 6 million-km^2 area spanning Indonesia, Malaysia, the Philippines, Papua New Guinea, Timor Leste and the Solomon Islands. Resources from the area directly sustain more than 120 million people. Within this nursery of the CT lives 76 per cent of the world's coral species, 6 of the world's 7 marine turtle species, and 2,228 reef fish species. With the growing awareness of the crisis facing the world's oceans, and more specifically coral reef ecosystems, there is need to highlight the impacts of overfishing, pollution and climate change (The Coral Triangle, 2017). The Coral Triangle Initiative on Coral Reefs, Fisheries and Food Security (CTI-CFF, 2009) is a multilateral partnership of six countries formed in 2007 to address the urgent threats facing the coastal and marine resources of the CT. This initative has a particular focus on: seascapes policy and implementation, marine protected area management, promoting sustainable livelihoods, developing management plans and creating practices that are low cost, feasible within the biological, social and political context of each place (Conservation International, 2017).

Coastal: Sunda Shelf (Brunei, the East Malaysian states of Sabah and Sarawak and the Indonesian state of Kalimantan)

Sunda Shelf, is a stable continental shelf, and a southward extension of mainland South-East Asia. A relatively warm and humid 'core', roughly centered on the islands of Borneo and Sumatra and the southernmost tip of the Malay Peninsula, characterizes the Sunda Shelf. An evaluation of the distribution patterns and systematics of Asian columbines, revealed a number of disjunctions and four biodiversity hotspots on the Sunda shelf (Brandon-Jones, 1996). Long *et al*. (1996) carried out a similar analysis for birds, and eight Endemic Bird Areas based on rain forest birds. Davies (1995) identified more than 20 centers of high biodiversity for plants. At least two thirds of all known butterfly species occur in a relatively small area of this forest. This area of forest is consistent with a zone of overlapping bird, columbine and plant biodiversity hotspots (Orr & Hauser, 1996). Climatic changes along with forest fires are major threats to this TBCA.

Type 3: Transboundary conservation migration area

Wildlife and plant species are rarely confined within national boundaries, and transboundary approaches are needed for effective conservation and management. Spatial mismatches and flows may occur when species with complex movement dynamics provide ecosystem services that have been termed 'mobile agent- based ecosystem services' (Kremen *et al.*, 2007). Movement causes species to act as 'mobile links', connecting ecological processes in different locations (Gilbert, 1980; Lundberg & Moberg, 2003). As they move throughout their ranges, species may provide critical ecosystem services for a variety of speciese.g. Amur tigers, rhinos, snow leopards, green turtles, olive ridley turtles, whales, dolphins, leatherback turtles, Siberian cranes and many more. Migratory birds and bats provide ecosystem services as diverse as controlling crop pests to seed dispersal and pollination (Cleveland *et al.*, 2006; Medellín, 2009; Sekercioglu, 2006; Wenny *et al.*, 2011; Whelan *et al.*, 2008).

It has been estimated that up to a third of the snow leopard's potential range is located less than 50-100 km from the international borders of the 12 range countries. Leaders in the governments of all 12 snow leopard range countries adopted the *Bishkek Declaration on the Conservation of the Snow Leopard* (in 2013 in Bishkek, Kyrgyz Republic). This declation relates to managing habitat and prey, combating illegal trade, transboundary management and enforcement, and building awareness. It also emphasizes the increased bilateral and regional cooperation for snow leopard conservation in transboundary landscapes (Snow Leopard Trust, 2013).

Salmon migrations move energy and nutrients between marine, freshwater, and terrestrial ecosystems. A run of 20 million fish moves over 50 million kg of biomass and associated nutrients into freshwater and terrestrial ecosystems (Gende *et al.*, 2002). In freshwater, decomposing salmon provide nutrients, which positively impact young salmon (Moore *et al.*, 2007; Wipfli *et al.*, 2003).

In the Upper Mekong, migration system fish migrate upstream to spawning habitats during the wet season. Big tributaries and local wetlands characterize the Middle Mekong migration system. The Lower Mekong migration system, characterized by its extensive floodplains, is limited downstream by the sea. Extensive wetlands and floodplains in the Mekong Basin with the areas of 185,000 and 50,000 km^2 respectively (Hortle, 2009), and their multiple resources, constitute a rich feeding place for both adults and juveniles. Specific management strategies for TBCA are required to ensure long-term conservation of biodiversity and ecosystem services.

Special designation: Korean Demilitarized Zone (DMZ)

The Korean Demilitarized Zone (DMZ) splits the Korean Peninsula in half creating a buffer zone between North and South Korea. It's the most militarized border on earth and is a strip of land 248 km long and 4 km wide. But the 'no man's land' between North and South Korea has become a *de facto* protected area providing a refuge for rare species and a stopover point for migratory birds. The DMZ has exceptional biodiversity including 11 threatened species on the IUCN Red List species, such as the red-crowned crane (*Grus japonensis*)[35], which has only 1100-1450 individuals left in the wild. Since, 1953 the DMZ has been part of a geopolitical vacuum and symbol of war, tension and separation. It provides a unique link to the entire East Asia flyway system for migratory birds from

[35] Birdlife International (2016) http://www.iucnredlist.org/details/full/22692167/0. Global population estimate is actually 3,050

Russia to Australia. Safeguarding the DMZ as a transboundary nature and peace park can provide significant ecosystem services benefits (Healy, 2007).

2.4 Biodiversity, ecosystem services and security of the society

2.4.1 Water security

Water is an important ecosystem service which is directly linked with good quality of life. Well-functioning ecosystems – forests, grasslands, soils, rivers, lakes, streams, wetlands, aquifers, estuaries and coastal waters – provide services that influence the availability of water and its quality (CBD, 2015). People can enjoy water security when they successfully manage their water resources to: (a) satisfy household water and sanitation needs; (b) support productive economies in agriculture, industry, and energy; (c) develop vibrant, liveable cities and towns; (d) restore healthy rivers and ecosystems; and (e) build resilient communities that can adapt to changes (Asian Development Bank, 2013d). In the Asia-Pacific, physical water scarcity has occurred in regions where groundwater and renewable water resources have been mined for irrigation (Asian Development Bank, 2013a).

Hotspots for economic water scarcity in the South Asia and Oceania subregions occur in countries such as: Vietnam, Lao PDR and Myanmar (Asian Development Bank, 2013a). In the region water for agriculture continues to consume 80 per cent of the region's fresh water resources (Asian Development Bank, 2016). Agriculture will need to produce more in developing countries, using diminishing water resources largely due to rapid groundwater depletion. In addition to ground water depletion, almost 80 per cent of wastewater being discharged in to water systems, in developing countries, receives little, or no, primary treatment. In Indonesia, only 14 per cent of wastewater is treated; in the Philippines, 10 per cent; India, 9 per cent; and Vietnam, 4 per cent. It is also projected that water demand in the region to increase by 55 per cent due to the growing needs for domestic water, manufacturing and thermal electricity generation (Asian Development Bank, 2016).

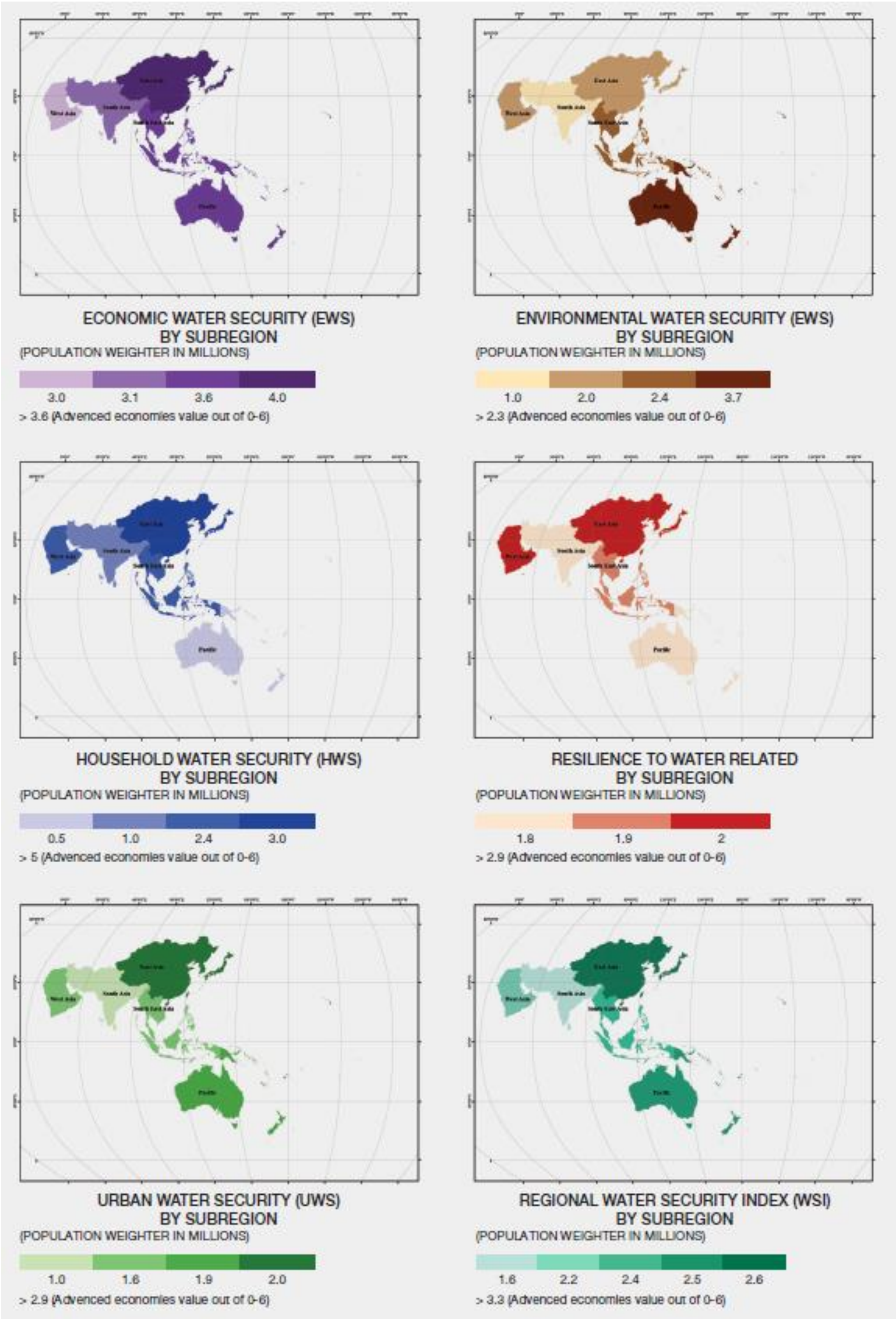

Figure 2.28 Water security in the Asia-Pacific region. Data Source: Based on Indicators published in Asian Development Bank (2013a).

South and Western Asia seems to be the most water stressed areas in the region. Countries, such as India, which is located in South Asia, shows a decline in the per capita availability of water in the country as a whole from 5,177 m3/year in 1951, to 1,588 m3/year in 2010 (CWC, 2010). It is projected to be 1235 m3 by 2050. Around 63.4 million rural poor people face water stress in India. It is also reported that about 70 per cent of the surface water resources, and large proportions of groundwater reserves, have been contaminated due to the indiscriminate discharge of wastewater from the industry, agriculture, and household sectors which contain biological as well as toxic organic and inorganic pollutants (Indian Central Pollution Control Board, 2009). In Pakistan, the per capita water availability is less than 1,000 m³ per person (Government of Pakistan, n.d.).

Unlike South Asia, the Western Asia subregion is undergoing significant socio-political and economic transitions. Perennial rivers contribute around 70 per cent of freshwater resources to Lebanon and Jordan. On the other hand, Oman, Saudi Arabia, Syria, United Arab Emirates and Yemen are dependent on surface water and seasonal rivers. For the remainder of the countries in this region, one third of the water demand is met by groundwater resources. The continuous extraction of groundwater at an unsustainable rate is leading to water scarcity at national and regional levels thus fueling conflicts. In fact, rising demand for water in Yemen, due to population growth and poor water management, is responsible for almost 80 per cent of internal conflicts in the country. Water availability has become a serious issue in Western Asia due to rapid population growth, climate change, droughts, desertification and scarce rainfall. Water availability in the Arab nations is a critical issue, as the region has 5 per cent of the world's population having access to 1 per cent of the world's total water resources. According to United Nations estimates, around 12 Arab countries suffer from severe water shortages. The per capita availability of renewable water resources is less than 500 m^3 per year. As far as the accessibility to safe drinking water and sanitation is concerned, there is variation across subregions and countries (Abumoghli, 2015; UNDP, 2013).

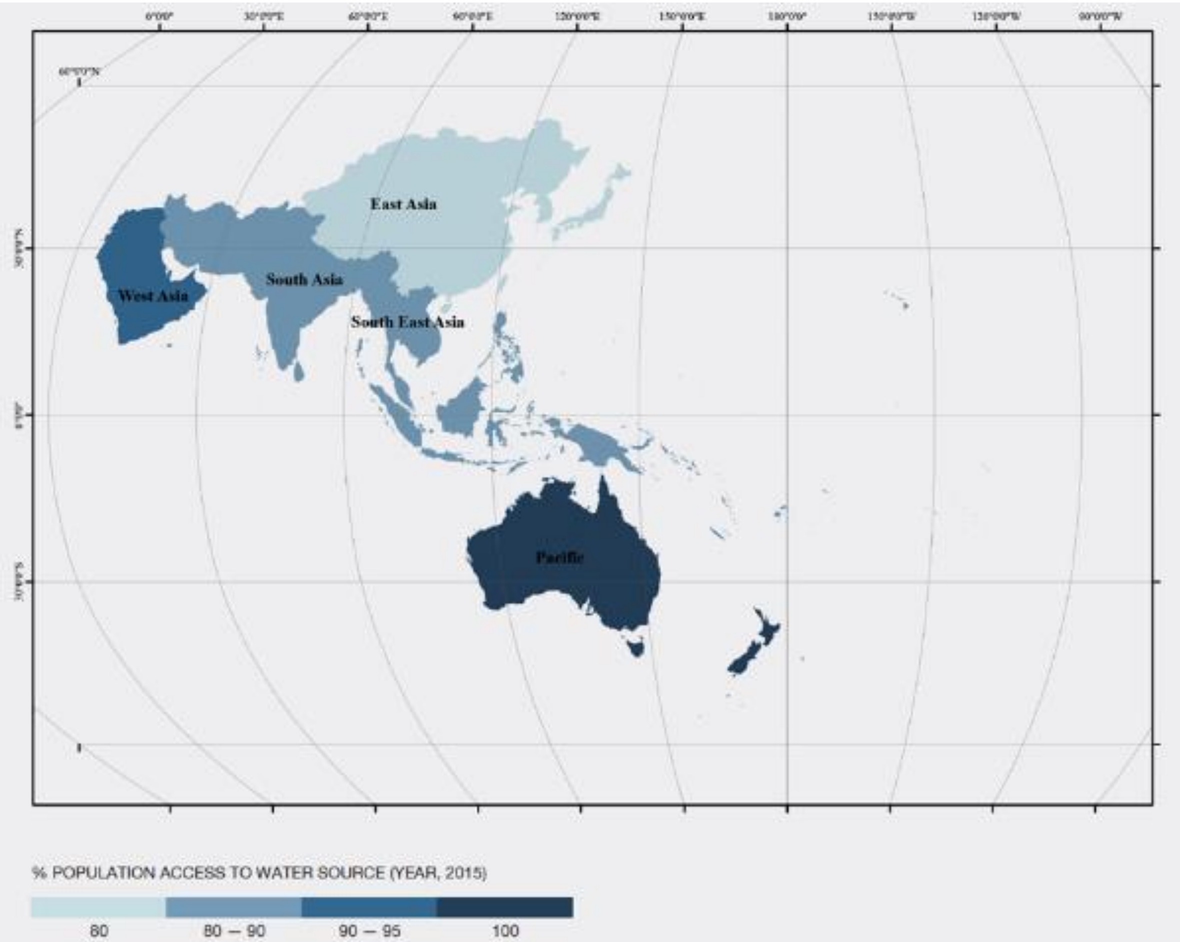

Figure 2.29 Access to an improved water source by subregion. Data source: World Bank.

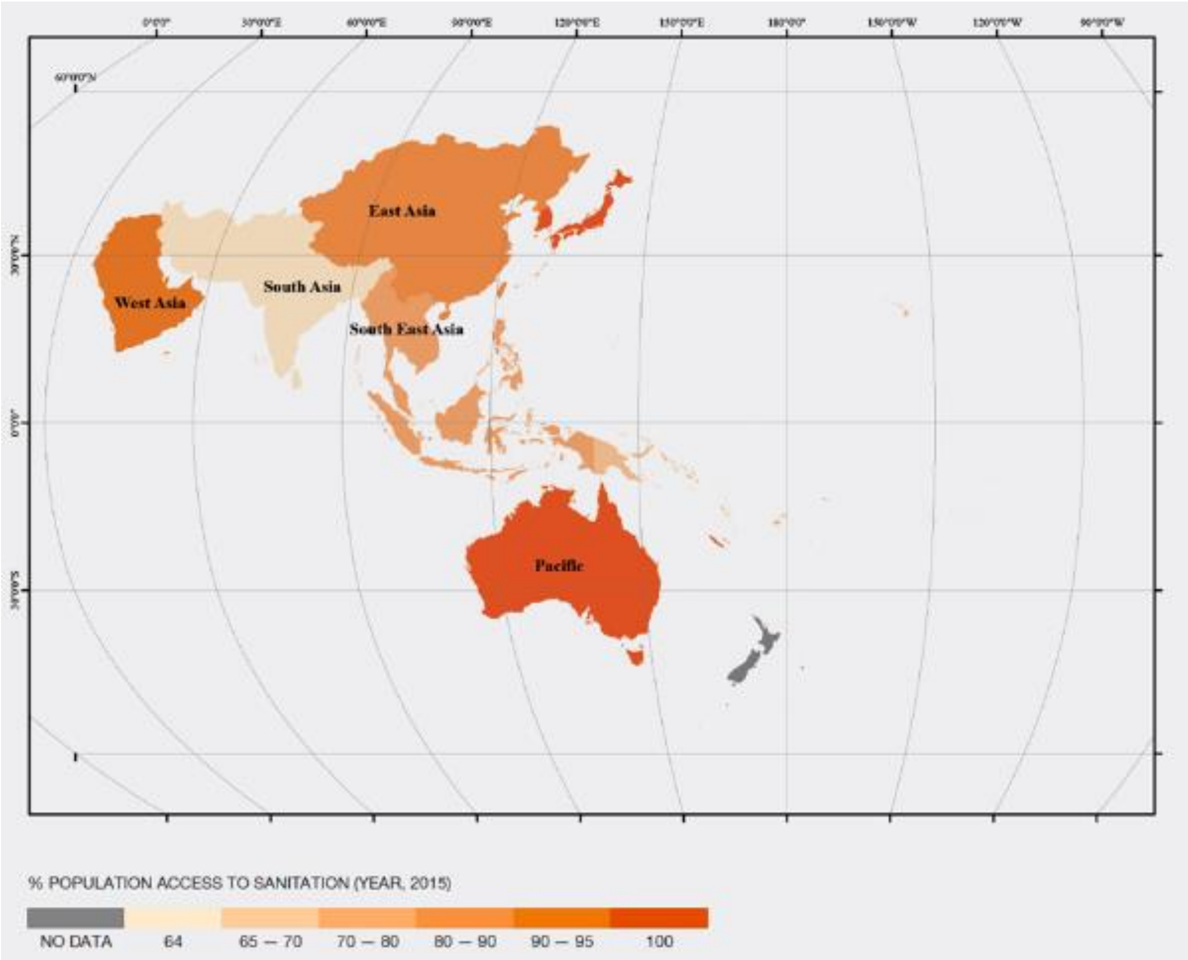

Figure 2.30 Access to safe water and sanitation in the Asia-Pacific region
Note: Maps are prepared based on subregional averages. Data source: World Bank.

2.4.2 Energy security

Energy security is the availability of energy at all times in various forms, in sufficient quantities and at affordable prices, without unacceptable or irreversible impact on the environment. Energy security has both producer and consumer dimensions (UNDP, 2004). Access to energy is critical in enabling people to meet essential needs linked with a good quality of life. The availability of modern forms of energy generates wide benefits for individuals and the community through time savings, reduction of illness from indoor air pollution, extended hours for work and study and the enhanced operation of health services (Moss *et al.*, 2011).

However, in the Asia-Pacific (approx.) 930 million people did not have access to electricity in 2005 (Asian Development Bank, 2009). Inequalities in access to energy between, and within, countries also persist throughout the region (Asian Development Bank, 2007). Many poor people are dependent on traditional biomass fuels (wood, agricultural residue, and dung) for heating and cooking needs. At a household level, poverty generally correlates to low energy usage, heavy biomass fuel use, and a lack of access to more modern, efficient energy sources, equipment and electricity (Pachauri *et al.*, 2004).

A recent report found that in Asia, 21 out of 47 nations have (at least) one-fourth of their energy consumption derived from renewable resources. Some of these countries have over 80 per cent of their energy consumption based on renewable sources, such as the Lao People's Democratic Republic (90.3 per cent), Bhutan (86.7 per cent), and Nepal (84.4 per cent). The nations with the lowest renewable energy usage were: Afghanistan, Bangladesh, Tajikistan, and Viet Nam (Asian Development Bank, 2017).

In the rural areas, a concern is the overexploitation of environmentally sensitive areas. Overuse of biomass can lead to the degradation of watersheds, and loss of biodiversity and habitats. This is because billions of people rely on biomass for cooking and heating, (approx.) 2 million tons is burned every day (WHO, 2006). Where wood is scarce or the population is dense, reforestation does not match the demand for fuel resulting in deforestation, desertification, and land degradation. Even when trees are not felled, collecting dung, branches, shrubs, roots, twigs, leaves, and bark can deplete forest ecosystems and soils of much needed nutrients (Alam *et al.*, 1999). South-East Asia also produces significant amounts of agricultural crops, led by paddy and oil-palm fruit. In 2005, Indonesia was the largest producer of paddy, maize and cassava, providing 33, 46 and 44 per cent, respectively, of the region's totals. Thailand was the largest producer of sugarcane, producing 37 per cent of the total, while Indonesia and Malaysia topped oil-palm fruit production together reaching a share of over 85 per cent. The region thus has huge potential for utilizing biomass resources (UNESCAP, 2008; www.indexmundi.com).

Women and children in rural poor communities are often affected by wood fuel scarcity. In some instances necessitating the need to walk long distances as they search for firewood and therefore leaving less time for cultivating crops and attending school. It is reported that in Asia alone, 730 teragrammes of biomass are burned in a typical year from both anthropogenic and natural causes. Forest burning comprises 45 per cent of the total, the burning of crop residues in the field comprises 34 per cent, and 20 per cent comes from the burning of grassland and savanna. China contributes 25 per cent of the total, India 18 per cent, Indonesia 13 per cent, and Myanmar 8 per cent. Regionally, forest burning in South-East Asia dominates (Streets *et al.*, 2003).

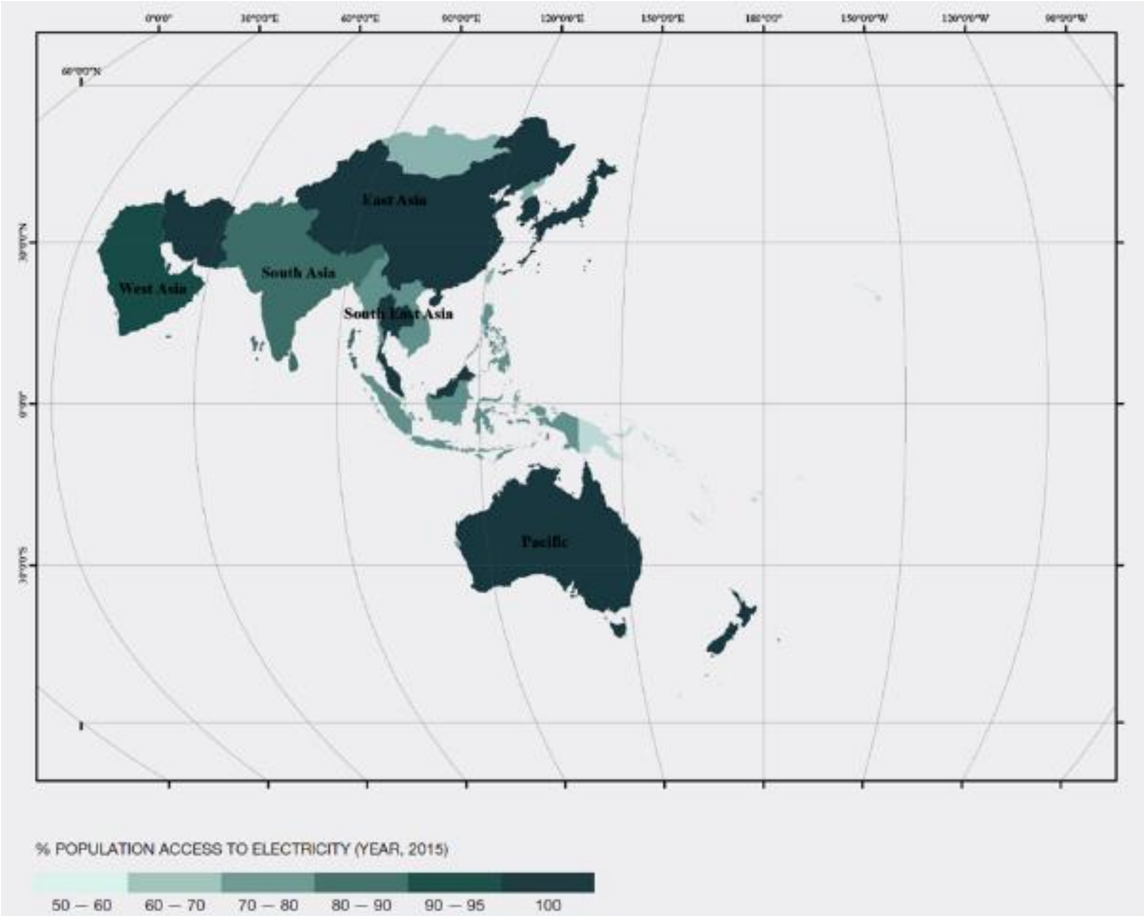

Figure 2.31 Access to electricity in the Asia-Pacific region
Note: Maps are prepared based on subregional averages. The data compiled by World Bank indicates that 79.50 percentage of population in south Asia and 85.19 percentage of population in west Asia have access to electricity. Data source: World Bank.

2.4.3 Food security

The Asia-Pacific, particularly the Pacific nations, is characterized by a fragile economic structure, largely dependent on natural resources (Asian Development Bank, 2013b). The agriculture sector in many Pacific nations is under pressure from limited arable land, population growth and urbanization, combined with the impacts of climate change, adding additional pressure. Even the industrial sectors of many Pacific nations are dependent on natural resources, such as; pearls, shells and wood (Asian Development Bank, 2013c) which indicate the degree of dependency on nature is relatively high in the region.

Food production and consumption in the Asia-Pacific has grown steadily from 2379 kilocalories per-capita per day in 1990, to 2665, in 2009 (Asian Development Bank, 2013b). The region made substantial progress in reducing the number of people suffering chronic hunger towards the world food summit target of halving the number of under nourished people by 2015. However, there remain 490 million people in the region who are still chronically hungry. Many of them are landless, indigenous people and ethnic minorities (FAO, 2015b). The poor mostly depend directly on nature for food and livelihoods. For example, the World Bank estimates more than 1.6 billion people around the world depend, to varying degrees, on forests for their livelihoods-not just for food but for fuels, livestock grazing and medicine. Of these, an estimated 350 million people live inside or close to dense forest, largely depending on these areas for subsistence living and income generation. An estimated range of 60 million to 200 million indigenous people are almost wholly dependent on forest resoucres to support their livelihoods (World Bank, 2002). For the Asia-Pacific, estimates of dependent population are within a range of 481 to 579 million (RECOFTC, 2009).

The Asia-Pacific continues to be the world's largest producer of marine and freshwater fish (Funge-Smith *et al.*, 2012). The capture production of the region has exceeded 50 per cent of world production since 2006. The FAO (2010) figure for capture production for the Asia-Pacific is 48.7 million tonnes. Data from 156 peer-reviewed papers, book chapters, theses, newsletters and conference proceedings during the period 1973 to 2014, shows that the increasing wealth of East and South Asia continues to create a stronger demand for the marine resources of the South Pacific. Additionally, the capture and sale of ornamental species for the aquarium trade is unique to this region's small-scale fisheries (TBTI, 2015).

Growing pollutions degrade ecosystems and further threaten biodiversity (species, ecosystems and genes). Asia is also one of the world's largest consumers of wildlife, wildlife products and natural resources. Large-scale, agriculture and monoculture plantations growing commercial products such as, oil palm and paper fiber, provide food and raw materials for growing economies. Increasingly these pose more serious threats, than small-scale rural uses and those driven by rural poverty, and require policies that differ from conservation's traditional focus (Squires, 2014).

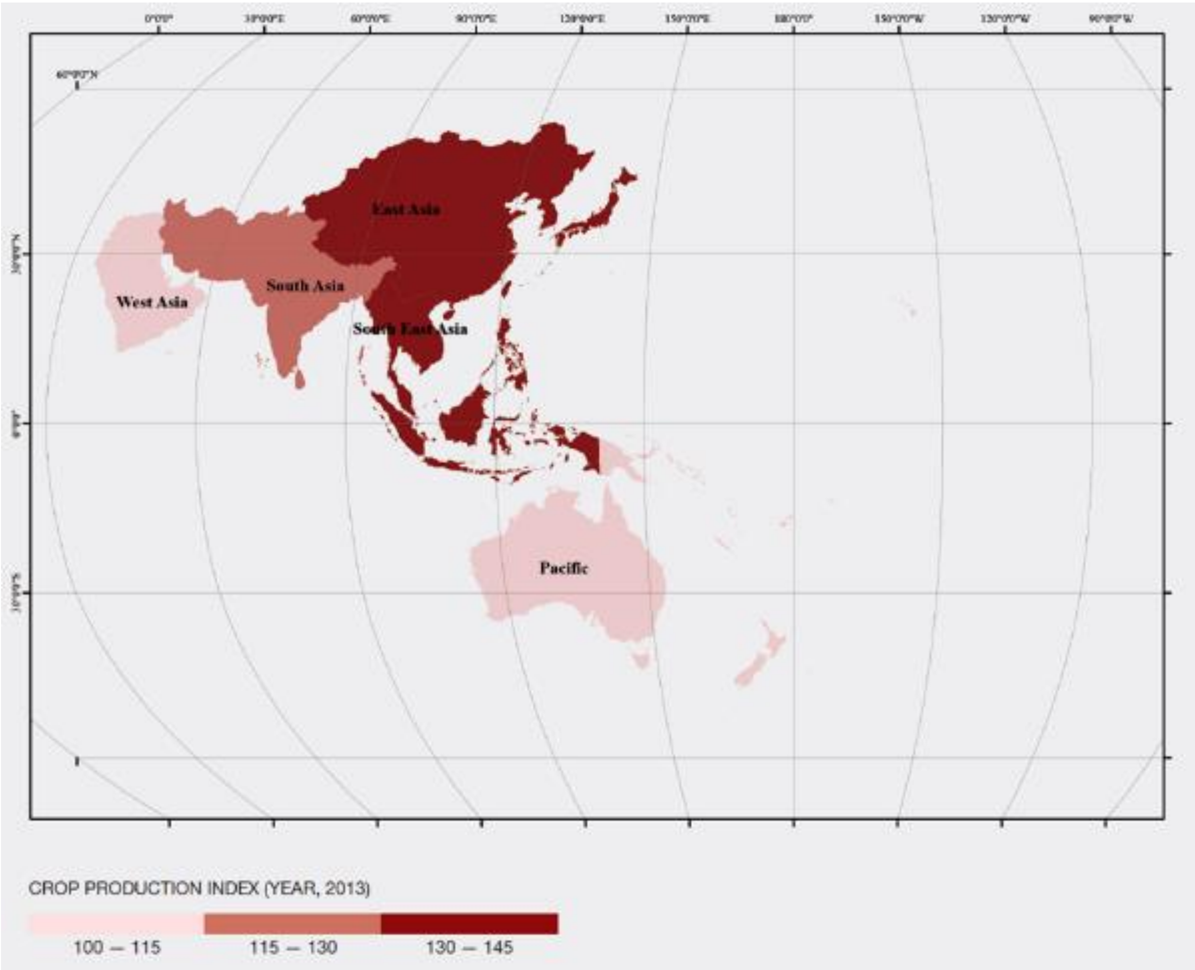

Figure 2.32 Crop production in the Asia-Pacific subregions. Data source: World Bank.

2.4.4 Livelihood and health security

Livelihood security

High levels of poverty and hunger in the region persist because of lack of livelihoods for a majority of people in rural areas. Modified ecosystems, such as agriculture and aquaculture, remain as the main livelihood provider in the region. The natural environment, including; forest, wetlands, freshwater and marine ecosystems directly provide goods. These include plants, animals, fish and fungi that people require to support sustainable livelihoods and incomes. The provisioning services, particularly, establish a close link between people and biodiversity (Bawa & Gadgil, 1997).

In India, almost 27 per cent of the Indian population, comprising about 275 million rural people, depend partly or completely on forests for their livelihoods. A study conducted in the South-western Ghats of India shows that more than 278 forest products are collected for different human uses which consist of; edible leaves gums, oils, nuts fruits, tubers and roots and fish, that play a significant role ensuring food and nutritional security of indigenous communities (Sathyapalan, 2005; Sathyapalan & Reddy, 2010). Nearly 27 per cent of these products are directly consumed at household level s and the remaining are marketed for other livelihood needs. A study conducted with communities residing on the Odisha coast, found that households derive (approx.) $107 per annum worth of livelihood support per year from mangrove conservation areas in India (Hussain & Badola, 2010). A study of a wetland on the *Ashtamudi* Lake, a Ramsar site on the southwest coast of India found that it contributes approximately 80 per cent of the overall clam export trade in India and provides livelihoods to at least 3,000 local people. Recent data collected by the Central Marine Fisheries Research Institute indicates that the stock is harvested sustainably with an annual catch of approximately 12,000 tonnes, which is close to the maximum sustainable yield (Mohamed, 2016).

Traditional landscape management provides multiple food products to indigenous and local communities thus contributing to their food and livelihood security. For example, the Karen people in Thailand conducts rotational farming that maintains more than 60 types of native plants, including 15 types of native rice, 15 varieties of bean, and more than 40 species/varieties of vegetables and herbs (Kawasaki, 2017). In another Karen community, the holistic management of different land use types (e.g. rotational farming, mixed farming, agroforestry, paddy fields) supports food and livelihood security, where 92 per cent of the food comes from household production and natural resources (Rattanakrajangsri *et al.*, 2017). 1262 species from the forests were identified for food, medicine, and others purposes in 60 communities of eight ethnic groups of highland communities in Thailand (Pilumwong, 2017).

These studies indicate that the livelihood systems and ecological integrity of the region are strongly interrelated. Many people across the Asia-Pacific are more concerned with the provisioning services and the extent of flow of these services to support their livelihood, which is the main determinant of their actions towards ecosystem sustainability.

Health security

Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity (WHO, 1946). Biodiversity and ecosystem services are linked with health and human well-being. Many health benefits are related to the conservation or use of specific elements of biodiversity, such as species or genetic resources. In India, Ayurveda is a traditional system of health care and medicine that depends on the rich and varied flora of medicinal plants. It is reported that Ayurvedic formulations use combinations of a selection of around 1200 species, about 500 of which are commercially traded (Subrat *et al.*, 2002). In many communities, the relationships between the natural environment and health are mediated by locally distinct cultural associations with species or habitats.Tulsi (*Ocimum sanctum*) is spiritually significant in India due to its role as a healing herb, and is worshiped in many parts of India. The traditional knowledge of the *Kani t*ribes living in the Western Ghats region was used to develop a drug called *Jevaani* and subsequently patented by the

Indian research institute, Jawaharlal Nehru Tropical Botanic Garden and Research Institute (World Intellectual Property Organization, 2016).

Environmental security

Environmental security is a concept linking human well-being to the state of the environment. It is considered as security from environmental shocks or stresses, thus linking societal well-being to environmental functioning (Falkenmark, 2001). It is an integral part of human security that encompasses a range of stresses such as environmental degradation, poverty and infectious diseases related to the environment (UNDP, 1994).

2.4.5 Vulnerability and adaptation/mitigation to climate change

Climate change is strongly interrelated with NCP and consequently has various impacts on 'Good Quality of Life'. For example, ecosystems regulate the global climate and contribute to the mitigation of climate change. They also regulate climate locally, e.g. through trees planted or grown nearby the agricultural fields, which contributes to increasing agricultural resilience to climate change (Locatelli, 2016). The material contributions include the provision of diverse products, which are important for food and livelihood security. A review of 117 studies found that the impact of climate change on ecosystem services was predominantly negative, although the results for carbon sequestration and CO2 fertilisation were mixed (Runting *et al.*, 2017). Across the Asia-Pacific, climate change presents many threats e.g. a risk of drought-related food shortage is expected due to the impxats of climate change, which may result in increases in malnutrition (IPCC, 2014).

The region is endowed with diverse ecosystems, from tropical forests, wetlands, coastal areas, floodplains, freshwater, to mountain ecosystems. These ecosystems not only support rich biodiversity but also play a critical role in supporting economy and livelihoods of billions of people in the region (Becken *et al.*, 2013). However, the increasing pressures of climate variability and change pose serious threats to the region and its people, thus making them further vulnerable. Counties where livelihoods of rural populations are primarily dependent on natural resources are more vulnerable (Agrawal & Perrin, 2008). Vulnerability is defined as the propensity or predisposition to be adversely affected, which encompasses a variety of concepts and elements including sensitivity or susceptibility to harm, and lack of capacity to cope and adapt (IPCC, 2014). Adaptive capacity is the ability of systems, institutions, humans, and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences (IPCC, 2014). Adaptation is the process of adjustment to actual, or expected climate change, and its effects (IPCC, 2014).

Effects of climate change tend to be more severe where people rely on natural resources or weather dependent agriculture for their livelihoods. With limited livelihood options, adaptive capacity is low due to limited information, poor access to services, and the inequitable access to productive assets. In this regard, local adaptation is crucial for reducing the vulnerabilities of communities and their surrounding ecological systems (Tompkins & Adger, 2004).

Box 2.3 Climate change mitigation and adaptation measures for crops and livestock in India

Climate change is of significant concern in India, particurly in the context of the growing population and the need to provide food security. India is particularly vulnerable, due to its community's high dependency on agriculture. Significant negative impacts have been predicted in the medium-term (2010-2039) with agricultural yields expected to reduce by 4.5 to 9 per cent. Since agriculture constitutes (approx.) 16 per cent of India's GDP, a 4.5-9 per cent reduction in production, indicating a cost of up to 1.5 per cent of GDP per annum. The Prime Minister's Nation Action Plan on Climate Change identified the protection and improvement of agriculture as one of eight national priorities. The National Initiative on Climate Resilient Agriculture (NICRA) 2010-11 was initiated to support the resilience of agriculture. This initiative focused on the application of improved production and risk management technologies for crops, livestock and fisheries. The initiative demonstrated site-specific technology for adapting to climate risks, enhancing the capacity building of scientists and stakeholders in applied climate research (Central Research Institute for Dryland Agriculture, n.d.).

Box 2.4 Role of Indigenous people in climate change mitigation

A joint study by the Rights and Resources Initiative, Woods Hole Research Centre and World Resources Institute analysed the roles of indigenous peoples' and local communities' contributions to climate change mitigation. The study quantified the contribution of traditional forest guardians to reducing emissions of greenhouse gases. Based on satellite surveys of 37 tropical countries across the world, the study estimated at least 54,546 million metric tonnes of carbon is held in collective forestland managed by these groups – roughly four times the world's annual emissions. Out of this total carbon store, 12,144 million metric tonnes are held by the indigenous peoples and local communities of the Asia-Pacific. These locally managed forests also provide benefits of clean water, pollination, biodiversity, flood control and tourist attractions. The report highlights strengthening the roles of indigenous peoples and local communities as a cost-effective way to protect forests and sequester carbon, and strongly advocates for the expansion of tribal land rights (Rights and Resources Initiative *et al.*, 2016).

2.4.6 Inter-relationship of biodiversity, ecosystem services and society

2.4.6.1 Spiritual and cultural identity

Indigenous people uphold a very distinctive cultural and spiritual value system in harmony with nature. The highly diversified areas of Asia and Oceania are inhabited by many indigenous and traditional peoples. The diversity of human languages has been used as the best available indicator of cultural diversity (Gorenflo *et al.*, 2012). Language carries many cultural differences; furthermore, using language as a proxy 'affords us the best chance of making a comprehensible division of the world's peoples into constituent cultural groups'. The indigenous worldviews also differ from one community to another.

2.4.6.2 Social relations

Many cultures attach religious and spiritual values to ecosystems, for example: a tree, river, hill, or grove. Thus any loss or damage to them can harm communities and individuals cultural identity and social relations.

For example, there has been a long history of bondage between sacred trees and village people in Korea, as demonstrated by the national foundation legend[36]. Korean people consider old trees as a channel though which God can communicate with them. There are still many villages where people continue to practice religious rituals for the protection of their safety and prosperity. While many old groves of trees are protected and managed by the village people, increasingly village groves are ill-managed or abandoned (Koo *et al.*, 2015).

Ecosystems can also contribute to enhancing social cohesion in urban communities. In the case of Seoul, in the Republic of Korea, multiple actors have collaborated with each other to establish and manage urban forests (M. S. Park & Youn, 2013). Seoul Metropolitan City, enterprises and forest NGO has built a partnership for creating an urban forest park via a voluntary agreement. Citizens

[36] The national foundation legend of Korea was recorded in Samguk Yusa or Memorabilia of the Three Kingdoms, a history book written by Buddhist monk Il-yeon published in 1281. In this memorabilia the first nation was established by Dangun, the first King of the nation in a city of forest where religious rituals for the god of heaven was performed.

played a significant role in establishing new forests by donating money and planting trees. The governance structure for cooperation among the stakeholders involved in urban forest management is being maintained. This case study indicates that urban ecosystems facilitate social cohesion by offering opportunities for social interaction in urban neighbourhoods.

2.4.6.3 Trade-offs of nature's contributions to people

In the Asia-Pacific, a large number of people depend on nature for their livelihoods, income and employment. Agriculture is the main livelihood provider to more than 50 per cent of the people living in the in the region. It is estimated that nearly 200 million people directly depend on the forest for non-timber forest products, medicine, food fuel as well as other subsistence needs (FAOSTAT, 2017).

In India, it is estimated that income derived from ecosystem services ranged between 9 to 26 per cent of the total income of the poor, while for the rich it is only 1 to 4 per cent (Jodha, 1986). In rural areas, about 70 per cent of employment opportunities came from the nature (Joshi, 2003). Around 20000 woodcutters and 7000 seasonal honey collectors depended on the Sundarbans forest for their subsistence (Chaudhury, 2007). Forest based enterprises provided up to 50 per cent of the household income and 20-30 per cent of the labour force in India (D. D. Tiwari & Campbell, 1993). Approx. 80 per cent of Nepal's household energy came from fuel wood (Clean Energy Nepal, 2008). 14-20 per cent of peoples' income comes directly from the community forests (Adhikari, 2005). Eco-tourism dependent poor in Sundarbans spent about 19 per cent more on food items, and 38 per cent more on non-food items, than the non-dependent poor (Guha & Ghosh, 2007).

Ecosystem service trade-offs arise from management choices and policies, which can change the; type, magnitude, functions, flows and relative mix of services provided by ecosystems (E. M. Bennett *et al.*, 2009). Trade-offs among different services and their consequences for the livelihoods of people do not happen solely because of biophysical factors, but also because of people's decisions and management regimes.

Water, energy and food nexus

The material aspects of nature's contributions to people are at the core of human needs. These linkages have recently been referred to as the; water–food–energy nexus (Bazilian *et al*., 2011; Biggs *et al*., 2014; Howells *et al*., 2013). Because these resources are interconnected, policy development and resource management requires careful consideration of the complex interconnections between nature and society (Hoff, 2011).

In the coming decades population growth and changes in diet will increase the global food demand and consequently the water demand for agricultural production (de Fraiture & Wichelns, 2010). To produce food, water and energy are needed. To produce energy, water is required, and to access water, energy is almost always needed (i. e. to run pumps). Due to the complexity of relationships among these three elements, there is a need for them to be considered simultaneously in decision-making (Bazilian *et al.*, 2011; Howells *et al.*, 2013). Ecosystems are in the center of this nexus, since they contribute to the provision of each component, making it an imperative to understand the role of ecosystems in securing food, water and energy for human well-being (Karabulut *et al.*, 2016).

Economic development and climate change are causing increased pressure on global water, energy, and food resources, presenting escalating levels of trade-offs and conflicts among these resources and stakeholders. Due to the interconnections of these resources, policy development and resource management require careful consideration. The nexus approach provides opportunities to improve water, energy and food security and thus security in nature's contributions to people. Specifically, this approach enhances the benefits from productive ecosystems. Improving the management of ecosystems can provide multiple services and increase the overall benefits. For example, additional benefits could result in 'green agriculture' or a shift towards integrated 'agro-ecosystems' and landscape management can provide additional benefits, such as carbon sequestration and resilience to climate risks, while improving food security (Hoff, 2011).

The majority of the world's poor people directly depend on ecosystems—both natural systems and managed agroecosystems for their food, fuel and livelihoods, they are the most vulnerable to ecosystem degradation and climate-related shocks (Boelee *et al.*, 2011). The action of poverty alleviation integrating with green growth and the sustainable use of resources, strengthens a wide range of ecosystem services and maintains the human 'life support system', especially of which the poorest depend most directly. For instance, the provision of clean water and energy would immediately improve the health and productivity of many people across the region. Bekchanov *et al.* (2015) highlighted the importance of ecosystem services in the water-food-energy nexus debate. They advocated for the need for more attention to be given, particularly on improving the quality of data and methods of assessing the value of ecosystems. They noted that rigorous data is essential for efficient policymaking. They promoted involving the direct beneficiaries of ecosystem services in research planning and design processes, claiming such n approach will enhance the data quality and subsequent policy recommendations.

Case of Lao People's Democratic Republic[24]

Lao People's Democratic Republic (Laos or Lao PDR) is rich with natural resources, such as forests and minerals and is one of the least developed countries dependent on natural resources (Vongpraseuth & Choi, 2015). The development of mining and deforestation of natural resources has negatively affected the biodiversity in Lao PDR. Private sector investments, such as agricultural expansion, forest extraction, mining, as well as infrastructure and hydro dam construction, are some of the developments that have negatively affected the nation's biodiversity (Ministry of Natural Resources and Environment, 2016). Several threats to the biodiversity and natural resources in Lao PDR continue to persist. One of the biggest threats is the Nam Theun 2 Hydropower Project (NT2), which supplies electricity to locals in the area. The project was completed in 2010 and began diverting water from the Theun River into the Xe Bang Fai River. However, findings suggest that the project has significant negative impacts on the livelihoods of large numbers of people dependent on the river's resources (Baird *et al.*, 2015). An overwhelming majority of locals from twenty-six villages in seven districts and two provinces in the Xe Bang Fai basin and other communities in the basin commented about the loss of fish biodiversity in the basin. Another consequence of the NT2 is the flooding of large areas of land, which affects the land available for agriculture and fishing.

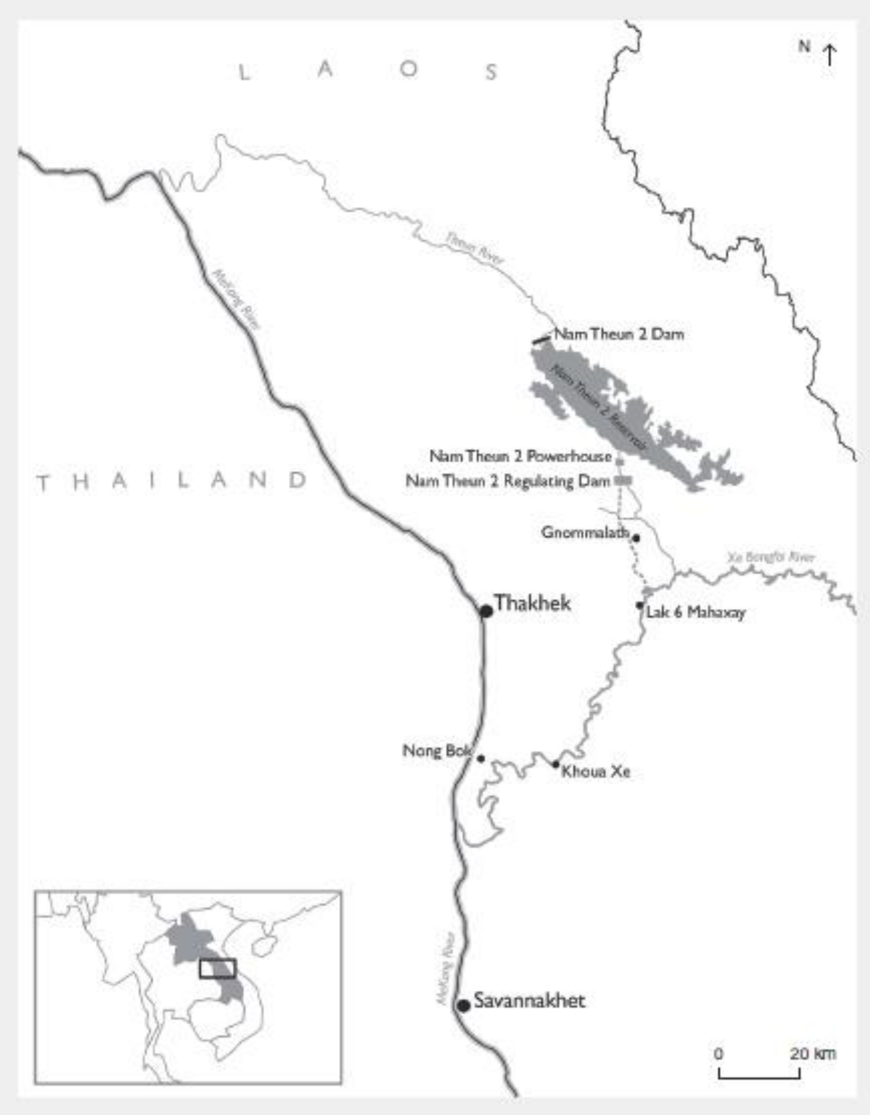

Figure 2.33 The project area of the Nam Theun 2 Dam. Source: Baird *et al.* (2015).

2.5 Institutional influences on nature's contributions to people

2.5.1 Institutions and organizations

Institutions are regulating frameworks that govern human actions that can be formal or informal (InfoResources, 2008). Formal institutions often manage, legislative arrangements, international conventions and treaties. Informal institutions are often engaged with self-imposed codes of conduct (e.g. customary laws, informal social norms and rules) that are embedded in interactions between groups or individuals (Díaz, Demissew, Carabias, *et al.*, 2015).

Institutions are considered as important in their roles of influencing and executing the governance and management of natural resources, including biodiversity and ecosystems (E. R. Alexander, 2006; Cronin & Pandya, 2009). They shape and condition what actors can, should and should not do (Ostrom, 1990; Scott, 2001), and largely determine access to, and control of natural systems and resoirces. They take responsibility for the allocation and distribution of components of natural (and anthropogenic) assets and their contributions to people (G. Borrini-Feyerabend & Hill, 2015; Duraiappah *et al.*, 2014; Primmer *et al.*, 2014). Attributes of management institutions can also help or hinder the ability to respond to change (Armitage *et al.*, 2007). Institutions and governance, therefore, play a central role in determining how people gain and secure contributions from nature and how this changes over time.

Institutions and organizations influence the provision of ecosystem services to human well-being in different ways. They, together with human judgment, have direct roles in the management and restoration of biodiversity and ecosystems. The type of management, in turn, affects the production of ecosystem services that are available for human well-being in a given time and space. The benefits and value so obtained, provide essential feedback to the design of institutions and organizations (TEEB, 2011). Institutions also play a significant role in influencing people's perceptions about the importance of ecosystem services and nature's contributions (Norgaard, 2010; Primmer *et al.*, 2014). This perception, in turn influences behaviour and decisions regarding the use of ecosystem services in a given socio-cultural context (Díaz, Demissew, Carabias, *et al.*, 2015).

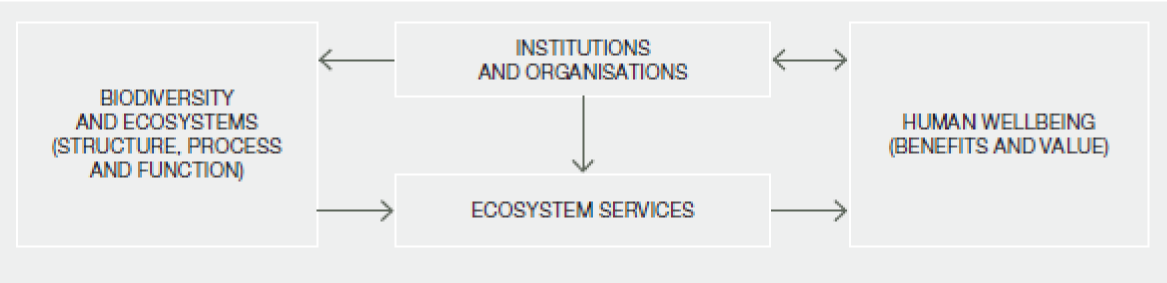

Figure 2.34 Linkages among ecosystems, institutions and human well-being. Source: adapted from TEEB (2011).

The success of institutions and organizations in furthering the equitable and sustainable management of biodiversity and ecosystem services can be analysed by testing the relationships between institutional arrangements and ecosystem service provision, and the interplay between different regulations and practices (Primmer *et al.*, 2014).

2.5.1.1 Social organization of nature's contributions to stakeholders

Stakeholders related to biodiversity and ecosystem services across the Asia-Pacific are organized at different levels and in different ways. The main stakeholder groups include the governments (national, sub-national, and local), business and industry related communities, nongovernmental organizations and other civil society organizations (e.g. community-based groups, indigenous peoples' organizations, and indigenous and local communities themselves). Regional and global international organizations and networks are other important stakeholders. These different organizations influence nature's contributions to human well-being through international, and respective regional, subregional, national and/or local level institutions (Yasmi *et al.*, 2010).

Different stakeholders and social actors, may have alternate perceptions of, and access to, ecosystem services and nature's contributions, together with variable motivations and capacities to change them. For example, for poor and vulnerable local populations, well conserved biodiversity and ecosystems can help to provide livelihood solutions, facilitating resilience and adaptation, and reducing poverty. At the national, regional and global scales, benefits from nature include mitigating the impacts of climate change; driving sustainable development; ensuring sustained flow of key ecosystem services, such as nutrient cycling, water retention and arresting environmental threats that affect the benefits from biodiversity and the flow of ecosystem services (Yasmi *et al.*, 2010).

2.5.1.2 Influence on terrestrial ecosystems

Most terrestrial ecosystems in the Asia-Pacific are facing unprecedented anthropcentrically driven changes at all levels. Continuously evolving institutions and governance systems have been influencing these changes. For example, many countries in the region have witnessed substantial changes in forest management policies and approaches over the last five decades. During the 1960s and 1970s, policymaking efforts in most countries across the region were oriented towards the national control of forests through stringent laws and the expansion of forest bureaucracy. This approach generally failed, as evidenced by widespread deforestation and forest degradation in many countries during the 1960s through 1980s (Gautam *et al.*, 2004). The negative outcomes of centralization paved the way for the devolution of forest management responsibility and authority to lower levels of decision-making, which has resulted in positive outcomes in conservation of forest ecosystems and enhanced benefits to the local people in many countries. In Nepal, for example, forest cover increased from 29 per cent in 1994, to 40.36 per cent in 2014 (DFRS, 2015). This increase is mainly credited to the extensive implementation of community based forestry programmes, particularly in the hills. There is evidence that under certain design conditions, community based management or co-management institutions are capable of meeting various conservation and economic development goals (Cinner & Huchery, 2014). Thus, many countries in the region (e.g. Nepal, Philippines, Vietnam, India, Indonesia, Lao PDR, Thailand) have put forward new organizations, authorities and bottom-up approaches to promote participatory approaches to management of forest and protected areas.

Box 2.5 Linking local communities to benefits of protected areas in Nepal

Kangchenjunga Conservation Area, covering 2,035 km2 in Eastern Nepal, has been managed by the local communities since 2006, under a, locally devised, institutional arrangement. Local people are also involved in the management of the country's other conservation areas (Annapurna, Manaslu and Gaurishankar) and 12 buffer zones established around nine national parks and three wildlife reserves. These initiatives have put Nepal at the forefront in linking communities to the benefits from protected areas. This has also helped promote the knowledge, innovations and practices of indigenous and local communities in the management of biodiversity and ecosystems (GoN/MoFSC, 2014).

Box 2.6 Traditional forest management system "*Saguday*" in the Philippines (Batang-ay, 2017; Pulhin *et al.*, 2006)

The Kankanaey tribes located in Sagada (Philippines), call their traditional forest management system *saguday*. This system has contributed to the sustainable provision of materials for household needs, conservation of habitat for wildlife, and cultural and religious practices. *Saguday* is governed by the council of elders who are recognized by the communities, and serve as the carriers of traditional knowledge. The caretakers designated by the council, manage *Saguday* and implement the indigenous rules concerning its use, including tree planting and harvesting, based on their assessment of the forest and its condition. *Saguday* incorporates customary law, including: membership rules, harvesting and allocation rules, grazing/cattle management, fire management and penalties for violators.

There are many different types of informal traditional institutions involved in the management of terrestrial ecosystems across the region. Traditional institutions are unique to a country or subregion. A recent study in 14 countries, including five in South Asia (Bangladesh, India, Nepal, Sri Lanka and Bhutan), six in South-East Asia (Indonesia, Malaysia, Philippines, Thailand, Vietnam and Lao PDR) and three in East Asia (China, Korea and Japan), found the existence of a remarkable diversity of forest governance institutions (Inoue & Shivakoti, 2015). In some cases, traditional institutions have lost their effectiveness in recent decades for various reasons (Gautam *et al.*, 2004).

Box 2.7 Traditional village councils for forest management in India

Van Panchayats, are traditional community forestry institutions that can be found in many parts of the Uttarakhand State. They have considerable autonomy in decision-making and control over the forest. An estimated 12,089 *Van Panchayats* cover (approx.) ~545,000 ha of forestland of the state. They have balanced the maintenance of ecological services, such as soil fertility and water source protection, with regulated grazing and the collection of forest resources necessary to support local livelihoods. High stakes in the forest, and strong bonds of trust among villagers, have allowed many of the *Van Panchayats* to remain successful till day. These village institutions have displayed remarkable resilience and adaptation to changing internal and external environments (Misra *et al.*, 2009). *Van Panchayat* rules have support from the government and have continuously evolved. Similarly, *Mahila Mangal Dals* (women self-help groups) have effective control over the management of the village forest for the collection of fuelwood, fodder and water as it is almost exclusively women's work in the Indian Himalaya Region (Dhyani *et al.*, 2011; Misra *et al.*, 2009).

Box 2.8 Traditional institutions and conservation benefits in Cambodia

The Virachey National Park in North-East Cambodia encompasses part of the ancestral territory of the ethnic Brao people who have developed different types of tenure regimes to promote the sustainable use of local resources to maximize benefits. Some of these traditional approaches, such as the management of the Dipterocarp wood resin trees as an inheritable private property by the Brao people, have proved to be successful traditional approaches to management of forest ecosystem services in the area (Baird & Dearden, 2003).

A number of regional organizations are involved in the management of biodiversity and ecosystems across the Asia-Pacific. The International Centre for Integrated Mountain Development is contributing to the management of biodiversity and ecosystems in eight countries (Afghanistan, Bangladesh, Bhutan, China, India, Myanmar, Nepal, and Pakistan). The six countries in the Mekong River Basin (China, Myanmar, Thailand, Lao PDR, Cambodia, and Viet Nam) are collaborating in the management of transboundary water and associated biodiversity and ecosystem resources, through the Mekong River Commission.

The ASEAN Centre for Biodiversity (ACB) serves as a centre of excellence for conservation and the sustainable use of biodiversity by promoting collaboration among the 10 ASEAN member states (Brunei Darussalam, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Thailand, and Vietnam), international development institutions, and the donor community. The corporate social responsibility programme is one of the best practices promoted by the ACB. The Biodiversity and Climate Change Project of the ACB successfully implemented pilot initiatives in different member states, including in: Lao PDR, Myanmar and Vietnam (ASEAN Center for Biodiversity, 2014).

Some international agencies are also active in the conservation of the region's biodiversity and ecosystems. The Critical Ecosystem Partnership Fund is playing important roles to enable civil society to participate in, and benefit from, conserving some of the world's biodiversity hotspots located in the region, including the Eastern Himalayas, Indo-Burma Mountains of Southwest China, Philippines, Polynesia-Micronesia, Sunderland, Western Ghats of India, and Sri Lanka. The fund directly supports conservation efforts of indigenous peoples and local communities. The Nature Conservancy has been providing practical tools and approaches to the stakeholders for conservation of Orangutan forests in Borneo, and is playing a catalytic role in the conservation of private land in China's Sichuan province, through an innovative initiative, the 'Land Trust Reserve' (International Land Conservation Network, 2016).

2.5.1.3 Influence on aquatic ecosystems

The Asia-Pacific has some of the most biodiversity-rich marine aquatic ecosystems in the world and freshwater wetlands that harbour threatened species of flora and fauna and serve as resting places for many migratory and globally threatened birds. These wetlands command high cultural and economic significance for many ethnic groups dependent on wetlands for their livelihoods. People from across the region have high levels of participation in small scale fisheries to sustain their livelihoods, and have high reliance on fish as the major source of protein.

Box 2.9 Role of formal institutions in managing aquatic ecosystem services in China

Jiaozhou Bay, covers an area of 343.5 km^2, and is a semi-enclosed shallow-water body situated on the southern coast of the Shandong Peninsula in East China. It exemplifies a typical case where ecosystem services (e.g. tourism, fisheries, transportation) strongly support urban development. The management of the Bay is governed by four plans, three local and one regional. These influence the coastal institutional networks and determine whether the ecosystem services concept will be considered in the management of the Bay. In addition, there is a number of: policies, legislation, regulations, and government requirements pertaining to the Bay. These formal institutions and organizations are critical for managing the utilization of the ecosystem services (Li *et al.*, 2015).

Many different types of community based and informal traditional institutions are involved in the management of marine and coastal resources across the Asia-Pacific. For example, in the South Pacific: the community based management of marine resources in Jorio, Solomon Islands; ecotourism management in Namena Marine Reserve, Fiji; building on traditional and modern approach to marine resource management project in Tuvalu; building decentralized support intuitions for community resource management and climate change adaptation in the Solomon Islands; locally managed marine area network in Fiji; and the community based fisheries management programme in Samoa. These provide examples of best practice in the management of aquatic biodiversity and ecosystems in the region. Between 81-98 per cent of the land in independent Melanesia and Polynesia is reportedly under some form of customary tenure indicating the significant influence of localized management (Govan *et al.*, 2008).

Box 2.10 Traditional knowledge, customary tenure and governance in the South Pacific

The community-based management of coastal resources in the South Pacific provides an example of the role of local institutions in the recovery of natural resources, greater food security, and improved governance and health. The initiative, which is known as 'locally managed marine areas', covers more than 12,000 km^2 and involves 500 communities in 15 Pacific island states. This initiative has helped to achieve widespread livelihood and conservation objectives, based on traditional knowledge, customary tenure and governance (Govan *et al.*, 2008).

In some cases, co-managed institutions have been found to be more successful than community based institutions (Dunning, 2014; Olsson *et al.*, 2004). The Tagal system in Sabah, Malaysia, is an example of successful case of co-management by government agencies and local communities for the sustainable management of inland fisheries (FAO, 2005a).

The Indian Ocean Tuna Commission, Western and Central Pacific Fisheries Commissions, and UNEP Regional Seas Programme are some regional level institutional entities related to the conservation of marine animals and ecosystems in the region. Bangladesh, India, Indonesia, Malaysia, Maldives, Myanmar, Sri Lanka, and Thailand, are collaborating in the Bay of Bengal Large Marine Ecosystem (BOBLME) Project, with the objective of bettering the lives of their coastal populations by improving the management of the Bay of Bengal environment, and its fisheries (BOBLME, 2015).

The Coral Triangle Initiative (CTI), formed in 2009, is working to address the urgent threats facing the coastal and marine resources in one of the most biologically diverse and ecologically rich regions on earth, through a multilateral partnership involving six countries: Indonesia, Malaysia, Papua New Guinea, Philippines, Solomon Islands, Timor-Leste (Figure 2.35).

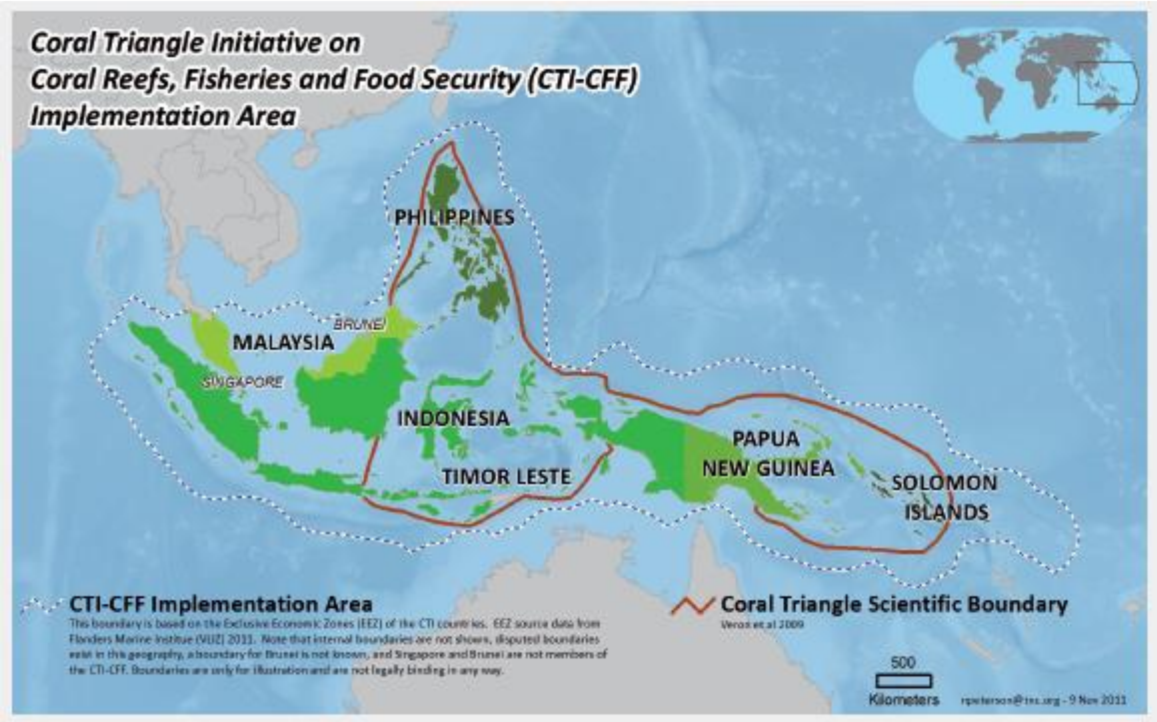

Figure 2.35 The coverage of the Coral Triangle Initiative. Source: CTI-CFF Secretariat (2011).

The Initiative has made significant progress in protecting the reefs and fisheries resources that support the livelihoods and food security of nearly 400 million people in the region, and millions more living in other parts of the world (Nature Conservancy, 2016). The CTI is also helping the coastal communities to adapt to the impacts of climate change through science-based decision-making, innovative tools, information sharing, and capacity development. It is working with local partners to implement community based resource management in remote coastal villages of Papua New Guinea and the Solomon Islands, and also playing a crucial role in the conservation of threatened sea turtles (CTI-CFF, 2009).

The Pacific Oceanscape Initiative of 23 Pacific island nations and territories (2.5.3) that came into being in 2009, is another regional initiative that marks a new era for the management of marine biodiversity and ecosystems at a multi-national scale.

2.5.1.4 Challenges

Institutions in the region face different types of challenges. Some of these challenges are related to the attributes of biodiversity and ecosystem services. For instance, many ecosystem services are derived from open access resources where property rights are not clearly allocated. Some ecosystem services are products of interactions between multiple ecosystems that fall between different governance systems. For example, the habitat of pollinators might cross the boundaries of agricultural areas (Primmer *et al.*, 2014).

Many community based institutions face design-related, and other challenges. As a result, not all community based institutions are equally successful in protecting and managing their resources in a sustainable manner. For example, in the Nepal Hills, clearly defined boundaries, congruence between the appropriation rules and provision rules, collective choice arrangements, effective monitoring, graduated sanctions for violation of the rules, and low-cost conflict resolution mechanisms in place are found to be the main factors determining the success of local forestry institutions (Gautam & Shivakoti, 2005). The 'one size fits all' approach to institutions is a reason for failure, in some cases (Dunning, 2014).

Institutions at the higher levels (national, international) are commonly criticized for overlapping mandates, unclear linkages between multi-level governance, and a lack of collaboration amongst stakeholders (Cinner *et al.*, 2012; Ekstrom & Young, 2009). National and local efforts to improving forest management and reducing deforestation and forest degradation, have not been so successful in many countries. This is partly because they have concentrated on regulating activities within the forest sector, while many of the problems arise from pressures outside the sector. Formal forest sector institutions in the region do not usually adopt the ecosystem approach to management, as proposed by the Convention on Biological Diversity. The inadequate capacity of stakeholders at different levels to address the most pressing issues at the corresponding level, is another important challenge (Louman *et al.*, 2010).

The 'landscape approach', which is being promoted in many countries in recent years, indicates potential to reconciling conservation and development goals and enhanced benefits to people, through strengthening social capital, and enhancing community income and employment opportunities. However, the conceptualisation and implementation of this approach has been limited (Reed *et al.*, 2017).

Some other barriers in the successful implementation of the ecosystem and landscape approaches often include the inadequate understanding of the interrelation between ecosystems and landscape level mechanisms. This includes a lack of understanding of the horizontal interactions across multiple landscape scales that influence ecological services. Corruption and institutional failure remain other major obstacles to the effective management of ecosystems in many parts of the region (Carpenter *et al.*, 2009).

One of the most intractable problems of terrestrial ecosystem management has been the mismatch between political boundaries and ecological units appropriate for the management of ecosystem goods and services. For example, in many trans-boundary situations the downstream communities or countries may not have access to the institutions through which upstream actions can be influenced. In other cases, the downstream communities, or countries, may play a dominant role to controlling upstream areas without addressing upstream needs, if they are politically or economically stronger than upstream regions (Millennium Ecosystem Assessment, 2005). Designing suitable governance regimes and institutions, in such situations, remains a challenge.

Some regional institutions, related to the management of aquatic ecosystems, are reportedly not successful in achieving their objectives, due to inadequacies in their design. For example, the Bay of Bengal Large Marine Ecosystem Project has not been successful in achieving some of its objectives due mainly to: the lack of a clear mandate, geographical scope and/or the limited capacity of the large number of international, regional and subregional bodies and programmes that are involved in the project (BOBLME, 2015).

2.5.2 Legislation and policy

Nations across the Asia-Pacific have developed environmental legislation and policies together with, multilateral agreements and assessments to manage ecosystems and biodiversity. Inadequate legal frameworks, as well as a lack of implementation and enforcement, are obstacles to the successful governance of ecosystem services (Greiber & Schiele, 2011). The low overall Environmental Performance Index assessment of Asia- Pacific countries (Hsu *et al.*, 2014; WRI, 2015) further reflects a measurable gap between environmental protection goals and aspirations, and the effectiveness of policies in the region.

Some countries have developed legislation and policies that reflect Governments' progress surrounding managing the economy in a more environmentally sustainable way. Larkin (2016) stated that the *Environmental Impact Assessment (EIA) Procedure* (2015) and its guidelines are the requirements for assessing , monitoring and reporting on the environmental and impacts of projects, minimizing aspects such as land and water degradation and levels of pollution. *Social Impact Assessments (SIA)* should accompany EIAs, as they address the social and cultural impacts of developments.

For example, China revised its environmental impact assessment law in 2016 to ensure more effective management. The revised regulation emphasises the importance of pre and post management approaches in planning activities (Lu, 2016).

2.5.2.1 Human rights, nature and the law

The provision of ecosystem services is linked to human rights, with a particular emphasis on equity to access natural resources (Jax *et al.*, 2013). Many people, particularly those living in developing states, and/or rural communities, directly depend on the environment to sustain their livelihoods. Environmental and social challenges, such as: development activities, global warming and pollution, population growth, interfere with natures provisioning services. Thus, the fundamental human rights of some Asia-Pacific individuals and communities, to access natural resources, is becoming more difficult (Lewis, 2012).

There are many legal instruments, both binding and non-binding, related to the protection of human rights at an international level, while domestic laws enforce human rights protection in each country's legal system.

Since 1948, basic human rights have been entrenched in the United Nations *Universal Declaration of Human Rights* (UDHR) (United Nations, 1948). Human rights and the conservation of ecosystems are interlinked (Campese *et al.*, 2009; Lewis, 2012). For example, the right to the highest standard of health and an adequate standard of living, depends on a certain degree of environmental quality. The right to a healthy environment is considered to be: the right to life (UDHR, art. 1), the right to property (UDHR, art. 17), the right to a standard of living that is adequate for health and well-being (UDHR, art. 25), and the right to culture (UDHR, art. 27). These rights relate to providing support to protect the ecosystem and promote human well-being.

In many Asia -Pacific countries, women, indigenous peoples, people from lower castes and ethnic minorities lack adequate legal representation, or the opportunity to participate in local or national institutions and to protect their rights and environment. For example, s. 46 and 56 of the *Constitution of the Kingdom of Thailand B.E. 2540* (1997) affirms the community rights, cultural rights, and environmental rights , which includes the right to participate in the management of the environment and the exploitation of natural resources, and conserve biological diversity in a balanced and persistent fashion. Additionally, The Consitution includes the right to live in a healthy environment, and the right to access justice. However, according to the Monitoring Report of the National Human Rights Commission (NHRC), the highest number of claims requiring investigation related to community rights (Chairos, 2006). The NHRC's investigations revealed that many government agencies had violated communities' rights in the process of their authority (National Human Rights Commission of Thailand, 2015). Therefore, the enforcement of community rights articulated through the Constitution was found to be ineffective, thus the livelihoods of many local community's and the environment has deteriorated. This case exemplifies the need for legislation, its enforcement, monitoring and reporting to protect the ongoing health of nature and communities.

Box 2.11 The Rock Mine in Dongmafai

This case represents the role of the community of the Dongmafai sub-district in the Suwankuha District of Nongbualampoo Province (Thailand) in protecting their rights. In 1993, the people of this community opposed concession rock mining in an area of 280 000 square meters but subsequently suspended their protest following the assassination of two village leaders. Later in 1994, the mining company re-submitted its case for the granting of a concession which was successful for a 10-year period commencing in 2000. The villagers made complaints to related government organizations against the granting of the concession, but were denied justice. In 2003, 340 villagers from the Dongmafai community and the Phupa-Pamai Forestry Conservation Club made a case of the violation of community rights to the National Human Rights Commission (NHRC) and also filed a case in the Konkaen Administrative Court, to exercise their rights to protect the mine area that served as the source of water, and provided community forest resources, to support their livelihoods. The community also claimed ownership of this land granted for agricultural purposes under the government's project of land reform and emphasised the cultural importance of a 4000 year-old pre-historic cultural site with paintings in the Phaya Cave in the rock mine area.

The investigation by the NHRC clearly indicated the violation of the community rights in the mining concession processes and its right to information, participation and access to justice. Following these investigations, the Administrative Court issued an injunction to the mine owner to suspend operations in 2002, and made a decision to revoke the clearance on the ground that it had ignored the objections that were lodged by the 393 villagers. In 2009, the Supreme Administrative Court reversed the judgment of the Konkaen Administrative Court on the grounds that only the 1st, 2nd, and 3rd plaintiffs who signed the complaint, had a standing to sue. The objections of the 393 villagers to the concessions were not given due consideration because they did not own the land. Their pleas to prevent noise and dust pollution caused by the rock-mining activities and to save the pre-historic paintings in the caves were therefore not accepted.

2.5.2.2 Customary law and ecosystem protection

"As communities globally grapple to respond to climate change damage to all ecological systems, there is much to be learnt from Pacific Island communities and their inseparable interconnections with nature. This highlights the need of customary laws to empower and involve indigenous peoples and their customs more broadly, in the protections of ecosystems and their services" (K. Davies, 2016, p. 25). Customary law incorporates traditional knowledge, cultural and religious beliefs and traditional customs that govern environmental protection, attitudes, values, family and community structures, behaviour and participation (K. Davies, 2015). The notion of 'Custom' refers to certain aspects of local knowledge and rituals, expanding increasingly to describe a 'way of life' that is culturally distinctive to indigenous people (Jolly, 1992).

Customary law does have some standing in international environmental law such as its inclusion in: The *International Labour Organization (ILO) Convention 169* (1989)[37], *United Nations Declaration on the Rights of Indigenous People* (2007)[38] and *The Nagoya Protocol* (2010)[39], which is an international agreement, aimed at equitable benefit sharing arising from traditional ecological knowledge (TEK) and genetic resources. Customary law offers historically tested governance

[37] International Labor Organization, *Indigenous and Tribal Peoples Convention,* C169 7 June 1989, (entered into force 5 September 1991) 1650 UNTS 383 (1989).

[38] *United Nations Declaration on the Rights of Indigenous Peoples,* GA Res 61/295, UN GAOR, 61st sess, 107th plen mtg, Supp No 49, UN Doc A/RES/61/295 (13 September 2007).

[39] *Protocol on the Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from Their Utilization to the Convention on Biological Diversity* (Nagoya) 29 October 2010 (entered into force 12 October 2014).

structures surrounding communities and nature, which is still practiced by indigenous peoples in many nations across the Asia-Pacific. It could be argued that these international instruments give rise to the international legal recognition of local and traditional customary law (K. Davies, 2015).

For example, in the Republic of Vanuatu, there is a deep history of recognising the significance of customary law as evidenced in the nation's Constitution (1980)[40], which is a combination of traditional customary law, French Civil Law and English Common Law. Vanuatu's Constitution reflects the commonly adopted sustainability principle of intergenerational equity as evidenced by its aim: "to protect the Republic of Vanuatu and to safeguard the national wealth, resources and environment in the interests of the present generation and of future generations (Constitution of the Republic of Vanuatu, 1980)."

Much of the traditional knowledge held by fishermen in Vanuatu relates to both managing sustainable resources to support subsistence livelihoods, while increasing catches (Hickey, 2006). Traditional fisheries management incorporates beliefs and practices that follow "natural cycles of resource abundance, accessibility, and respect for customary rules enshrined in oral traditions (Hickey, 2006, pp. 1–16)". In Vanuatu, customary law is recognised as a formal source of law, however it is not always used as such by the judiciary (Corrin, 2011). Some will argue that compliance with customary law is higher than State law due to the fear associated with the breaking of taboos (or tabus) in place by customary sanctions (Cox *et al.*, 2014).

Tabu areas are 'no-take' zones that involve harvesting prohibitions (K. Davies, 2016) and are applied to marine and terrestrial ecosystem management in many nations across the Asia-Pacific, such as Fiji, Kiribati and Tuvalu. These zones are often put in place by a chiefly authority, marked with tabu sticks and/or leaves and ritualized. Breaching the rules of these areas leads to fines and supernatural retribution, often described as 'Black Magic'. In addition to these 'no go zones' there are customary legal mechanisms controlling who can fish, where, when, and the quantity and species of fish they can harvest (Techera, 2015). Alternatively, in an area of partial depletion, the chief may ban all net fishing and only permit rod fishing, as a management method of limiting the number of fish extracted (K. Davies, 2016).

Evidence of the significance of customary management is provided by a scientific study that compiled data from more than 25,000 reefs in over 46 States to identify coral ecosystem 'outliers' (Cinner *et al.*, 2016). The outliers are 'bright spots' that are in substantially better condition and and 'dark spots' which are found to be in worse condition than expected, given the environmental conditions and socio-economic drivers they have been exposed to. Significantly, the data shows that bright spots do not always appear in remote areas, such as marine park protected areas, with low fishing pressure and beneficial environmental conditions. In fact, bright spots are generally areas of high use "characterized by strong socio-cultural institutions such as customary taboos and marine tenure, high levels of local engagement in management, [and] high dependence on marine resources" (Cinner *et al.*, 2016). One bright spot, the authors cite, is Karkar Island, Papua New Guinea, where adaptive rotational harvest systems, and a marine tenure that excludes fishers from other villages, together with initiation rites limiting entry into particular fisheries, restrict marine resource use (Cinner *et al.*, 2016).This data adds to a growing body of research that suggests the long-term viability of ecosystems will depend on local populations willingly cooperating in the collective management of marine resources (Folke *et al.*, 2005).

Enforcement of customary law, at a local level, offers important governance opportunities, such as; effective community monitoring and the application of appropriate sanctions and penalties. Communities are rewarded by receiving direct benefits, for example through the sustainable provision of seafood (K. Davies, 2016).

[40] *Constitution of the Republic of Vanuatu 1980* (Vanuatu).

A further example are the customary laws of Indigenous Australians, who historically have relied on plants, animals and the seasonal environment for their survival, and have a well- developed knowledge of the natural world (Great Barrier Reef Marine Park Authority, 2016).

Box 2.12 Indigenous Australian marine management of the Great Barrier Reef

The Great Barrier Reef is the world's largest coral reef system, spanning across the length of 2,300 kilometres and the area of 344,400 square kilometres, off the coast of Queensland, Australia. There are more than 70 Aboriginal and Torres Strait Islander Traditional Owner groups that have connections with the Great Barrier Reef region and its natural resources. These traditional owners value this landscape and actively take part in traditional practices to ensure that this ecosystem remains viable.

With various threats to the reef including, but not limited to, climate change, poor water quality from land-based run-off, potential oil spills, impacts from ill-planned coastal development, inadvertent introduction of invasive species and illegal fishing (Great Barrier Reef Marine Park Authority, 2014), the Great Barrier Reef is an important ecosystem that requires adequate and proactive management plan if it is going to be viable in the future. The involvement of Traditional owners is pivotal to the success of this sort of planning.

The *Great Barrier Reef Marine Park Act* (1975) aims to "provide for the long term protection and conservation of the environment, biodiversity and heritage values of the Great Barrier Reef Region". The Great Barrier Reef Marine Park Authority is a Commonwealth development that is responsible for the management of the Marine Park. In partnership with the traditional owners of the reef, the Park Authority works to: conserve biodiversity, protect the heritage of the site, preserve cultural values and contribute to the resilience of the Great Barrier Reef (Great Barrier Reef Marine Park Authority, 2011). It is committed to the"identification, protection and maintenance of both Indigenous and non-Indigenous culturally and historically significant sites throughout the Great Barrier Reef World Heritage Area" (Great Barrier Reef Marine Park Authority, 2005).

The Great Barrier Reef Marine Park Authority works to preserve the biodiversity of this ecosystem by adopting the various policies, procedures, laws and regulations and with the assistance and guidance from traditional owners of the land. Under the *Community Services (Aborigines) Act* (1984) (Queensland), indigenous Australians living on this land have the right to use land and waterways for traditional uses including collecting, hunting and fishing for food for consumption. Placing hunting restrictions within the Great Barrier Reef, is a management strategy that works to ensure that specific species do not become at risk of extinction or endangerment (Sweeney, 1993). These strategies aim to ensure that the ecosystem will be viable for future generations.

2.5.2.3 Hybrid governance and adaptive co-management

'Co-management', or 'hybrid governance', is a governance strategy involving the sharing of rights and responsibilities among those who have a claim to an environment or natural resource (Olsson *et al.*, 2007). It can also be described as 'adaptive co-management' (ACM) which has received considerable recent attention as a means of sustaining socio-ecological systems by building their resilience and adaptive capacity and establishing sustainable pathways (Olsson *et al.*, 2007). ACM can contribute to climate change adapation by building generalised adaptive capacity, or characteristics that promote the ability to respond to almost any kind of challenge, as well as providing a novel institutional arrangement to generate adaptive responses (Plummer, 2009).

Custom or 'Kastom' as it is known in Vanuatu, is a hybrid mixture of customary laws and aspects of traditional ecological knowledge (M. Forsyth, 2004). The reality is that there are two systems of law, or legal dualism, operating in Vanuatu, which run in parallel to one another, the official and unofficial systems (M. Forsyth, 2004). This is the case in many Asia-Pacific nations, which results in systems of hybrid governance or co-management (K. Davies, 2016).

The First Global Integrated Marine Assessment: World Ocean Assessment 1 (2016b)[41] highlighted the importance of hybrid approaches to management, in the context of climate change, noting that “its impacts will be local, depending on a host of local/regional drivers that will interact with global climate changes” (United Nations, 2016b).

Box 2.13 Case study: Fiji – hybrid governance

Fiji is facing many challenges in managing its biodiversity because of the emerging problems associated the fastest growing rate of tourism anywhere in the South Pacific (Sutton, 2005). Fijians have continuously important relationships with their land and marine areas. Under customary law, the traditional ownership involves a combination of ownership of coastal waters and fishing grounds that were governed by customary law and protected by traditional ecological knowledge. These fishing grounds have traditionally provided the main protein food sources and income from the sale of any excess seafood (Techera, 2009). Fiji adopts community based ecological management for the network of marine areas in combination with modern methods of monitoring (Techera, 2009). They have developed locally based management plans that enforce both traditional customs, and contemporary laws. This approach has helped to increase biodiversity and reduce poverty among communities who depend on marine resources for incomes and living. This strategy has strengthened community solidarity and policy, by increasing the support for indigenous methods and customs (Techera, 2009).

The Government of Fiji, which is a signatory of the ' *Convention on Biodiversity* ' and the ‘*SPREP Convention of the Protection of the Natural Resources and Environment of the South Pacific Region'* has stipulatied a moratorium on the harvesting of turtles. However, existing legislation protects the rights of the native Fijians by permitting the harvesting of up to 5 turtles. Contrary to the law, some fishermen harvest large catches, totaling 79 turtles, stating they are unaware of these laws and their provisions. This practice of illegal harvesting has created conflicts between indigenous peoples, the conservation community, government agencies and citizens. This case has sparked a debate surrounding indigenous rights versus wildlife conservation (Maunders, 2007).

2.5.2.4 Access regimes and utilization rights of nature’s contributions

Rights based approach

Rights-based approaches (RBAs) to the conservation of biodiversity and ecosystems, are informed by the framework of international human rights law, and the values that underpin it. These have had a significant impact on the ways in which environment and development agencies operate. RBA’s emphasise the centrality of power relations, and the core principles of participation, accountability and non-discrimination.

The connection of, and access to, indigenous and local communities traditional lands can be expressed in term of their ‘customary rights’. Despite the fact that 65 per cent of the world’s land tenure is claimed to have customary use, indigenous peoples and local communities lack legal rights to (approx.) three quarters of this land. The failure to recognize these land rights hampers efforts to combat hunger and poverty, while causing social conflict, and undermining efforts to reduce environmental degradation, such as deforestation and the impacts of climate change (Rights and Resources Initiative, 2015).

[41] Office of Legal Affairs, *The First Global Integrated Marine Assessment: World Ocean Assessment 1*, (21 January 2016) Oceans and Law of the Sea: United Nations http://www.un.org/Depts/los/global_reporting/WOA_RPROC/WOACompilation.pdf 4.

Community based tenure

'Community-based tenure' refers to when the community holds the right to own or manage natural resources. The term 'regime' is applied to refer to the legal recognition expressed in a country's statutes. Thus, community-based tenure regimes represents a category that includes all situations where rights to own or manage terrestrial natural resources are held at the community level under statutory law, and refers to the area of land recognized by governments under community-based tenure regimes (Rights and Resources Initiative, 2015).

Approximately 40 million hectares of customary-held forest land in both India and Indonesia has not yet secured formal land recognition (Rights and Resources Initiative, 2014). Such lack of legal recognition of land rights makes indigenous people vulnerable to dispossession and loss of identity, livelihoods and culture. As governments issue concessions for: forestry, industrial, agriculture, large scale mining and oil and gas production, on community held lands, people may lose access and connections to lands often leading to conflict (UN Interagency Framework Team for Preventive Action, 2011). The contrary situation can occur where lands governed under community-based tenure systems often have well established local institutions and practices for the stewardship of land and resources, enabling the sustainability of large intact ecosystems including: tropical forests, rangelands and rotational agricultural systems (Wily, 2011). In return these ecosystems provide a foundation for health, livelihoods and food security for those who govern their lands through community-based tenure (Kothari *et al.*, 2012).

Box 2.14 Threats to access to land and local communities ('Land Grabbing')

In some areas, access to land by local communities is at risk as a result of large- scale land acquisition by foreign countries or corporate entities (sometimes called 'land grabbing') has dramatically increased since 2005 (Anseeuw *et al.*, 2012). Although data about transnational land deals are scarce and difficult to access (Messerli *et al.,* 2014), the assessment by Rulli *et al.* (2013) reports that it is a global phenomenon, and Asia accounts for 33 per cent of the global large scale land acquisition (following Africa at 47 per cent). Purchase of land also involves freshwater resources (Rulli *et al.*, 2013). Foreign investment may provide opportunities for economic growth for local communities, including the creation of employment opportunities and the transfer of technology (FAO, 2009). However dispossession, or reduction of farmland and forests, have negatively affected the livelihoods of local farmers who may be dependent on them for income generation and subsistence living (Jiao *et al.*, 2015; Suhardiman *et al.*, 2015).

There are growing trends of implementing economic incentive-based policies to protect natural resources (such as carbon, water, and biodiversity), such as through PES or REDD programs. Challenges of implementing them are partly due to poorly defined or weak property rights. Tenure security is necessary to prevent deforestation through market-based mechanisms, however this approach in isolation, does not necessarily protect forests (Robinson *et al.*, 2014).

On a global scale, Asia has the largest total proportion of land formally owned or controlled by indigenous peoples and local communities (26 per cent). However, China makes up the vast majority of the Asia results. With China excluded, the total for the rest of Asia, is less than 1 per cent ownership and 6 per cent control (Rights and Resources Initiative, 2015). Across these countries, Cambodia, China, India, Indonesia, Kazakhstan, Kyrgyz Republic, Lao PDR, Myanmar, Nepal, Philippines, Tajikistan, Thailand, Timor-Leste, Turkmenistan, and Uzbekistan, indigenous peoples and local communities own 23 per cent of the total land area, with 3 per cent designated for community use.

China comprises 44 per cent of the land area of the Asian countries, while contributing 87 per cent of the total area owned or controlled by communities across the region. However in India, Indonesia, the

Lao Peoples Democratic Republic, Myanmar, Tajikistan, Thailand, Timor-Leste, and Uzbekistan less than1 per cent of the countries' area is owned or controlled by communities in the region. Kyrgyzstan, Nepal, the Philippines, and Turkmenistan have more than 10 per cent of their land under community ownership or control (Rights and Resources Initiative, 2015).

In many of the countries of Asia, women, indigenous peoples, lower castes, and ethnic minorities lack adequate representation or the opportunity for participation in local or national institutions. These groups of people, who are often forest dependent communities, require a stronger voice in the governance of the land to which their lives and well-being are critically tied (State of the Tropics, 2014).

Customary rights to land and natural resources are increasingly being recognized under statutory law in some countries. For example, in the Philippines, the 1997 *Indigenous Peoples Rights Act* recognizes indigenous ownership and control of ancestral domains. Exploitation or development by non members requires approval from indigenous peoples (Borrini-feyerabend, 2014; Walpole & Annawi, 2011). In India, the *Scheduled Tribes and Other Traditional Forest Dwellers Act 2006* (Recognition of Forest Rights) recognizes various forest rights of tribal communities who have been residing in forests for generations, but whose rights could not be recorded. The rights vested to them include rights to: hold and live in the forest; use, conserve and protect it, get rehabilitated in the case of illegal eviction or forced displacement; receive basic amenities subject to the restrictions imposed to the forests (Perera, 2009). There has been criticism on its implementation in protected areas, because while *the Act* empowers communities to protect forests and biodiversity, it can also cause fragmentation of forests, if rights to land and development facilities are claimed in deep forest areas (Kothari *et al.*, 2011). *The Act* , together with, the provisions of the *Wildlife Protection Act*, as amended in 2006, provides financial assistance for the voluntary relocation of tribes, and in some cases, can provide positive impacts on conservation.

Box 2.15 Data on forest ownership

FAO's Global Forest Resources Assessment (2015a), provides data on forest ownership in most countries and territories (representing more than 70 per cent in number of countries and territories; 99 per cent in forest area). In the Asia-Pacific in total, more than 70 per cent of the forest is under public ownership. South-East Asia and South Asia shows higher public ownership (91 per cent and 88 per cent, respectively) whereas East Asia and Oceania has lower public ownership (58 per cent and 56 per cent, respectively).

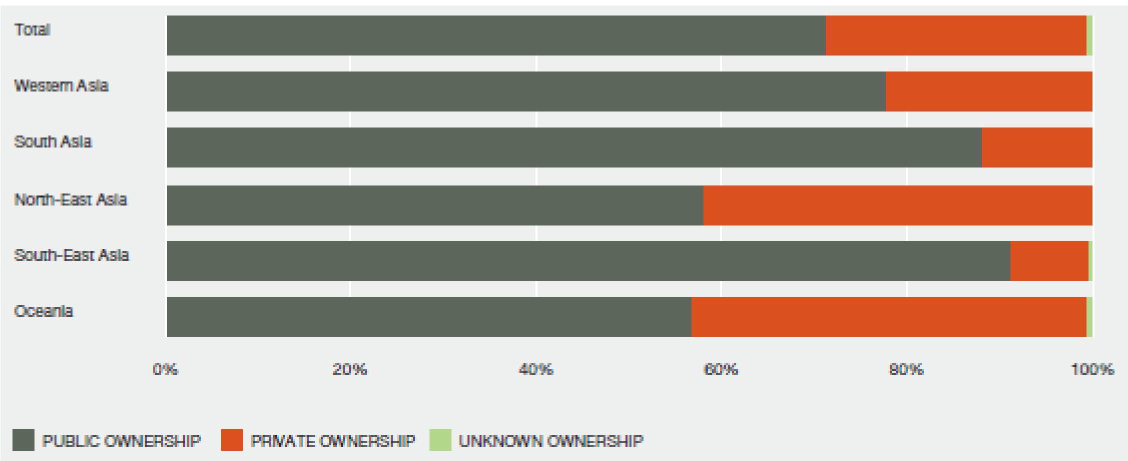

Figure 2.36 Forest ownership by subregion in 2010. Source: FAO Global Forest Resources Assessment (2015a).

Marine rights

In the marine environment, fishing activities, in many cases, are limited to those who hold fishing rights or licenses. From the perspective of marine resource conservation and economic efficiency, New Zealand and Australia have adapted Individual Transferable Quotas (ITQs) since 1980s. Under this mechanism, the government allocates quotas for designated fish species to individual licensed fishers. In the Pacific Island countries, maritime people held sea tenure rights before colonial intervention. Some countries like Samoa, Fiji, Palau, PNG, Solomon and Vanuatu recognize the indigenous tenure in their over sea space in their statutory law, despite the varying degree of protection of the rights by states.

The importance of community-based management is increasingly being recognized and revitalized in many areas of the Pacific Islands (Aswani, 2005; Jupiter *et al.*, 2014). In the Philippines, the rights of indigenous peoples to their ancestral domains, including waters, has been recognized through the *Indigenous Peoples Rights Act* (IPRA) and associated regulations since the end of 1990s (Capistrano & Charles, 2012). In Japan, fishing rights for coastal fisheries are given to the local Fishery Cooperative Associations (FCAs), which are composed of local fishermen in each coastal community that historically have depended on fisheries resources. FCAs establish operational regulations that stipulate restrictions such as, closures of the fishing ground on a seasonal or area basis (Makino & Matsuda, 2005).

2.5.2.5 Intra and inter-generational equity and fairness

According to Brown Weiss (1990, p. 10), “each generation has a right to receive the planet in no worse condition than that of previous generations, to inherit comparable diversity in natural and cultural resources, and to have equitable access to use and secure benefits from the planet”. Inter-generational equity was referred to in the influential 1987 United Nations report, *Our Common Future,* otherwise known as the Brundtland Report. This report defined the term ‘sustainable development’ as development that “meets the needs of the present without compromising the ability of future generations to meet their own needs” (World Commission on Environment and Development, 1987, p. 43). This definition clearly links the key aims of sustainable development to inter-generational equity.

Indigenous peoples and religious traditions have historically recognized the need for the protection of natural resources for future generations (K. J. Davies, 2012). For example: Pope Francis (2015) in his climate change-focused encyclical *On Care for our Common Home* wrote, “Once we start to think about the kind of world we are leaving to future generations, we look at things differently; we realize that the world is a gift which we have freely received and must share with others” (Pope Francis, 2015, p. 159).The Encyclical Letter “On Care for Our Common Home” (Pope Francis, 2015) addressed inter-generational equity and the loss of biodiversity. It argued for the importance of the option values of biodiversity: "The loss of forests and woodlands entails the loss of species which may constitute extremely important resources in the future, not only for food but also for curing disease and other uses. Different species contain genes, which could be key resources in years ahead for meeting human needs and regulating environmental problems” (Pope Francis, 2015, paras. 32, 33).

Young conservation leaders are well placed to help create change as they bring new values and ways of thinking that can influence significant debates of national or international importance (E. Ho *et al.*, 2015). The effective participation of youth at the Global Landscapes Forum affirmed that young people want to be listened to and taken seriously in matters that affect them (GLF, 2014).
Despite their input, however, there is still a risk that young leaders are increasingly feeling disenfranchised from decision-making processes (E. Ho *et al.*, 2015).

IUCN Resolution 4.098 (IUCN, 2008) on Intergenerational Partnership (IPS) provides an example of members of young professionals groups joining together with senior colleagues to form the IPS Task

Force (September 2011) to promote youth engagement and intergenerational partnership to deliver the IUCN's vision of a world that is just and one that conserves and values biodiversity.

Across the Asia-Pacific, legal systems are increasingly being challenged to address community concerns surrounding intergenerational equity, such as the following Philippines case study.

Box 2.16 Case study - intergenerational equity *Oposa v. Factoran*.

A group of 43 Filipino children in 1992, in their capacity as their own representatives and also for the future generations, filed a case against the Secretary of the Department of Environment and Natural Resources, Government of Philippines, to draw attention to the management of public forest land. As approximately, 100,000 hectares of national forest was being logged each year, the children sought to oppose further deforestation, on the grounds that continued logging would violate their right to live in a healthy environment under the Filipino Constitution, and that deforestation would cause irrevresible damage to themselves and to future generations. In the first instance, the case was turned down on the argument that the children, as petitioners, were not deemed to have the legal standing to sue in court. This ruling was overturned by the Philippines Supreme Court on the grounds of inter-generational responsibility and with regard to statistical evidence presented regarding the extent of forest cover necessary to maintain a healthy environment for present and future generations. Whilst the case was at appeal, a new law was passed by the Philippines Government to protect all remaining virgin forest within national protected areas (Oposa v. Factoran, 1994).

2.5.2.6 Citizen science and environmental volunteerism

Citizen science can also be understood as the citizen volunteers involved in environmental development and environmental protection (Wiggins & Crowston, 2011). There is evidence of citizen science growing in popularity across the Asia-Pacific. For example, citizen science has seen significant growth across New Zealand and Australia (Hin & Subramanium, 2014; Monica A. Peters, Eames, *et al.*, 2015). The advent of web communication tools, mobile apps and Smartphone technology has assisted citizen science activies. For example, in an Australian study, citizen scientists used technology to register photos and counts of Koala populations in local areas. Over 13,000 submissions were received from more than 1,000 people, representing a significant advance in knowledge regarding the Koala population (Williamson, 2012).

The Asia-Pacific, with up to 42 per cent of the population living in cities (United Nations, 2015c, p. 9), has promoted opportunities for environmental volunteerism amongst urban communities. Typically, these programs focus on promoting education about nature and how to care for it (Measham & Barnett, 2008). The need for the conservation and maintenance of surrounding ecosystems amongst urban communities tends to hold strong interest among residents, with the majority believing that the wildlife in local parks, bush lands and backyards should be strongly encouraged (Woolcott *et al.*, 2002). Grassroots activism is also adopted by volunteers as a means to raise the environmental awareness about urban environmental issues, such as: air, light and noise pollution (United Nations, 2015c).

Educating young people on sustainability and issues faced within ecosystems, as well as providing opportunities for them to apply their skills towards environmental volunteerism are some of the approaches that are being adapted in the Asia-Pacific (United Nations, 2014). Young volunteers are using their skills innovatively in raising environmental awareness and are performing different skill-based roles in areas such as: education, mapping and media outreach (United Nations, 2014).

Another major focus area for volunteers and NGO's, is the poverty faced in the region due to the lack of access to food, water and health care for some communities. The need for this support is predicted to escalate with the rising impacts of climate change on natural resources (United Nations, 2015b).

Box 2.17 Case Study - young people and the environment- Indonesia

A study conducted in eight secondary schools in Indonesia with over six hundred students, provides some understanding of the factors that influence young people's environmental attitudes and knowledge (Brikké, 2014). Based on the survey results, nearly 79 per cent of students claimed that they had sound knowledge of environmental concepts, especially those related to 'renewable energy' (Brikké, 2014). Over 67 per cent of students reported that school based activities, centred on the conservation and protection of the environment, and positively shaped their behavior towards caring for nature. The study also indicated that cultural influences impact the perspectives of young people towards the environment (Brikké, 2014).

2.5.2.7 Climate change and human rights

The historic *Paris Agreement* of 2015 has fundamentally transformed the role of developing countries in global climate governance. In response to this landmark Agreement, many countries in the Asia-Pacific, that still rely on fossil fuels, made clear articulation in their Nationally Determined Contributions (NDCs) to either undertake absolute emission reductions from business-as-usual levels (e.g. Bangladesh, Bhutan, Indonesia, Kazakhstan, Philippines, Tajikistan, Thailand, and Viet Nam), reduce emission intensity of growth (e.g. China, India, and Malaysia), increase the share of renewable energy in the energy mix (e.g. China, India, Lao PDR, and Papua New Guinea), or improve forest cover (e.g. Cambodia, Lao PDR, and Sri Lanka) are indicative of their resolve to reduce their national emissions .The Asia-Pacific is home to six of the top 10 emitters in the world - China, India, Russia, Japan, Indonesia and Iran – which account for about 43 per cent of global emissions. These countries have submitted Intended Nationally Determined Contributions to the *United Nations Framework Convention on Climate Change* for reductions of greenhouse gas (GHG) emissions (UNESCAP, n.d.).

Despite these conditional and unconditional commitments to address climate impacts, the long-term impacts of climate change are likely to be the most significant environmental legacy that would pass on to descendants (K. Davies, 2016). This is particularly applicable in the Asia-Pacific which includes some of the most vulnerable nations that are disproportionately impacted by climate change (Tubiello *et al.*, 2009).

Across the region, trends are emerging of crops failing, coral systems dying, species shifting geographically and seasonally, melting permafrost causing flood damage and the inundation of the sea, impacting the viability of coastal communities (IPCC, 2014). As a result species and sustainable livelihoods are vanishing. In addition to these trends, increases in the intensity and frequency of ecosystem disturbances (e.g. droughts, floods, windstorms, fires and pest outbreaks) are destabilizing states, contributing to conflicts and mass human migrations, such those of recent times in Syria (Kelley *et al.*, 2015). Climate change is a 'threat multiplier' that can catalyse conflict and threatening peace and security.

Agriculture is increasingly being threatened across the Asia-Pacific, by desertification, such as experienced by China. While rising sea levels threaten the low-lying delta states, such as Bangladesh and Vietnam (Collectif Argos., 2010). The most vulnerable and exposed populations include those in low-lying island nations such as, the Maldives and Tuvalu (Collectif Argos., 2010).

Of more recent times, intra and intergenerational equity have been framed in the context of human rights and climate change, such exemplified by the 2016, *Declaration on Human Rights and Climate Change* (K. Davies, 2016).

Additionally, the rapidly changing international and domestic legal landscapes are facing the challenges of how to hold major GHG emitters responsible and accountable for the damages that have been caused. For example, in 2015, the Philippines Commission on Human Rights announced an investigation, which could hold fossil fuel companies responsible for the impacts of climate change and ocean acidification (Forum on Human Rights and Climate Change, 2015).

Coupled with these discussions have been the rights, including the legal standing, of nature. For example, in 2014 the former National Park, TeUrewera, in New Zealand, gained status as a legal entity with "all the rights, powers, duties and liabilities of a legal person" (*TeUrewera Act*, 27 July 2014, New Zealand Public Act, No 51) when the *TeUrewera Act* was passed.

2.5.2.8 Equity in access to, and utilization of, nature's contributions

A key approach to conserving biodiversity has been the establishment of 'protected areas'. To minimize human use, or at least reduce it significantly, an exclusionary approach has often been employed, typically involving the forced removal of people, or a significant reduction of their livelihood activities in an area. Although this approach has provided biodiversity gains in certain locations, it has imposed severe hardships on local communities through physical, economic, and cultural displacement, often leading to conflict (Lele *et al.*, 2010). Different approaches have begun to be adopted over recent decades, including community- based conservation.

In Asian countries that were colonised, the state-dominated systems of natural resource exploitation established during this period, and the forest concessions that followed after countries' independence, deprived indigenous peoples and local communities from accessing resources that underpinned their livelihoods. Governments began to recognize, around the 1970s, the necessity to involve local communities in forest management in order to reduce social unrest and enhance sustainable management (R. Fisher *et al.*, 2007). For example, a participatory approach to forest management (known as joint forest management) has been employed in India since 1990, based on earlier experiments at Arabari and Sukhomajiri (Ravindranath & Sudha, 2004). The broad emphasis of joint forest management involves village communities in protecting and managing forests, and regenerating degraded forests, while ensuring a share of livelihood benefits from their use of forest resources. This approach has spread rapidly in India and has had some successes in meeting both its environmental and economic objectives, although outcomes have been mixed (Bhattacharya *et al.*, 2010; Ravindranath & Sudha, 2004).

The Philippines has allocated 37 per cent of its total forest land area for community forest management (CFM), whereas Nepal has allocated 30 per cent, and India has allocated 28 per cent of its forests (Ibarra Gené *et al.*, 2012). However it should to be noted, that in countries such as, the Philippines and Cambodia, and presumably Indonesia, forest resources had tended to be in severely degraded condition before becoming become managed under the CFM scheme (Ibarra Gené *et al.*, 2012; Sunderlin, 2006). Conditions regarding the operation of CFM's vary, depending on countries. For example, complicated administrative procedures, higher limitations on the amount of resources allowed for commercial use, unfair distributions affected by caste, gender, and religion, have been observed in some countries in South East Asia (Ibarra Gené *et al.*, 2012).

Equitable access to, and sharing of, the benefits from use of genetic resources is another area where policy frameworks in the region have developed. The *Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization* is an international agreement adopted by the Conference of the Parties to the *Convention on Biological Diversity* (CBD) at its tenth meeting in 2010, and entered into force on 12 October 2014. It aims at sharing the benefits arising from the utilization of genetic resources in a fair and equitable way, ensuring that access to such resources is only gained after the granting of prior informed consent by indigenous and local communities and sovereign states.

100 Parties have ratified the *Nagoya Protocol* (as of August 31 2017), 24 of these Parties are from the Asia-Pacific, with seven more having signed but not yet ratified (CBD, 2017). Regionally the Association of Southeast Asian Nations (ASEAN) has developed a Draft Framework Agreement on the Protocol. Countries within the Asia-Pacific with legislation in place pertaining to the Protocol are: India, Bhutan, Philippines, Malaysia, Australia and Afghanistan, while China, Indonesia, Thailand, Bangladesh and Nepal have developed other initiatives (Medaglia *et al.*, 2014).

2.5.3 Other issues

2.5.3.1 Technology transfer

Developing, demonstrating, deploying, and diffusing environmentally sound technologies (ESTs) are critical activities on a path towards an effective global response to environmental challenges (GEF, 2010). The *Convention on Biological Diversity* represents a major global initiative, as it provides a broad framework for technology transfer. The requirements of the CBD on technology transfer, as laid down in key international policy documents such as: the *Rio Declaration on Environment and Development*, *Agenda 21*, and the *Johannesburg Plan of Implementation of the World Summit on Sustainable Development* (WSSD), reflect the overall agreement of the international community that developing, transfering, adaptating and diffusing technology. This is particularly relevant to the application of environmentally sound technology and biotechnology, and capacity building, which is critical for achieving sustainable development (CBD, 2006, 2007; IGES, 2012; Pisupati & Rubian, 2008; UNEP-WCMC, 2009). The right to use and transfer of technology among contracting Parties is essential for achieving the objectives of the CBD. Contracting Parties agree to provide and/or facilitate access for and transfer of technologies that relate to the conservation and sustainable use of biological diversity ,or make use of genetic resources, and do not cause significant environmental damage to other Contracting Parties.

Although, many significant efforts have been made towards developing global guidance on how to best implement technology transfer under the CBD, Parties continue to face major challenges and hurdles in adopting the technologies. It is relevant to appreciate that the concept of technology as used under the Convention covers both ‘soft’ and ‘hard’ technologies. While ‘soft technology’ refers to technological information and related know-how, ‘hard technology’ includes hardware and machinery. Soft technology is often adopted in the form of collaborative research and innovation, training and capacity building. Technologies relevant to the CBD include both modern technologies and also those developed and adopted by indigenous and local communities (UNEP, 2010).

The *Bali Strategic Plan for Technical Support and Capacity Building* was adopted by the UNEP in 2005. The guidelines are intended to assist governments in the adoption of specific intellectual property rights and related mechanisms, such as joint patents with stakeholders in the countries of origin of the genetic resources, as well as joint research programmes with institutions in such countries. Options such as ‘shared technology packages’ and ‘Patent Pools’ could be helpful in promoting better transfer of technologies. The Biodiversity Indicators Partnership (BIP) project demonstrates that most countries face serious challenges in clearly defining and reporting on technology transfer and cooperation. *Target on Technology Transfer and Cooperation by 2020*, is another mechanism developed to secure technology transfer and cooperation under the CBD and is fully operational, as reflected in the increased flow of technologies between Parties.

The Union for Ethical Biotrade (UEBT) launched the 8th Biodiversity Barometer on 26 May 2016. The UEBT Biodiversity Barometer provides insights on evolving biodiversity awareness among consumers and how the beauty and food industries report on biodiversity. It contributes to measuring the first of the CBD Aichi Targets: Awareness of biodiversity values. In 2015, research for the UEBT Biodiversity Barometer was conducted in nine countries (including India in Asia) to measure trends in biodiversity awareness (Union for Ethical BioTrade, 2016). Eight years of research, among 54,000 people, and hundreds of leading companies, has provided several valuable insights that may guide companies and governments in their future approaches towards people and biodiversity. Some other partnerships for Technology Transfer and Cooperation are: Global Alliance on Vaccine and Immunisation; CGIAR (Consultative Group on International Agricultural Research); UNDP-GEF (Technology Transfer Network); WBCSD (World Business Council on Sustainable Development) (ITPGRFA, 2013).

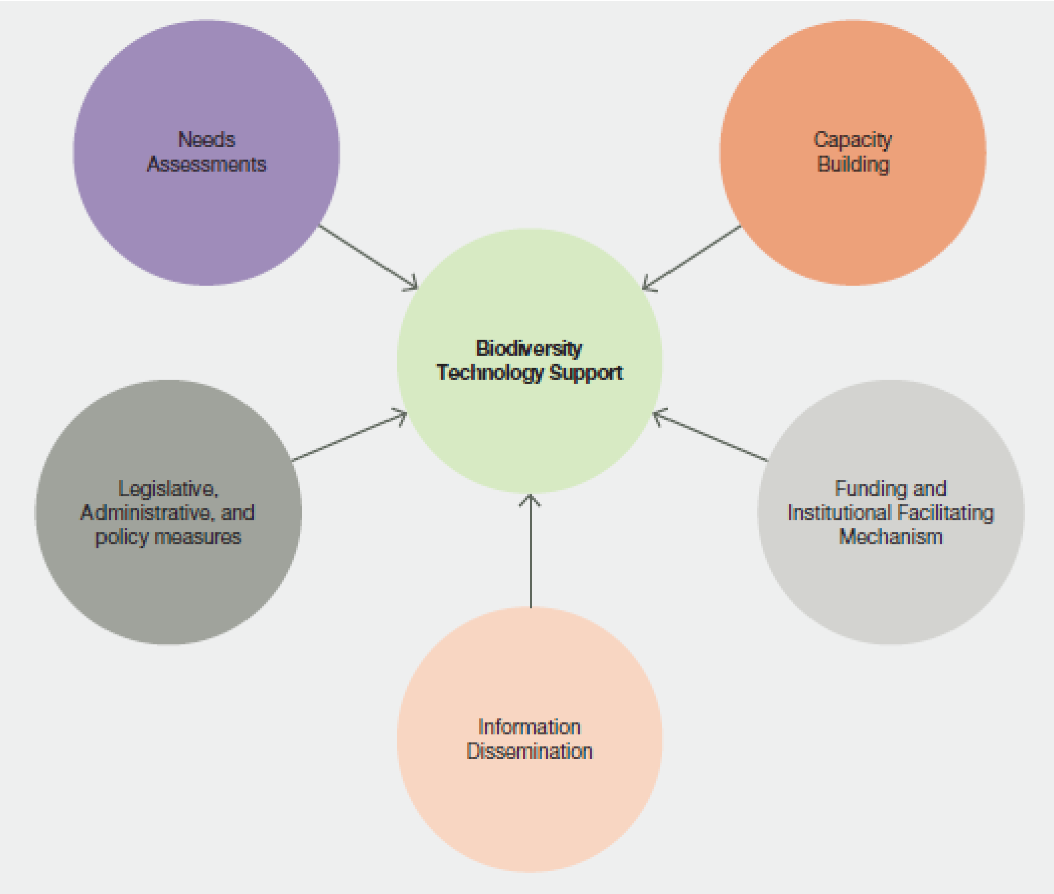

Figure 2.37 Enabling environments needed for both providers and receivers of technologies, including facilitating mechanisms to deal with challenges. Source: UNEP (2010).

2.5.3.2 Innovative practices

Innovations in governance are important for overcoming some of the deficits that impede the delivery of biodiversity conservation and ecosystem services, such as food provisioning. Problems include: institutional fragmentation and inflexibility, social-ecological system decoupling, power and knowledge asymmetries, burdensome decision-making processes, cross-scale mismatches and the relatively low position of biodiversity and ecosystem services conservation compared to economic development in the hierarchy of policy goals (Cash *et al.*, 2006; Cid Aguayo & Latta, 2015; R. Hill, Halamish, *et al.*, 2013; R. Hill *et al.*, 2015; Nuno & Bunnefeld, 2014; Pereira & Ruysenaar, 2012).

In the Asia-Pacific, there are thousands of small and large sites where biodiversity and ecosystem services have been conserved through community actions deeply interlinked with local culture, lifestyles and needs (Kothari *et al.*, 2012). Innovations often arise at the intersection of traditional forms of governance with both colonial and post-colonial institutions, and are now being recognised as a global phenomenon termed, Indigenous and Community Conserved Areas (ICCAs). In Iran, for example, the Indigenous Nomadic Tribes have systems of natural resource management based on nomadic pastoralism that dates back 10,000-12,000 years. These systems, which have been suppressed by many governments over decades, are now undergoing rejuvenation through an innovative mechanism that involves recognition by a hierarchy of structures ranging from local through to global institutions. These include: Community Declarations of their own ICCAs supported by the national non-government organization; the Union of the Indigenous Nomadic Tribes of Iran, a National Multi-Stakeholder ICCA Support Council; and linkages to a global ICCA monitoring mechanism through the World Conservation Monitoring Centre (Naqizdeh *et al.*, 2012). This innovative mechanism helps to overcome scale mismatches as well as the power asymmetries between nomadic and sedentary peoples.

In Australia, Indigenous Protected Areas (IPA) are part of the Australian Government's National Reserve System. These have distinctive socio-cultural and political characteristics, as indigenous people are the primary decision makers and drivers of knowledge integration (J. Davies *et al.*, 2013). Innovations evident in Indigenous Protected Area management plans include: (1) a focus on customary institutions in governance; (2) strategic planning approaches that respond to inter-linkages of stewardship between people, place and nature; (3) planning frameworks that bridge scales by considering values and issues across the whole territory; and (4) varied communication modes, appropriate to audiences, including an emphasis on visual and spatial modes (J. Davies *et al.*, 2013).

Indigenous Australian land management

Indigenous Australian land management is an integral part of the lives of communities in ensuring that the land is protected for future generations. Land and sea management play an important role in ensuring the biodiversity of ecosystems is sustained for future use, and it draws on ancient knowledge systems that continue to be actively transferred from generation to generation.

Across Australia, land management practices are highly diverse and include the management of: natural resources, fire, endangered species, and water (R. Hill, Pert, *et al.*, 2013).

For example, in the Northern Territory, Indigenous Australians use fire management as an economically and ecologically sustainable approach to long-term fire management in areas that are: remote, rugged, vast and biologically diverse, with high risk of fire damage (Yibarbuk *et al.*, 2002).

Through burning, Indigenous Australian communities are able to "encourage the re-sprouting of perennial grass, *angolde,* or 'green pick', and to attract male and female wallabies" (Russell-Smith *et al.*, 1997). Through frequent, strategically planned low intensity burns; the risk of permanent damage to the ecosystems and land is decreased substantially (M. G. Turner *et al.*, 1993; Yibarbuk *et al.*, 2002).

Figure 2.38 Map of Arnhem Land, Australia
Note: Located in the Northern Territory of Australia, Arnhem Land is entirely owned by indigenous people from a range of language groups, and is largely managed to support a traditional subsistence economy. Source: National Museum of Australia.

Located in the Northern Territory, Arnhem Land, spanning across 97,000 km², has been occupied by indigenous Australians, for more than 60,000 years (Zander *et al.*, 2014). In this region, indigenous land management practice is a vital part in ensuring that the ecosystems benefits are preserved and protected. Indigenous Australians have an intergrated and spititual understanding of people- nature relationships (Grieves, 2009).

The *West Arnhem Fire Management Agreement* (WAFMA) was developed in 2006, by the traditional owners, the Northern Territory Government and the Northern Land Council, Topical Savannas Cooperative Research Centre and ConocoPhillips. This agreement was created to offset some of the greenhouse gas emissions generated at ConocoPhillips' liquefied natural gas plant in Darwin Harbour (North Australian Land and Sea Management Alliance, 2012). West Arnhem Land Fire Abatement project (WALFA), established in 1997, "represents an important new way in that skilled indigenous fire managers in Australia's fire-prone tropical savannas can work with the broader community", ensuring that the land is protected from damage due to fires across 28,000km^2 of Western Arnhem Land (Tropical Savannas CRC, n.d.).

The WALFA is a fire management initiative that produces tradable carbon offset though the application of improved fire management ,and has the potential to deliver environment, economic, social and cultural outcomes (Australian Human Rights Commission, 2007). Through this project, Indigenous Australians are working with local initiatives and government agencies in improving the sustainability and preservation of their land. In the Northern Territory, they protect their land, based on customary and traditional laws, and ensure that the practices they undertake are culturally appropriate.

2.5.3.3 Multilateral agreements and engagements

Multilateral environmental agreements (MEAs), together with efforts to achieve sustainable development at the national level, formulate a comprehensive global environmental governance system. Presently, over 500 MEAs exist. Among them, more than 155 are biodiversity related instruments. Biodiversity MEAs can be implemented in an increasingly coherent manner with greater cooperation and collaboration among parties, secretariats and partners for more efficiency and effectiveness. Increased cooperation and collaboration in the implementation of biodiversity MEAs at all levels facilitates engagement with other sectors leading to improved opportunities for mainstreaming biodiversity objectives into other policies and sectors (Cowie *et al.*, 2007; UNEP, 2016). These MEAs will however not make a substantial difference without equipping both existing and new environment and sustainable development institutions with strong accountability mechanisms.

The region has also seen an increase in regional and bilateral environmental agreements such as: the *1986 Convention for the Protection of the Natural Resources and Environment of the South Pacific Region* (Noumea Convention), the *1995 Agreement on Cooperation for the Sustainable Development of the Mekong River Basin*, the *Ganges River Basin Water Sharing Agreement* between India and Bangladesh (1977 and 1996), and the *Association of Southeast Asian Nations (ASEAN) Agreement on Transboundary Haze Pollution*. In addition, individual countries have adopted successful policies, either as a response to the changing landscape of global and regional agreements, or developed domestically from global or regional agreements. Examples include, the Green Development/Growth Policies in Cambodia.

Seven international conventions that specially focus on biodiversity issues include: the *Convention on Biological Diversity* (year of entry into force: 1993), the *Convention on Conservation of Migratory Species* (1983), the *Convention on International Trade in Endangered Species of Wild Fauna and Flora* (1975), the *International Treaty on Plant Genetic Resources for Food and Agriculture* (2004), the *Ramsar Convention on Wetlands* (1971), the *World Heritage Convention* (1972) and *the International Plant Protection Convention* (1952). Each of the biodiversity-related conventions works to implement actions at the national, regional and international level in order to reach shared goals of conservation and sustainable use. In meeting their objectives, the conventions have developed a number of complementary approaches (site, species, genetic resources and/or ecosystem-based) and operational tools (e.g.programmes of work, trade permits and certificates, multilateral system for access and benefit-sharing, regional agreements, site listings, funds) (CBD, 2015).

In the Asia-Pacific, UNEP works with intergovernmental bodies, environment ministries, research organizations, international bodies, UN agencies and major groups and stakeholders to identify and address common and emerging environmental issues. UNEP assists governments by providing information and technical expertise for environment management and decision-making, enhancing regional environmental governance and cooperation, strengthening national and regional environmental law, advancing national and regional implementation of internationally agreed environmental goals under MEAs, and bridging major groups and governments in policy development and implementation processes. To do this, UNEP mainstreams the environment through regional forums, including: advancing environmental law and MEA implementation; integrating the environment in national UN planning processes and engaging with major groups and stakeholders.

At the Sustainable Development Summit (2015), UN Member States adopted the 2030 Agenda for Sustainable Development, which includes 17 Sustainable Development Goals (SDGs) to end poverty, fight inequality and injustice, and tackle climate change by 2030.

The ASEAN Centre for Biodiversity (ACB) was established in 2005 to **s**upport member governments in the following areas: agriculture and food security; access to, and fair and equitable sharing of benefits from biological and genetic resources; climate change and biodiversity conservation; ecotourism and biodiversity conservation; payment for ecosystems services scheme and valuation of biodiversity; wildlife enforcement; managing invasive alien species; peat land management and biodiversity; managing biodiversity information and knowledge and support to Global Taxonomic Initiative and Programme of Work on Protected Areas. These areas have been identified in the various global biodiversity related agreements such as the CBD, CITES, *Ramsar Convention* and the *Cartagena Protocol on Biosafety* (ASEAN, 2015).

2.5.3.4 New and emerging issues and opportunities

The increasing pressures of climate variability and change pose emerging threats to the region and its people, thus adding a new level of vulnerability. Counties where livelihoods of rural populations are primarily dependent on natural resources are more vulnerable (Agrawal & Perrin, 2008). Local adaptation measures are crucial for reducing these vulnerabilities (Tompkins & Adger, 2004). Local adaptation practices mostly related to: crop diversification, irrigation, water management, disaster risk management and providing insurance (IPCC, 2007). Emerging evidence indicates that adaptation strategies for the poor in developing countries are highly varied and local- level studies are needed for development policies to be effective (IPCC, 2007).

One of the recent trends to address poverty and climate vulnerability is migration. Migration trends in the Asia-Pacific are particularly high (G. Hugo, 2005; International Organization for Migration, 2015). Countries have also started to build institutional resilience by establishing organizations that are dedicated to responding to climate change issues. They often promote community resilience by enhancing local ownership, building capacity, and by creating networks that help people learn and adapt to climate change (Bahinipati & Venkatachalam, 2015). National policies, in particular, influence local adaptive capacity and the mainstreaming of adaptation into wider national development agendas (Huq *et al.*, 2003; Mitchell & Tanner, 2006). Among many, ecosystem-based adaptation is an emerging approach that recognizes the importance of ecosystem services in reducing vulnerability of people to the impacts of climate change (CBD, 2009; W. R. Turner *et al.*, 2009; World Bank, 2009). The main objectives are to promote societal resilience through the management and conservation of ecosystems (Pérez *et al.*, 2010). Examples include: the restoration of mangroves for protecting coastal settlements against storm surges; the conservation of upstream forests to regulate water flow and control erosion for the benefit of vulnerable communities; and sustainable forest management for the provision of safety nets to livelihoods (CBD, 2009). It is also important to recognise that the resource dependent communities, historically, have managed weather-dependent natural resources such as: forestry, fish stocks, livestock and water resources, experiencing collective adaptation practices (Adger, 2006; Agrawal, 2001; K. S. Alexander *et al.*, 2012).

Since its inception in 2010, by the Government of Japan, several Satoyama conservation initiatives were launched in various parts of Japan, promoting the preservation of nature and cultural landscapes of people (Kazuhiko Takeuchi, 2003).The use of ecosystem-based adaptation practices in agriculture also offers an important opportunity to help smallholder farmers adapt to climate change, while providing important livelihoods and environmental co-benefits. Similarly, Satoumi conservation initiatives focus on the conservation and sustainable use measures as applied to marine ecosystems located near densely populated coastal areas. These include: the conservation, and restoration of seagrass beds, tidal lands and coral reefs; measures for reducing water pollution in semi-enclosed seas; and sustainable resource management and livelihood enhancement (United Nations University Institute of Advanced Studies Operating Unit Ishikawa/Kanazawa, 2011).

Conservation conflicts have fueled long-standing debates between sociologists and conservation biologists (Wilkie *et al.*, 2006). Biodiversity conservation efforts often fail because of inadequate compensation for the costs of conservation to the local people. Governments must balance development and conservation, and facilitate interdisciplinary projects to conserve nature and alleviate poverty (Kolahi, 2013; Sodhi *et al.*, 2006). The failure of governments and institutions to address environmental degradation, BES loss and social injustices exacerbates conservation conflicts (Sodhi & Brook, 2006). Such conflicts have negative impacts on biodiversity, human livelihoods, and human well-being (Kolahi, 2014; Redpath *et al.*, 2013).

Weak governance has also been recognised as one of major politico-economic drivers, that has significant impact (Balmford *et al.*, 2002) lacking the capacity to alleviate social and environmental problems (Kolahi, Sakai, *et al.*, 2014). Furthermore, many conservation efforts have been implemented without proper community consultation. In cases pertaining to rights to customary lands and livelihoods, sometimes open confrontation with conservation authorities, even resulting in fatalities have occurred (Balmford & Bond, 2005; Borchers, 2005; Geist & Lambin, 2002; Kolahi *et al.*, 2012, 2013; Kolahi, Moriya, *et al.*, 2014; Lane, 2003; Şekercioğlu *et al.*, 2011; Sodhi *et al.*, 2006; Sodhi & Brook, 2006; West *et al.*, 2006; Yang *et al.*, 2015). Conflict-sensitive approaches to conservation are beginning to provide an array of tools to help work with these situations. A starting point is the recognition that conservation efforts can contribute to conflict and can also help to address conflict (Hammill, 2009). Tools such as, 'the conflict tree' and 'the conflict map' can underpin the analysis of problems and provide the basis for implementing conflict-sensitive approaches (Ioja *et al.*, 2016).

Intellectual convergences, such as integrating indigenous conservation regimes and local knowledge into conservation planning, are urgently needed. These require intergration in to policies to improve resource governance and for promoting collaboration amongst: conservation biologists, social scientists, government agencies, environmental and human-rights lawyers, local NGOs, business interests, and civil society (Sodhi *et al.*, 2006).

Creative interdisciplinary efforts can provide well-grounded approaches for improving governance (Kolahi, 2015). Four main governance types for nature conservation include: governance by government (at all levels); by rights holders and stakeholders together (shared governance); by private individuals and organizations (usually the landholders); and by indigenous peoples and/or local communities (Grazia Borrini-Feyerabend *et al.*, 2012). Stronger links among biological, social, and governance issues will result in the further conservation of biodiversity and improvement of human well-being (Kolahi *et al.*, 2013; Kolahi, Sakai, *et al.*, 2014).

2.6 Conclusion

The Asia-Pacific upholds long term distinctive knowledge and cultural values and practices that are derived from nature. These close human- nature relationships can be observed, particularly in areas that have been inhabited by indigenous peoples and local communities, over time. These systems and practices can provide the foundation of biodiversity and ecosystem resource management strategies that support a good quality of life for the regional community.

This chapter has reflected on the two boxes "Nature's contributions to people" and "Good quality of life" of the Conceptual Framework adopted by IPBES and the fluxes between these two boxes as relevant in the context of the region. The contributions of nature to the people of the Asia-Pacific have been investigated, including the interrelationships between biodiversity, ecosystem functions, services and societal well-being in changing economic scenarios. Economic and population growth, together with changing values, migration and technological capacity have all influenced human-nature relationships. Consequently, the region has experienced declining trends in the contributions of nature to people. This is partly due to the unequal distribution and access of some communities to natural resources. The consequence of these increased demands for natural resources, are the environmental threats, including global warming, that is threatening the sustainability of the marine, coastal and terrestrial ecosystems of the region.

2.6.1 Key findings: nature's contributions to people and quality of life

People across the Asia-Pacific depend on nature's contributions to support their livelihoods, including their social and cultural needs. The material contributions of nature include: food, water, shelter, energy, genetic resources and other materials derived from ecosystems (Asian Development Bank, 2013b; FAO, 2015a, 2016a)(Figures 2.2-21). There is geographic heterogeneity in the use and dependency on nature's contributions to people which varies between, and within, countries (Figure 2.3). Ecosystems support the livelihoods of people, including providing opportunities for recreation, cultural and spiritual fulfilment (Díaz, Demissew, Joly, *et al.*, 2015; FAO, 2016b; Koo *et al.*, 2015). The material benefits from nature establish the close link between people, ecosystems and biodiversity. Some rural populations across the region, particularly those living in developing countries, are highly dependent on the use of nature for subsistence income and energy needs e.g. forest enterprises, woodcutting, honey collection, and fuelwood collection (Figures 2.2-21).

The declining status and trends of nature's provisioning goods and services threaten the sustainable livelihoods of future generations across the Asia-Pacific**.** These trends are driven by factors such as: environmental degradation, migration (Shah, 2005; UNESCAP, 2014; United Nations, 2016a), changing values, inadequate laws, policy and governance (Greiber & Schiele, 2011), conflicts, rapid population growth (United Nations, 2015c), urbanization (UN-Habitat & UNESCAP, 2015; World Bank, 2015), pollution (United Nations, 2015b, 2016a) and the impacts of climate change (IPCC, 2014). Significant and persistent barriers exist in terms of protecting nature to sustain future generations. Simultaneously, there is an increasing trend to address these issues through: legal, policy and management responses surrounding intra and inter-generational equity and justice, all of which aim to secure and protect the environmental rights of future generations (Hsu *et al.*, 2014; Larkin, 2016; WRI, 2015).

Subregional institutional initiatives have resulted in opportunities for managing transboundary ecosystems and sustaining, or improving, the flow of ecosystem services. Some of these initiatives include: reducing climate change induced vulnerabilities, improving adaptation capacities, and promoting green growth and inclusive development (G. C. Daily, 1997a, 1997b; Gautam *et al.*, 2004; López-Hoffman *et al.*, 2009; Millennium Ecosystem Assessment, 2005). Persistent regional transboundary issues require urgent solutions, such as haze pollution, largely attributable to forest fires that are having detrimental effects on human health (Othman *et al.*, 2014). Many ecosystem resources, such as water from transboundary river systems, are used and managed at multiple scales (local, national, and regional) and governed by diverse stakeholders. The increasing anthropogenic pressure on surface and groundwater for multiple human uses (agriculture, urban and industrial purposes) across national borders leads to persistent water insecurity in the region, particularly environmental water insecurity which is crucial for ecosystem functions (WHO, 2006). The transboundary landscape management approach makes it possible to address the conservation and sustainable use of natural resources (biodiversity, rangelands, farming systems, forests, wetlands, and watersheds) in landscapes defined by ecosystems rather than administrative boundaries (Yasmi *et al.*, 2010) . However, the value of nature's contributions to people from transboundary areas has not been optimally utilised by regional, national and sub-national governments.

The impacts of climate change and geo-political instability in some areas of the Asia- Pacific have led to large scale human migration, which has resulted in localised and transboundary pressures on nature to provide ecosystem goods and services to support these changes in population distributions. These pressures are predicted to escalate in the future. The region is predicted to experience some of the highest human impacts, globally, due to global warming. For example: There may be up to 150 million climate change refugees, this century, in the Asia-Pacific (Dunlop & Spratt, 2017). Mass migration has direct impacts on nature. For example, changes in land use and increased demand for provisioning services, such as food, water and materials (United Nations, 2016a). Protection, conservation, preservation and rehabilitation of transboundary conservation areas, in the context of increased migration and changes in settlement patterns, depend strongly on governance and initiatives involving multi-level institutions and stakeholders (Díaz, Demissew, Carabias, *et al.*, 2015).

The impacts of waste on terrestrial, freshwater and marine ecosystems are of significant concern for the current, and future, health of nature, and people, across the Asia-Pacific. Rapid population growth (United Nations, 2015c), changing values (Abasolo *et al.*, 2007, 2008; Bickerstaff, 2004; C. K. Chan & Yao, 2008; Clark *et al.*, 2014; State of the Tropics, 2014; Zheng *et al.*, 2008), shifting socio-economic status, technological and industrial capabilities and urbanization (United Nations, 2013, 2016a) trends across the region are some of the factors resulting in an increase in the consumption of natural resources and the production of waste. For example, quantities of household hazardous waste, e-waste and food waste are rising with the growth of urbanization across the Asia-Pacific An estimated 870 million tonnes of municipal solid waste was produced within the region in 2014, and is projected to increase to possibly 1.4 billion tonnes per year by 2030. Construction and demolition waste linked to rapid industrialisation and urbanization is also increasing. Of particular concern is plastic waste. For example, studies on plastic waste have found that eight of the top 10 rivers globally carrying the highest amounts of plastic waste are located in Asia (United Nations, 2016b). This waste accounts for 88 to 95 per cent of the total global load of plastics in the oceans. Water pollution, air pollution, soil contamination, and chemical waste pose ongoing threats to human and environmental health (Abasolo *et al.*, 2007, 2008; Bickerstaff, 2004; C. K. Chan & Yao, 2008; Clark *et al.*, 2014; State of the Tropics, 2014; Zheng *et al.*, 2008). The diverse values and value systems across the Asia-Pacific drive interactions between people and nature (Harvey, 2005; Pascual *et al.*, 2017; Stern, 2000; N. J. Turner *et al.*, 2000). Significant valuation data gaps exist. Based on the limited data available, ecosystem service values could drop by an estimated one-third by 2050 from their current value (Kubiszewski *et al.*, 2016). Across the Asia-Pacific, people value nature for its contributions to their spiritual, psychological, physical and economic well-being. Marine, freshwater and terrestrial ecosystems all support the livelihoods of the regional community through various ecosystem services (FAO, 2016b; United Nations, 1982). However, these contributions have been measured to differing extents in terms of their economic value (Díaz, Demissew, Carabias, *et al.*, 2015; Millennium Ecosystem Assessment, 2005; Pascual *et al.*, 2017). Economic valuation studies on tropical forests, tundra, and marine ecosystems are scarce in the Asia-Pacific, as were those from Western Asia. The following figure should be viewed with caution, due to the limited data available. According to accessible literature, nature's contributions to people in the region have been shown to have a high economic value**.** For example, for temperate, boreal forests and woodlands, median values identified for habitat creation and maintenance ($864 per hectare per year), carbon stores ($760 per hectare per year) and water reserves ($544 per hectare per year) were even higher than the median values identified for material provision ($434 per hectare per year) or for energy provision ($31 per hectare per year) (*2.3.3.4*). Wetlands including peat land, mires and bogs showed the highest median values for their water regulating services ($3,957 per hectare per year for regulating water flows, $6,485 per hectare per year for regulating water quality). The same results were seen for inland surface waters and water bodies ($4,371 per hectare per year for regulating water flows, $3,899 per hectare per year for regulating water quality). Furthermore, high economic values were also observed for physical and psychological experiences obtained from wetlands and inland surface waters (median values $1,506 per hectare per year and $1,047 per hectare per year, respectively). Overall, there is a downward trend in the economic value of ecosystem services in the region, which resembles the global trends of ecosystem depletion (Table 2.4).

The rich biodiversity of the region keeps options open for future benefits for people in the Asia-Pacific. The value of biodiversity is evidenced by recent scientific reports of unanticipated uses of a diversity of species in the region. However, there is predicted to be significant loss of these options, based on the expected loss of biodiversity**.** Measures of the maintenance of options draw upon effective measures of biodiversity, including phylogenetic diversity. The portion of imperilled phylogenetic diversity found within the Asia-Pacific is estimated as 38 per cent of the global imperilled phylogenetic diversity (Brooks *et al.*, 2016).

Although trends are improving, high levels of poverty persist in the region. The provisioning services of goods from sustainable ecosystems are essential to further reduce poverty (UNESCAP, 2015). The challenge is especially great in South Asian countries where more than 40 per cent of the world's poor live and some 51 per cent of the population is food-energy deficient (Ahmed *et al.*, 2007). However, 400 million of the world's 767 million poor people live in Asia and the Pacific (UNESCAP, 2017). Lifting people out of poverty requires multiple strategies, including the protection of managed ecosystems, such as agriculture, forests and aquaculture systems that remain the main livelihood sources in the region (FAO, 2016b). Unmodified terrestrial, freshwater and marine ecosystems also provide various goods, such as plants, animals, fish and fungi that people need in order to earn an income and secure sustainable livelihoods. Sustaining the viability of, and access to, these provisioning services, will assist in the alleviation of poverty (Bawa & Gadgil, 1997)

Participatory approaches, volunteer programs, indigenous and local knowledge, co-management, and technological solutions, for the management of natural resources have resulted in positive outcomes in the conservation of biodiversity and ecosystem services and enhanced benefits to people (Cinner & Huchery, 2014; DFRS, 2015; Maddugoda, 1991; Olsson *et al.*, 2007; Plummer, 2009). Many communities based participatory, and co-management systems across the region have benefitted through the support of government and non-government agencies. These often include the adoption of: science-based decision-making processes, technology, innovative tools, information sharing and capacity development (E. R. Alexander, 2006; Cronin & Pandya, 2009). Conversely the one size fits all policy and management approaches have led to failed or less successful outcomes. Knowledge, innovations and the practices of indigenous peoples and local communities have been especially useful for overcoming some of the governance deficits associated with the top-down approach, including adapting to the impacts of climate change. Important positive trends include increased volunteerism and citizen science activities (M. A. Peters *et al.*, 2015; Monica A. Peters, Hamilton, *et al.*, 2015).

The Asia-Pacific holds distinctive knowledge and cultural heritage values and practices that are in harmony with nature, particularly in areas that have been inhabited by indigenous peoples and local communities over long periods of time. These systems and practices can provide the foundation of biodiversity and ecosystem resource management strategies that support a good quality of life for some of the regional community (Berkes *et al.*, 2000) .Adopting indigenous and local knowledge and practices as a platform for management strategies accommodates the unique characteristics of local ecosystems and communities, which may lead to increased local ownership and engagement. Incorporating the values and beliefs of indigenous peoples is crucial to the understanding, knowing and being of place, people and spirit within complex natural and cultural landscapes while combining traditional practices with western understandings of landscapes (Ens *et al.*, 2015). Where indigenous peoples and local communities are engaged in the design and implementation of culturally appropriate, participatory, and cost-effective ecosystem resource management strategies there is a high likelihood of successful outcomes. For example, proven strategies for multiple species cropping, rotation and landscape management (K. Davies, 2015; Plummer, 2009; Republic of Vanuatu, 1980; Rights and Resources Initiative, 2015).

Exemplary models of legislation, policies and their implementation, exist in some nations across the Asia-Pacific region. However, gaps exist and in some cases, a lack of appropriate legislation, policy and practices is evident (Greiber & Schiele, 2011). These gaps are adversely affecting some citizens, with respect to their rights, including access to ecosystem services (Lewis, 2012). In addition inadequate governance mechanisms may limit community capacity to conserve nature (Campese *et al.*, 2009; K. Davies, 2016; Lewis, 2012)**.** In many Asia- Pacific countries, vulnerable people, such as: women, indigenous peoples, young people, the elderly and ethnic minorities, lack adequate representation or opportunities for their participation in local and national decision-making processes . These groups require a voice in the governance of nature which sustains their lives and well-being (K. Davies, 2016; GLF, 2014; E. Ho *et al.*, 2015; IUCN, 2008; Oposa v. Factoran, 1994; Rights and Resources Initiative, 2015). There is some evidence of this changing trend. For example, customary law and rights to land and natural resources are increasingly being recognised under statutory law. Additionally legislative and trends incorporating co-management approaches are becoming increasingly evident across the region (K. Davies, 2016; Olsson *et al.*, 2007).

2.6.2 Emerging issues and opportunities

Understanding of human dependence on nature is improving with rapid advancements in the science and economics of ecosystem services. Despite limited data, the valuations of ecosystem services in the Asia-Pacific were assessed in this chapter. These results support the declining trends of these services (Asian Development Bank, 2013a; FAO, 2016a, 2016b; Motaleb, 2010), highlighting the need to invest in their protection to ensure the ongoing: food, water, energy and general livelihood and health security for the regional community. This is important in terms of buffering people from poverty, particularly as they encounter the impacts of climate change. There is an urgent need to attain more comprehensive evidences pertaining to the values of ecosystems across the Asia-Pacific to enable future regional assessment that will support decision-making processes.

Nations across the Asia- Pacific have developed environmental legislation and policies to manage intensifying threats, in particular, those related to global warming (Li *et al.*, 2015). These include: transboundary arrangements, multilateral environment agreements and assessments. Opportunities are emerging for promoting increased national, regional and global cooperation (BOBLME, 2015; Medaglia *et al.*, 2014). These efforts are garnering the support of institutions to improve policies and practices, including valuing the benefits of ecosystems (Nature Conservancy, 2016). Transboundary opportunities are emerging, involving networking amongst countries, as evidenced by the establishment of several regional platforms for managing and protecting biodiversity, reducing climate change induced vulnerabilities and promoting green and sustainable growth (ASEAN Center for Biodiversity, 2014; G. C. Daily, 1997a, 1997b; He *et al.*, 2014; Healy, 2007; López-Hoffman *et al.*, 2009; Millennium Ecosystem Assessment, 2005). Additionally, regional cooperation is improving the capacity of organizations to interpret conditions, change, responses, and develop a stronger understanding of the causal relationships in the dynamics of social-ecological systems (International Land Conservation Network, 2016). However, due to resource constraints and pressures, policy priorities and activities differ significantly across the region. The Asia-Pacific would benefit from a cohesive legislative and policy framework, spanning international, regional and local jurisdictions, to protect sustainable ecosystems and the livelihoods of the regional community. This framework could be based on the Sustainable Development Goals which provide the global transformative agenda to reverse the trends of biodiversity loss and increase ecosystem benefits.

There is a growing trend to work closely with indigenous and local communities in the management of ecosystems (Baird & Dearden, 2003; Batang-ay, 2017; CTI-CFF, 2009; FAO, 2005a; GoN/MoFSC, 2014; Govan *et al.*, 2008; Pulhin *et al.*, 2006; United Nations, 2014, 2015a, p. 9). These communities are the local stewards of nature, thus their engagement is critical for the protection of ecosystems and biodiversity. Community engagement approaches include initiatives such as: citizen science, volunteerism and co-management (Dunning, 2014; Hin & Subramanium, 2014; Olsson *et al.*, 2004; Monica A. Peters, Eames, *et al.*, 2015; Wiggins & Crowston, 2011). The increased involvement and empowerment of indigenous and local communities in the management of ecosystems presents an important opportunity to enhance the ongoing care of nature across the Asia-Pacific.

With the Asia-Pacific emerging as a world power of economic growth (UNESCAP, 2014), greater levels of investment, including economic incentives, are required to sustain the regions ecological assets (FAO, 2009). To achieve this, a regional, economic investment and incentive strategy would provide financial resources to restore and conserve the health of ecosystems and biodiversity across the Asia-Pacific.

Technological solutions are increasingly assisting the reduction of the environmental impact of human activities on nature e.g. the uptake of solar energy and water saving technologies (Central Research Institute for Dryland Agriculture, n.d.; Larkin, 2016; UNEP, 2010; Williamson, 2012). Progressing and supporting technological advancements, aimed at minimizing ecological footprints, will assist innovative solutions to the protection of the Asia-Pacific's ecosystems.

2.6.3 Challenges and implications

Although, the Asia-Pacific region, with South Asia as an exception, has achieved the Millennium Development Goal (MDG) 1C hunger target of "halving, between 1990 and 2015 the proportion of people who suffer from hunger", over 20 per cent of the people still live in extreme poverty in a number of countries (UNESCAP, 2015), including those with large populations (e.g. Bangladesh, India and Pakistan) and those with smaller populations (e.g. Lao PDR and Nepal). As economies and populations grow, and the impacts of climate change become more pronounced (IPCC, 2014, p. 2), the demands from nature for: food, water and energy is likely to increase (Asian Development Bank, 2016; de Fraiture & Wichelns, 2010). These trends are likely to lead to a continuous decline in the quality of ecosystems and their capacity to provide for human well-being (Karabulut *et al.*, 2016; Runting *et al.*, 2017). The challenge exists as to how to reverse these trends and develop new and sustainable human- nature relationships.

The flow of benefits from nature is tied to ecosystem health and productivity, which can be jeopardised by the impacts of: climate change, natural disasters, and political and economic instability (Dunlop & Spratt, 2017). There are trade-offs and compromises vis-à-vis resource use and conservation (E. M. Bennett *et al.*, 2009). For example, the Asia-Pacific has the highest annual water withdrawal of the world's regions. This scale is attributed to the geographic size and population, coupled with extensive and intensive irrigation practices (Asian Development Bank, 2016). Water security in the region is greatly influenced by issues of: access to depletion and pollution of water (Asian Development Bank, 2013a), and migration and disaster (United Nations, 2016a, p. 8). These all pose challenges for food security, especially in South Asia (Ahmed *et al.*, 2007; CWC, 2010; Indian Central Pollution Control Board, 2009).

A significant challenge in managing ecosystems has been the mismatch between political boundaries and ecological systems. This is best exemplified in many trans-boundary situations where the 'downstream' communities, do not fall under the jurisdiction where 'upstream' governance and actions can influence (Millennium Ecosystem Assessment, 2005). The challenge remains regarding the establishment of appropriate governance regimes and institutions to protect ecosystems and their services. Greater levels of cooperation are required between the nations of the Asia-Pacific to improve environmental management to achieve objectives, such as the reduction of poverty and vulnerability.

The vulnerability of ecosystems has been influenced by the rapidly changing, human driven paradigm, occurring across the Asia-Pacific. This paradigm is being driven by factors such as: migration, shifting value systems, population growth, intergenerational change, and the economic and political 'landscape'. Additionally, the region is highly vulnerable to climate-related disasters, especially Small Island Developing States (UNDP, 2012). The implications of these disasters have most affected poor and vulnerable communities, who have least capacity to adapt to these changing conditions (Agrawal & Perrin, 2008). The escalating challenge is: how to ensure the protection and ongoing viability of sustainable ecosystems to provide for current and future generations of the Asia- Pacific community?

Across the Asia-Pacific, ecosystems support and enrich human lives. This chapter has merely touched upon some of the depth and breadth of the regions human- nature relationships. Its narratives celebrate the life sustaining basis of these symbiotic relationships and warn of the increasing threats. This chapter has described how people are not only the beneficiaries of nature's resources, they are also the stewards and decision makers of the management of the regions ecosystems. The 'life-blood' of the Asia-Pacific lies within its expansive rivers, soils, mountains, plains, birds, insects, animals, flowers, forests and its oceans, to name just a few. This 'life blood' sits in the hands and the hearts of the regional community, to ensure its future, sustainable health and viability.

2.7 References

Abasolo, E., Matsui, T., Saito, O., & Morioka, T. (2007). Evaluating the Ecosystem Services-related Quality of Life (E-QOL) of Students in the Urban Areas. *Environmental Systems Research, 35,* 517–526.

Abasolo, E., Saito, O., Matsui, T., & Morioka, T. (2008). Perception and attitude towards ecosystem services in the urban areas. *Sylvatrop, The Technical Journal of Philippine Ecosystem and Natural Resources*, *17*(1&2), 81–100.

Abe, H. (2010). Concept of "Kyosei" in Japan: an idea of "Kyosei" under the expansion of Buddhism in Japan. In *Research Institute for Humanity and Nature (ed.), Encyclopedia of Global Environmental Studies, Koubundou, Tokyo, (in Japanese).* (pp. p570-571).

Abumoghli, I. (2015). Water Security in the Arab World. Retrieved January 15, 2018, from http://www.ecomena.org/water-arab/

Adger, W. N. (2006). Vulnerability. *Global Environmental Change*, *16*(3), 268–281. https://doi.org/10.1016/j.gloenvcha.2006.02.006

Adhikari, B. (2005). Poverty, property rights and collective action: understanding the distributive aspects of common property resource management. *Environment and Development Economics*, *10*, 7–31. https://doi.org/10.1017/S1355770X04001755

Adriansen, H. K. (2006). The Iraqi Marshlands: Is Environmental Rehabilitation Possible? *Papers and Proceedings of Applied Geography Conferences*, *29*, 214.

Agrawal, A. (2001). Common property institutions and sustainable governance of resources. *World Development*, *29*(10), 1649–1672. https://doi.org/10.1016/S0305-750X(01)00063-8

Agrawal, A., & Perrin, N. (2008). *Climate adaptation, local institutions and rural livelihoods.* (In IFRI Working Paper No. W081-6). Michigan: International Forestry Resources and Institutions Program, University of Michigan.

Ahmed, A. U., Hill, R. V., Smith, L. C., Wiesmann, D., Frankenberger, T. R., Gulati, K., Quabili, W., & Yohannes, Y. (2007). *The world's most deprived : Characteristics and causes of extreme poverty and hunger*. International Food Policy Research Institute. https://doi.org/10.2499/0896297705

Al-Assaf, A. A. (2015). Applying contingent valuation to measure the economic value of forest services: A case study in Northern Jordan. *International Journal of Sustainable Development and World Ecology*, *22*(3), 242–250. https://doi.org/10.1080/13504509.2015.1004379

Alam, M. S., Islam, K. K., & Huq, A. M. Z. (1999). Simulation of rural household fuel consumption in Bangladesh. *Energy*, *24*(8), 743–752. https://doi.org/10.1016/S0360-5442(99)00015-8

Aldrich, D. P. (2013). A Normal Accident or a Sea-Change? Nuclear Host Communities Respond to the 3/11 Disaster. *Japanese Journal of Political Science*, *14*(02), 261–276. https://doi.org/10.1017/S1468109913000066

Alexander, E. R. (2006). Institutional design for sustainable development1. *Town Planning Review*, *77*(1), 1–28.

Alexander, K. S., Ryan, A., & Measham, T. G. (2012). Managed retreat of coastal communities: understanding responses to projected sea level rise. *Journal of Environmental Planning and Management*, *55*(4), 409–433. https://doi.org/10.1080/09640568.2011.604193

Alongi, D. (2008). Mangrove forests: Resilience, protection from tsunamis and responses to global climate change. *Estuarine, Coastal and Shelf Science*, *76*.

Anacio, D. B. (2017). Biodiversity Requirements of the Begnas Ritual System in Sagada, Northern Philippines. In W. V. Alangui, K. Ichikawa, & Y. Takahashi (Eds.), *IPBES-JBF Sub-regional Dialogue Workshop Report on Indigenous and Local Knowledge (ILK) for South-East and North-East Asia sub-region, Thailand* (p. 143). Tokyo, Japan: Institute for Global Environmental Strategies. Retrieved from https://pub.iges.or.jp/pub/ipbes-jbf-sub-regional-dialogue-workshop-0

Anderson-Teixeira, K. J., Snyder, P. K., Twine, T. E., Cuadra, S. V., Costa, M. H., & DeLucia, E. H. (2012). Climate-regulation services of natural and agricultural ecoregions of the Americas. *Nature Climate Change*, *2*(3), 177–181. https://doi.org/10.1038/nclimate1346

Anseeuw, W., Boche, M., Breu, T., Giger, M., Lay, J., Messerli, P., & Nolte, K. (2012). *Transnational Land Deals for Agriculture in the Global South. Analytical Report based on the Land Matrix Database*. *Science* (Vol. 327). https://doi.org/10.1126/science.1186834

APO, & FAO. (2006). *Postharvest Management of Fruit and Vegetables in the Asia-Pacific Region*. Tokyo, Japan/Rome, Italy. Retrieved from http://www.apo-tokyo.org/00e-books/AG-18_PostHarvest/AG-18_PostHarvest.pdf

Armatas, C. A., Venn, T. J., McBride, B. B., Watson, A. E., & Carver, S. J. (2016). Opportunities to utilize traditional phenological knowledge to support adaptive management of social-ecological systems vulnerable to changes in climate and fire regimes. *Ecology and Society*, *21*(1), art16. https://doi.org/10.5751/ES-07905-210116

Armitage, D., Berkes, F., & Doubleday, N. (Eds.). (2007). *Adaptive Co-Management: Collaboration, Learning, and Multi-Level Governance*. Canada: UBC Press.

ASEAN. (2015). ASEAN.

ASEAN Center for Biodiversity. (2014). ASEAN Center for Biodiversity: Annual Report 2014. Retrieved from http://www.aseanbiodiversity.org/phocadownload/reports/2014ACBAnnualReport.pdf

Asian Development Bank. (2007). *Energy for All: Addressing the Energy, Environment, and Poverty Nexus in Asia*. Asian Development Bank, Manila.

Asian Development Bank. (2009). *Improving Energy Security and Reducing Carbon Intensity in Asia and the Pacific*. Asian Development Bank, Manila.

Asian Development Bank. (2013a). *Asian Water Development Outlook 2013: Measuring Water Security in Asia and Pacific*. Asian Development Bank, Mandaluyong City, Philippines.

Asian Development Bank. (2013b). *Food Security in Asia and the Pacific*. Asian Development Bank, Mandaluyong City, Philippines.

Asian Development Bank. (2013c). *The economics of climate change in the Pacific*. Asian Development Bank, Mandaluyong City, Philippines.

Asian Development Bank. (2013d). *Thinking about water differently: Managing the water-food-energy nexus*. Asian Development Bank, Manila, Philippines.

Asian Development Bank. (2016). *Asian Water Development Outlook 2016: Strengthening water security in Asia and the Pacific*. Mandaluyong City, Philippines. Retrieved from https://www.adb.org/sites/default/files/publication/189411/awdo-2016.pdf

Asian Development Bank. (2017). *Key Indicators for Asia and the Pacific 2017*. Manila, Philippines: Asian Development Bank. https://doi.org/10.22617/FLS178890-2

Aswani, S. (2005). Customary sea tenure in Oceania as a case of rights-based fishery management: Does it work? *Reviews in Fish Biology and Fisheries*, *15*(3), 285–307. https://doi.org/10.1007/s11160-005-4868-x

Australian Government. (1975). Great Barrier Reef Marine Park Act 1975. Attorney-General's Department. Retrieved from https://www.legislation.gov.au/Details/C2017C00279

Australian Human Rights Commission. (2007). Study: Western Arnhem Land fire management. Retrieved January 17, 2018, from https://www.humanrights.gov.au/publications/native-title-report-2007-chapter-12

Baggoley, C. (2015). *Review of the Australian Government Rebate on Natural Therapies for Private Health Insurance Natural Therapies Review*. https://doi.org/10.1017/CBO9781107415324.004

Bahinipati, C. S., & Venkatachalam, L. (2015). What drives farmers to adopt farm-level adaptation practices to climate extremes: Empirical evidence from Odisha, India. *International Journal of Disaster Risk Reduction*, *14*, 347–356. https://doi.org/10.1016/j.ijdrr.2015.08.010

Baird, I. G., & Dearden, P. (2003). Biodiversity Conservation and Resource Tenure Regimes: A Case Study from Northeast Cambodia. *Environmental Management*. https://doi.org/10.1007/s00267-003-2995-5

Baird, I. G., Shoemaker, B. P., & Manorom, K. (2015). The People and their River, the World Bank and its Dam: Revisiting the Xe Bang Fai River in Laos. *Development and Change*, *46*(5), 1080–1105. https://doi.org/10.1111/dech.12186

Balmford, A., & Bond, W. (2005). Trends in the state of nature and their implications for human well-being. *Ecology Letters*, *8*(11), 1218–1234.

Balmford, A., Bruner, A., Cooper, P., Costanza, R., Farber, S., Green, R. E., Jenkins, M., Jefferiss, P., Jessamy, V., & Madden, J. (2002). Economic reasons for conserving wild nature. *Science, 297*(5583), 950–953.

Bandaranayake, W. (1998). Traditional and medicinal uses of mangroves. In *Mangroves and Salt Marshes 2.*

Bandot, B. S. (2012). Approaching harmony with nature, Future Perfect. In *Future Perfect* (pp. 22–25). Tudor Rose.

Barker, H. (2012). *Bravo for the Marshallese: regaining control in a post-nuclear, post-colonial world* (Second Edi). Belmont, USA.

Batang-ay, M. J. C. (2017). Sustaining indigenous forest management system: the case of saguday in Sagada, Philippines. In W. V. Alangui, K. Ichikawa, & Y. Takahashi (Eds.), *IPBES-JBF Sub-regional Dialogue Workshop Report on Indigenous and Local Knowledge (ILK) for South-East and North-East Asia sub-region, Thailand* (p. 143). Tokyo, Japan: Institute for Global Environmental Strategies. Retrieved from https://pub.iges.or.jp/pub/ipbes-jbf-sub-regional-dialogue-workshop-0

Bawa, K., & Gadgil, M. (1997). Ecosystem Services, Subsistence Economies and Conservation of Biodiversity. In G. Daily (Ed.), *Ecosystem Services: Their Nature and Value.* Washington DC, USA: Island Press.

Bazilian, M., Rogner, H., Howells, M., Hermann, S., Arent, D., Gielen, D., Steduto, P., Mueller, A., Komor, P., Tol, R. S. J., & Yumkella, K. K. (2011). Considering the energy, water and food nexus: Towards an integrated modelling approach. *Energy Policy*, *39*(12), 7896–7906. https://doi.org/10.1016/j.enpol.2011.09.039

Becken, S., Lama, A. K., & Espiner, S. (2013). The cultural context of climate change impacts: Perceptions among community members in the Annapurna Conservation Area, Nepal. *Environmental Development*, *8*(1), 22–37. https://doi.org/10.1016/j.envdev.2013.05.007

Bekchanov, M., Ringler, C., & Mueller, M. (2015). Ecosystem Services in the Water-Energy-Food Nexus. *Change and Adaptation in Socio-Ecological Systems, 2*(1). https://doi.org/10.1515/cass-2015-0016

Bennett, E. L., & Rao, M. (2002). Wild meat consumption in Asian tropical forest countries: Is this a glimpse of the future for Africa? In S. Mainka & M. Trivedi (Eds.), *Links between Biodiversity Conservation Livelihoods and Food Security: The Sustainable Use of Wild Species for Meat* (pp. 39–44). Gland, Switzerland and Cambridge, UK: IUCN.

Bennett, E. M., Peterson, G. D., & Gordon, L. J. (2009). Understanding relationships among multiple ecosystem services. *Ecology Letters*, *12*(12), 1394–1404. https://doi.org/10.1111/j.1461-0248.2009.01387.x

Berkes, F., Colding, J., & Folke, C. (2000). Rediscovery of traditional ecological knowledge as adaptive management. *Ecological Applications*, *10*(5), 1251–1262.

Berkes, F., Folke, C., & Gadgil, M. (1995). Traditional Ecological Knowledge Biodiversity, Resilience and Sustainability. In C.A. Perrings et al (Ed.), *Biodiversity Conservation* (pp. 281–299). Kluwer Academic Publishers.

Bhat, S. A., & Pandit, A. K. (2014). Surface Water Quality Assessment of Wular Lake , A Ramsar Site in Kashmir Himalaya , Using Discriminant Analysis and WQI. *Hindawi Publishing Corporation*, *2014*.

Bhattacharya, P., Pradhan, L., & Yadav, G. (2010). Joint forest management in India: Experiences of two decades. *Resources, Conservation and Recycling*, *54*(8), 469–480.

Bickerstaff, K. (2004). Risk perception research: Socio-cultural perspectives on the public experience of air pollution. *Environment International*, *30*(6), 827–840. https://doi.org/10.1016/j.envint.2003.12.001

Biggs, E., Boruff, B., & Bruce, E. (2014). *Environmental livelihood security in Southeast Asia and Oceania: a water-energy-food-livelihoods nexus approach for spatially assessing change*. Colombo, Sri Lanka: International Water Management Institute (IWMI).

Blondel, A. (2012). Climate Change Fuelling Resource-Based Conflicts in the Asia-Pacific. *Asia-Pacific Human Development Report Background Papers Series 2012/12*.

BOBLME. (2015). *Making a Difference to Resource Management in the Bay of Bengal: Meeting International Obligations* (Vol. 1). Bay of Bengal Large Marine Ecosystem Project (BOBLME). https://doi.org/10.1017/CBO9781107415324.004

Boelee, E., Chiramba, T., & Khaka, E. (2011). *An Ecosystem Services Approach to Water and Food Security*. Colombo: Nairobi: United Nations Environment Programme. Retrieved from http://www.iwmi.cgiar.org/Issues/Ecosystems/PDF/Synthesis_Report-An_Ecosystem_Services_Approach_to_Water_and_Food_Security_2011_UNEP-IWMI.pdf

Boeve-de Pauw, J., & Van Petegem, P. (2013). A Cross-Cultural Study of Environmental Values and Their Effect on the Environmental Behavior of Children. *Environment and Behavior*, *45*(5), 551–583. https://doi.org/10.1177/0013916511429819

Borchers, H. (2005, August). Komodo Park: A future Jurassic tragedy. *The Jakarta Post*.

Borrini-feyerabend, G. (2014). Indigenous Peoples' and Community Conserved Territories and Areas (ICCA) Consortium. In N. Dudley, J. L. Boucher, A. Cuttelod, T. M. Brooks, & P. F. Langhammer (Eds.), *Applications of Key Biodiversity Areas: End-user consultations Applications* (pp. 85–87). IUCN.

Borrini-Feyerabend, G., Dudley, N., Jaeger, T., Lassen, B., Broome, N. P., & Phillips, A. (2012). Governance of Protected Areas: From understanding to action.

Borrini-Feyerabend, G., & Hill, R. (2015). Governance of the conservation of nature. In G. L. Worboys, M. Lockwood, A. Kothari, S. Feary, & I. Pulsford (Eds.), *Protected Area Governance and Management*, (pp. 169–206). Canberra: ANU Press.

Brandon-Jones, D. (1996). The Asian Colobinae (Mammalia: Cercopithecidae) as indicators of Quaternary climatic change. *Biological Journal of the Linnean Society*, *59*(3), 327–350. https://doi.org/10.1111/j.1095-8312.1996.tb01469.x

Brauman, K. A., Daily, G. C., Duarte, T. K., & Mooney, H. A. (2007). The Nature and Value of Ecosystem Services: An Overview Highlighting Hydrologic Services. *Annual Review of Environment and Resources*, *32*(1), 67–98. https://doi.org/10.1146/annurev.energy.32.031306.102758

Brikké, S. (2014). Young People and the Environment: Exploring factors that influence young people's environmentally caring behaviors in Indonesia. Griffith School of Environment, Griffith University.

Brondízio, E. S., Gatzweiler, F. W., Zografos, C., & Kumar, M. (2010). Socio-cultural context of ecosystem and biodiversity valuation. *The Economics of Ecosystems and Biodiversity: Ecological and Economic Foundations*, (March), 3–29. https://doi.org/10.4324/9781849775489

Brooks, T. M., Akçakaya, H. R., Burgess, N. D., Butchart, S. H. M., Hilton-Taylor, C., Hoffmann, M., Juffe-Bignoli, D., Kingston, N., MacSharry, B., Parr, M., Perianin, L., Regan, E. C., Rodrigues, A. S. L., Rondinini, C., Shennan-Farpon, Y., & Young, B. E. (2016). Analysing biodiversity and conservation knowledge products to support regional environmental assessments. *Scientific Data*, *3*, 160007. https://doi.org/10.1038/sdata.2016.7

Brown, R. D., & Yokohari, M. (2003). Ideological Contribution of Satoyamas. In K. Takeuchi, R. D. Brown, I. Washitani, I. Tsunekawa, & M. Yokohari (Eds.), *Satoyama – The Traditional Rural Landscape of Japan* (pp. 1–7). Tokyo: Springer Japan. https://doi.org/10.1007/978-4-431-67861-8_1

Cabinet Office Government Of Japan. (2017). *Public Opinion Survey on the Life of the People (in Japanese)*. Retrieved from https://survey.gov-online.go.jp/h29/h29-life/index.html

Campese, J., Sunderland, T. C. H., Greiber, T., & Oviedo, G. (Eds.). (2009). *Rights-based approaches: Exploring issues and opportunities for conservation*. Center for International Forestry Research (CIFOR) and and The International Union for Conservation of Nature (IUCN), Bogor, Indonesia. Retrieved from http://www.cifor.org/library/2800/rights-based-approaches-exploring-issues-and-opportunities-for-conservation/

Capistrano, R. C. G., & Charles, A. T. (2012). Indigenous rights and coastal fisheries: A framework of livelihoods, rights and equity. *Ocean and Coastal Management*. https://doi.org/10.1016/j.ocecoaman.2012.08.011

Carpenter, S. R., Mooney, H. A., Agard, J., Capistrano, D., Defries, R. S., Díaz, S., Dietz, T., Duraiappah, A. K., Oteng-Yeboah, A., Pereira, H. M., Perrings, C., Reid, W. V., Sarukhan, J., Scholes, R. J., & Whyte, A. (2009). Science for managing ecosystem services: Beyond the

Millennium Ecosystem Assessment. *Proceedings of the National Academy of Sciences of the United States of America*, *106*(5), 1305–1312. https://doi.org/10.1073/pnas.0808772106
Carroll, C., Dunk, J. R., & Moilanen, A. (2010). Optimizing resiliency of reserve networks to climate change: multispecies conservation planning in the Pacific Northwest, USA. *Global Change Biology*, *16*(3), 891–904. https://doi.org/10.1111/j.1365-2486.2009.01965.x
Cash, D. W., Adger, W. N., Berkes, F., Garden, P., Lebel, L., Olsson, P., Pritchard, L., & Young, O. (2006). Scale and Cross-Scale Dynamics: Governance and Information in a Multilevel World. *Ecology and Society*, *11*(2), 8. https://doi.org/8
CBD. (2006). *Programme of Work on on technology transfer and technological and scientific cooperation (CBD Programmes of Work)*. Montreal. Retrieved from https://www.cbd.int/doc/meetings/ttc/egttstc-02/other/egttstc-02-oth-techstudy-en.pdf
CBD. (2007). *The role of intellectual property rights in technology transfer in the context of the Convention on Biological Diversity*. Retrieved from https://www.cbd.int/doc/publications/ttc-brochure-01-en.pdf
CBD. (2009). *Connecting Biodiversity and Climate Change Mitigation and Adaptation: Report of the Second Ad Hoc Technical Expert Group on Biodiversity and Climate Change*. *Technical Series* (Vol. 41). Montreal.
CBD. (2010). Protocol on the Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from Their Utilization to the Convention on Biological Diversity. Nagoya: Convention on Biological Diversity. Retrieved from https://www.cbd.int/abs/doc/protocol/nagoya-protocol-en.pdf
CBD. (2015). Secretariat of the Convention on Biological Diversity. Retrieved January 26, 2016, from https://www.cbd.int/secretariat/
CBD. (2017). Parties to the Nagoya Protocol. Retrieved January 17, 2018, from https://www.cbd.int/abs/nagoya-protocol/signatories/default.shtml
Central Research Institute for Dryland Agriculture. (n.d.). National Innovations in Climate Resilient Agriculture (NICRA). Retrieved from http://www.nicra-icar.in/nicrarevised/
Chairos, S. (Ed.). (2006). *2005 Annual Report of National Human Rights Commission of Thailand's Examination Report 2548, National Human Rights Commission*.
Chan, C. K., & Yao, X. (2008). Air pollution in mega cities in China. *Atmospheric Environment*, *42*(1), 1–42. https://doi.org/10.1016/j.atmosenv.2007.09.003
Chan, H. (2007). *Survival in the Rainforest: Change and Resilience among the Punan Vuhang of Eastern Sarawak, Malaysia*.
Chan, H. T. (1986). Human habitation and traditional uses of the mangrove ecosystem in Peninsular Malaysia. In *Man in the mangroves : A socio-economic situation of human settlements in mangrove forests* (pp. 1–11). United Nations University.
Chassagnon, I. R., McCarthy, C. A., Chin, Y. K.-Y., Pineda, S. S., Keramidas, A., Mobli, M., Pham, V., De Silva, T. M., Lynch, J. W., Widdop, R. E., Rash, L. D., & King, G. F. (2017). Potent neuroprotection after stroke afforded by a double-knot spider-venom peptide that inhibits acid-sensing ion channel 1a. *Proceedings of the National Academy of Sciences of the United States of America*, *114*(14), 3750–3755. https://doi.org/10.1073/pnas.1614728114
Chaudhury, M. (2007). *A Situation Analysis of Ecosystem Services and Poverty Linkage in Bangladesh*. BRAC Paper.
Chen, I.-C., Hill, J. K., Ohlemüller, R., Roy, D. B., & Thomas, C. D. (2011). Rapid Range Shifts of Species Associated with High Levels of Climate Warming. *Science*, *333*(6045), 1024 LP-1026. Retrieved from http://science.sciencemag.org/content/333/6045/1024.abstract
Chen, S.-L., Yu, H., Luo, H.-M., Wu, Q., Li, C.-F., & Steinmetz, A. (2016). Conservation and sustainable use of medicinal plants: problems, progress, and prospects. *Chinese Medicine*, *11*(1), 37. https://doi.org/10.1186/s13020-016-0108-7
Chen, Y., & Tang, H. (2005). Desertification in north China: background, anthropogenic impacts and failures in combating it. *Land Degradation & Development*, *16*(4), 367–376. https://doi.org/10.1002/ldr.667
Cid Aguayo, B., & Latta, A. (2015). Agro-Ecology and Food Sovereignty Movements in Chile: Sociospatial Practices for Alternative Peasant Futures. *Annals of the Association of American Geographers*, *105*(2), 397–406. https://doi.org/10.1080/00045608.2014.985626

Cinner, J. E., & Huchery, C. (2014). A comparison of social outcomes associated with different fisheries co-management institutions. *Conservation Letters*, *7*(3), 224–232. https://doi.org/10.1111/conl.12057

Cinner, J. E., Huchery, C., MacNeil, M. A., Graham, N. A. J., McClanahan, T. R., Maina, J., Maire, E., Kittinger, J. N., Hicks, C. C., Mora, C., Allison, E. H., D'Agata, S., Hoey, A., Feary, D. A., Crowder, L., Williams, I. D., Kulbicki, M., Vigliola, L., Wantiez, L., Edgar, G., Stuart-Smith, R. D., Sandin, S. A., Green, A. L., Hardt, M. J., Beger, M., Friedlander, A., Campbell, S. J., Holmes, K. E., Wilson, S. K., Brokovich, E., Brooks, A. J., Cruz-Motta, J. J., Booth, D. J., Chabanet, P., Gough, C., Tupper, M., Ferse, S. C. A., Sumaila, U. R., & Mouillot, D. (2016). Bright spots among the world's coral reefs. *Nature*, *535*(7612), 416–419. Retrieved from http://dx.doi.org/10.1038/nature18607

Cinner, J. E., McClanahan, T. R., MacNeil, M. A., Graham, N. A. J., Daw, T. M., Mukminin, A., Feary, D. A., Rabearisoa, A. L., Wamukota, A., Jiddawi, N., Campbell, S. J., Baird, A. H., Januchowski-Hartley, F. A., Hamed, S., Lahari, R., Morove, T., & Kuange, J. (2012). Comanagement of coral reef social-ecological systems. *Proceedings of the National Academy of Sciences*, *109*(14), 5219–5222. https://doi.org/10.1073/pnas.1121215109

Clark, N. E., Lovell, R., Wheeler, B. W., Higgins, S. L., Depledge, M. H., & Norris, K. (2014). Biodiversity, cultural pathways, and human health: a framework. *Trends in Ecology & Evolution*, *29*(4), 198–204. https://doi.org/10.1016/j.tree.2014.01.009

Claudet, J., Osenberg, C. W., Benedetti-Cecchi, L., Domenici, P., García-Charton, J.-A., Pérez-Ruzafa, Á., Badalamenti, F., Bayle-Sempere, J., Brito, A., Bulleri, F., Culioli, J.-M., Dimech, M., Falcón, J. M., Guala, I., Milazzo, M., Sánchez-Meca, J., Somerfield, P. J., Stobart, B., Vandeperre, F., Valle, C., & Planes, S. (2008). Marine reserves: size and age do matter. *Ecology Letters*, *11*(5), 481–489. https://doi.org/10.1111/j.1461-0248.2008.01166.x

Clayton, L., Keeling, M., & Milner-Gulland, E. J. (1997). Bringing home the bacon: A spatial model of wild pig hunting in Sulawesi, Indonesia. *Ecological Applications*, *7*(2), 642–652. https://doi.org/10.1890/1051-0761(1997)007[0642:BHTBAS]2.0.CO;2

Clean Energy Nepal. (2008). *Energy Consumption in Rural Nepal. Clean Energy Nepal*.

Cleveland, C. J., Betke, M., Federico, P., Frank, J. D., Hallam, T. G., Horn, J., López, J. D., McCracken, G. F., Medellín, R. A., Moreno-Valdez, A., Sansone, C. G., Westbrook, J. K., & Kunz, T. H. (2006). Economic value of the pest control service provided by Brazilian free-tailed bats in south-central Texas. *Frontiers in Ecology and the Environment*, *4*(5), 238–243. https://doi.org/10.1890/1540-9295(2006)004[0238:EVOTPC]2.0.CO;2

Collectif Argos. (2010). *Climate refugees*. MIT Press. Retrieved from https://mitpress.mit.edu/books/climate-refugees

Commonwealth of Australia. (2016). *Transforming Australia's forest products industry: recommendations from the Forest Industry Advisory Council*. Canberra: Forest Industry Advisory Council, Department of Agriculture and Water Resources. Retrieved from http://ausfpa.com.au/wp-content/uploads/2016/06/Transforming-Australias-forest-products-industry-Recommendations-from-the-Forest-Industry-Advisory-Council-May-2016.pdf

Conservation International. (2017). The Coral Triangle Initiative. Retrieved April 18, 2017, from http://www.conservation.org/projects/Pages/Coral-Triangle-Initiative-pacific-ocean-islands.aspx

Cordonnery, L. (2014). The Legacy Of French Nuclear Testing In The Pacific. In *The Oceans in the Nuclear Age* (pp. 69–78). Brill. https://doi.org/10.1163/ej.9789004156753.i-576.30

Corlett, R. T. (2007). The Impact of Hunting on the Mammalian Fauna of Tropical Asian Forests. *Biotropica*, *39*(3), 292–303. https://doi.org/10.1111/j.1744-7429.2007.00271.x

Corrin, J. (2011). Accommodating Legal Pluralism in Pacific Courts: Problems of Proof of Customary Law. *The International Journal of Evidence & Proof*, *15*(1), 1–25. https://doi.org/10.1350/ijep.2011.15.1.366

Costanza, R., d'Arge, R., de Groot, R., Farber, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., O'Neill, R. V., Paruelo, J., Raskin, R. G., Sutton, P., & van den Belt, M. (1997). The value of the world's ecosystem services and natural capital. *Nature*, *387*(6630), 253–260. https://doi.org/10.1038/387253a0

Costanza, R., de Groot, R., Sutton, P., van der Ploeg, S., Anderson, S. J., Kubiszewski, I., Farber, S., & Turner, R. K. (2014). Changes in the global value of ecosystem services. *Global Environmental Change*, *26*, 152–158.
Cowie, A., Schneider, U. A., & Montanarella, L. (2007). Potential synergies between existing multilateral environmental agreements in the implementation of land use, land-use change and forestry activities. *Environmental Science and Policy*, *10*(4), 335–352. https://doi.org/10.1016/j.envsci.2007.03.002
Cox, M., Villamayor-Tomas, S., & Hartberg, Y. (2014). The Role of Religion in Community-based Natural Resource Management. *World Development*, *54*, 46–55. https://doi.org/10.1016/j.worlddev.2013.07.010
Cronin, R., & Pandya, A. (Eds.). (2009). *Exploiting Natural Resources Growth, Instability, and Conflict in the Middle East and Asia*. The Henry L. Stimson Center. Retrieved from http://www.stimson.org/images/uploads/research-pdfs/Exploiting_Natural_Resources-Introduction.pdf
CTI-CFF. (2009). Regional Plan of Action, Coral Triangle Initiative on Coral Reefs, Fisheries and Food Security, 87.
CTI-CFF. (2011). CTI-CFF Regional Boundaries Map. Retrieved from http://coraltriangleinitiative.org/library/cti-cff-regional-boundaries-map
CWC. (2010). *Water and Related Statistics*. *Water*. New Delhi.
D'Amato, D., Rekola, M., Li, N., & Toppinen, A. (2016). Monetary valuation of forest ecosystem services in China: A literature review and identification of future research needs. *Ecological Economics*, *121*, 75–84. https://doi.org/10.1016/J.ECOLECON.2015.11.009
D'Souza, C., Taghian, M., & Lamb, P. (2006). An empirical study on the influence of environmental labels on consumers. *Corporate Communications: An International Journal*, *11*(2), 162–173. https://doi.org/10.1108/13563280610661697
Daily, G. C. (1997a). Introduction: What are ecosystem services? In G. C. Daily (Ed.), *Nature's services : societal dependence on natural ecosystems* (pp. 1–10). Washington, D.C: Island Press.
Daily, G. C. (1997b). Valuing and safeguarding Earth's life support systems. In G. C. Daily (Ed.), *Nature's services : societal dependence on natural ecosystems* (pp. 365–374). Washington, D.C: Island Press.
Daily, G. C., Alexander, S., Ehrlich, P. R., Goulder, L., Lubchenco, J., Matson, P. A., Mooney, H. A., Postel, S., Schneider, S. H., & Tilman, D. (1997). *Ecosystem services: benefits supplied to human societies by natural ecosystems* (Vol. 2). Ecological Society of America Washington (DC).
Daily, G. C., Söderqvist, T., Aniyar, S., Arrow, K., Dasgupta, P., Ehrlich, P. R., Folke, C., Jansson, A., Jansson, B., Kautsky, N., Lubchenco, J., Mäler, K., Simpson, D., Starrett, D., Tilman, D., Levin, S., Maler, K., & Walker, B. (2000). The Value of Nature and the Nature of Value. *Science*, *289*(5478), 395–396. https://doi.org/10.1126/science.289.5478.395
Dang, T. K. (2017). Status and changes of local rice varieties: a case study from four villages in Po E commune, Kon Plong district, Kon Tum province, Central Highlands of Vietnam. In W. V. Alangui, K. Ichikawa, & Y. Takahashi (Eds.), *IPBES-JBF Sub-regional Dialogue Workshop Report on Indigenous and Local Knowledge (ILK) for South-East and North-East Asia sub-region, Thailand* (p. 143). Tokyo, Japan: Institute for Global Environmental Strategies. Retrieved from https://pub.iges.or.jp/pub/ipbes-jbf-sub-regional-dialogue-workshop-0
Daru, B. H., Yessoufou, K., Mankga, L. T., & Davies, T. J. (2013). A Global Trend towards the Loss of Evolutionarily Unique Species in Mangrove Ecosystems. *PloS One*, *8*(6), e66686. https://doi.org/10.1371/journal.pone.0066686
Davies, J., Hill, R., Walsh, F. J., Sandford, M., Smyth, D., & Holmes, M. C. (2013). Innovation in management plans for community conserved areas: Experiences from Australian indigenous protected areas. *Ecology and Society*, *18*(2). https://doi.org/10.5751/ES-05404-180214
Davies, K. (2015). Ancient and new legal landscapes: Customary law and climate change, a vanuatu case study. *Asia Pacific Journal of Environmental Law*, *18*, 43–67. Retrieved from http://search.informit.org/documentSummary;res=IELHSS;dn=749813526351296
Davies, K. (2016). Changing Tides - a South Pacific Study. *Journal of South Pacific Law*, 147–159. Retrieved from

https://www.usp.ac.fj/fileadmin/random_images/home_middle_banners/emalus/JSPL/2016/Marine_Paper__Climate_Change__marine_ecosystem_and_Customary_Law_.pdf

Davies, K. J. (2012). *Intergenerational Democracy: Rethinking Sustainable Development*. Illinois: Common Ground Publishing. Retrieved from http://onsustainability.cgpublisher.com/product/pub.197/prod.5

Davies, S. D. (1995). Identifying sites of global importance for conservation: the IUCN/WWF Centres of Plant Diversity Project. In R. N. Primack & T. E. Lovejoy (Eds.), *Ecology, Conservation and Management of Southeast Asian Rainforests* (pp. 176–203). New Haven, CT: Yale University Press.

Davis, J., Street, M., Malo, H., Cherel, I., & Woodward, E. (2011). Mingayooroo – Manyi Waranggiri Yarrangi. Gooniyandi Seasons (calendar), Margaret River, Fitzroy Valley, Western Australia. *CSIRO Ecosystem Sciences, Darwin, NT*.

de Fraiture, C., & Wichelns, D. (2010). Satisfying future water demands for agriculture. *Agricultural Water Management*, *97*(4), 502–511. https://doi.org/10.1016/j.agwat.2009.08.008

DFRS. (2015). *State of Nepal's Forests*. *Government of Nepal, Ministry of Forests and Soil Conservation, Department of Forest Research and Survey Forest*. Retrieved from www.dfrs.gov.np

Dhyani, S., Maikhuri, R. K., & Dhyani, D. (2011). Energy budget of fodder harvesting pattern along the altitudinal gradient in Garhwal Himalaya, India. *Biomass and Bioenergy*, *35*(5), 1823–1832. https://doi.org/10.1016/j.biombioe.2011.01.022

Díaz, S., Demissew, S., Carabias, J., Joly, C., Lonsdale, M., Ash, N., Larigauderie, A., Adhikari, J. R., Arico, S., Báldi, A., Bartuska, A., Baste, I. A., Bilgin, A., Brondizio, E., Chan, K. M. A., Figueroa, V. E., Duraiappah, A., Fischer, M., Hill, R., Koetz, T., Leadley, P., Lyver, P., Mace, G. M., Martin-Lopez, B., Okumura, M., Pacheco, D., Pascual, U., Pérez, E. S., Reyers, B., Roth, E., Saito, O., Scholes, R. J., Sharma, N., Tallis, H., Thaman, R., Watson, R., Yahara, T., Hamid, Z. A., Akosim, C., Al-Hafedh, Y., Allahverdiyev, R., Amankwah, E., Asah, T. S., Asfaw, Z., Bartus, G., Brooks, A. L., Caillaux, J., Dalle, G., Darnaedi, D., Driver, A., Erpul, G., Escobar-Eyzaguirre, P., Failler, P., Fouda, A. M. M., Fu, B., Gundimeda, H., Hashimoto, S., Homer, F., Lavorel, S., Lichtenstein, G., Mala, W. A., Mandivenyi, W., Matczak, P., Mbizvo, C., Mehrdadi, M., Metzger, J. P., Mikissa, J. B., Moller, H., Mooney, H. A., Mumby, P., Nagendra, H., Nesshover, C., Oteng-Yeboah, A. A., Pataki, G., Roué, M., Rubis, J., Schultz, M., Smith, P., Sumaila, R., Takeuchi, K., Thomas, S., Verma, M., Yeo-Chang, Y., & Zlatanova, D. (2015). The IPBES Conceptual Framework - connecting nature and people. *Current Opinion in Environmental Sustainability*, *14*, 1–16. https://doi.org/10.1016/j.cosust.2014.11.002

Díaz, S., Demissew, S., Joly, C., Lonsdale, W. M., & Larigauderie, A. (2015). A Rosetta Stone for Nature's Benefits to People. *PLoS Biology*, *13*(1), 1–8. https://doi.org/10.1371/journal.pbio.1002040

Do, K. H. P., & Dinar, A. (2014). The Role of Issue Linkage in Managing Noncooperating Basins: The Case of the Mekong. *Natural Resource Modeling*, *27*(4), 492–518. https://doi.org/10.1111/nrm.12052

Dudgeon, P., Wright, M., Paradies, Y., Garvey, D., & Walker, I. (2010). Reproduced with the kind permission of the copyright owner Copyright: 2010, Australian Institute of Health and Welfare. In *Working together: Aboriginal and Torres Strait Islander mental health and wellbeing principles and practice* (pp. 25–42). Canberra.

Dudley, N., Stolton, S., Belokurov, A., Krueger, L., Lopoukhine, N., MacKinnon, K., Sandwith, T., & Sekhran, N. (2010). *Natural Solutions: Protected areas helping people cope with climate change*. Gland, Switzerland, Washington DC and New York, USA: IUCN-WCPA,TNC, UNDP, WCS, The World Bank and WWF. Retrieved from www.panda.org

Dunlop, I., & Spratt, D. (2017). *Disaster Alley ~ Climate Change Conflict and Risk*. Melbourne, Australia. Retrieved from https://ja.scribd.com/document/353944809/Disaster-Alley-Climate-Change-Conflict-Risk-Dunlop-Spratt-June-2017

Dunning, K. H. (2014). Ecosystem services and community based coral reef management institutions in post blast-fishing Indonesia. *Ecosystem Services*, *16*, 319–332. https://doi.org/10.1016/j.ecoser.2014.11.010

Duraiappah, A. K., Asah, S. T., Brondizio, E. S., Kosoy, N., O'Farrell, P. J., Prieur-Richard, A.-H., Subramanian, S. M., & Takeuchi, K. (2014). Managing the mismatches to provide ecosystem services for human well-being: a conceptual framework for understanding the New Commons. *Current Opinion in Environmental Sustainability*, *7*, 94–100. https://doi.org/10.1016/j.cosust.2013.11.031

Dwivedi, O. P. (1990). Satyagraha for Conservation : Awakening the Spirit of Hinduism. *Ethics of Environment and Development*, 1–8.

Ekstrom, J. A., & Young, O. R. (2009). Evaluating functional fit between a set of institutions and an ecosystem. *Ecology and Society*, *14*(2). https://doi.org/16

El-Fadel, M., Zeinati, M., & Jamali, D. (2000). Water Resources in Lebanon: Characterization, Water Balance and Constraints. *International Journal of Water Resources Development*, *16*(4), 615–638. https://doi.org/10.1080/713672540

Ens, E. J., Pert, P., Clarke, P. A., Budden, M., Clubb, L., Doran, B., Douras, C., Gaikwad, J., Gott, B., Leonard, S., Locke, J., Packer, J., Turpin, G., & Wason, S. (2015). Indigenous biocultural knowledge in ecosystem science and management: Review and insight from Australia. *Biological Conservation*, *181*, 133–149. https://doi.org/10.1016/j.biocon.2014.11.008

Ervin, J., Sekhran, N., Dinu, A., Gidda, S., Vergeichik, M., & Mee, J. (2010). *Protected Areas for the 21st Century: Lessons from UNDP/GEF's Portfolio*. New York: United Nations Development Programme and Montreal: Convention on Biological Diversity. Retrieved from http://www.undp.org/content/dam/undp/library/Environment and Energy/biodiversity/PA_21Century.pdf

European Union. (2010). *Changing International Markets for Timber and Wood Products -Main Policy Instruments*. *EFI Policy Brief 5*.

Faith, D. P. (1992). Conservation evaluation and phylogenetic diversity. *Biological Conservation*, *61*(1), 1–10. https://doi.org/10.1016/0006-3207(92)91201-3

Faith, D. P., Magallón, S., Hendry, A. P., & Donoghue, M. J. (2017). Future Benefits from Contemporary Evosystem Services: A Response to Rudman et al. *Trends in Ecology & Evolution*, *32*(10), 717–719. https://doi.org/10.1016/j.tree.2017.07.005

Falkenmark, M. (2001). The Greatest Water Problem: The Inability to Link Environmental Security, Water Security and Food Security. *International Journal of Water Resources Development*, *17*(4), 539–554. https://doi.org/10.1080/07900620120094073

FAO. (1997). *Trends and outlook for forest products consumption, production and trade in the Asia-Pacific region*. (D. Zhang, J. Buongiorno, & S. Zhu, Eds.).

FAO. (2005a). Increasing the Contribution of small-scale fisheries to poverty alleviation and food security. FAO Technical Guidelines for Responsible Fisheries. No.10. Rome: FAO.

FAO. (2005b). *Trade in Medicinal Plants*. Rome. Retrieved from http://www.fao.org/tempref/docrep/fao/008/af285e/af285e00.pdf

FAO. (2009). *From Land Grab to Win-Win: Seizing the Opportunities of International Investments in Agriculture*. *Economic and Social Perspectives Policy Brief* (Vol. 4). Rome, Italy.

FAO. (2010). *The State of World Fisheries and Aquaculture*. Rome.

FAO. (2011a). *Global food losses and food waste*. Rome. Retrieved from http://www.fao.org/docrep/014/mb060e/mb060e00.pdf

FAO. (2011b). *The State of the World's land and water resources for Food and Agriculture (SOLAW) - Managing systems at risk*. *The Food and Agriculture Organization of the United Nations and Earthscan*. Rome, London. https://doi.org/978-1-84971-326-9

FAO. (2014). *FAO Statistical Yearbook 2014: Asia and the Pacific Food and Agriculture*. Bangkok, Thailand.

FAO. (2015a). *Global Forest Resources Assessment 2015: How are the world's forests changing?* Rome: Food and Agriculture Organization of the United Nations. Retrieved from http://www.fao.org/forest-resources-assessment/en/

FAO. (2015b). *Regional Overview of Food and Insecurity-Asia and the Pacific*. *Strategic Survey* (Vol. 90). Bangkok: Food and Agriculture Organisation of the United Nations. https://doi.org/10.1080/04597238908460834

FAO. (2016a). AQUASTAT Main Database, Food and Agriculture Organization of the United Nations (FAO). Retrieved September 1, 2017, from http://www.fao.org/nr/water/aquastat/data/query/index.html?lang=en

FAO. (2016b). FAOSTAT Database. Retrieved from http://www.fao.org/faostat/en/#data

FAO. (2016c). FAOSTAT Emissions Database, Agriculture, Agriculture Total. Retrieved from http://faostat3.fao.org/download/G1/GT/E

FAO. (2017). FAOSTAT Emissions Database, Land use, Land Use Total. Retrieved from http://www.fao.org/faostat/en/#data/GL

FAOSTAT. (2017). Forestry Production and Trade. Retrieved from http://www.fao.org/faostat/en/#data/FO

Farhadi, M. (1997). Cooperative Culture in Iran. In *An Introduction to Ethnology and Sociology of Cooperation* (2nd Editio). Tehran: University Press Center.

Farhadi, M. (2009). *Cooperative Anthropology* (1st ed.). Tehran: Saless.

Farhadi, M. (2014). *Vareh: An Introduction to Ethnology and Sociology of Cooperation* (4th Editio). Tehran: Joint Stock Company of Press.

Felbab-Brown, V. (2011). *The Disappearing Act: The Illicit Trade in Wildlife in Asia* (Foreign Policy at Brookings No. 6). Retrieved from https://www.brookings.edu/wp-content/uploads/2016/06/06_illegal_wildlife_trade_felbabbrown.pdf

Fisher, J. (1998). *Bannister Creek Management Plan, Prepared for the City of Canning*.

Fisher, R., Prabhu, R., & McDougall, C. (Eds.). (2007). *Adaptive collaborative management of community forests in Asia: experiences from Nepal, Indonesia and the Philippines*. Bogor, Indonesia: Center for International Forestry Research (CIFOR). https://doi.org/10.17528/cifor/002350

Folke, C., Hahn, T., Olsson, P., & Norberg, J. (2005). Adaptive Governance of Social-ecological Systems. *Annual Review of Environment and Resources*, *30*(1), 441–473. https://doi.org/10.1146/annurev.energy.30.050504.144511

Forsyth, M. (2004). Beyond case law: kastom and courts in Vanuatu. *Victoria University of Wellington Law Review*, *35*(2), 427–446. Retrieved from http://www.mjcs.gov.vu/images/research_database/Beyond_Case_Law_Kastom_and_Courts_in_Vanuatu.pdf

Forsyth, T. (2014). Public concerns about transboundary haze: A comparison of Indonesia, Singapore, and Malaysia. *Global Environmental Change*, *25*(1), 76–86. https://doi.org/10.1016/j.gloenvcha.2014.01.013

Forum on Human Rights and Climate Change. (2015). Requesting for Investigation of the Responsibility of the Carbon Majors for Human Rights Violations or Threats of Violations Resulting from the Impacts of Climate Change. the Honourable Commission on Human Rights. Retrieved from http://www.greenpeace.org/seasia/ph/PageFiles/735232/Climate_Change_and_Human_Rights_Petition.pdf

Frazer, J. G. (1935). *The Golden Bough: A Study in Magic and Religion, 12 vols*. New York: Macmillan. Retrieved from http://onlinebooks.library.upenn.edu/webbin/metabook?id=goldenbough3

Fujii, E., & Shibata, T. (1981). Studies on the regional characteristics of floor layers of the Pinus plain forests (in Japanese with English summary). *Journal of the Japanese Forestry Society*, *63*(9), 305–310. https://doi.org/10.11519/jjfs1953.63.9_305

Fujii, E., & Zinnai, I. (1979). Studies on the relationship between the management of floor layers and the succession of Pinus plain forests in Kanto Region (I): Especially on the floras and the life-form spectra according to the number of species (in Japanese with English summary). *Journal of the Japanese Forestry Society*, *61*(3), 76–82. https://doi.org/10.11519/jjfs1953.61.3_76

Fuller, C. J. (1980). The Calendrical System in Tamilnadu (South India). *Journal of the Royal Asiatic Society of Great Britain & Ireland*, *112*(01), 52–63. https://doi.org/10.1017/S0035869X00135890

Funge-Smith, S., Briggs, M., & Miao, W. (2012). *Regional overview of fisheries and aquaculture in Asia and the Pacific 2012*. *RAP publication*. Food and Agriculture Organisation of the United

Nations. Retrieved from http://www.fao.org/documents/card/en/c/951b0503-aece-5bdf-a4fa-500b868b55a1/

Gadgil, M., & Vartak, V. D. (1973). Groves dedicated to the Gods. *The Illustrated Weekly of India*, 4.

Gadgil, M., & Vartak, V. D. (1981). Sacred Groves of Maharashtra: An Inventory. In S. Jain (Ed.), *Glimpses of Indian Ethnobotany* (pp. 279–294). Bombay: Oxford University Press.

Garnett, T. (2011). Where are the best opportunities for reducing greenhouse gas emissions in the food system (including the food chain)? *Food Policy*, *36*, S23–S32. https://doi.org/10.1016/J.FOODPOL.2010.10.010

Gascon, C., Brooks, T. M., Contreras-MacBeath, T., Heard, N., Konstant, W., Lamoreux, J., Launay, F., Maunder, M., Mittermeier, R. A., Molur, S., Al Mubarak, R. K., Parr, M. J., Rhodin, A. G. J., Rylands, A. B., Soorae, P., Sanderson, J. G., & Vié, J.-C. (2015). The importance and benefits of species. *Current Biology : CB*, *25*(10), R431-8. https://doi.org/10.1016/j.cub.2015.03.041

Gautam, A. P., & Shivakoti, G. P. (2005). Conditions for Successful Local Collective Action in Forestry: Some Evidence From the Hills of Nepal. *Society & Natural Resources*, *18*, 153–171. https://doi.org/10.1080/08941920590894534

Gautam, A. P., Shivakoti, G. P., & Webb, E. L. (2004). A review of forest policies, institutions, and changes in the resource condition in Nepal. *International Forestry Review*, *6*(2), 136–148. https://doi.org/10.1505/ifor.6.2.136.38397

GEF. (2010). *Implementation of the Poznan Strategic Program on Technology Transfer: Report of the GEF to the Sixteenth Session of the Conference of the Parties to the United Nations Framework Convention on Climate Change.*

Geist, H. J., & Lambin, E. F. (2002). Proximate Causes and Underlying Driving Forces of Tropical Deforestation. *BioScience*, *52*(2), 143. https://doi.org/10.1641/0006-3568(2002)052[0143:PCAUDF]2.0.CO;2

Gende, S. M., Edwards, R. T., Willson, M. F., & Wipfli, M. S. (2002). Pacific Salmon in Aquatic and Terrestrial Ecosystems. *BioScience*, *52*(10), 917. https://doi.org/10.1641/0006-3568(2002)052[0917:PSIAAT]2.0.CO;2

Gilbert, L. E. (1980). Food web organization and the conservation of neotropical diversity. In M. E. Soulé & B. A. Wilcox (Eds.), *Conservation Biology: An Evolutionary Ecological Perspective* (pp. 11–34). Sunderland: Sinauer Associates.

GLF. (2014). Building cross-cutting skills and landscapes knowledge for effective youth leadership. *20th Conference of the Parties to the UN Framework Convention on Climate Change (COP20)*. Lima, Peru: Global Landscapes Forum Publication.

GoN/MoFSC. (2014). Nepal National Biodiversity Strategy and Action Plan: 2014-2020. Kathmandu, Nepal: Government of Nepal Ministry of Forests and Soil Conservation.

Gore, P. G., Prasad, T., & Hatwar, H. R. (2010). *Mapping of Drought Areas over India* (No. Research Report No.12/2010). Pune, India. Retrieved from http://imdpune.gov.in/Clim_Pred_LRF_New/Reports/NCCResearchReports/research_report_12.pdf

Gorenflo, L. J., Romaine, S., Mittermeier, R. A., & Walker-Painemilla, K. (2012). Co-occurrence of linguistic and biological diversity in biodiversity hotspots and high biodiversity wilderness areas. *Proceedings of the National Academy of Sciences of the United States of America*, *109*(21), 8032–8037. https://doi.org/10.1073/pnas.1117511109

Govan, H., Aalbersberg, W., Tawake, A., & Parks, J. E. (2008). *Locally-Managed Marine Areas : A guide for practitioners*. Suva, Fiji: The Locally-Managed Marine Area Network. Retrieved from www.LMMAnetwork.org

Government of China. (2015). Twenty-four Solar Terms. Beijing, China: National Publication Foundation, Chinese Red.

Government of Pakistan. (n.d.). Ministry of Finance website. Retrieved from http://www.finance.gov.pk/

Government of Thailand. (1997). Constitution of the Kingdom of Thailand B.E. 2540 (1997). *Government Gazette Vol.114, Part 55a*. Retrieved from http://thailaws.com/law/t_laws/claw0010.pdf

Great Barrier Reef Marine Park Authority. (2005). Heritage Strategy. *Great Barrier Reef Marine Park Heritage Strategy*. Retrieved from http://www.banyule.vic.gov.au/files/assets/public/files-forms-and-attachments/3-services/31-planning/reference-documents/banyule-heritage-strategy.pdf

Great Barrier Reef Marine Park Authority. (2011). *Great Barrier Reef Fact Sheet*.

Great Barrier Reef Marine Park Authority. (2014). *Threats to the Reef*.

Great Barrier Reef Marine Park Authority. (2016). *Traditional Owners of the Great Barrier Reef*.

Greiber, T., & Schiele, S. (Eds.). (2011). *Governance of Ecosystem Services*. Gland, Switzerland: IUCN. Retrieved from https://portals.iucn.org/library/sites/library/files/documents/EPLP-079.pdf

Grieves, V. (2009). *Aboriginal Spirituality: Aboriginal Philosophy The Basis of Aboriginal Social and Emotional Wellbeing*.

Guha, I., & Ghosh, S. (2007). *Does Tourism Contribute to Local Livelihoods? A Case Study of Tourism, Poverty, and Conservation in the Indian Sunderbans*. Nepal: SANDEE.

Haines-Young, R., & Potschin, M. (2013). *Common International Classification of Ecosystem Services (CICES): Consultation on Version 4, August-December 2012*. Retrieved from https://cices.eu/content/uploads/sites/8/2012/07/CICES-V43_Revised-Final_Report_29012013.pdf

Hamada, H., & Kuramoto, N. (1994). A study of seed bank in Quercus serrata forest by surveying seedling emergence and its application to forest management. *Journal of the Japanese Institute of Landscape Architects (Japan)*.

Hamilton, A. C. (2004). Medicinal plants, conservation and livelihoods. *Biodiversity and Conservation*, *13*(8), 1477–1517. https://doi.org/10.1023/B:BIOC.0000021333.23413.42

Hamilton, T. (2013). A Visual Description of the Concrete Exterior of the Cactus Crater Containment Structure, (LLNL-TR-648143), 438. Retrieved from https://marshallislands.llnl.gov/ccc/Hamilton_LLNL-TR-648143_final.pdf

Hammill, A. (2009). *Conflict-sensitive Conservation: Practitioners' Manual*. International Institute for Sustainable Development, available at http://www.iisd.org/pdf/2009/csc_manual.pdf.

Hart, B. T., Taylor, M., Iles, M., Kyle, G., & Sinclair, G. (2015). Resolving long-term issues related to surface water management and monitoring associated with the Ranger Uranium Mine, Northern Territory, Australia. *Australasian Journal of Environmental Management*, *6563*(July), 1–15. https://doi.org/10.1080/14486563.2015.1028487

Harvey, G. (2005). *Animism: Respecting the Living World*. London.

Haskins, C. (1974). Scientists Talk of the Need for Conservation and an Ethic of Biotic Diversity to Slow Species Extinction. *Science*, *184*, 646–647.

Hayama, Y., Takahashi, R., & Katsuno, T. (1996). The relationship between wood structure and avifauna at Higashiyamato park, Tokyo (Papers of the 14th scientific research meeting, in Japanese with English summary). *Journal of the Japanese Institute of Landscape Architecture (Japan)*, *59*(5), 89–92.

He, D., Wu, R., Feng, Y., Li, Y., Ding, C., Wang, W., & Yu, D. W. (2014). REVIEW: China's transboundary waters: new paradigms for water and ecological security through applied ecology. *Journal of Applied Ecology*, *51*(5), 1159–1168. https://doi.org/10.1111/1365-2664.12298

Healy, H. (2007). Korean demilitarized zone: peace and nature park. *International Journal on World Peace*, *24*(4), 61–83.

Heart of Borneo Rainforest Foundation. (2013). Heart of Borneo Project - A Beyond Conservation Initiative Home - Heart of Borneo Project - A Beyond Conservation Initiative. Retrieved April 18, 2017, from http://www.heartofborneo.org/

Hergoualc'h, K. A., & Verchot, L. V. (2012). Changes in soil CH4 fluxes from the conversion of tropical peat swamp forests: a meta-analysis. *Journal of Integrative Environmental Sciences*, *9*(2), 93–101. https://doi.org/10.1080/1943815X.2012.679282

Heydari-Malayeri. (2004). A concise review of the Iranian calendar. Retrieved January 27, 2016, from https://arxiv.org/abs/astro-ph/0409620

Hickey, F. R. (2006). Traditional Marine Resource Management in Vanuatu: Acknowledging, Supporting and Strengthening Indigenous Management Systems. *SPC Traditional Marine Resource Management and Knowledge Information Bulletin*, *20*, 11–23. Retrieved from https://books.google.co.jp/books?id=baUySByM5DIC&pg=PA269&lpg=PA269&dq=Traditiona

l+Marine+Resource+Management+in+Vanuatu:+Acknowledging,+Supporting+and+Strengthening+Indigenous+Management+Systems&source=bl&ots=AxUjFa-xXn&sig=P7AftjgtvSQHtvgj8StWz9j91no&hl

Hien, V. T., Tuyet, N. T., Giap, N. X., & Xa, V. H. (2011). Ethnic Minority Women in Traditional Forest Management at Binh Son Village. In W. V. Alangui, G. Subido, & R. Tinda-an (Eds.), *Indigenous Women, Climate Change and Forests. Baguio* (pp. 247–266). Thai Nguyen Province, Vietnam: Tebtebba Foundation.

Hill, R., Dyer, G. A., Lozada-Ellison, L. M., Gimona, A., Martin-Ortega, J., Munoz-Rojas, J., & Gordon, I. J. (2015). A social-ecological systems analysis of impediments to delivery of the Aichi 2020 Targets and potentially more effective pathways to the conservation of biodiversity. *Global Environmental Change*, *34*, 22–34. https://doi.org/10.1016/j.gloenvcha.2015.04.005

Hill, R., Halamish, E., Gordon, I. J., & Clark, M. (2013). The maturation of biodiversity as a global social-ecological issue and implications for future biodiversity science and policy. *Futures*, *46*(March 2016), 41–49. https://doi.org/10.1016/j.futures.2012.10.002

Hill, R., Pert, P., Davies, J., Robinson, C. J., Walsh, F., & Falco-Mammone, F. (2013). *Indigenous Land Management in Australia: Extent, Scope, Diversity, Barriers and Success Factors*. Cairns.

Hin, L. T. W., & Subramanium, R. (2014). *Communicating Science to the Public: Opportunities and Challenges for Asia-Pacific Region.* Springer Netherlands.

Hind, R. (2007). *Sacred Places: Sites of Spirituality & Faith*. Carlton Books.

Hinman, G. W., Rosa, E. A., Kleinhesselink, R. R., & Lowinger, T. C. (1993). Perceptions of Nuclear and Other Risks in Japan and the United States. *Risk Analysis*, *13*(4), 449–455. https://doi.org/10.1111/j.1539-6924.1993.tb00745.x

Ho, E., Clarke, A., & Dougherty, I. (2015). Youth-led social change: Topics, engagement types, organizational types, strategies, and impacts. *Futures*, *67*, 52–62. https://doi.org/10.1016/J.FUTURES.2015.01.006

Ho, J.-C., Lee, C.-T. P., Kao, S.-F., Chen, R.-Y., Ieong, M. C. F., Chang, H.-L., Hsieh, W.-H., Tzeng, C.-C., Lu, C.-F., Lin, S.-L., & Chang, P. W. (2014). Perceived environmental and health risks of nuclear energy in Taiwan after Fukushima nuclear disaster. *Environment International*, *73*, 295–303. https://doi.org/10.1016/j.envint.2014.08.007

Hoff, H. (2011). Understanding the Nexus. Background Paper for the Bonn2011 Conference: The Water, Energy and Food Security Nexus. Stockholm: Stockholm Environment Institute. Retrieved from http://wef-conference.gwsp.org/fileadmin/documents_news/understanding_the_nexus.pdf

Hortle, K. G. (2007). *Consumption and the yield of fish and other aquatic animals from the Lower Mekong Basin* (MRC Technical Paper No.16). Vientiane: Mekong River Commission.

Hortle, K. G. (2009). Fisheries of the Mekong River Basin. In I. C. Campbell (Ed.), *The Mekong : Biophysical Environment of an International River Basin.* (p. 199-253). New York: Elsevier Science.

Horton, D. R. (1996). Indigenous language map. Australian Institute for Aboriginal and Torres Strait Islander Studies. Retrieved from http://aiatsis.gov.au/aboriginal-studies-press/products/aiatsis-map-indigenous-australia

Howells, M., Hermann, S., Welsch, M., Bazilian, M., Segerström, R., Alfstad, T., Gielen, D., Rogner, H., Fischer, G., van Velthuizen, H., Wiberg, D., Young, C., Alexander Roehrl, R., Mueller, A., Steduto, P., & Ramma, I. (2013). Integrated analysis of climate change, land-use, energy and water strategies. *Nature Publishing Group*, *3*. https://doi.org/10.1038/NCLIMATE1789

Hsu, A., Emerson, J., Levy, M., de Sherbinin, A., Johnson, L., Malik, O., Schwartz, J., & Jaiteh, M. (2014). The 2014 environmental performance index. Retrieved September 16, 2015, from http://www.epi.yale.edu

Huang, L., Zhou, Y., Han, Y., Hammitt, J. K., Bi, J., & Liu, Y. (2013). Effect of the Fukushima nuclear accident on the risk perception of residents near a nuclear power plant in China. *Pnas*, *110*(49), 19742–19747. https://doi.org/10.1073/pnas.1313825110/-/DCSupplemental.www.pnas.org/cgi/doi/10.1073/pnas.1313825110

Hugo, G. (2005). *Migration in Asia-Pacific region.* (Global Commission on International Migration (GCIM) report). Geneva, Switzerland.

Hugo, G. (2008). *Migration, Development and Environment*. Geneva. Switzerland.

Hunter, L. M., & Nawrotzki, R. (2011). Migration and the Environment. In M. J. White (Ed.), *International Handbook of Migration and Population Distribution*. Dordrecht: Springer.

Huq, S., Rahman, A., Konate, M., Sokona, Y., & Reid, H. (2003). *Mainstreaming Adaptation to Climate Change in Least Developed Countries (LDCs)*. IIED, London.

Hussain, S. A., & Badola, R. (2010). Valuing mangrove benefits: Contribution of mangrove forests to local livelihoods in Bhitarkanika Conservation Area, East Coast of India. *Wetlands Ecology and Management*, *18*(3), 321–331. https://doi.org/10.1007/s11273-009-9173-3

Ibarra Gené, E., Scheyvens, H., & López-Casero, F. (2012). *Community Forest Management and REDD+: Opportunities and Challenges. In: IGES White Paper IV 2012 Greening Governance in Asia-Pacific*. Institute for Global Environmental Strategies (IGES), Hayama, Japan.

IGES. (2012). *IGES White Paper IV: Greening Governance in Asia-Pacific*.

IGES. (2017). *IPBES-JBF Sub-regional Dialogue Workshop Report on Indigenous and Local Knowledge (ILK) for South and West Asia sub-region March 2017*.

Iiyama, N., Kamada, M., & Nakagoshi, N. (2005). Ecological and social evaluation of landscape in a rural area with terraced paddies in southwestern Japan. *Landscape and Urban Planning*, *73*(1), 60–71. https://doi.org/10.1016/J.LANDURBPLAN.2004.12.003

ILO. (1989). Convention C169 - Indigenous and Tribal Peoples Convention, 1989 (No. 169). Geneva: International Labour Organization. Retrieved from http://www.ilo.org/dyn/normlex/en/f?p=NORMLEXPUB:12100:0::NO::P12100_ILO_CODE:C169

Indian Central Pollution Control Board. (2009). *Status of water supply, wastewater generation and treatment in Class I cities and Class II towns of India (2009-10)*. Retrieved from http://cpcb.nic.in/upload/NewItems/NewItem_153_Foreword.pdf

InfoResources. (2008). *Shaping Institutions for Natural Resource Management. InfoResources Focus No 3/08*. Retrieved from http://www.inforesources.ch/pdf/focus08_3_e.pdf

Inglehart, R., & Welzel, C. (2005). *Modernization, Cultural Change and Democracy*. New York and Cambridge: Cambridge University Press.

Inoue, M., & Shivakoti, G. (Eds.). (2015). *Multi-level Forest Governance in Asia: Concepts, Challenges and the Way Forward*. SAGE India.

International Land Conservation Network. (2016). International Land Conservation Network. *Continuing Medical Education*, p. ILCN Newsletter. Retrieved from http://www.landconservationnetwork.org/sites/default/files/ILCN Newsletter September 2016.pdf

International Organization for Migration. (2015). Regional Strategy for Asia and the Pacific 2012-2015. Retrieved from http://www.iom.int/sites/default/files/country/docs/AUP00548-RO-Bangkok-Regional-Strategy.pdf

Ioh, H. (2014). The Calendar in Pre-Islamic Mecca. *Arabica*, *61*(5), 471–513. https://doi.org/10.1163/15700585-12341319

Ioja, C., Nita, M. R., & Hossu, C. A. (2016). Environmental Conflicts. In *Interdisciplinary Perspectives on Contemporary Conflict Resolution* (pp. 56–79). https://doi.org/10.4018/978-1-5225-0245-6.ch004

IPBES. (2015). IPBES/3/18, Annex III: Generic scoping report for the regional and subregional assessments of biodiversity and ecosystem services (deliverable 2 (b)). Bonn, Germany. Retrieved from https://www.ipbes.net/event/ipbes-3-plenary

IPBES. (2017). IPBES/5/INF/24: Update on the classification of nature’s contributions to people by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. Bonn, Germany. Retrieved from https://www.ipbes.net/sites/default/files/downloads/pdf/ipbes-5-inf-24.pdf

IPCC. (2007). *Climate Change 2007: impacts, adaptation and vulnerability: contribution of Working Group II to the fourth assessment report of the Intergovernmental Panel*. *Genebra, Suíça*. Retrieved from http://books.google.com/books?hl=en&lr=&id=TNo-SeGpn7wC&oi=fnd&pg=PA81&dq=Climate+Change+2007:+Impacts,+Adaptation+and+Vulnerability.+Contribution+of+Working+Group+II+to+the+Fourth+Assessment+Report+of+the+Intergovernmental+Panel+on+Climate+Change&ots=vP2

IPCC. (2014). *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. (V. R. Barros, C. B. Field, D. J. Dokken, M. D. Mastrandrea, K. J. Mach, T. E. Bilir, M. Chatterjee, K. L. Ebi, Y. O. Estrada, R. C. Genova, B. Girma, E. S. Kissel, A. N. Levy, S. MacCracken, P. R. Mastrandrea, & L. L. White, Eds.). Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press.

Ipsos, & New Zealand Department of Conservation. (2016). *Survey of New Zealanders*. Retrieved from http://www.doc.govt.nz/Documents/about-doc/role/visitor-research/survey-of-new-zealanders-2016.pdf%0A

Ishii, M. (2005). *Seitaigaku kara mita satoyama no sizen to hogo (Nature and Conservation of Satoyama Based on Ecology, in Japanese)*. Tokyo: Kodansha.

ITPGRFA. (2013). Reports of Meetings on the Establishment of a Platform for the Co-Development and Transfer of Technology. Retrieved May 25, 2016, from http://www.planttreaty.org/sites/default/files/gb5i16_FINAL.pdf

IUCN. (2008). Resolution 4.098 Intergenerational partnerships: fostering ethical leadership for a just, sustainable and peaceful world.

IUCN. (2011). *Natural Resource Economic Valuations Environmental Economic Valuation of the HIMA System The Case of Zarqa River Basin – Jordan*. Amman, Jordan.

IUCN WCPA. (2011). Typology of Transboundary Conservation Areas. Retrieved April 18, 2017, from http://www.tbpa.net/page.php?ndx=83

Jacobs, J. W. (2002). The Mekong River Commission: transboundary water resources planning and regional security. *The Geographical Journal*, *168*(4), 354–364. https://doi.org/10.1111/j.0016-7398.2002.00061.x

Jakobsson, K. M., & Dragun, A. K. (2001). The Worth of a Possum: Valuing Species with the Contingent Valuation Method. *Environmental and Resource Economics*, *19*(3), 211–227. https://doi.org/10.1023/A:1011128620388

Jax, K., Barton, D. N., Chan, K. M. A., de Groot, R., Doyle, U., Eser, U., Görg, C., Gómez-Baggethun, E., Griewald, Y., Haber, W., Haines-Young, R., Heink, U., Jahn, T., Joosten, H., Kerschbaumer, L., Korn, H., Luck, G. W., Matzdorf, B., Muraca, B., Neßhöver, C., Norton, B., Ott, K., Potschin, M., Rauschmayer, F., von Haaren, C., & Wichmann, S. (2013). Ecosystem services and ethics. *Ecological Economics*, *93*, 260–268. https://doi.org/10.1016/j.ecolecon.2013.06.008

Jiao, X., Smith-Hall, C., & Theilade, I. (2015). Rural household incomes and land grabbing in Cambodia. *Land Use Policy*, *48*, 317–328. https://doi.org/10.1016/j.landusepol.2015.06.008

Jodha, N. S. (1986). Common Property Resources and Rural Poor in Dry Regions of India. *Economic and Political Weekly*, *21*, 1169–1181.

Jolly, M. (1992). Custom and the Way of the Land: Past and Present in Vanuatu and Fiji. *Oceania*, *62*(4), 330–354. https://doi.org/10.1002/j.1834-4461.1992.tb00361.x

Joshi, S. (2003). Super Market, Secretive, Exploitative: Is The Market in The Minor Forest Produce Unmanageable? *Down to Earth*, *28*, 27–34. Retrieved from http://www.downtoearth.org.in/coverage/super-market-12525

Jung, W. H., Woo, J. M., & Ryu, J. S. (2015). Effect of a forest therapy program and the forest environment on female workers' stress. *Urban Forestry and Urban Greening*, *14*(2), 274–281. https://doi.org/10.1016/j.ufug.2015.02.004

Jupiter, S. D., Cohen, P. J., Weeks, R., & Tawake, A. (2014). Locally-managed marine areas : Multiple objectives and diverse strategies Locally-managed marine areas : multiple objectives and diverse strategies. *Pacific Conservation Biology*, *20*(August 2015), 165–179.

Karabulut, A., Egoh, B. N., Lanzanova, D., Grizzetti, B., Bidoglio, G., Pagliero, L., Bouraoui, F., Aloe, A., Reynaud, A., Maes, J., Vandecasteele, I., & Mubareka, S. (2016). Mapping water provisioning services to support the ecosystem–water–food–energy nexus in the Danube river basin. *Ecosystem Services*, *17*, 278–292. https://doi.org/10.1016/j.ecoser.2015.08.002

Kawasaki, J. (2017). Assessment of the role of Karen's ecological knowledge to sustain biodiversity, ecosystems and ecosystem services in northern Thailand. In W. V. Alangui, K. Ichikawa, & Y. Takahashi (Eds.), *IPBES-JBF Sub-regional Dialogue Workshop Report on Indigenous and Local Knowledge (ILK) for South-East and North-East Asia sub-region, Thailand* (p. 143).

Tokyo, Japan: Institute for Global Environmental Strategies. Retrieved from https://pub.iges.or.jp/pub/ipbes-jbf-sub-regional-dialogue-workshop-0

Kelley, C. P., Mohtadi, S., Cane, M. A., Seager, R., & Kushnir, Y. (2015). Climate change in the Fertile Crescent and implications of the recent Syrian drought. *Proceedings of the National Academy of Sciences of the United States of America*, *112*(11), 3241–3246. https://doi.org/10.1073/pnas.1421533112

Khan, K. S., Kunz, R., Kleijnen, J., & Antes, G. (2003). Five Steps to Conducting a Systematic Review. *Journal of the Royal Society of Medicine*, *96*(3), 118–121. https://doi.org/10.1177/014107680309600304

Khandu, E., Forootan, E., Schumacher, M., Awange, J. L., & Müller Schmied, H. (2016). Exploring the influence of precipitation extremes and human water use on total water storage (TWS) changes in the Ganges-Brahmaputra-Meghna River Basin. *Water Resources Research*, *52*(3), 2240–2258. https://doi.org/10.1002/2015WR018113

Kim, J. J., Lee, H. K., Choi, M. H., Youn, Y. C., & Lee, J. K. (1994). Quantification of Welfare Functions of Forests in Korea. *Korean Journal of Forest Economics*, *2*(1), 127–139.

Kim, W., Lim, S. K., Chung, E. J., & Woo, J. M. (2009). The effect of cognitive behavior therapy-based psychotherapy applied in a forest environment on physiological changes and remission of major depressive disorder. *Psychiatry Investigation*, *6*(4), 245–254. https://doi.org/10.4306/pi.2009.6.4.245

Kolahi, M. (2013). *Synergisms for the intricate system of biodiversity and society in the conservation management of Iran*. Kyoto University.

Kolahi, M. (2014). *Protected Areas Management and Environmental Sociology in Iran*. Scholars' Press.

Kolahi, M. (2015). Forecasting Iran Forests Futures: The ways of forests decline towards expansion. *CEESP Newsletter 1517, IUCN, Available at Http://Goo.Gl/D9KQks*, 16–17. Retrieved from http://www.iucn.org/about/union/commissions/ceesp/ceesp_news/?uNewsID=22318

Kolahi, M., Moriya, K., Sakai, T., Khosrojerdi, E., & Etemad, V. (2014). Introduction of participatory conservation in Iran: Case study of the rural communities' perspectives in Khojir National Park. *International Journal of Environmental Research*, *8*(4), 913–930.

Kolahi, M., Sakai, T., Moriya, K., & Makhdoum, M. F. (2012). Challenges to the future development of Iran's protected areas system. *Environmental Management*, *50*(4), 750–765. https://doi.org/10.1007/s00267-012-9895-5

Kolahi, M., Sakai, T., Moriya, K., Makhdoum, M. F., & Koyama, L. (2013). Assessment of the Effectiveness of Protected Areas Management in Iran: Case Study in Khojir National Park. *Environmental Management*, *52*(2), 514–530. https://doi.org/10.1007/s00267-013-0061-5

Kolahi, M., Sakai, T., Moriya, K., Yoshikawa, M., & Esmaili, R. (2014). From paper parks to real conservations: Case study of social capital in iran's biodiversity conservation. *International Journal of Environmental Research*, *8*(1), 101–114.

Koo, J.-C., Kweon, D., & Youn, Y.-C. (2015). Conditions for sustainability of traditional village woods (Maeulsoop) in Korea. In M. Inoue & G. Shivakoti (Eds.), *Multi-level forest governance in Asia : concepts, challenges and the way forward* (p. 461). SAGE Publications. Retrieved from https://us.sagepub.com/en-us/nam/multi-level-forest-governance-in-asia/book246161

KOSIS. (2014). Korean Statistical Information Service. Retrieved from http://kosis.kr/index/index.do

Kothari, A., Corrigan, C., Jonas, H., Neumann, A., & Shrumm, H. (2012). *Recognising and supporting territories and areas conserved by indigenous peoples and local communities: global overview and national case studies*. *CBD Technical Series*. Montreal, Canada: Secretariat of the Convention on Biological Diversity. Retrieved from http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:Recognising+and+Supporting+Territories+and+Areas+Conserved+By+Indigenous+Peoples+and+Local+Communities:+Global+Overview+and+National+Case+Studies#1

Kothari, A., Pathak, N., & Bose, A. (2011). FORESTS, RIGHTS AND CONSERVATION: FRA ACT 2006, INDIA. In H. Scheyvens (Ed.), *CRITICAL REVIEW OF SELECTED FOREST-RELATED REGULATORY INITIATIVES: APPLYING A RIGHTS PERSPECTIVE* (pp. 19–50). Institute for Global Environmental Strategies (IGES).

Kremen, C., Williams, N. M., Aizen, M. A., Gemmill-Herren, B., LeBuhn, G., Minckley, R., Packer, L., Potts, S. G., Roulston, T., Steffan-Dewenter, I., Vázquez, D. P., Winfree, R., Adams, L., Crone, E. E., Greenleaf, S. S., Keitt, T. H., Klein, A.-M., Regetz, J., & Ricketts, T. H. (2007). Pollination and other ecosystem services produced by mobile organisms: a conceptual framework for the effects of land-use change. *Ecology Letters*, *10*(4), 299–314. https://doi.org/10.1111/j.1461-0248.2007.01018.x

Kubiszewski, I., Anderson, S. J., Costanza, R., & Sutton, P. C. (2016). The Future of Ecosystem Services in Asia and the Pacific. *Asia & the Pacific Policy Studies*, *3*(3), 389–404. https://doi.org/10.1002/app5.147

Kubiszewski, I., Costanza, R., Dorji, L., Thoennes, P., & Tshering, K. (2013). An initial estimate of the value of ecosystem services in Bhutan. *Ecosystem Services*, *3*, e11–e21. https://doi.org/10.1016/J.ECOSER.2012.11.004

Kumar, B. M., Singh, A. K., & Dhyani, S. K. (2012). South Asian agroforestry: traditions, transformations, and prospects. In Nair PKR and Garrity DP (Ed.), *Agroforestry: The Future of Global Landuse* (p. 359-389). The Netherlands: Springer.

Kumar, M. R., & Janagam, D. (2011). Export and Import Pattern of Medicinal Plants in India. *Indian Journal of Science and Technology*, *4*(3), 245–248. https://doi.org/10.17485/IJST/2011/V4I3/29975

Kurokawa, K. (1996). New: Philosophy of Symbiosis. *Tokuma Shoten, Tokyo (in Japanese)*.

Kusrini, M. D., & Alford, R. A. (2006). Indonesia's exports of frogs' legs. *TRAFFIC Bulletin*, *21*(1), 13–24. Retrieved from https://researchonline.jcu.edu.au/4216/

Lakon, F., Unjing, P., Andi, V., Ngiuk, E., & Alloy, S. (2013). The Dayak Jalai Peoples & their Concept of Dahas in Ketapangan District, West Kalimantan, Indonesia: A Case Study. In W. V. Alangui, G. Subido, & R. Tinda-an (Eds.), *Indigenous Peoples, Forests & REDD Plus: Sustaining & Enhancing Forests Through Traditional Resource Management* (pp. 119–187). Baguio City, Philippines: Tebtebba Foundation.

Lane, M. B. (2003). Decentralization or privatization of environmental governance? Forest conflict and bioregional assessment in Australia. *Journal of Rural Studies*, *19*(3), 283–294. https://doi.org/10.1016/S0743-0167(02)00084-0

Larkin, J. G. (2016). New EIA Requirements to Help Safeguard Myanmar's Environment. Retrieved January 16, 2018, from https://www.adb.org/news/new-eia-requirements-help-safeguard-myanmars-environment

Lebreton, L. C. M., van der Zwet, J., Damsteeg, J.-W., Slat, B., Andrady, A., & Reisser, J. (2017). River plastic emissions to the world's oceans. *Nature Communications*. https://doi.org/10.1038/ncomms15611

Lee, T. M., Sigouin, A., Pinedo-Vasquez, M., & Nasi, R. (2014). *The harvest of wildlife for bushmeat and traditional medicine in East, South and Southeast Asia: Current knowledge base, challenges, opportunities and areas for future research*. Bogor, Indonesia: Center for International Forestry Research (CIFOR). https://doi.org/10.17528/cifor/005135

Lele, S., Wilshusen, P., Brockington, D., Seidler, R., & Bawa, K. (2010). Beyond exclusion: Alternative approaches to biodiversity conservation in the developing tropics. *Current Opinion in Environmental Sustainability*, *2*(1–2), 94–100. https://doi.org/10.1016/j.cosust.2010.03.006

Leonard, S., Mackenzie, J., Kofod, F., Parsons, M., Langton, M., Russ, P., Ormond-parker, L., Smith, K., & Smith, M. (2013). *Indigenous climate change adaptation in the Kimberley region of North-western Australia*.

Leschine, T. M. (2014). Risk And Vulnerability At Contaminated Sites In The Pacific And Australian Proving Grounds From A "Long-Term Stewardship" Perspective: What Have We Learned? In *The Oceans in the Nuclear Age* (pp. 39–48). Brill. https://doi.org/10.1163/ej.9789004156753.i-576.18

Lewis, B. (2012). Environmental Rights or a Right to the Environment?: Exploring the Nexus between Human Rights and Environmental Protection. *Macquarie Journal of Comparative and International Environmental Law*, *8*(2), 36–47. Retrieved from https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2673932

Li, R., Li, Y., van den Brink, M., & Woltjer, J. (2015). The capacities of institutions for the integration of ecosystem services in coastal strategic planning: The case of Jiaozhou Bay. *Ocean and Coastal Management*, *107*, 1–15. https://doi.org/10.1016/j.ocecoaman.2015.02.001

Linden, O., & Jernelov, O. (1980). The mangrove swamp: an ecosystem in danger. *Ambio, 9*.

Locatelli, B. (2016). 38. Ecosystem Services and Climate Change. Retrieved from https://www.routledge.com/products/9781138025080.

Long, A. J., Crosby, M. J., & Stattersfield, A. J. (1996). Towards a Global Map of Biodiversity: Patterns in the Distribution of Restricted-Range Birds. *Global Ecology and Biogeography Letters*, *5*(4/5), 281. https://doi.org/10.2307/2997796

López-Hoffman, L., Varady, R., & Balvanera, P. (2009). Finding mutual interest in shared ecosystem services: new approaches to transboundary conservation. In L. López-Hoffman, E. McGovern, R. Varady, & K. Flessa (Eds.), *Conservation of shared environments : learning from the United States and Mexico* (pp. 137–153). Tucson: University of Arizona Press. Retrieved from http://www.worldcat.org/title/conservation-of-shared-environments-learning-from-the-united-states-and-mexico/oclc/319500760

Louman, B., DeClerck, F., Ellatifi, M., Finegan, B., Thompson, I., & Others. (2010). Forest biodiversity and ecosystem services: drivers of change, responses and challenges. *IUFRO World Series*, *25*(Ricketts 2004), 95–112. Retrieved from http://www.cabdirect.org/abstracts/20113395935.html

Lu, M. (2016). *China Revised Environmental Impact Assessment Law*. Retrieved from https://chemlinked.com/news/chemical-news/china-revised-environmental-impact-assessment-law

Lundberg, J., & Moberg, F. (2003). Mobile Link Organisms and Ecosystem Functioning: Implications for Ecosystem Resilience and Management. *Ecosystems*, *6*(1), 0087–0098. https://doi.org/10.1007/s10021-002-0150-4

Maclean, K. (2015). Crossing cultural boundaries: Integrating Indigenous water knowledge into water governance through co-research in the Queensland Wet Tropics, Australia. *Geoforum*, *59*, 142–152. https://doi.org/10.1016/j.geoforum.2014.12.008

Maddugoda, P. (1991). *Experience of community forestry in Sri Lanka* (Proceedings from second regional workshop on multi-purpose trees). Kandy, Sri Lanka.

Mah, D. N. yin, Hills, P., & Tao, J. (2014). Risk perception, trust and public engagement in nuclear decision-making in Hong Kong. *Energy Policy*, *73*, 368–390. https://doi.org/10.1016/j.enpol.2014.05.019

Makino, M., & Matsuda, H. (2005). Co-management in Japanese coastal fisheries: Institutional features and transaction costs. *Marine Policy*, *29*(5), 441–450. https://doi.org/10.1016/j.marpol.2004.07.005

Malhotra, K. C. (1998). Anthropological Dimensions of Sacred Groves in India: An Overview. In P. S. Ramakrishnan, K. G. Saxena, & U. M. Chandrasekharan (Eds.), *Conserving the Sacred for Biodiversity Management*. New Delhi: Oxford and IBH.

Malhotra, K. C., Gokhale, Y., Chatterjee, S., & Srivastava, S. (2001). *Cultural and ecological dimensions of sacred groves in India*. *Indian National Science Academy, New Delhi and Indira Gandhi Rashtriya Manav Sangrahalaya, Bhopal*.

Mao, G.-X., Cao, Y.-B., Lan, X.-G., He, Z.-H., Chen, Z.-M., Wang, Y.-Z., Hu, X.-L., Lv, Y.-D., Wang, G.-F., & Yan, J. (2012). Therapeutic effect of forest bathing on human hypertension in the elderly. *Journal of Cardiology*, *60*(6), 495–502. https://doi.org/10.1016/j.jjcc.2012.08.003

Marin, A. (2010). Riders under storms: Contributions of nomadic herders' observations to analysing climate change in Mongolia. *Global Environmental Change*, *20*(1), 162–176. https://doi.org/10.1016/j.gloenvcha.2009.10.004

Markandya, A., Son, Y., & Lee, W.-K. (2017). Valuation of Reforestation in Terms of Disaster Risk Reduction: A Technical Study from the Republic of Korea.

Marsh, J. K. (2013). Decolonising the interface between indigenous peoples and mining companies in Australia: Making space for cultural heritage sites. *Asia Pacific Viewpoint*, *54*(2), 171–184. https://doi.org/10.1111/apv.12017

Marui, A., & Gallardo, A. H. (2015). Managing Groundwater Radioactive Contamination at the Daiichi Nuclear Plant. *International Journal of Environmental Research and Public Health*, *12*(7), 8498. https://doi.org/10.3390/ijerph120708498

Mashayekhi, Z., Panahi, M., Karami, M., Khalighi, S., & Malekian, A. (2010). Economic valuation of water storage function of forest ecosystems (case study: Zagros Forests, Iran). *Journal of Forestry Research*, *21*(3), 293–300. https://doi.org/10.1007/s11676-010-0074-3

Masoodi, A., & Khan, F. A. (2012a). A New Record to the Invasive Alien Flora of India: Azolla cristata. *National Academy Science Letters*, *35*(6), 493–495. https://doi.org/10.1007/s40009-012-0084-0

Masoodi, A., & Khan, F. A. (2012b). Invasion of alligator weed (Alternanthera philoxeroides) in Wular Lake, Kashmir, India. *Aquatic Invasions*, *7*(1), 143–146. https://doi.org/10.3391/ai.2012.7.1.016

Massey, D. S., Axinn, W. G., & Ghimire, D. J. (2010). Environmental Change and Out-Migration: Evidence from Nepal. *Population and Environment*, *32*(2–3), 109–136. https://doi.org/10.1007/s11111-010-0119-8

Matsuoka, S. (2015). The changing role of a Vaidya (non-codified traditional doctor) in the community health of Kerala, Southern India: comparison of treatment-seeking behaviours between the Vaidya's patients and community members. *Journal of Ethnobiology and Ethnomedicine*, *11*(1), 57–66. https://doi.org/10.1186/s13002-015-0042-2

Maunders, K. (2007). Culture Versus Sustainability - A Case Study from the Fiji Islands. *Asia Pacific Centre for Environmental Accountability Journal*, *13*(4).

MBIE. (2013). International Visitor Survey - key data tables. Retrieved from http://www.mbie.govt.nz/info-services/sectors-industries/tourism/tourism-research-data/ivs/ivs-key-data-tables

McMillen, H. L., Ticktin, T., Friedlander, A., Jupiter, S. D., Thaman, R., Campbell, J., Veitayaki, J., Giambelluca, T., Nihmei, S., Rupeni, E., Apis-Overhoff, L., Aalbersberg, W., & Orcherton, D. F. (2014). Small islands, valuable insights: Systems of customary resource use and resilience to climate change in the Pacific. *Ecology and Society*, *19*(4). https://doi.org/10.5751/ES-06937-190444

Measham, T. G., & Barnett, G. B. (2008). Environmental volunteering: motivations, modes and outcomes. *Australian Geographer*, *39*(4), 537–552. Retrieved from http://dx.doi.org/10.1080/00049180802419237

Medaglia, J. C., Perron-welch, F., & Phillips, F. (2014). *Overview of National and Regional Measures on Access and Benefit Sharing: Challenges and Opportunities in Implementing the Nagoya Protocol* (Third Edit). Centre for International Sustainable Development Law (CISDL).

Medellín, R. . (2009). Sustaining transboundary ecosystem services provided by bats. In L. López-Hoffman, E. McGovern, R. Varady, & K. Flessa (Eds.), *Conservation of Shared Environments: Learning from the United States and Mexico* (p. 170). Tucson: University of Arizona Press.

Medicinal Plant Specialist Group. (2007). *International Standard for Sustainable Wild Collection of Medicinal and Aromatic Plants (ISSC-MAP) Version 1.0*. Bonn, Gland, Frankfurt, and Cambridge (BfN-Skripten 195). Retrieved from https://www.bfn.de/fileadmin/MDB/documents/service/skript195.pdf

Messerli, P., Giger, M., Dwyer, M. B., Breu, T., & Eckert, S. (2014). The geography of large-scale land acquisitions: Analysing socio-ecological patterns of target contexts in the global South. *Applied Geography*, *53*, 449–459. https://doi.org/10.1016/j.apgeog.2014.07.005

MfE. (2001). *Our clean green image: what's it worth?* Wellington. Retrieved from http://www.mfe.govt.nz/publications/sustainability/our-clean-green-image-whats-it-worth

Middleton, N. J. (1991). Dust storms in the Mongolian People's Republic. *Journal of Arid Environments*, *20*(3), 287–297. Retrieved from http://cat.inist.fr/?aModele=afficheN&cpsidt=5254607

Millennium Ecosystem Assessment. (2005). *Millennium Ecosystem Assessment Synthesis Report*. Washington: Island Press.

Milner-Gulland, E. J., & Bennett, E. L. (2003). Wild meat: the bigger picture. *Trends in Ecology & Evolution*, *18*(7), 351–357. https://doi.org/10.1016/S0169-5347(03)00123-X

Milroy, H. (2008). Restoring life and spirit: Recovery from trauma. In Aboriginal & Torres Strait Islander Social Justice Commissioner (Ed.), *Social Justice Report 2007*. Sydney: Human Rights and Equal Opportunity Commission. Retrieved from https://www.humanrights.gov.au/sites/default/files/content/social_justice/sj_report/sjreport07/pdf/sjr_2007.pdf

Ministry of Environmental Protection of China, & Chinese Academy of Sciences. (2015). *National Ecosystem Service Zoning in China*. Beijing, China.

Ministry of Natural Resources and Environment. (2016). *Fifth National Report to the United Nations Convention on Biological Diversity*. Retrieved from https://www.cbd.int/reports/nr5/

Misra, S., Maikhuri, R. K., Dhyani, D., & Rao, K. S. (2009). Assessment of traditional rights, local interference and natural resource management in Kedarnath Wildlife Sanctuary. *International Journal of Sustainable Development & World Ecology*, *16*(6), 404–416. https://doi.org/10.1080/13504500903332008

Mitchell, T., & Tanner, T. (2006). *Overcoming the barriers: mainstreaming climate change adaptation in developing countries* (A report for Tearfund).

Mohamed, S. K. (2016). Conservation of Marine Fishery Resources Through Eco-labelling in India. In A. Joseph & R. Philip (Eds.), *Marine Biodiversity and Bio-prospecting for Sustainable Livelihood* (p. 123). Cochin University of Science and Technology. Retrieved from http://eprints.cmfri.org.in/11773/1/Marine Biodiversity and Bioprospecting_2016_K S Mohamed_Conservtion of Marine Fishery Resources Through Eco-labelling in India.pdf

Moonen, A. ., & Marshall, E. J. . (2001). The influence of sown margin strips, management and boundary structure on herbaceous field margin vegetation in two neighbouring farms in southern England. *Agriculture, Ecosystems & Environment*, *86*(2), 187–202. https://doi.org/10.1016/S0167-8809(00)00283-8

Moore, J. W., Schindler, D. E., Carter, J. L., Fox, J., Griffiths, J., & Holtgrieve, G. W. (2007). Biotic Control of Stream Fluxes: Spawning Salmon Drive Nutrient and Matter Export. *Ecology*, *88*(5), 1278–1291. https://doi.org/10.1890/06-0782

Morioka, R. (2014). Gender difference in the health risk perception of radiation from Fukushima in Japan: The role of hegemonic masculinity. *Social Science & Medicine*, *107*, 105–112. https://doi.org/10.1016/J.SOCSCIMED.2014.02.014

Morita, E., Fukuda, S., Nagano, J., Hamajima, N., Yamamoto, H., Iwai, Y., Nakashima, T., Ohira, H., & Shirakawa, T. (2007). Psychological effects of forest environments on healthy adults: Shinrin-yoku (forest-air bathing, walking) as a possible method of stress reduction. *Public Health, 121*(1), 54–63. https://doi.org/10.1016/j.puhe.2006.05.024

Moss, J., Mcmann, M., Zipprich, A., Macer, D. R. J., Aori, R., Ngo, D., Cheng, M., Manohar, N., & Wolbring, G. (2011). *Energy Equity and Environmental Security*. Retrieved from http://unesdoc.unesco.org/images/0021/002182/218271E.pdf

Motaleb, M. A. (2010). *Approaches to Conservation of Medicinal Plants and Traditional Knowledge: A Focus on the Chittagong Hill Tracts*. (R. Firoz, A. Adrika, & N. A. Khan, Eds.). Bangladesh Country Office, Dhaka, Bangladesh: IUCN (International Union for Conservation of Nature).

Motiee, H., Mcbean, E., Semsar, A., Gharabaghi, B., & Ghomashchi, V. (2006). Assessment of the Contributions of Traditional Qanats in Sustainable Water Resources Management. *International Journal of Water Resources Development*, *22*(4), 575–588. https://doi.org/10.1080/07900620600551304

Mushtaq, F., & Pandey, A. C. (2014). Assessment of land use/land cover dynamics vis-??-vis hydrometeorological variability in Wular Lake environs Kashmir Valley, India using multitemporal satellite data. *Arabian Journal of Geosciences*, *7*, 4707–4715. https://doi.org/10.1007/s12517-013-1092-1

Myers, N., Mittermeier, R. A., Mittermeier, C. G., Da Fonseca, G. A. B., & Kent, J. (2000). Biodiversity hotspots for conservation priorities. *Nature*, *403*(6772), 853–858.

Naqizdeh, N., Didari, A., & Farvar, T. (2012). Recognition and Support of ICCAs in Iran. In A. Kothari, C. Corrigan, H. Jonas, A. Neumann, & H. Shrumm (Eds.), *Recognising and Supporting Territories and Areas Conserved By Indigenous Peoples And Local Communities: Global Overview and National Case Studies* (p. 132-134). Montreal, Canada.

Nasi, R., Brown, D., Wilkie, D., Bennett, E., Tutin, C., van Tol, G., & Christophersen, T. (2008). *Conservation and use of wildlife-based resources: the bushmeat crisis*. *CBD Technical Series No. 33*. Montreal and Bogor: Secretariat of the Convention on Biological Diversity and Montreal, and Center for International Forestry Research (CIFOR). Retrieved from https://www.cbd.int/doc/publications/cbd-ts-33-en.pdf

National Human Rights Commission of Thailand. (2015). *2014 Human Rights Evaluation Report and Annual Report 2014 of the National Human Rights Commission of Thailand*.

National Parks Board Singapore. (2015). Singapore 5th National Report to the Convention on Biological Diversity (2010-2014).

National Wetland Atlas. (2013). *National Wetland Atlas: Wetlands of International Importance Under Ramsar Convention*. (T. V. R. Murthy, J. G. Patel, S. Panigrahy, & J. S. Parihar, Eds.). Ahmedabad, India: Space Applications Centre, ISRO. https://doi.org/ISBN 9789382760054

Natsagdorj, L., Jugder, D., & Chung, Y. S. (2003). Analysis of dust storms observed in Mongolia during 1937-1999. *Atmospheric Environment, Volume 37, Issue 9, p. 1401-1411.*, *37*, 1401–1411. https://doi.org/10.1016/S1352-2310(02)01023-3

Nature Conservancy. (2016). The Coral Triangle Initiative: Reefs, Fisheries and Food Security. Retrieved from http://www.nature.org/ourinitiatives/regions/asiaandthepacific/coraltriangle/overview/coral-triangle-initiative.xml

Needham, S., & Funge-Smith, S. J. (2014). *The consumption of fish and fish products in the Asia-Pacific region based on household surveys* (RAP Publication 2015/12). Bangkok, Thailand.

NIWA. (2010). *Waikato River independent scoping study*. Ministry for the Environment, New Zealand, National Institute of Water and Atmospheric Research, Hamilton. Retrieved from http://www.mfe.govt.nz/publications/fresh-water/waikato-river-independent-scoping-study

Norgaard, R. B. (2010). Ecosystem services: From eye-opening metaphor to complexity blinder. *Ecological Economics*, *69*(6), 1219–1227. https://doi.org/10.1016/j.ecolecon.2009.11.009

North Australian Land and Sea Management Alliance. (2012). WALFA-West Arnhem Land Fire Abatement project. Retrieved January 17, 2018, from https://www.nailsma.org.au/walfa-west-arnhem-land-fire-abatement-projecthtml.html

Nuno, A., & Bunnefeld, N. (2014). Managing social – ecological systems under uncertainty : implementation in. *Ecology and Society*, *19*(2).

Office of the Law Revision Council of the House of Representatives. (2007). *United States Code 2000 Edition Supplement Volume Six Jan 2 2001-Jan 2 2006. Title 43 to Title 50. Published under the authority of Title 2, U.S. Code, Section 285b, Washington, US*.

Okney, P. A. (2014). Legacies and Perils from the Perspective of the Republic of the Marshall Islands Nuclear Claims Tribunal. In D. D. Caron & H. N. Scheiber (Eds.), *The Oceans in the Nuclear Age*. Brill. Retrieved from http://www.brill.com/products/book/oceans-nuclear-age

Olsen, C. S. (1998). The trade in medicinal and aromatic plants from central Nepal to Northern India. *Economic Botany*, *52*(3), 279–292. https://doi.org/10.1007/BF02862147

Olson, D. M., & Dinerstein, E. (2002). The Global 200: Priority Ecoregions for Global Conservation. *Annals of the Missouri Botanical Garden*, *89*(2), 199. https://doi.org/10.2307/3298564

Olsson, P., Folke, C., & Berkes, F. (2004). Adaptive Comanagement for Building Resilience in Social-Ecological Systems. *Environmental Management*, *34*(1), 75–90. https://doi.org/10.1007/s00267-003-0101-7

Olsson, P., Folke, C., Galaz, V., Hahn, T., & Schultz, L. (2007). Enhancing the Fit through Adaptive Co-management: Creating and Maintaining Bridging Functions for Matching Scales in the Kristianstads Vattenrike Biosphere Reserve, Sweden. *Ecology and Society*, *12*(1), 28. Retrieved from http://www.ecologyandsociety.org/vol12/iss1/art28/

Ono, M., & Woodard, W. P. (1962). *Shint : the Kami way*. Tuttle Publishing, US.

Oposa v. Factoran. (1994). 224 SCRA 792 (1993); reprinted in 33 ILM 173 (1994).

Orr, A. G., & Hauser, C. L. (1996). Kuala Belalong, Brunei: A hotspot of old world butterfly diversity. *Tropical Lepidoptera Research*, *7*(1), 1–12. Retrieved from http://journals.fcla.edu/troplep/article/view/90054

Ostrom, E. (1990). *Governing the commons: The evolution of institutions for collective action*. Cambridge, United Kingdom: Cambridge University Press.

Othman, J., Sahani, M., Mahmud, M., & Sheikh Ahmad, M. K. (2014). Transboundary smoke haze pollution in Malaysia: Inpatient health impacts and economic valuation. *Environmental Pollution*, *189*, 194–201. https://doi.org/10.1016/j.envpol.2014.03.010

Ouyang, Z., Zheng, H., Xiao, Y., Polasky, S., Liu, J., Xu, W., Wang, Q., Zhang, L., Xiao, Y., Rao, E., Jiang, L., Lu, F., Wang, X., Yang, G., Gong, S., Wu, B., Zeng, Y., Yang, W., & Daily, G. C. (2016). Improvements in ecosystem services from investments in natural capital. *Science*, *352*(6292). Retrieved from http://science.sciencemag.org/content/352/6292/1455

Özensel, E. (2013). In Search of Coexistence in Eastern Societies: Multiculturalism or a New Model? In *Proceedings of First International and Middle East Conference on Sustainability and Human Development*.

Pachauri, S., Mueller, A., Kemmler, A., & Spreng, D. (2004). On measuring energy poverty in Indian households. *World Development*, *32*(12), 2083–2104. https://doi.org/10.1016/j.worlddev.2004.08.005

Pandit, R., Polyakov, M., & Sadler, R. (2014). Valuing public and private urban tree canopy cover. *Australian Journal of Agricultural and Resource Economics*, *58*(3), 453–470. https://doi.org/10.1111/1467-8489.12037

Pandit, R., Subroy, V., Garnett, S. T., Zander, K. K., & Pannell, D. (2015). *A review of non-market valuation studies of threatened species and ecological communities*. *Report to the National Environmental Science Programme*. Canberra: Department of the Environment.

Panipilla, R., & Jament, J. (2016). *Mukkuva Community in South India: socio-religious history and biocultural diversity*. Paris. Retrieved from http://fmlindia.in/wp-content/uploads/2017/01/UNESCO-Case-Study-Report-Final.pdf

Park, B. J., Tsunetsugu, Y., Kasetani, T., Kagawa, T., & Miyazaki, Y. (2010). The physiological effects of Shinrin-yoku (taking in the forest atmosphere or forest bathing): Evidence from field experiments in 24 forests across Japan. *Environmental Health and Preventive Medicine*, *15*(1), 18–26. https://doi.org/10.1007/s12199-009-0086-9

Park, M. S., & Youn, Y.-C. (2013). Development of urban forest policy-making toward governance in the Republic of Korea. *Urban Forestry & Urban Greening*, *12*(3), 273–281. https://doi.org/10.1016/j.ufug.2013.04.004

Pascual, U., Balvanera, P., Díaz, S., Pataki, G., Roth, E., Stenseke, M., Watson, R. T., Başak Dessane, E., Islar, M., Kelemen, E., Maris, V., Quaas, M., Subramanian, S. M., Wittmer, H., Adlan, A., Ahn, S. E., Al-Hafedh, Y. S., Amankwah, E., Asah, S. T., Berry, P., Bilgin, A., Breslow, S. J., Bullock, C., Cáceres, D., Daly-Hassen, H., Figueroa, E., Golden, C. D., Gómez-Baggethun, E., González-Jiménez, D., Houdet, J., Keune, H., Kumar, R., Ma, K., May, P. H., Mead, A., O'Farrell, P., Pandit, R., Pengue, W., Pichis-Madruga, R., Popa, F., Preston, S., Pacheco-Balanza, D., Saarikoski, H., Strassburg, B. B., van den Belt, M., Verma, M., Wickson, F., & Yagi, N. (2017). Valuing nature's contributions to people: the IPBES approach. *Current Opinion in Environmental Sustainability*, *26–27*, 7–16. https://doi.org/10.1016/j.cosust.2016.12.006

Peel, E., Cheng, Y., Djordjevic, J. T., Fox, S., Sorrell, T. C., & Belov, K. (2016). Cathelicidins in the Tasmanian devil (Sarcophilus harrisii). *Scientific Reports*, *6*(1), 35019. https://doi.org/10.1038/srep35019

Pereira, L. M., & Ruysenaar, S. (2012). Moving from traditional government to new adaptive governance: the changing face of food security responses in South Africa. *Food Security*, *4*(1), 41–58. https://doi.org/10.1007/s12571-012-0164-5

Perera, J. (2009). *Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act 2006: A Charter of Forest Dwellers' Rights? Land and Cultural Survival: The Communal Land Rights of Indigenous Peoples in Asia*. Retrieved from http://www.adb.org/sites/default/files/publication/27980/land-cultural-survival.pdf

Pérez, a a, Fernández, B. H., & Gatti, R. C. (2010). *Building Resilience to Climate Change: Ecosystem-based adaptation and lessons from the field*.

Peters, M. A., Eames, C., & Hamilton, D. (2015). The use and value of citizen science data in New Zealand. *Journal of the Royal Society of New Zealand*, *45*(3), 151–160. https://doi.org/10.1080/03036758.2015.1051549

Peters, M. A., Eames, C., & Hamilton, D. (2015). The use and value of citizen science data in New Zealand. *Journal of the Royal Society of New Zealand*, *45*(3), 151–160. Retrieved from http://www.tandfonline.com/doi/abs/10.1080/03036758.2015.1051549?tab=permissions&scroll=top&

Peters, M. A., Hamilton, D., & Eames, C. (2015). Action on the ground: A review of community environmental groups' restoration objectives, activities and partnerships in New Zealand. *New Zealand Journal of Ecology*, *39*(2), 179–189. Retrieved from http://newzealandecology.org/nzje/3234.pdf

Pew Research Center. (2012). *The Global Religious Landscape. A Report on the Size and Distribution of the World's Major Religious Groups as of 2010*. Washington, D.C. Retrieved from https://unitedcor.org/sites/default/files/edit-contentfile/butte_county/International - Pew Religious Study.pdf

Pilumwong, J. (2017). Local Biodiversity Restoration for Food Banks in the Highland Community of Thailand. In W. V. Alangui, K. Ichikawa, & Y. Takahashi (Eds.), *IPBES-JBF Sub-regional Dialogue Workshop Report on Indigenous and Local Knowledge (ILK) for South-East and North-East Asia sub-region, Thailand* (p. 143). Tokyo, Japan: Institute for Global Environmental Strategies. Retrieved from https://pub.iges.or.jp/pub/ipbes-jbf-sub-regional-dialogue-workshop-0

Pisupati, B., & Rubian, R. (2008). MDG on Reducing Biodiversity Loss and the CBD‘s 2010 Target. Retrieved January 30, 2016, from http://www.eldis.org/go/home&id=41878&type=Document#.WNHPMFTyiUn

Plummer, R. (2009). The Adaptive Co-Management Process: an Initial Synthesis of Representative Models and Influential Variables. *Ecology and Society*, *14*(2).

Polasky, S., Nelson, E., Pennington, D., & Johnson, K. A. (2011). The Impact of Land-Use Change on Ecosystem Services, Biodiversity and Returns to Landowners: A Case Study in the State of Minnesota. *Environmental and Resource Economics*, *48*(2), 219–242. https://doi.org/10.1007/s10640-010-9407-0

Polyakov, M., Fogarty, J., Zhang, F., Pandit, R., & Pannell, D. J. (2016). The value of restoring urban drains to living streams. *Water Resources and Economics*, 1–14. https://doi.org/10.1016/j.wre.2016.03.002

Pope Francis. (2015). Encyclical Letter Laudato Si' of the Holy Father Francis on Care for Our Common Home. The Vatican. Retrieved from http://w2.vatican.va/content/dam/francesco/pdf/encyclicals/documents/papa-francesco_20150524_enciclica-laudato-si_en.pdf

Pople, T., & Grigg, G. (1999). *Commercial harvesting of Kangaroos in Australia*. Retrieved from http://www.environment.gov.au/resource/commercial-harvesting-kangaroos-australia

Primmer, E., Schleyer, C., Bela, G., Bouwma, I., Görg, C., Keune, H., Mortelmans, D., & Saarikoski, H. (2014). Institutional Analysis. In K. Potschin, M. and Jax (Ed.), *OpenNESS Reference Book. EC FP7 Grant Agreement no. 308428*. https://doi.org/10.4016/15656.01

Prober, S. M., O'Connor, M. H., Walsh, F. J., Connor, M. H. O., & Walsh, F. J. (2011). Australian Aboriginal Peoples ' Seasonal Knowledge : a Potential Basis for Shared Understanding in Environmental Management. *Ecology And Society*, *16*(2). https://doi.org/12

Proudfoot, I. (2006). *Old Muslim Calendars of Southeast Asia*. Brill. Retrieved from http://www.brill.com/old-muslim-calendars-southeast-asia

Prugh, L. R., Hodges, K. E., Sinclair, A. R. E., & Brashares, J. S. (2008). Effect of habitat area and isolation on fragmented animal populations. *Proceedings of the National Academy of Sciences of the United States of America*, *105*(52), 20770–20775. https://doi.org/10.1073/pnas.0806080105

Pulhin, J., Amaro, J. M., & Bacalla, C. (2006). Phippines community-based forest management 2005. In RECOFTC (Ed.), *First Regional Community Forestry Forum – Regulatory Frameworks for Community Forestry in Asia (Proceedings of a Regional Forum held in Bangkok, Thailand, August 24-25)* (pp. 85–100).

Qin, H. (2010). Rural-to-Urban Labor Migration, Household Livelihoods, and the Rural Environment in Chongqing Municipality, Southwest China. *Human Ecology*, *38*(5), 675–690. https://doi.org/10.1007/s10745-010-9353-z

Quah, E. (2002). Transboundary Pollution in Southeast Asia: The Indonesian Fires. *World Development*, *30*(3), 429–441. https://doi.org/10.1016/S0305-750X(01)00122-X

Ramakrishnan, P. S., Saxena, K. G., & Chandrasekharan, U. M. (1998). *Conserving the sacred for biodiversity management*. New Delhi, India: Oxford and IBH publication Co Pvt Ltd.

Ramawat, K. G., & Merillon, J. M. (2008). *Bioactive molecules and medicinal plants*. Springer.

Rattanakrajangsri, K., Shimray, G., & Indigenous Peoples' Foundation for Education and Environment. (2017). Forest, Communities and Ecosystems: The case of Huay Hin Lad Nai community. In W. V. Alangui, K. Ichikawa, & Y. Takahashi (Eds.), *IPBES-JBF Sub-regional Dialogue Workshop Report on Indigenous and Local Knowledge (ILK) for South-East and North-East Asia sub-region, Thailand* (p. 143 pages). Tokyo, Japan: Institute for Global Environmental Strategies. Retrieved from https://pub.iges.or.jp/pub/ipbes-jbf-sub-regional-dialogue-workshop-0

Ravindranath, N. H., & Sudha, P. (2004). *Joint Forest Management in India: Spread, Performance and Impact*. Hyderabad, India: Universities Press.

RECOFTC. (2009). *Is There a Future Role for Forests and Forestry in Reducing Poverty? Asia-Pacific Forestry Sector Outlook Study II* (Working Paper Series No. APFSOS II/WP/2009/24). Bangkok: Regional Community Forestry Training Center. Retrieved from http://www.fao.org/docrep/014/am619e/am619e00.pdf

Redpath, S. M., Young, J., Evely, A., Adams, W. M., Sutherland, W. J., Whitehouse, A., Amar, A., Lambert, R. A., Linnell, J. D. C., Watt, A., & Gutiérrez, R. J. (2013). Understanding and managing conservation conflicts. *Trends in Ecology and Evolution*, *28*(2), 100–109. https://doi.org/10.1016/j.tree.2012.08.021

Reed, J., van Vianen, J., Barlow, J., & Sunderland, T. (2017). Have integrated landscape approaches reconciled societal and environmental issues in the tropics? *Land Use Policy*. https://doi.org/10.1016/j.landusepol.2017.02.021

Reidsma, P., Tekelenburg, T., van den Berg, M., & Alkemade, R. (2006). Impacts of land-use change on biodiversity: An assessment of agricultural biodiversity in the European Union. *Agriculture, Ecosystems & Environment*, *114*(1), 86–102. https://doi.org/10.1016/J.AGEE.2005.11.026

Republic of Vanuatu. (1980). Constitution of the Republic of Vanuatu. Retrieved from http://publicofficialsfinancialdisclosure.worldbank.org/sites/fdl/files/assets/law-library-files/Vanuatu_Constitution_en.pdf

Rights and Resources Initiative. (2014). *What Future for Reform ?* Washington, DC.

Rights and Resources Initiative. (2015). *Who owns the world's lands? A global baseline of formally recognized indigenous and community land rights*. Washington, DC.

Rights and Resources Initiative, Woods Hole Research Center, & World Resources Institute. (2016). *Toward a Global Baseline of Carbon Storage in Collective Lands: An Updated Analysis of Indigenous Peoples' and Local Communities' Contributions to Climate Change Mitigation*. Washington. Retrieved from http://rightsandresources.org/wp-content/uploads/2016/10/Toward-a-Global-Baseline-of-Carbon-Storage-in-Collective-Lands-November-2016-RRI-WHRC-WRI-report.pdf

Ripple, W. J., Abernethy, K., Betts, M. G., Chapron, G., Dirzo, R., Galetti, M., Levi, T., Lindsey, P. A., Macdonald, D. W., Machovina, B., Newsome, T. M., Peres, C. A., Wallach, A. D., Wolf, C., & Young, H. (2016). Bushmeat hunting and extinction risk to the world's mammals. *Royal Society Open Science*, *3*(10), 160498. https://doi.org/10.1098/rsos.160498

Robb, C., & Bright, J. (2004). Values and uses of water. In J. Harding, M. Mosley, C. Pearson, & B. Sorrell (Eds.), *Freshwaters of New Zealand* (p. 42.1–42.14). Christchurch: New Zealand Hydrological Society and New Zealand Limnological Society.

Robinson, B. E., Holland, M. B., & Naughton-Treves, L. (2014). Does secure land tenure save forests? A meta-analysis of the relationship between land tenure and tropical deforestation. *Global Environmental Change*, *29*, 281–293. https://doi.org/10.1016/j.gloenvcha.2013.05.012

Rose, B. (2015). Southeast Asia's Illicit Wildlife Trade: International Cooperation Necessary to Find Solution. Retrieved from http://www.eastbysoutheast.com/southeast-asias-illicit-wildlife-trade-international-cooperation-necessary-to-find-solution/

Rosenfeld, D., Rudich, Y., & Lahav, R. (2001). Desert dust suppressing precipitation: a possible desertification feedback loop. *Proceedings of the National Academy of Sciences of the United States of America*, *98*(11), 5975–5980. https://doi.org/10.1073/pnas.101122798

Rulli, M. C., Saviori, A., & D'Odorico, P. (2013). Global land and water grabbing. *PNAS*, *110*(3), 892–897. https://doi.org/10.1073/pnas.1213163110/-/DCSupplemental.www.pnas.org/cgi/doi/10.1073/pnas.1213163110

Runting, R. K., Bryan, B. A., Dee, L. E., Maseyk, F. J. F., Mandle, L., Hamel, P., Wilson, K. A., Yetka, K., Possingham, H. P., & Rhodes, J. R. (2017). Incorporating climate change into ecosystem service assessments and decisions: a review. *Global Change Biology*. https://doi.org/10.1111/gcb.13457

Russell-Smith, J., Lucas, D., Gapindi, M., Gunbunuka, B., Kapirigi, N., Namingum, G., Lucas, K., Giuliani, P., & Chaloupka, G. (1997). Aboriginal Resource Utilization and Fire Management Practice in Western Arnhem Land, Monsoonal Northern Australia: Notes for Prehistory, Lessons for the Future. *Human Ecology*, *25*(2), 159–195. https://doi.org/10.1023/A:1021970021670

Safi, K., Armour-Marshall, K., Baillie, J. E. M., & Isaac, N. J. B. (2013). Global Patterns of Evolutionary Distinct and Globally Endangered Amphibians and Mammals. *PLoS ONE*, *8*(5), e63582. https://doi.org/10.1371/journal.pone.0063582

Sathyapalan, J. (2005). Households' dependence on protected forests: Evidence from the western Ghats. *Indian Journal of Agricultural Economics*, *60*(1), 60–70.

Sathyapalan, J., & Reddy, M. G. (2010). *Recognition of Forest Rights and Livelihoods of Tribal Communities A Study of Western Ghats Region, Kerala State*.

Sattout, E. J., Talhouk, S. N., & Caligari, P. D. S. (2007). Economic value of cedar relics in Lebanon: An application of contingent valuation method for conservation. *Ecological Economics*, *61*(2–3), 315–322. https://doi.org/10.1016/j.ecolecon.2006.03.001

Scheffers, B. R., Corlett, R. T., Diesmos, A., & Laurance, W. F. (2012). Local Demand Drives a Bushmeat Industry in a Philippine Forest Preserve. *Tropical Conservation Science*, *5*(2), 133–141. https://doi.org/10.1177/194008291200500203

Schippmann, U., Leaman, D., & Cunningham, A. B. (2006). A comparison of cultivation and wild collection of medicinal and aromatic plants under sustainability aspects. In *Medicinal and Aromatic Plants: Agricultural, Commercial, Ecological, Legal, Pharmacological and Social Aspects* (pp. 75–95). Retrieved from https://library.wur.nl/ojs/index.php/frontis/article/view/1225

Scott, W. R. (2001). *Institutions and Organisations* (2nd ed.). Thousand Oaks: Sage Publications.

Sekercioglu, C. H. (2006). Increasing awareness of avian ecological function. *Trends in Ecology & Evolution*, *21*(8), 464–471. https://doi.org/10.1016/j.tree.2006.05.007

Şekercioğlu, Ç. H., Anderson, S., Akçay, E., Bilgin, R., Can, Ö. E., Semiz, G., Tavşanoğlu, Ç., Yokeş, M. B., Soyumert, A., & Ipekdal, K. (2011). Turkey's globally important biodiversity in crisis. *Biological Conservation*, *144*(12), 2752–2769.

Shah, A. (2005). *Land Degradation and Migration in a Dry Land Region in India* (No. SANDEE Working Paper No. 10-05). Kathmandu, Nepal. Retrieved from http://www.sandeeonline.org/uploads/documents/publication/774_PUB_report_wp10.pdf

Shairp, R., Veríssimo, D., Fraser, I., Challender, D., & MacMillan, D. (2016). Understanding Urban Demand for Wild Meat in Vietnam: Implications for Conservation Actions. *PLOS ONE*, *11*(1), e0134787. https://doi.org/10.1371/journal.pone.0134787

Sharma, R., Aggarwal, N., & Kumar, S. (2014). Ecological Sustainability in India through the Ages. *International Research Journal of Environment Sciences*, *3*(1), 70–73. Retrieved from http://www.isca.in/IJENS/Archive/v3/i1/13.ISCA-IRJEvS-2013-254.pdf

Sharma, U. R., Malla, K. J., & Uprety, R. K. (2004). *Banko janakari : a journal of forestry information for nepal. Banko Janakari* (Vol. 14). Retrieved from https://www.nepjol.info/index.php/BANKO/article/view/17044/13851

Shin, Y.-K., Kim, D. J., Jung-Choi, K., Son, Y., Koo, J.-W., Min, J.-A., & Chae, J.-H. (2013). Differences of psychological effects between meditative and athletic walking in a forest and gymnasium. *Scandinavian Journal of Forest Research*, *28*(1), 64–72. https://doi.org/10.1080/02827581.2012.706634

Shinwari, Z. K. (2010). Medicinal plants research in Pakistan. *Journal of Medicinal Plants Research*, *4*(3), 161–176. Retrieved from http://www.academicjournals.org/journal/JMPR/article-abstract/19C2CE115158

Shrestha, S. S., & Bhandari, P. B. (2005). Environmental Security and Labour Migration in Nepal. Tours, France: IUSSP's XXV International Population Conference.
Sierra, R. (1999). Traditional resource-use systems and tropical deforestation in a multi-ethnic region in North-West Ecuador. *Environmental Conservation*, *26*(2), 136–145.
Simon, S. L., & Bouville, A. (2015). Health effects of nuclear weapons testing. *The Lancet*, *386*(9992), 407–409. https://doi.org/10.1016/S0140-6736(15)61037-6
Slovic, P., Fischhoff, B., & Lichtenstein, S. (1980). Facts and Fears: Understanding Perceived Risk. In *Societal Risk Assessment* (pp. 181–216). Boston, MA: Springer US. https://doi.org/10.1007/978-1-4899-0445-4_9
Slowinski, J. B., & Crother, B. I. (1998). Is the PTP Test Useful? *Cladistics*, *14*(3), 297–302. https://doi.org/10.1111/j.1096-0031.1998.tb00340.x
Snow Leopard Trust. (2013). The Bishkek Declaration on the Conservation of the Snow Leopard. Retrieved April 18, 2017, from https://www.snowleopard.org/the-bishkek-declaration-on-the-conservation-of-the-snow-leopard/
Sodhi, N. S., & Brook, B. W. (2006). *Southeast Asian biodiversity in crisis*. Cambridge University Press.
Sodhi, N. S., Brooks, T. M., Koh, L. P., Acciaioli, G., Erb, M., Tan, A. K. J., Curran, L. M., Brosius, P., Lee, T. M., Patlis, J. M., Gumal, M., & Lee, R. J. (2006). Biodiversity and human livelihood crises in the Malay Archipelago. *Conservation Biology*, *20*(6), 1811–1813. https://doi.org/10.1111/j.1523-1739.2006.00541.x
Song, C., Ikei, H., Kobayashi, M., Miura, T., Li, Q., Kagawa, T., Kumeda, S., Imai, M., & Miyazaki, Y. (2017). Effects of viewing forest landscape on middle-aged hypertensive men. *Urban Forestry and Urban Greening*, *21*, 247–252. https://doi.org/10.1016/j.ufug.2016.12.010
Spalding, M., Kainuma, M., & Collins, L. (2010). *World Atlas of Mangroves. Earthscan, London.*
Sponsel, L. E. (2012). *Spiritual Ecology: A Quiet Revolution*. Praeger.
Squires, D. (2014). Biodiversity Conservation in Asia. *Asia & the Pacific Policy Studies*, *1*(1), 144–159. https://doi.org/10.1002/app5.13
State of Queensland. (1984). Community Services (Aborigines) Act 1984. State of Queensland. Retrieved from https://www.legislation.qld.gov.au/view/pdf/1997-06-01/act-1984-051
State of the Tropics. (2014). *State of the Tropics 2014 report*. Retrieved from https://www.jcu.edu.au/state-of-the-tropics/publications/2014/2014-report/SOTT-2014-Section1-Introduction.pdf
Staudinger, M. D., Grimm, N. B., Staudt, A., Carter, S. L., Stuart III, F. S., Kareiva, P., Ruckelshaus, M., & Stein, B. A. (2012). *Impacts of climate change on biodiversity, ecosystems, and ecosystem services: technical input to the 2013 National Climate Assessment*. Washington, D.C. Retrieved from http://pubs.er.usgs.gov/publication/70039460
Stern, P. C. (2000). Toward a Coherent Theory of Environmentally Significant Behavior. *Journal of Social Issues*, *56*(3), 407–424. https://doi.org/10.1111/0022-4537.00175
Streets, D. G., Yarber, K. F., Woo, J.-H., & Carmichael, G. R. (2003). Biomass burning in Asia: Annual and seasonal estimates and atmospheric emissions. *Global Biogeochemical Cycles*, *17*(4), n/a-n/a. https://doi.org/10.1029/2003GB002040
Subrat, N., Iyer, M., & Prasad, R. (2002). *The ayurvedic medicine industry: Current status and sustainability. Ecotech Services (India) Pvt.* London.
Suhardiman, D., Giordan, M., Keovilignavong, O., & Sotoukee, T. (2015). Revealing the hidden effect of land grabbing through better understanding of farmers' strategies in dealing with land loss. *Land Use Policy*, *49*, 195–202. https://doi.org/10.1016/j.landusepol.2015.08.014
Sunderlin, W. D. (2006). Poverty alleviation through community forestry in Cambodia, Laos, and Vietnam: An assessment of the potential. *Forest Policy and Economics*, *8*(4), 386–396. https://doi.org/10.1016/j.forpol.2005.08.008
Sutton, V. (2005). Custom, Tradition And Science In the South Pacific: Fiji's New Environmental Management Act and Vanuatu. *Journal of South Pacific Law*, *9*(2).
Swamy, V., & Pinedo-Vasquez, M. (2014). *Bushmeat harvest in tropical forests: Knowledge base, gaps and research priorities* (Occasional Paper 114). Bogor, Indonesia. Retrieved from http://www.cifor.org/publications/pdf_files/OccPapers/OP-114.pdf

Sweeney, D. (1993). Fishing, Hunting and Gathering Rights of Aboriginal Peoples in Australia. *University of New South Wales Law Journal*, *16*(1), 97–160.
Takala, B. A. (2017). Ejab maron ERUB: Recentering traditional Marshallese Knowledge Systems (MKS). In R. Hill, H. Scheyvens, & T. Shortland (Eds.), *IPBES-JBF Sub-regional Dialogue Workshop Report on Indigenous and Local Knowledge (ILK) for Pacific sub-region, New Zealand (1-4 Nov. 2016)*. Tokyo, Japan: Institute for Global Environmental Strategies. Retrieved from https://pub.iges.or.jp/pub/ipbes-jbf-sub-regional-dialogue-workshop-1
Takeuchi, K. (2003). Satoyama Landscapes as Managed Nature. In K. Takeuchi, R. D. Brown, I. Washitani, A. Tsunekawa, & M. Yokohari (Eds.), *Satoyama: The Traditional Rural Landscape of Japan* (pp. 9–16). Tokyo: Springer.
TBTI. (2015). State of small-scale fisheries research: Asia & Oceania. Too Big to Ignore (Global Partneship for Small Scale Fisheries). Retrieved from http://toobigtoignore.net/wp-content/uploads/2014/09/asia.oceania.poster.final_.pdf
Techera, E. J. (2009). Customary law and community-based fisheries management across the South Pacific region. *Journal of the Australasian Law Teachers Association*, *24*, 279–292.
Techera, E. J. (2015). Enhancing legal frameworks for biodiversity conservation in the Pacific. *Pacific Conservation Biology*, 1–10. https://doi.org/10.1071/PC14906
TEEB. (2010). *The Economics of Ecosystems and Biodiversity Ecological and Economic Foundations*. (P. Kumar, Ed.). London and Washington: Earthscan.
TEEB. (2011). *The Economics of Ecosystems and Biodiversity (TEEB) in National and International Policy Making*. (P. ten Brink, Ed.). Earthscan, London and Washington.
The Coral Triangle. (2017). The Coral Triangle - Amazon of the Ocean. Retrieved April 18, 2017, from http://thecoraltriangle.com/
Thompson, I., Mackey, B., Mcnulty, S., & Mosseler, A. (2009). *Forest Resilience, Biodiversity, and Climate Change. A Synthesis of the Biodiversity/Resilience/Stability Relationship in Forest Ecosystems*. *CBD Technical Series No. 43*. Montreal: Secretariat of the Convention on Biological Diversity. Retrieved from https://www.cbd.int/doc/publications/cbd-ts-43-en.pdf
Tipa, G., & Teirney, L. D. (2006). *Using the Cultural Health Index: How to assess the health of streams and waterways*. Ministry for the Environment, Manatū Mō Te Taiao.
Tisdell, C. (2014). *Human Values and Biodiversity Conservation : The Survival of Wild Species*. Cheltenham: UK: Edward Elgar Publishing.
Tisdell, C., Nantha, H. S., & Wilson, C. (2007). Endangerment and likeability of wildlife species: How important are they for payments proposed for conservation? *Ecological Economics*, *60*, 627–633. https://doi.org/10.1016/j.ecolecon.2006.01.007
Tisdell, C., & Wilson, C. (2006). Information, wildlife valuation, conservation: Experiments and policy. *Contemporary Economic Policy*, *24*(1), 144–159. https://doi.org/10.1093/cep/byj014
Tisdell, C., Wilson, C., & Nantha, H. S. (2005). Policies for saving a rare Australian glider: economics and ecology. *Biological Conservation*, *123*(2), 237–248. https://doi.org/10.1016/j.biocon.2004.11.012
Tiwari, D. D., & Campbell, J. Y. (1993). *Developing and Sustaining Nontimber Forest Products: Some Policy Issues and Concerns with a Special Reference to India*. Ahmedabad.
Tiwari, P. C. (2000). Land-use changes in Himalaya and their impact on the plains ecosystem: need for sustainable land use. *Land Use Policy*, *17*(2), 101–111. https://doi.org/10.1016/S0264-8377(00)00002-8
Tompkins, E. L., & Adger, W. N. (2004). Does adaptive management of natural resources enhance resilience to climate change? *Ecology and Society*, *9*(2). https://doi.org/10
Tonini, J. F. R., Beard, K. H., Ferreira, R. B., Jetz, W., & Pyron, R. A. (2016). Fully-sampled phylogenies of squamates reveal evolutionary patterns in threat status. *Biological Conservation*, *204*, 23–31. https://doi.org/10.1016/J.BIOCON.2016.03.039
Tropical Savannas CRC. (n.d.). West Arnhem Land Fire Abatement Project. Retrieved January 17, 2018, from http://savanna.cdu.edu.au/information/arnhem_fire_project.html
Tsunetsugu, Y., Lee, J., Park, B. J., Tyrväinen, L., Kagawa, T., & Miyazaki, Y. (2013). Physiological and psychological effects of viewing urban forest landscapes assessed by multiple measurements. *Landscape and Urban Planning*, *113*, 90–93. https://doi.org/10.1016/j.landurbplan.2013.01.014

Tubiello, F. N., Rahman, A., Mann, W., Schmidhuber, J., Koleva, M., & Müller, A. (2009). Carbon financial mechanisms for agriculture and rural development: challenges and opportunities along the Bali roadmap. *Climatic Change*, *97*(1–2), 3–21. https://doi.org/10.1007/s10584-009-9611-5
Tuncak, B. (2015). *Report of the Special Rapporteur on the implications for human rights of the environmentally sound management and disposal of hazardous substances and wastes. A/HRC/30/40: United Nations General Assembly Human Rights Council Thirtieth Session*.
Turner, M. G., Romme, W. H., Gardner, R. H., O'Neill, R. V., & Kratz, T. K. (1993). A revised concept of landscape equilibrium: Disturbance and stability on scaled landscapes. *Landscape Ecology*, *8*(3), 213–227. https://doi.org/10.1007/BF00125352
Turner, M., Nassar, K., & Al Khateeb, N. (2005). *Crossing the Jordan: Concept document to rehabilitate, promote prosperity and help bring peace to the Lower Jordan River Valley*. Amman, Bethlehem and Tel Aviv. Retrieved from http://ecopeaceme.org/uploads/publications_publ21_1.pdf
Turner, N. J., Ignace, M. B., & Ignace, R. (2000). Traditional Ecological Knowledge and Wisdom of Aboriginal Peoples in British Columbia. *Ecological Applications*, *10*(October), 1275–1287.
Turner, W. R., Oppenheimer, M., & Wilcove, D. S. (2009). A force to fight global warming. *Nature*, *462*(7271), 278–279. https://doi.org/10.1038/462278a
Turpin, M., Ross, A., Dobson, V., & Turner, M. K. (2013). The spotted nightjar calls when dingo pups are born: Ecological and social indicators in central Australia. *Journal of Ethnobiology*, *33*(1), 7–32. https://doi.org/10.2993/0278-0771-33.1.7
UKNEA. (2011). *The UK National Ecosystem Assessment Technical Report*. Cambridge, UK.
UN-Habitat, & UNESCAP. (2015). *The State of Asian and Pacific Cities 2015, Urban transformations Shifting from quantity to quality*. Retrieved from http://www.unescap.org/sites/default/files/The State of Asian and Pacific Cities 2015.pdf
UN Interagency Framework Team for Preventive Action. (2011). Toolkit and Guidance for Preventing and Managing Land and Natural Resources Conflict. *The United Nations Interagency Framework Team for Preventive Action*. https://doi.org/10.1038/206985b0
UNDP. (1994). *Human Development Report 1994*. https://doi.org/http://hdr.undp.org/sites/default/files/reports/255/hdr_1994_en_complete_nostats.pdf
UNDP. (2004). *World Energy Assessment: Overview 2004*. *Energy*.
UNDP. (2012). *One Planet to Share Sustaining Human Progress in a Changing Climate: Sustaining human progress in a changing climate*. Retrieved from file:///C:/Users/AR/Downloads/UNDP_Asia_Pacific_H DR_En_2012.pdf
UNDP. (2013). *Water Governance in the Arab Region*. *Book*.
UNEP-WCMC. (2009). Preconditions for harmonization of reporting to biodiversity-related multilateral environmental agreements, (June), 1–10.
UNEP. (2010). *Technology Transfer and Cooperation under the Convention on Biological Diversity. Towards more effective implementation*. *Issue Brief*. Retrieved from http://staging.unep.org/delc/portals/119/TechnicalTransferCBD.pdf
UNEP. (2012). *Global Environment Outlook (GEO 5), Environment for the future we want*. Retrieved from http://www.unep.org/geo/geo5.asp
UNEP. (2016). Enhancing Synergies across Global Biodiversity Conventions - Experiences from the Global South Workshop Proceedings and Country Reports (p. 96). Nairobi, Kenya: United Nations Environment Programme.
UNESCAP. (n.d.). Asia Pacific: Response to Climate Change. Retrieved January 16, 2018, from http://www.unescap.org/ru/node/11461
UNESCAP. (2005). *State of the Environment in Asia and the Pacific. Bangkok: United Nations ESCAP*. Bangkok, Thailand. Retrieved from http://www.unescap.org/resources/state-environment-asia-and-pacific-2005
UNESCAP. (2008). *Energy Security and Sustainable Development in Asia and the Pacific*. Bangkok, Thailand: United Nations Economic and Social Commission for Asia and the Pacific.
UNESCAP. (2013). *Urbanisation Trends in Asia and the Pacific*. Bangkok, Thailand.
UNESCAP. (2014). Statistical Yearbook for Asia and the Pacific 2014. Retrieved September 15, 2015, from http://www.unescap.org/resources/statistical-yearbook-asia-and-pacific-2014

UNESCAP. (2015). *Economic and Social Survey of Asia and the Pacific 2015: Making Growth More Inclusive for Sustainable Development*. Bangkok. Retrieved from http://www.unescap.org/sites/default/files/Economic and Social Survey of Asia and the Pacific 2015.pdf

UNESCAP. (2017). *Statistical Yearbook for Asia and the Pacific 2016: SDG Baseline Report*. Bangkok. Retrieved from http://www.unescap.org/sites/default/files/ESCAP_SYB2016_SDG_baseline_report.pdf

Union for Ethical BioTrade. (2015). UEBT Biodiversity Barometer 2009-2015. Retrieved from http://ethicalbiotrade.org/dl/UEBT - EN Barometer 2015.pdf

Union for Ethical BioTrade. (2016). *UEBT Biodiversity Barometer 2009-2016*. Retrieved from http://ethicalbiotrade.org/dl/Baro-2016-web.pdf

United Nations. (1948). *Universal Declaration of Human Rights*. UN General Assembly.

United Nations. (1982). World Charter for Nature, adopted by the General Assembly, 48th plenary meeting, 28 October 1982, A/Res/37/7. Retrieved from http://www.un.org/documents/ga/res/37/a37r007.htm

United Nations. (2007). United Nations Declaration on the Rights of Indigenous Peoples, GA Res 61/295, UN GAOR, 61st sess, 107th plen mtg, Supp No 49, UN Doc A/RES/61/295. United Nations. Dag Hammarskjöld Library. Retrieved from http://research.un.org/en/docs/ga/quick/regular/61

United Nations. (2009). A/RES/64/196, Resolution adopted by the General Assembly on 21 December 2009. 64/196. Harmony with Nature. Retrieved from http://www.un.org/en/ga/search/view_doc.asp?symbol=A/RES/64/196

United Nations. (2011a). A/RES/65/164, Resolution adopted by the General Assembly on 20 December 2010. 65/164. Harmony with Nature. Retrieved from http://www.un.org/en/ga/president/65/initiatives/Harmony with Nature/A-RES-65-164.pdf

United Nations. (2011b). A/RES/66/204, Resolution adopted by the General Assembly on 22 December 2010. 66/204. Harmony with Nature. United Nations. Retrieved from http://www.un.org/en/ga/search/view_doc.asp?symbol= A/RES/66/204

United Nations. (2013). Population Facts. Retrieved September 8, 2015, from http://www.un.org/en/development/desa/population/publications/pdf/popfacts/PopFacts_2013-2_new.pdf

United Nations. (2014). Achieving Development Results in Asia and the Pacific 2013-2014. Retrieved January 31, 2016, from http://www.cn.undp.org/content/china/en/home/library/annual-reports/achieving-development-results-in-asia-and-the-pacific--2013-2014.html

United Nations. (2015a). *State of the World's Indigenous Peoples 2015*. Retrieved from http://www.un.org/esa/socdev/unpfii/documents/2015/sowip2volume-ac.pdf

United Nations. (2015b). *The Millennium Development Goals Report*. New York. https://doi.org/978-92-1-101320-7

United Nations. (2015c). *World Population Prospects The 2015 Revision, Key Findings and Advance Tables* (Working Paper No. ESA/P/WP.241). Retrieved from http://esa.un.org/unpd/wpp/Publications/Files/Key_Findings_WPP_2015.pdf

United Nations. (2016a). *GEO-6 Regional Assessment for Asia and the Pacific*.

United Nations. (2016b). *The First Global Integrated Marine Assessment: World Ocean Assessment 1*. Retrieved from http://www.un.org/Depts/los/global_reporting/WOA_RPROC/WOACompilation.pdf

United Nations University Institute of Advanced Studies Operating Unit Ishikawa/Kanazawa. (2011). *Biological and Cultural Diversity in Coastal Communities, Exploring the Potential of Satoumi for Implementing the Ecosystem Approach in the Japanese Archipelago. Technical Series no. 61*. Montreal: Secretariat of the Convention on Biological Diversity. Retrieved from https://www.cbd.int/doc/publications/cbd-ts-61-en.pdf

Ünver, İ., & Olcay, H. (2001). Southeastern Turkey: Sustainable Development and Foreign Investment. *Development*, *11*(12).

van den Bosch, M., & Ode Sang, Å. (2017). Urban natural environments as nature-based solutions for improved public health – A systematic review of reviews. *Environmental Research*, *158*(July), 373–384. https://doi.org/10.1016/j.envres.2017.05.040

van der Ploeg, J., Cauillan-Cureg, M., van Weerd, M., & Persoon, G. (2011). “Why must we protect crocodiles?” Explaining the value of the Philippine crocodile to rural communities. *Journal of Integrative Environmental Sciences*, 287–298. https://doi.org/10.1080/1943815X.2011.610804
Van Dyke, J. M. (2014). Ocean transport of radioactive fuel and waste. In *The Oceans in the Nuclear Age: Legacies and Risks* (Expanded E, pp. 147–167).
Vartak, V. D. (1996). Sacred groves for in situ conservation. In S. K. Jain (Ed.), *Ethnobiology in Human Welfare* (pp. 300–302). New Delhi: Deep Publication.
Vartak, V. D., & Suryanarayana, M. C. (1995). Enumeration of wild edible plants from Susala Island, Mulshi reservoir, Pune district. *Journal of Economic and Taxonomic Botany*, *19*(3), 555–569.
Vasilijević, M., Zunckel, K., McKinney, M., Erg, B., Schoon, M., Rosen Michel, T., & Groves, C. (2015). *Transboundary Conservation: A systematic and integrated approach.* (A. Phillips, Ed.). Gland, Switzerland.
Verma, S., & Singh, S. (2008). Current and future status of herbal medicines. *Veterinary World*, *2*(2), 347. https://doi.org/10.5455/vetworld.2008.347-350
Vongpraseuth, T., & Choi, C. G. (2015). Globalization, foreign direct investment, and urban growth management: POLICIES and conflicts in Vientiane, Laos. *Land Use Policy*, *42*, 790–799. https://doi.org/10.1016/j.landusepol.2014.10.003
Wadley, R. L., & Colfer, C. J. P. (2004). Sacred Forest, Hunting, and Conservation in West Kalimantan, Indonesia. *Human Ecology*, *32*(3), 313–338. https://doi.org/10.1023/B:HUEC.0000028084.30742.d0
Walpole, P. W., & Annawi, D. (2011). WHERE ARE INDIGENOUS PEOPLES GOING? REVIEW OF THE INDIGENOUS PEOPLES RIGHTS ACT 1997 PHILIPPINES. In H. Scheyvens (Ed.), *CRITICAL REVIEW OF SELECTED FOREST-RELATED REGULATORY INITIATIVES: APPLYING A RIGHTS PERSPECTIVE* (p. 83–115.). Institute for Global Environmental Strategies (IGES).
Wang, J., Caccamise, S. A. L., Wu, L., Woodward, L. A., & Li, Q. X. (2011). Spatial distribution of organochlorine contaminants in soil, sediment, and fish in Bikini and Enewetak Atolls of the Marshall Islands, Pacific Ocean. *Chemosphere*, *84*(7), 1002–1008. https://doi.org/10.1016/j.chemosphere.2011.04.001
Wani, A. S. (2009). Wullar Gasps for BREATH. Retrieved January 13, 2018, from http://www.greaterkashmir.com/news/eco-plus/wullar-gasps-for-breath/55395.html
Warkentin, I. G., Bickford, D., Sodhi, N. S., & Bradshaw, C. J. A. (2009). Eating Frogs to Extinction. *Conservation Biology*, *23*(4), 1056–1059. https://doi.org/10.1111/j.1523-1739.2008.01165.x
Washitani, I. (2001). Traditional Sustainable Ecosystem “SATOYAMA” and Biodiversity Crisis in Japan: Conservation Ecological Perspective. *Global Environmental Research*, *5*, 119–133.
Webb, E. L., Jachowski, N. R. ., Phelps, J., Friess, D. A., Than, M. M., & Ziegler, A. D. (2014). Deforestation in the Ayeyarwady Delta and the conservation implications of an internationally-engaged Myanmar. *Global Environmental Change*, *24*.
Webb, T. J., Bengston, D. N., & Fan, D. P. (2008). Forest value orientations in Australia: An application of computer content analysis. *Environmental Management*, *41*(1), 52–63. https://doi.org/10.1007/s00267-007-9011-4
Weiss, E. B. (1990). In Fairness to Future Generations. *Environment: Science and Policy for Sustainable Development*, *32*(3), 6–31. https://doi.org/10.1080/00139157.1990.9929015
Wenny, D. G., DeVault, T. L., Johnson, M. D., Kelly, D., H. Sekercioglu, C., Tomback, D. F., & Whelan, C. J. (2011). The Need to Quantify Ecosystem Services Provided by Birds. *The Auk*, *128*(1), 1–14. https://doi.org/10.1525/auk.2011.10248
Wesche, K., & Retzer, V. (2005). *Is Degradation a Major Problem in Semi-Desert Environments of the Gobi Region in Southern Mongolia? Erforschung biologischer Ressourcen der Mongolei / Exploration into the Biological Resources of Mongolia*.
West, P., Igoe, J., & Brockington, D. (2006). Parks and peoples: the social impact of protected areas. *Annu. Rev. Anthropol.*, *35*, 251–277.
Wetlands International. (2007). *Comprehensive Management Action Plan for Wular Lake Kashmir. Final Report*. South Asia.
Wheatley, S., Sovacool, B. K., & Sornette, D. (2016). Reassessing the safety of nuclear power. *Energy Research and Social Science*, *15*, 96–100. https://doi.org/10.1016/j.erss.2015.12.026

Whelan, C. J., Wenny, D. G., & Marquis, R. J. (2008). Ecosystem Services Provided by Birds. *Annals of the New York Academy of Sciences*, *1134*(1), 25–60. https://doi.org/10.1196/annals.1439.003
WHO. (1946). Preamble to the Constitution of WHO as adopted by the International Health Conference, 19 June - 22 July 1946. New York.
WHO. (2006). *Fuel For Life : Household Energy and Health*.
WHO. (2014). *Burden of disease from ambient air pollution for 2012*. Geneva. Retrieved from http://www.who.int/phe/health_topics/outdoorair/ databases/AAP_BoD_results_March2014.pdf
Wiggins, A., & Crowston, K. (2011). From Conservation to Crowd sourcing: A Typology of Citizen Science. In *44th Hawaii International Conference on System Sciences* (pp. 1–10).
Wilkie, D. S., Morelli, G. A., Demmer, J., Starkey, M., Telfer, P., & Steil, M. (2006). Parks and people: Assessing the human welfare effects of establishing protected areas for biodiversity conservation. *Conservation Biology*, *20*(1), 247–249.
Wilkinson, M., Peres-Neto, P. R., Foster, P. G., & Moncrieff, C. B. (2002). Type 1 Error Rates of the Parsimony Permutation Tail Probability Test. *Systematic Biology*. Oxford University PressSociety of Systematic Biologists. https://doi.org/10.2307/3070887
Williamson, B. (2012). Great Koala Count success. Retrieved March 9, 2013, from http://www.abc.net.au/local/stories/2012/11/29/3643529.htm
Wily, L. A. (2011). “The law is to blame”. Taking a hard look at the vulnerable status of customary land rights in Africa. *Development and Change*, *42*(3), 733–757. https://doi.org/10.1111/j.1467-7660.2011.01712.x
Wipfli, M. S., Hudson, J. P., Caouette, J. P., & Chaloner, D. T. (2003). Marine Subsidies in Freshwater Ecosystems: Salmon Carcasses Increase the Growth Rates of Stream-Resident Salmonids. *Transactions of the American Fisheries Society*, *132*(2), 371–381. https://doi.org/10.1577/1548-8659(2003)132<0371:MSIFES>2.0.CO;2
Woolcott, I., Wong, K., & Verschoor, D. (2002). *Urban Wildlife Renewal “Growing Conservation in Urban Communities.”* New South Wales.
World Bank. (2002). *A Revised Forest Strategy for World Bank Group*. Washington D.C.
World Bank. (2009). Convenient Solutions to an Inconvenient Truth : Approaches to Climate Change June 2009. *World*, (June), 91. https://doi.org/10.1596/978-0-8213-8126-7
World Bank. (2015). *East Asia’s Changing Urban Landscape: Measuring a Decade of Spatial Growth*.
World Commission on Environment and Development. (1987). *Our Common Future*. Retrieved from http://www.channelingreality.com/Documents/Brundtland_Searchable.pdf
World Intellectual Property Organization. (2016). Using Traditional Knowledge to Revive the Body and a Community. Retrieved February 21, 2016, from http://www.wipo.int/ipadvantage/en/details.jsp?id=2599
World Water Assessment Programme. (2009). *The United Nations World Water Development Report 3: Water in a Changing World* (Vol. 11). Paris: UNESCO, and London: Earthscan. https://doi.org/10.3390/w3020618
WRI. (2015). *CAIT Climate Data Explorer: Overview*.
WUCMA. (2016). Wular. Retrieved October 15, 2017, from http://wular.org/about/wular/
Wulff, H. E. (1968). The Qanats of Iran. *Scientific American*, *218*(4), 94–105.
WWF. (2013). *The Economic Value of Ecosystem Services in the Mekong Basin: What we know, and what we need to know*. Gland, Switzerland. Retrieved from https://d2ouvy59p0dg6k.cloudfront.net/downloads/report_economic_analysis_of_ecosystemservicesnov2013.pdf
WWF. (2017). Heart of Borneo (HoB). Retrieved April 18, 2017, from http://wwf.panda.org/what_we_do/where_we_work/borneo_forests/
Yang, L., Lan, G. Z., & He, S. (2015). Roles of scholars in environmental community conflict resolution: A case study in contemporary China. *International Journal of Conflict Management*, *26*(3), 316–341.
Yasmi, Y., Broadhead, J., Enters, T., & Genge, C. (2010). *Forestry policies, legislation and institutions in Asia and the Pacific: Trends and emerging needs for 2020* (Asia-Pacific Forestry Sector Outlook Study II, Working Paper Series No. Working Paper No. APFSOS

II/WP/2010/34). Bangkok, Thailand. Retrieved from http://www.fao.org/docrep/013/i1722e/i1722e00.pdf

Yessoufou, K., Daru, B. H., Tafirei, R., Elansary, H. O., & Rampedi, I. (2017). Integrating biogeography, threat and evolutionary data to explore extinction crisis in the taxonomic group of cycads. *Ecology and Evolution*, *7*(8), 2735–2746. https://doi.org/10.1002/ece3.2660

Yibarbuk, D., Whitehead, P. J., Russell-Smith, J., Jackson, D., Godjuwa, C., Fisher, A., Cooke, P., Choquenot, D., & Bowman, D. M. J. S. (2002). Fire ecology and Aboriginal land management in central Arnhem Land, northern Australia: a tradition of ecosystem management. *Journal of Biogeography*, *28*(3), 325–343. https://doi.org/10.1046/j.1365-2699.2001.00555.x

Yin, R. (1994). *The Farmer Tree Planting Response to Political Uncertainty in China. Ph.D. dissertation.* Athens.

Young, M. (2015). Climate change implications on transboundary water management in the Jordan River Basin: A Case Study of the Jordan River Basin and the transboundary agreements between riparians Israel, Palestine and Jordan.

Zander, K. K., Dunnett, D. R., Brown, C., Campion, O., Daniels, C., Daniels, G., Nelson, E., Daniels, G., Blitner, G., Carson, D., & Garnett, S. T. (2014). Indigenous Cultural and Natural Resources Management and Mobility in Arnhem Land, Northern Australia. *Human Ecology*, *42*(3), 443–453. https://doi.org/10.1007/s10745-014-9657-5

Zekri, S., Mbaga, M., Fouzai, A., & Al-Shaqsi, S. (2011). Recreational value of an oasis in Oman. *Environmental Management*, *48*(1), 81–88. https://doi.org/10.1007/s00267-011-9678-4

Zheng, S., Fu, Y., & Liu, H. (2008). Demand for Urban Quality of Living in China: Evolution in Compensating Land-Rent and Wage-Rate Differentials. *The Journal of Real Estate Finance and Economics*, *38*(3), 194–213. https://doi.org/10.1007/s11146-008-9152-0

Zhu, H., Deng, Y., Zhu, R., & He, X. (2016). Fear of nuclear power? Evidence from Fukushima nuclear accident and land markets in China. *Regional Science and Urban Economics*, *60*(August 2011), 139–154. https://doi.org/10.1016/j.regsciurbeco.2016.06.008

Chapter 3. Status, trends and future dynamics of biodiversity and ecosystems underpinning nature's contributions to people

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Table of Contents

Executive summary

Biodiversity at the species and ecosystem levels is currently under multiple threats almost everywhere in the Asia-Pacific region, and in many areas the situation is now critical (*well established*). Of the various ecosystems, lowland evergreen forests, alpine ecosystems, limestone karsts, inland wetlands, and estuarine and coastal habitats are most threatened (*well established*). Genetic diversity within species, both wild and domestic, is also decreasing in many cases as a result of decreasing ranges (*established but incomplete*). In several countries there has been a small increase in the forest cover which is mostly attributed to monoculture forestry plantations and enabling policies of the governments. Forest fires associated with rapid loss of forest cover is leading to enormous environmental and socio-economic loss (*well established*) {3.2.1; 3.2.2; 3.2.3; 3.2.4; 3.2.5; 3.3.1}.

There has been a steady decline in the populations of large vertebrates due to poaching and illegal trade in wildlife parts and products in the Asia-Pacific region (*well established*). As a result, most of these species now survive only in the best-managed protected areas (*well established*). Widespread loss of large vertebrates has had a measureable impact on several forest functions and services, including seed dispersal (*established but incomplete*). Australia has the highest rate of mammal extinction (>10 per cent) of any continent globally. Bird extinctions on individual Pacific islands range from 15.4 per cent to 87.5 per cent for those with good fossil records, and these extinctions have resulted in the loss of many ecological functions previously performed by birds (*well established*). Besides wildlife, there is a massive regional trade in timber, traditional medicines and other products (*well established*). Without adequate protection, remediation and proper policies, the current decline in biodiversity and nature's contributions to people on land, in freshwaters, and in the sea will threaten the quality of life of future generations in the Asia-Pacific region {3.2.1.1; 3.2.1.2; 3.2.1.4; 3.2.1.7; 3.2.2.1; 3.3.1}

With the current rate of human population growth, expansion of urban industrial environments, transformation of agriculture in favour of high yielding varieties, transforming forests to uniform plantations of oil palm, rubber or timber trees, the biodiversity and nature's contributions to people in the Asia-Pacific region are likely to be adversely affected in the coming decades (*well established*). It is predicted that most of the biodiversity in the next few decades may be confined to protected areas or in places where the local communities have taken the lead in local level conservation *in lieu* of economic incentives and equitable compensation by the stake-holders. Unprecedented increase in human population of the Asia-Pacific region has stressed the fragile ecosystems to their limits; while arable cropping has been extended to sites which were not entirely suitable for it, resulting in soil degradation and erosion (*well established*) {3.2.1.1; 3.2.1.2; 3.2.1.5; 3.2.2.2; 3.2.2.4; 3.3; 3.3.1; 3.3.6; 3.4}.

Freshwater ecosystems in the Asia-Pacific region support more than 28 per cent of aquatic and semi-aquatic species but nearly 37 per cent of these species are threatened due to anthropogenic and climatic drivers (*well established*). Cumulative impacts of global warming and damming of rivers in some of the river basins will have significant negative impacts on fish production and environmental flows (*well established*). Likewise, degradation of wetlands has had severe negative impacts on migratory waterfowl, fish production and local livelihoods (*well established*). However, there are scientific data gaps on the current status of biodiversity and nature's contributions to people in most of the river basins, inland wetlands and peatlands of the region {3.2.2.1; 3.2.2.2; 3.2.2.3; 3.2.2.4}.

Coastal and marine habitats are likewise threatened due to commercial aquaculture, overfishing, and pollution affecting biodiversity and nature's contributions to people (*well established*). Detailed analyses of fisheries production in the region have shown severe decline in recent decades. It is projected that if unsustainable fishing practices continue, there could be no exploitable stocks of fish by as early as 2048. This could lead to trophic cascades and collapse of marine ecosystems (*established but incomplete*). Loss of *seagrass beds* which forms main diet of several threatened species such as dugong is a major concern (*well established*). There is a need to conduct systematic and region-wide assessment of fisheries stocks and coastal habitat in the region to aid conservation, management and restoration. {3.1.3.1; 3.2.3.3; 3.2.3.6; 3.2.4.6; 3.4}.

Mangrove ecosystems in the Asia-Pacific region are most diverse in the world. They support a rich biodiversity and provide a range of provisioning, regulating and supporting services, which are crucial for the livelihood of local communities (*well established*). Both mangrove and intertidal habitats form a buffer from siltation for offshore coral reefs protection hence affecting productivity of reefs including seagrass. However, up to 75 per cent of the mangroves have been degraded or converted in recent decades (*well established*). The conversion of mangroves to aquaculture, rice, oil palm, and other land-use changes is leading to the loss of the buffer between sea and land which can reduce the impact of natural disasters such as cyclones and tsunamis. It is projected that rise in sea level due to global warming would pose the biggest threat to mangroves, thereby affecting nature's contributions to people especially in Bangladesh, Philippines, New Zealand, Viet Nam and China (*well established*) {3.2.3.1; 3.2.3.2; 3.3.4}.

There has been a steady increase in the number, abundance and impacts of invasive alien species in the Asia-Pacific region, negatively affecting native biodiversity, ecosystem functioning and socio-cultural environments (*well established*). The total annual loss caused by invasive alien species has been estimated at US$35.5 billion in SE Asia and US$9B in Australia. Costs to agriculture due to invasive alien species are likewise immense in the region {3.2.1.1; 3.2.1.2; 3.2.1.4; 3.2.1.5; 3.2.1.6; 3.2.1.7; 3.2.2.1; 3.2.2.2; 3.2.2.3; 3.2.3.6; 3.3.5}.

There has been a nearly 30 per cent decline in biocultural diversity in the Asia-Pacific region since the 1970s (*well established*). Decline of linguistic diversity has been catastrophic in the indigenous Australian and Trans-New Guinean families, as a result of a shifting away from small indigenous languages towards larger, national or regional languages (*well established*). Linguistic and biological diversity often coincide in the Asia-Pacific region and parallel strategies need to be developed for their conservation. National conservation priorities should take into consideration the bioculturally rich areas that are facing great threats {3.2.5; 3.2.5.2; 3.2.5.4; 3.4}.

Protected Area coverage in the Asia-Pacific region has increased substantially since last three decades. Despite this progress, however, at least 75 per cent of Key Biodiversity Areas remain unprotected, suggesting that the region is not on track to conserve areas of particular importance for biodiversity, as called for under Aichi Target 11 (*well established*). Oceania has the highest overall Protected Area coverage in the region. North-East Asia has the highest proportion of Key Biodiversity Areas covered by Protected Areas, but only 1 per cent of its marine area is protected (*well established*) {3.2.5.6; 3.2.6; 3.2.6.1}.

The Asia-Pacific region has high levels of endemism, and some 25 per cent of the region's endemic species are facing high extinction risks as per the IUCN Red List. Endemic species in some subregions face an extinction risk as high as 46 per cent of endemic species threatened in South Asia (*well established*). South-East Asia has the greatest number of threatened species and the fastest increases in extinction risk (Red List Index) in the Asia-Pacific region. North Asian endemic species extinction risk is also higher than the regional average; the high percentage of Data Deficient species (36 per cent) indicates that more research and conservation action are needed for endemic species in this subregion (*well established*) {3.2.1; 3.2.2; 3.2.6.2; 3.3.4}.

Some aspects of biodiversity have recently started to recover in several countries in the Asia-Pacific region (*established but incomplete*). This recovery has resulted from various changes, including population concentration in cities, increased agricultural production per unit area, increasing conservation awareness among citizens, and the enabling policies of the governments. Future trends of biodiversity in the Asia-Pacific region will largely depend on whether other countries will follow this recovering trajectory by stabilizing land/sea use change, manage their natural resources sustainably, and cooperating with each other in meeting the Aichi Targets and the Sustainable Development Goals {3.2.1.5; 3.2.3.5; 3.3.1; 3.3.3; 3.3.6}.

Given that the scientific information on the status and trends of biodiversity and nature's contributions to people is not available uniformly across all ecosystems and habitats in the region, the national governments are encouraged to initiate systematic documentation and monitoring of health of ecosystems and ecosystem flows (*established but incomplete*). Saving terrestrial fauna especially big mammals and other fauna that require large roaming areas such as Orangutans, proboscis monkey, hornbills, tigers, Sumatran rhinoceros, gaurs and Asian elephants can be done by connecting large tracts of forests with wildlife corridors or through rehabilitation projects; the same goes for coastal and marine, freshwater and other ecosystems in the region {3.2.1.1; 3.2.2.4; 3.3.4; 3.4}.

3.1 Introduction

3.1.1 Background and context

The Asia-Pacific region is among the most diverse regions of the globe with unique biodiversity, multitudes of ecosystems and highly-valued habitats spread across terrestrial, marine and freshwater biomes. The natural as well as human engineered ecosystems such as agroecosystems in the region provide numerous goods and services to the diverse ethnic groups and societies in the region which are crucial for sustaining the human civilizations (Chapter 2). With steady growth of human population and economy, there is increasing demand for these services resulting in altered land use, disruption of biogeochemical cycling and ecosystem functioning. This region varies considerably in terms of documentation of biodiversity and analysis of trends. Moreover, valuation of nature's contributions to people in the region is still at the infancy. This means our understanding of the contributions of ecosystem processes to human well-being and our ability to quantify the services is limited. Given that the scientific information on the biodiversity and nature's contributions to people is not available uniformly across all taxonomic groups, subregions and habitats in the region, this assessment relies on the past and current trends within subregions and major ecosystems.

This chapter deals with trends and the current state of biodiversity in the Asia-Pacific region, and how these components affect the nature's contributions to people. Based on the review of recent (past 15-20 years) scientific publications and reports from this region, and current trends, both positive and negative, in biodiversity are presented. The chapter addresses policy question 3 of the Asia-Pacific region, i.e., "What are the status, trends and potential future dynamics of biodiversity, ecosystem functions that affect their contributions to the economy, livelihoods and well-being in the Asia-Pacific region?" Essentially these aspects and all ecosystem services cover the 'Nature and Nature's contributions to people (NCP) in the region. Given the dynamic nature of these contributions drawn by the society in different parts of the Asia-Pacific region and lack of quantitative information on their state, it has not been possible to cover contributions from all ecosystems. We recognize that much of the published literature on the ecosystem services is based on bio-physical and ecological aspects and there has been very little research on bio-cultural aspects of ecosystem services. The chapter identifies information gaps and areas of future research on the status and trends of biodiversity.

3.1.2 Methodology of assessment

The status and trends of biodiversity in the Asia-Pacific region and the potential impacts of loss across various scales are based on scientific information and other knowledge systems. These data sets are given in Chapter 1. The relevant datasets from ongoing activities were drawn from a wide range of sources, including global, regional, national, local institutions and used for this assessment. Some examples include: national biodiversity strategies and action plans, national reports and data portals; National Specimen Information Infrastructure (NSII); the Global Biodiversity Information Facility[42]; the Indian Bio-resource Information Network[43]; the Group on Earth Observations Biodiversity Observation Network[44] with regional components; the Asia-Pacific Biodiversity Observation Network[45] and subregional or national components; the Japanese Biodiversity Observation Network[46] and the Korea Biodiversity Observation Network[47]; the Atlas of Living Australia and Species Profile and Threats Database[48]; Threatened Island Biodiversity Database[49]; regional initiatives: the

[42] https://www.gbif.org/

[43] http://www.ibin.gov.in/

[44] https://geobon.org/

[45] http://www.esabii.biodic.go.jp/ap-bon/index.html

[46] http://www.jbon.org/eng

[47] http://www.k-bon.net/

[48] https://www.ala.org.au/

[49] http://tib.islandconservation.org/

Economics of Ecosystems and Biodiversity for South-East Asia[50]; regional research institutes: Bioversity International[51] (Asia-Pacific Oceania division), Ocean Biogeographic Information System[52], the World Resources Institute[53], the CGIAR Consortium for Spatial Information[54], the International Centre for Integrated Mountain Development[55], the International Union for Conservation of Nature[56]; government research institutes and non-governmental organizations. Datasets from both published scientific literature and grey materials, along with indigenous and local knowledge sources, were used for this assessment.

The ecosystem-based hierarchical layers of classification was adopted with case studies for all five subregions in the Asia-Pacific region (Chapter 1). For specific habitats especially unique and threatened, box items and trends are given as examples of fine scale assessments. At the species level, examples were chosen from the IUCN Red List of Threatened Species that are presented in most of the subregions and globally monitored; at the country level, significant declining populations of plants and animals were selected. Traded wildlife and plants that also appeared in CITES Appendix 1 & Appendix 2 were also chosen for this assessment.

It is clarified that there are no data available for the vast majority of species/biodiversity, since Red Lists generally and particularly in the Asia-Pacific region (maybe with the partial exception of Australia and New Zealand) are focussed on plants and vertebrates that jointly are likely to account for < 5 per cent of species.

3.2 Status and trends in biodiversity and nature's contributions to people

Status of biodiversity in the Asia-Pacific region has been assessed and described under the following major biomes, namely, terrestrial, freshwater and inland wetlands, coastal, marine, and agro-ecosystems. Of these, the terrestrial biomes are diverse particularly in terms of biophysical features comprising high mountains, plateaus, vast deserts, alluvial plains and low-lying forested tracts. Status of freshwater and inland wetlands have been assessed separately for lentic (lakes and ponds), lotic (rivers and streams) and inland wetlands. Likewise, coastal and marine ecosystems have been assessed under finer habitat classes. Agroecosystems, urban environments and biocultural diversity have been dealt with separately. An approximation to the current status of biodiversity in the Asia-Pacific region was obtained by disaggregating global biodiversity information products (T. M. Brooks *et al.*, 2016). The IUCN Red List of Threatened Species includes 14,249 species in taxonomic groups that have been comprehensively assessed, of which around 21 per cent are considered threatened, which is similar to the global percentage of 23 per cent. Plants have not been comprehensively assessed yet, but a random global sample of 7000 land plant species gives a similar estimate of 16-21 per cent threatened in the Asia-Pacific region, compared with 22 per cent globally (Brummitt *et al.*, 2015). Currently 14 per cent of the land area of the Asia-Pacific region is in areas protected for the conservation of nature, which is equal to the global mean (T. M. Brooks *et al.*, 2016).

3.2.1 Terrestrial biomes

3.2.1.1 Forests and woodlands

The current status of forests and woodlands in the Asia-Pacific region varies among subregions (Table 3.1). According to Global Forest Resources Assessment (FAO, 2015c), which uses a 10 per cent

[50] http://www.teebweb.org/countryprofile/asean/
[51] https://www.bioversityinternational.org/
[52] http://iobis.org/
[53] https://www.wri.org/
[54] https://cgiarcsi.community/
[55] http://www.icimod.org/
[56] https://www.iucn.org/

canopy cover and 5 m height threshold for 'forest' and thus includes woodland, two-thirds of the approximately 7.8 million km^2 of forest in the Asia-Pacific region in 2015 occurs in China, Australia, Indonesia, and India. In percentage terms, forest cover was highest (c. 50 per cent) in South-East Asia, which has adequate rainfall for forest almost throughout the subregion, while it was lowest (1 per cent) in Western Asia, which is mostly too dry. Forest cover was more than 70 per cent in Bhutan, Brunei, Lao PDR, Papua New Guinea, Solomon Islands, and on several small islands in the Pacific, while it was less than 25 per cent in Afghanistan, Australia, Bangladesh, China, India, Iran, Maldives, Pakistan, Singapore, and all countries in Western Asia.

The trends in forest cover also varies among subregions. From 2010-2015, the total forest area increased in North-East Asia, South Asia, Western Asia, and Oceania (for which the forest statistics are dominated by Australia), while it decreased in South-East Asia (Keenan *et al.*, 2015) (Table 3.1). China reported the largest increase in forest area (1.5 M ha/yr) for this period, followed by the Philippines (0.24 M ha/yr), Lao Democratic People's Republic (0.19 M ha/yr), and Vietnam (0.13 M ha/yr) (FAO, 2015c). Indonesia (-0.68 M ha/yr) and Myanmar (-0.54 M ha/yr) reported the highest losses, although Indonesia's rate of loss was only about 40 per cent of the rate in the 1990s. In Australia, reduced clearance resulted in an increase in forest area before 2000, while fires, droughts, and urban and agricultural development have caused fluctuations since (Department of the Environment and Energy, 2016).

Table 3.1 Recent trends in the change of forest cover in the Asia-Pacific region. Source: FAO (2015c).

Region	Forest area (1000 ha)					Annual rate of change							
						1990-2000		2000-2005		2005-2010		2010-2015	
	1990	2000	2005	2010	2015	1000 ha/yr	%	1000 ha/yr	%	1000 ha/yr	%	1000 ha/yr	%
East Asia	209,198	226,815	241,841	250,504	257,047	1762	0.81	3005	1.28	1733	0.70	1309	0.52
South Asia	87,995	88,348	91,518	93,405	94,086	35	0.04	634	0.70	377	0.41	136	0.15
South-East Asia	242,030	220,956	217,107	214,578	210,742	-2,107	-0.91	-770	-0.35	-506	-0.23	-767	-0.36
West Asia	3,182	3,323	3,368	3,403	3,409	14	0.43	9	0.27	7	0.21	1	0.03
Oceania	176,825	177,641	176,485	172,002	173,524	82	0.05	-231	-0.13	-897	-0.51	304	0.18

The subregional rates of forest change hide high percentage losses in some countries and forest types. While an overall decline in forest cover in insular South-East Asia between 2000 and 2010 was 1%/yr, the highest deforestation rates is shown by peat swamp forests at an average annual rate of 2.2 per cent while the lowland evergreen forests declined by 1.2%/yr (Miettinen *et al.*, 2011). Further, the rate of loss exceeded 5%/yr in the Sumatran lowlands and the peatlands of Sarawak, Malaysian Borneo, where around half of the forest cover in 2000 was lost by 2010 (Miettinen *et al.*, 2011). Approximately 35 per cent of Indonesia's remaining forests are located within industrial concessions, and thus vulnerable to loss in the future (Abood *et al.*, 2015).

The FAO statistics used above are based on the national data reported by each country, which have been collected by various methods, but independent assessments by remote-sensing data show broadly similar trends in most, but not all, cases (Keenan *et al.*, 2015). Many of the discrepancies reflect the wide range of definitions of 'forest', with the minimum canopy cover cut-off ranging from the 10 per cent used by the FAO to 60 per cent used by the International Geosphere-Biosphere Programme (Sexton *et al.*, 2015). Other differences reflect variations in the time period covered, in the area cut-off for the inclusion of forest fragments, and in the inclusion or exclusion of tree crops. The latter issue is a particular problem in South-East Asia, where large areas of tropical rainforests have been replaced by monoculture plantations of oil palm, rubber, and trees grown for pulp or timber. The FAO definition of forest excludes oil palm, but includes rubber and other tree plantations, although the areas of planted forests and primary forests, without obvious signs of human influence, are also reported (FAO, 2015c). Japan (41.1 per cent of the total forest area), China (37.9 per cent), and Vietnam (24.8 per cent), reported the highest percentages of planted forests, while Brunei (69.3 per cent), Papua New Guinea (52.4 per cent), and Indonesia (50.6 per cent) reported the highest percentages of primary forest. Papua New Guinea and Indonesia reported the highest primary forest losses for 2000-2015 (Morales-Hidalgo *et al.*, 2015). On some of the small islands in Oceania, such as the atolls of Tuvalu, Kiribati, Tokelau, the Marshall Islands, and the main island of Tongatapu in Tonga, there is very little remaining original forest.

Rapid forest loss is associated with fires in Sumatra and the Indonesian part of Borneo (Kalimantan) where forests and secondary vegetation are often burned to develop oil palm and pulpwood plantations (see Chapter 4). The extensive and persistent fires that can result impose enormous environmental and economic costs (Chisholm *et al.*, 2016; Drake, 2015) and the associated haze seriously threatens human health (Sahani *et al.*, 2014). Fires are particularly extensive and serious when strong El Niño events coincide with positive Indian Ocean Dipole conditions, which both promote drought (Koplitz *et al.*, 2016). The 1997/98 and 2015 events burned around 11 million hectares (Wooster *et al.*, 2012) and 4.6 million hectares (Lohberger *et al.*, 2018) respectively, and one recent study estimated that the haze in 2015 caused 11,880 (6,153–17,270) excess deaths in Equatorial Asia (Koplitz *et al.*, 2016).

Rapid forest loss has direct negative consequences for survival of forest-dependent vertebrate species. In Sundaland (the Malay Peninsula, Borneo, Sumatra, and Java), (Wilcove *et al.*, 2013) projected that in the lowland forests as many as 29 per cent of the bird species and 24 per cent of the mammals are likely to go extinct in coming decades if the rate of forest loss continues at the present rate. The extinction risks are disproportionately high in some hot spots including Borneo (Betts *et al.*, 2017). The faunal depauperation can also lead to decline in the population of large seeded animal-dispersed trees in tropical forests. A simulation study (Osuri *et al.*, 2016) estimated that aboveground carbon stocks will be lost by up to 5 per cent under the 50 per cent removal scenario. In lowland forests where wind-dispersed trees such as dipterocarps are dominant, the loss of carbon stocks may be insignificant but the capacity of many tree species to track shifts in suitable habitat under climate change may be markedly reduced (Mokany *et al.*, 2014).

In Australia, woodland bird sightings have declined between 11 and 51 per cent over the past 20 years (Morton *et al.*, 2014). Plant species are also under threat, since the highest plant diversities in the Asia-Pacific region are in the tropical lowlands of Sundaland (Pimm & Joppa, 2015; Raes *et al.*, 2009, 2013). Whereas there have been few other quantitative assessments of plant extinction risks in the Asia-Pacific region, it has been estimated in Japan that 370-561 taxa of vascular plants from all habitats are likely to face serious threats of extinction during the 21st century despite an increase in forest cover (Kadoya *et al.*, 2014). Both natural regeneration of forest (Zou *et al.*, 2016) and active reforestation (Korea Forest Service, 2014) can provide habitats for many forest-dependent species, but the extent and regional importance of these new forests has not yet been assessed for the Asia-Pacific region.

In addition to deforestation, forest degradation is driving biodiversity loss and a decline in ecosystem services (Haddad *et al.*, 2015). Logging (i.e. timber harvest) and hunting are the most pervasive impacts on native forests that have not been cleared. Although logging has adverse impacts on sensitive species, logged forests still retain a relatively high conservation value and this increases over time if they are protected (J. F. Brodie *et al.*, 2015; Edwards *et al.*, 2014; Ewers *et al.*, 2015; Wilcove *et al.*, 2013). Even forests that appear intact in high-resolution satellite images, without logging roads and large canopy gaps, have often lost much or all of their large vertebrate fauna as a result of hunting (Harrison *et al.*, 2016). As a result, many large vertebrate species (for example, elephants, tigers, and most primates) now survive mainly in the best-managed protected areas and few, if any, areas in the Asia-Pacific region support all the species they did 100 years ago. This widespread loss of large vertebrates has had a measureable impact on many forest functions and services, including seed dispersal (Harrison *et al.*, 2013, 2016). While some hunting is for subsistence or local markets, there is also a massive regional trade in wildlife and wildlife products for food, traditional medicines, ornaments, and pets (Hughes, 2017; Wilcove *et al.*, 2013). Valuable plant species (medicinal plants and orchids, in particular) may also be threatened by overcollection in some areas (Phelps & Webb, 2015). In Australia, long-term grazing pressure from exotic livestock threatens understory plants in forests that appear intact in satellite images (Auld *et al.*, 2015), while invasive alien species, including the fungal pathogen myrtle rust (*Puccinia psidii*) from South America, threaten native forest trees (Carnegie *et al.*, 2016).

Under rapid forest loss and degradation, within-species genetic variation is expected to be decreasing under the power low relationship between genetic diversity and population size (Mimura *et al.*, 2017), but this decrease remains poorly documented. Despite a large population of the threatened timber tree *Dalbergia cochinchinensis* being fragmented into smaller populations with the lack of gene flow between them, the species still maintains a fair amount of genetic diversity at the nuclear loci (Moritsuka *et al.*, 2017). This could be due to only several generations have passed since the beginning of artificial logging. Long-term monitoring as well as efforts for studying more species are needed to assess trends of genetic diversity in threatened species. As for animals, a recent discovery of the third species of Orangutan from Sumatra (Nater *et al.*, 2017) demonstrated that even single taxonomic "species" include multiple lineages that are threatened under forest loss.

Whereas the FAO reports that forest area is increasing in the Asia-Pacific region, this largely reflects a massive increase in plantation forests—usually monocultures and usually of non-native species—while loss of natural forests often continues (S. Liu *et al.*, 2017; Zhai *et al.*, 2017). Both economic development and state policies have been important in driving these changes. Plantations typically support fewer native species than natural primary or secondary forests, particularly in tropical Asia and particularly when the plantations are intensively managed (Phillips *et al.*, 2017).

3.2.1.2 Grasslands and savannas

Grasslands in the Asia-Pacific region occur in a wide range of eco-climatic conditions such as flood plains of Gangetic and Brahmaputra in India, semi-arid and arid regions of west and central Asia, sub-tropical and temperate regions of Australia and New Zealand (Dixon *et al.*, 2014; Rawat & Adhikari, 2015; Suttie *et al.*, 2005) For the purpose of this assessment we separate the tropical and temperate grasslands and savannas from the alpine rangelands including the alpine scrub and desert steppes of Tibetan plateau and the Greater Himalaya which are described under 3.2.1.3. The geographical spread of grasslands in the Asia-Pacific region varies considerably across the region, from nearly 70 per cent in Australia (McIvor, 2005) to smaller areas. Savannahs are distributed between semi-arid thorn scrub and dry sclerophyllous forests in sub-tropical Asia and Australia. Both grasslands and savannah are amongst the most dynamic terrestrial ecosystems providing numerous contributions to people (Suttie *et al.*, 2005; White *et al.*, 2000). They are home to a diverse assemblage of flora and fauna. Typical and in many cases even emblematic are grass species such as feather grasses (*Stipa* spp.), and obligate grassland herbivores such as antelopes, rhinoceroses, equids, rodents and associated carnivores. Grasslands of Australia are rich in marsupial kangaroos and also harbour the highest diversity of lizards in the world (Morton *et al.*, 2014). Grasslands support a large number of bird species including partridges, quails, floricans, larks, pipits and several raptors (e.g., Suttie *et al.*, 2005). Rodents and a large number of invertebrates including termites and nematodes depend on underground biomass and contribute to ecosystem functioning in the grasslands (Borer *et al.*, 2014; Maestre *et al.*, 2012; Reich *et al.*, 2012).

The biodiversity of natural grasslands in the Asia-Pacific region are threatened largely due to (i) conversion of this habitat into agriculture and habitation, (ii) climate change, (iii) invasive species, and (iv) CO_2 and N-enrichment. Under the land conversion in Australia, grasslands with the lowest percentage of undisturbed ecosystems have been reduced to the south-east (Department of the Environment and Energy, 2016; Morton *et al.*, 2014). It is estimated that over 60 per cent grasslands in the tropics of the Asia-Pacific region are degraded or encroached for other land uses (Rawat & Adhikari, 2015). Land use, climate change and invasive species have resulted in rapid decline in obligate grassland fauna including keystone species mammals and birds (Dutta *et al.*, 2011). Under global CO_2 and N-enrichment (M. Lee *et al.*, 2010), from 2000 to 2013, productivity increased in large parts of the Asia-Pacific region grasslands in the West, and North of the region, New Zealand,

and eastern Australia while other parts, especially western Australia show decreased productivity. The increase in primary productivity especially in temperate grasslands can lead to decrease in biodiversity (C. M. Clark *et al.*, 2007; Hautier *et al.*, 2009), with light competition by plants as the underlying mechanism (Hautier *et al.*, 2009). This decrease is, however, predicted from findings derived in small scale experimental settings (though in global networks), and it remains unclear whether the observed NPP increases already have led to biodiversity loss on the scale of the Asia-Pacific region.

Among grassland animals, most of the large ungulates especially in temperate grasslands have declined in number. Much of these declines in larger mammals are attributed to massive poaching, but more recently infrastructure development (fences, traffic lines; Batsaikhan *et al.*, 2014) and agricultural expansion (Berger *et al.*, 2013) have become major obstacles. For other species long-term trends (decadal scale) are less clear, and sound data such as Red Lists are hardly available. An exception is China, where the national Red List for plants indicate that a number species in southeastern Xizang are threatened (Zejin Zhang *et al.*, 2015). In Australia, feral cats in combination with changing fire regimes are causing widespread declines in native small mammal populations in grasslands and savannas across the north (Frank *et al.*, 2014; J. C. Z. Woinarski *et al.*, 2015). Australia has the highest rate of mammal extinction (>10 per cent) of any continent globally accounting for 30 per cent of the world's mammal extinctions in the last few hundred years, mainly from predation by alien foxes and cats (Morton *et al.*, 2014). The most recent mammal extinctions were from islands in 2009 and 2016 (Department of the Environment and Energy, 2016).

In Australia, where >60 per cent of the country is grazed by livestock, trampling and compaction of soil has been reported leading to loss in primary productivity . Here, native grassland plant communities have not evolved with ungulate grazers (Fensham *et al.*, 2014) and there are many feral populations of twelve invasive alien grazing ungulates (E. J. Ens *et al.*, 2016). In many areas the native herb layer is gone or made up of exotic plants. In some of the best surveyed parts of Australia, 25 per cent of herbaceous species are rare, endangered or vulnerable (Morton *et al.*, 2014). Grazing exclusion proved a suitable measure for soil restoration in most Chinese grasslands (Z. Hu *et al.*, 2016). Chronic pressure of livestock grazing reduces N availability due to indirect removal via livestock use, collection of dung for fuel and accelerated soil erosion (Giese *et al.*, 2013; Tang *et al.*, 2017). A review of N-fertilizaton experiments shows that most grasslands are nitrogen limited (Tang *et al.*, 2017). Addition of N in natural grasslands could enhance biomass productivity, but may have negative effects on biodiversity.

Savannhas in the Asia-Pacific region have existed for over 1 million years, and have high level of C4 grass endemism and diversity (Ratnam *et al.*, 2016). Its distinct functional ecologies reflect fire- and herbivory-driven community assembly. For maintenance of savannahs, appropriate fire management system is a clear need to have in-depth understanding on spatio-temporal effects of burning (Dexter *et al.*, 2015). Savannahs in the Asia-Pacific region are heavily threatened due to: (i) land-use changes including conversion to agriculture and plantations, (ii) mismanagement of fire and herbivory which could otherwise be helpful in maintaining ecosystem health and diversity provided these are used judiciously; (iii) invasion by alien plant species such as *Prosopis juliflora* and *Lantana camara* that leads to changed physiognomy (Lunt *et al.*, 2007), and (iv) likely changes in precipitation regimes under changing climate scenario (Klein *et al.*, 2004; Ratnam *et al.*, 2016). A recent study has revealed that in Indian sub-continent sub-tropical and tropical savannahs are in particular risk of biome shift under changing precipitation regimes (Rasquinha & Sankaran, 2016). Continuous commercial livestock grazing, particularly in arid and semi-arid savannas and other rangelands is known to have changed vegetation structure and composition and increase in proportion of unpalatable woody cover (Yun Wang & Wesche, 2016). Grazing induced changes in abundance of various faunal groups such as small mammals (G. Li *et al.*, 2016; Zhibin Zhang *et al.*, 2003), grasshoppers (Hao *et al.*, 2015; Zhu *et al.*, 2015) and microbial diversity (Qu *et al.*, 2016) have been documented in various grasslands but clear trends cannot be deducted at present.

3.2.1.3 Alpine ecosystems

The alpine ecosystems are generally located in high mountains between the upper limits of tree growth (alpine treeline) and snowline, characterized by highly seasonal environment with short growing season and treeless vegetation. The alpine treelines in the Asia-Pacific region can be as low as 1000 – 1200 m asl in New Zealand (Wiser *et al.*, 2001) and reach an elevation of 4200 m asl ± 200 m in the eastern Himalaya. Spread over a considerably large area in the Asia-Pacific region (Olson *et al.*, 2001; Wesche *et al.*, 2016), the alpine ecosystems encompass alpine moist and dry meadows, moist and dry scrub, and steppes of Iran, Pamir, Hindu Kush Himalayan region, Hengduan, Tian Shan, Altai and Sino-Japanese mountains. In the Pacific region, alpine zone is distributed in Java, Papua New Guinea, New Zealand, and Australia. These ecosystems harbour a rich array of floral and faunal diversity and provide a variety of nature's contributions to people. Besides the outstandingly rich biodiversity and endemism in the Himalayan alpines, especially in its eastern part as shown for vascular plants by Mutke and Barthlott (2005), plant diversity of the upper vegetation belts is often composed of a high degree of locally endemic species in other areas, such as in the mountains of Iran (Noroozi *et al.*, 2011), New Guinea (Hope, 2014), Australia (Costin *et al.*, 2000) and New Zealand (Mark & Adams, 1995). Most of these alpine areas are intimately linked with local culture and tradition thereby providing bio-cultural services. For example, many of the sacred mountains in the region are located in the alpine regions. However, in many parts of the Asia-Pacific region, especially in the Himalayan region, the alpine habitats are rapidly changing due to anthropogenic and climatic drivers (Chapter 4). Simulation models, experimental studies and empirical evidence show that the rising temperature and increasing extreme climatic events are likely to alter the vegetation structure, ecosystem processes and biogeochemical cycling in the alpine region of the Asia-Pacific region affecting ecosystem services including hydrology and local livelihoods (Shrestha & Aryal, 2011; Xu *et al.*, 2009). Extent and drivers of the change are, however, under debate as shown for the case of the Tibetan Plateau where commonly quoted estimates of up to 90 per cent of degraded land may be far too large and are in any case subject to large uncertainty (R. B. Harris, 2010; P. Wang *et al.*, 2015).

A few authors have predicted that global warming is likely to induce upward shifts in alpine timberline or poleward shift of boreal forests (e.g., Holtmeier & Broll, 2007; Panigrahy *et al.*, 2010; Parmesan, 2006). However, to date no long term studies have yet proven such shifts (Bharti *et al.*, 2011). Cao *et al.*(2015), based on an experimental study, concluded that with increasing temperature, a native voracious grassland caterpillar (*Gynaephora menyuanensis*) is likely to increase which may further reduce production of grasslands and negatively affect livestock production. A study in alpine regions of Sikkim, India, has revealed that the plant assemblages of endemic species have been affected by ongoing global warming through species range shifts and are likely to result in species extinctions, particularly at mountaintops (Telwala *et al.*, 2013). Expansions of dwarf bamboo and dwarf pines into alpine meadows and associated impacts on alpine species diversity were observed in northern Japan (Amagai *et al.*, 2015; Kudo *et al.*, 2011). Climate change has also affected vegetation seasonality (phenology) with most sites across Tibetan Plateau showing earlier onset and later offset of the vegetation period and thus increased net primary production (Siyuan Wang *et al.*, 2017). Patterns do, however, differ between local climatic regimes. A recent remote sensing study with improved local calibration showed that trends in vegetation cover over time differ across the Tibetan plateau (Lehnert *et al.*, 2016). Trends were associated with changes in precipitation rather than with grazing pressure, and declining precipitation may reduce rangeland productivity in western and southern Tibetan plateau. Of all the alpine habitats, mesic *Kobresia pygmaea* at the transition between the moist east and the drier west of the Tibetan plateau mats are most vulnerable due to changes in hydrology and grazing intensity (Yun Wang *et al.*, 2017) and decline in native herbivores (Batsaikhan *et al.*, 2014). However, much of the decline in larger mammals are attributable to massive poaching, but more recently infrastructure development (fences, traffic lines) and agricultural expansion have become major obstacles. For other species long-term trends (decadal scale) are less clear, and sound data such as Red Lists are hardly available. Exceptionally, the national Red List for plants in China indicated that a number species in western and southern Xizang are threatened (Zejin Zhang *et al.*, 2015).

Compared to degraded meadows, intact alpine meadows provided more economic benefits from carbon and nutrient maintenance when compared to degraded meadows as shown by a study in the Tibetan plateau (Wen *et al.*, 2013) . Destruction of the alpine grasslands led to economic loss of about $198/ha due to decrease in biomass. Also, the economic cost caused by carbon emissions and nitrogen loss on severely degraded grassland was up to $8 033/ha and $13 315/ha until 2008, respectively. Actions to maintain nature's contributions to people, especially hydrological functions of alpine habitats, are urgently required in all the alpine regions of the Asia-Pacific region (Shaheen & Mashwani, 2015).

The coverage of protected area is increasing in the alpine ecosystems (Figure 3.1), although the reserve system has important gaps such as in NW-China / Xinjiang and South-eastern Tibetan plateau (Wesche *et al.*, 2016; Zejin Zhang *et al.*, 2015). Most of the large reserves are located in Xizang, where the coverage of reserves is >30 per cent (Wesche *et al.*, 2016), the Changthang Nature Reserve being the largest (UNEP-WCMC & IUCN, 2017). Grazing is strictly controlled and often not allowed in these reserves, and large parts of the plateau outside the protected areas are also subjected to governmental schemes for reduced grazing and sedentarization (Bai *et al.*, 2010; Gongbuzeren *et al.*, 2015; J. Huang *et al.*, 2016; Yang Wang *et al.*, 2014; Yun Wang & Wesche, 2016; Wesche *et al.*, 2016).

Name	Countries	Trends in cover of protected areas (%)	Trends in RLI of Key Vertebrate Species	Grassland conversion	Grazing degradation	Climate change effects
Steppes and dry steppes of Mongolia	Mongolia	↑ WE	↓ WE	↔ WE	↑ UR (locally)	↑ UR
Steppes and dry steppes of northern China	China	↑ WE	↓ WE	↑ WE	↑ WE	↑ UR
Alpine steppes and pastures of Tibetan plateau	China	↑ WE	↓ WE	↑ WE	↑ UR (locally)	↑ IC
Alpine steppes and pastures of western Himalaya-Tien Shan	India, Afghanistan, Tajikistan	↑ WE	↓ WE	↑ EI	↑ IC (locally)	↑ UR

Figure 3.1 General trends in alpine rangelands of the Hindu Kush Himalayan region over 50 years, assessed using the Red List Index (RLI).
Note: Arrows indicate direction: increasing - ↑, declining - ↓, largely unchanged - ↔. Confidence of estimated impact: well established - WE, unresolved - UR, established but incomplete - EI, inconclusive – IC (see IPBES confidence levels, IPBES, 2016). Shadings indicate magnitude of trend (very high / high / moderate / low)

3.2.1.4 Deserts and semi-deserts

Deserts and semi-deserts occupy almost 20 per cent of the land area of the Asia-Pacific region and provide important ecosystem services. They are located between 15° and 40° north and south of the equator and characterized by low and infrequent precipitation, high rates of evapotranspiration, poorly developed soil, and very low (<5 per cent) vegetation cover (Figures 3.2 and 3.3).

In north-eastern Asia and rain-shadow zones of the Himalaya, there are extensive cold deserts. Despite their low primary productivity, both hot and cold deserts harbour rich faunal assemblages, including some globally threatened species, most of them exhibiting special adaptive features. Deserts and semi-deserts cover more than 1 million km^2 of northern China and southern Mongolia. The conservation status of some flagship species in this biome is endangered and their status has not been improved, e.g. snow leopard; *Panthera uncia* (R. B. Harris & Reading, 2008; R. Jackson *et al.*, 2008). This region supports the world's largest remaining populations of the Near Threatened khulan; *Equus hemionus hemionus* (Moehlman *et al.*, 2008), the Critically Endangered wild Bactrian camel; *Camelus ferus* (Bannikov, 1974; Hare, 2008; Kaczensky *et al.*, 2014), and the Vulnerable goitered gazelle (*Gazellus subgutturosa*) (Kingswood & Blank, 1996). This ecoregion has experienced thousands of years of apparently sustainable land use by traditional nomadic herders, with wild herbivores playing an important role for local livelihoods as meat supply (World Bank, 2006). However, the wildlife and pastoral livelihoods of this area are threatened by rapid growth in mining and related infrastructure (The Nature Conservancy, 2012). The number of planned and constructed large infrastructure projects has increased rapidly over the last 10 years (Lkhagvasuren *et al.*, 2011), resulting in major habitat loss for wild ungulates, as well as cutting off critical animal movements, and reducing substantial portions of all of their population ranges (Batsaikhan *et al.*, 2014). The northeastern deserts of the Asia-Pacific region suffer largely from overgrazing, increased mining, and other developmental projects. The cold deserts of the Trans-Himalaya have undergone local level changes in land use and land cover due to increased livestock densities and forage use, and the sedentarization of herders. Since 1991 substantial plant species shifts and losses occurred in the regions and few have crossed an irreversible threshold of ecological change (Fernández-Giménez *et al.*, 2017).

The Arabian Desert in western Asia extends from Yemen to the Persian Gulf, and Oman to Jordan and Iraq. One of the largest bodies of continuous sand in the world, Rub'al-Khali or 'The Empty Quarter' is located in this region. The Arabian Deserts hosts several endangered native mammals, including the likely Critically Endangered Arabian leopard; *Panthera pardus nimr* (Spalton & Hikmani, 2006), and the Vulnerable Arabian oryx; *Oryx leucoryx* (IUCN SSC Antelope Specialist Group, 2011). There are also several endangered bird species in this desert whose populations have declined drastically during the last 15 years, including the Endangered Saker falcon; *Falco cherru* (BirdLife International, 2017a; Shobrak, 2015) that winters in the region, and the Critically Endangered sociable lapwing; *Vanellus gregarius* (BirdLife International, 2016). Plant species in the region are also under heavy anthropogenic pressures. According to one assessment, 36 per cent of desert plant species in the northwestern Red Sea region are at the risk of extinction (Lovett-Doust *et al.*, 2009) and even date palm trees; *Phoenix dactylifera* has been degraded in several countries (El-Juhany, 2010). The Arabian deserts have undergone rapid degradation, especially in the countries where the share of agriculture in the gross domestic product (GDP) is high, such as Syria and Yemen (Abahussain *et al.*, 2002; ACSAD *et al.*, 2004; SRAP, 2007). Rapid industrial development in the Gulf countries has similarly led to degradation of desert and specifically semi-desert ecosystems (Edgell, 2006; Gardner & Howarth, 2009; Mubarak, 2004).

There are several other desert biomes in the South Asia subregion. The status of the fauna and flora of the region has not been assessed comprehensively in the last decade, though they exhibit signs of degradation. Overgrazing by domestic livestock and introduction of fast growing plant species have led to habitat degradation (Amiraslani & Dragovich, 2011). Species which have suffered most from habitat degradation in this region include the Critically Endangered Asiatic Cheetah; *Acinonyx jubatus venaticus* (Jowkar *et al.*, 2008) and several endemic endangered medical plants (T. I. Khan *et al.*, 2003). Weaponry, war and political conflicts pose a risk directly and/or indirectly to the environmental stability of the area. This region is geo-politically sensitive and prone to political conflicts and military activities. Hence, environmental issues are not given high priority at the national levels (El-Showk, 2016; Van Damme, 2011).

The Australian deserts are vast, unique and diverse. They support more lizard species than any other comparable environment, and exhibit the highest diversity of soil arthropods such as termites and nematodes (Steffen, 2009). More than one-third (22 species) of the terrestrial mammal species of the central deserts of Australia have vanished since the 1900s (Burbidge *et al.*, 1988; J. C. Z. Woinarski *et al.*, 2015), which has had significant consequences for native plant communities via the decrease in ecological functions (Fleming *et al.*, 2014) (e.g., bioturbation) and seed dispersal (Murphy *et al.*, 2005). There are several threats to these deserts, such as invasive alien species, especially vertebrate predators including feral cats that have been largely responsible for native mammal extinctions and have put extinction pressure on 124 extant but threatened species including the iconic night parrot (Department of the Environment, 2015) and feral wild camels (Saalfeld *et al.*, 2010). Increase in exotic plants, particularly buffel grass; *Cenchrus ciliaris* has led to altered fire regimes (M. L. Brooks *et al.*, 2004; Burrows *et al.*, 1991; Russell-Smith *et al.*, 2003) which together with predation has caused further decline of certain species, e.g. greater bilby; *Macrotis lagotis* (Cramer *et al.*, 2016), and the desert bandicoot; *Perameles eremiana* (Atchison, 2009; J. C. Z. Woinarski *et al.*, 2015). Climate change is another key threat to Australian deserts and not only to the wildlife (McKechnie & Wolf, 2009), but also regarding psychosocial determinants of human health (D. Campbell *et al.*, 2008) and the adaptive capacity of human communities (Race *et al.*, 2016). Pastoralism has had the greatest impact on the desert landscape, with the introduction of permanent herds for commercial exotic ungulates and artificial water sources, which have artificially increased kangaroo populations. These have led to severely degraded areas surrounding these water points, overgrazing, changed plant community structure, loss of soil nutrients and increased soil erosion (Letnic, 2007). In turn there is increased competition between native species and livestock, altered species distributions due to increased habitat openness and pest control, e.g., historical baiting of the dingo, *Canis lupus dingo* (Letnic, 2007). Finally the growth in mining activities have negatively impacted some arid regions (160 000 ha affected by mining from 1986 to 2002; (Brueckner *et al.*, 2013; Environmental Protection Authority, 2008; Mudd, 2007; Nicol, 2006), but with this has come regional funding for environmental monitoring and management through offset programs (Morton *et al.*, 2014).

More than 16 per cent of the deserts and semi-deserts in the Asia-Pacific region are protected, of which, 22 per cent of the area has been classified as IUCN category I and II (UNEP-WCMC & IUCN, 2015). In terms of area, the total coverage of protected desert and semi-deserts increased by 25 per cent in the Asia-Pacific region from 1990 to 2014. Recent changes in the deserts of the Asia-Pacific region have been noticed mostly along their boundaries as a result of desertification or changes in the land use (Ezcurra, 2006; UNCCD, 2008). Adeel (2005) has estimated that nearly 20 per cent of the deserts and semi-desert in the Asia-Pacific region have undergone rapid degradation owing to imbalance between demand and supply of ecosystem services. Overgrazing by domestic livestock, soil erosion, urbanization, and formation of caliche (a hardened natural cement) are major drivers of change affecting the desert ecosystem functions (J. F. Reynolds *et al.*, 2007).

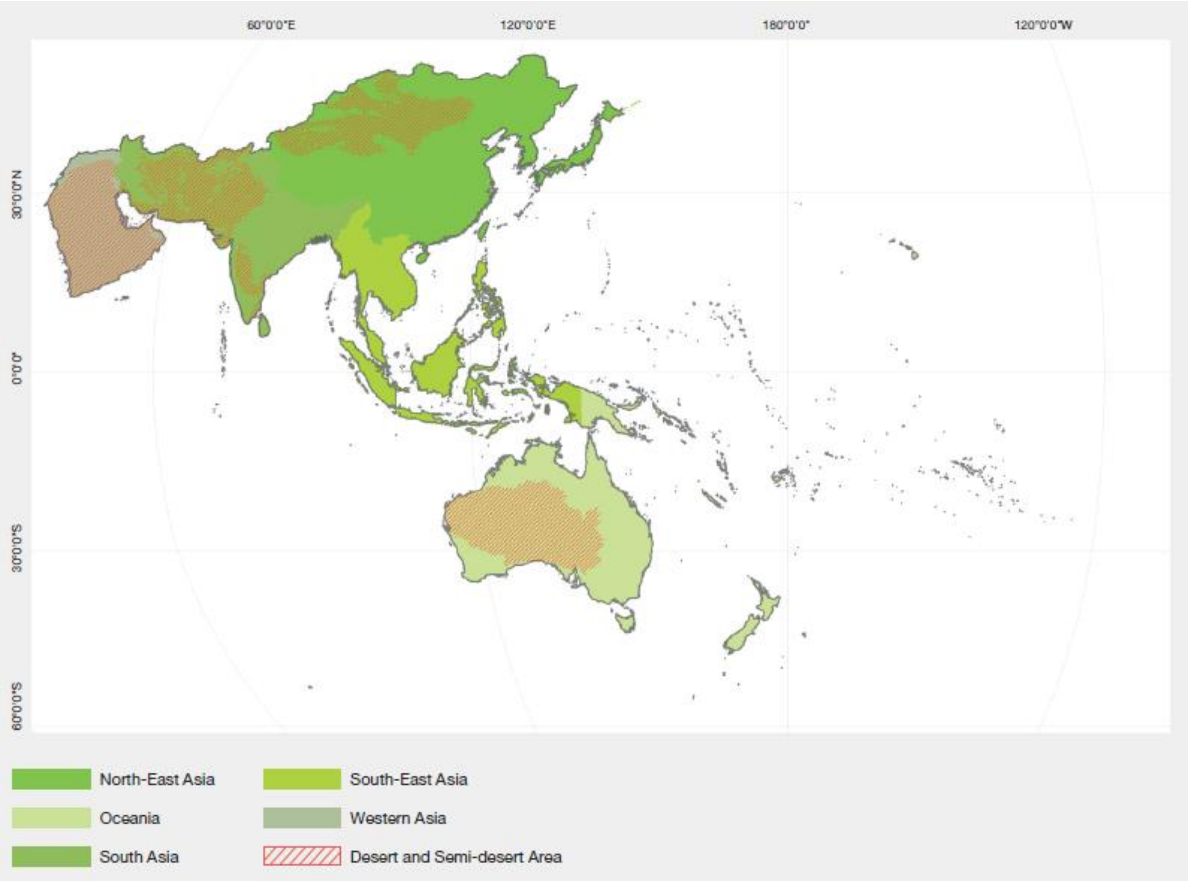


Figure 3.2 Desert and semi-desert area of the Asia-Pacific region. Source: WWF Terrestrial Ecoregions of the World (Olson *et al.*, 2001).

Name	Area (1000 km²)	Countries	Trends in PAI (%)	Trends in RLI	Trends in SHI
1 - Arabian Peninsula coastal fog desert	80	Oman, Yemen, Saudi Arabia	5 ↑	↓	–
2 - Gulf of Oman desert and semi-desert	61	Oman, UAE	1 ↑	↓	↓
3 - Persian Gulf desert and semi-desert	71	Saudi Arabia, Kuwait, Qatar, UAE, Bahrain	4 ↑	↓	↓
4 - Red Sea Nubo-Sindian tropical desert and semi-desert	640	Saudi Arabia, Yemen, Oman, Iraq, Jordan	5 ↑	↓	↓
5 - Gibson desert	155	Australia	60 ↑	–	–
6 - Great Sandy-Tanami desert	820	Australia	32 ↑	↓	↓
7 - Great Victoria desert	423	Australia	30 ↑	–	–
8 - Simpson desert	583	Australia	22 ↑	↓	↓
9 - Tirari-Sturt stony desert	376	Australia	10 ↑	↓	↓
10 - Badghyz and Karabil semi-desert	55	Afghanistan, Iran	14 –	↓	↓
11 - Central Persian desert basins	577	Iran, Afghanistan	9 ↑	↓	↓
12 - Indus Valley desert	19	Pakistan	63 ↑	↓	↓
13 - Mesopotamian shrub desert	206	Iraq, Syria, Jordan, Iran	3 –	↓	↓
14 - Registan-North Pakistan sandy desert	277	Afghanistan, Pakistan, Iran	2 ↑	↓	↓
15 - South Iran Nubo-Sindian desert and semi-desert	349	Iran, Pakistan, Iraq	5 ↑	↓	↓
16 - Thar desert	238	India, Pakistan	17 ↑	↓	↓
17 - Alashan Plateau semi-desert	674	China, Mongolia	15 ↑	↓	↓
18 - Junggar Basin semi-desert	273	China, Mongolia	11 ↑	–	–
19 - Qaidam Basin semi-desert	192	China	8 ↑	↓	↓
20 - Taklimakan desert	742	China	9 ↑	↓	↓

Figure 3.3 Deserts and semi-deserts in AP region by area and countries, current percentage coverage, and 50-year trends in areas covered by protected areas (PAI)[57], trends in Red List Index (RLI) [58] and Species Habitat Index (SHI)[59] for key vertebrate species.
Note: Arrows represent either positive (green) or negative (red) trends. No change has been shown in grey. There was not enough evidence to support the RLI and SHI trends quantitatively. Hence, the assigned trends are based on expert knowledge, personal communication, and grey literature.

[57] See IPBES Core Indicators: Percentage of areas covered by protected areas - (1960 – 2010) Calculated based on (IUCN & UNEP-WCMC, 2015)

[58] See IPBES Core Indicators: Red List Index - (1960 – 2010)

[59] See IPBES Core Indicators: Species Habitat Index - (1960 – 2010)

3.2.1.5 Agro-ecosystems

Agriculture represents humankind's largest engineered ecosystem, providing food and nutrition to the ever-increasing human population. The Asia-Pacific region accounts for about 30 per cent of the world’s agricultural lands (approximately 1.5 billion ha; FAO, 2014a) and about 60 per cent of its human population (UNESCAP, 2014). While agricultural land expansion occurred throughout the world during the period from 1970 to 2007, it was more rapid in the Asia-Pacific region. For instance, agricultural lands increased by about 6 per cent in the Asia-Pacific region, whereas it was only 1 per cent for the other regions of the world (UNEP, 2011), which however, slowed down subsequently (UNEP, 2016). Per capita food availability has increased in the region over the last two decades due to increased production (FAO, 2015a). However, it is projected that owing to pressing issues such as health insecurity and environmental degradation, Asia is likely to face with daunting food problems (McKay, 2009). According to Ravanera & Gorra (2011), there is a change in food demographics in the Asia-Pacific region and the growing middle class is now consuming more meat. In particular, intake of non-vegetarian diet (meat and fish) increased nearly two-fold in the Asia-Pacific region from 15 to 26 g per person per day over the period between 1990-1992 and 2011-2013 (FAO, 2014a).

A prominent structural feature of agriculture in the Asia-Pacific region is the prevalence of smallholder production systems, which use labour-intensive methods (Otsuka *et al.*, 2016). This region accounts for approximately 87 per cent of the 500 million small farms (less than 2 ha) world-wide with 193 million and 93 million farms in China and India respectively (Thapa & Gaiha, 2011). The smallholder agriculture systems in the Asia-Pacific region are significant sources of agricultural production, and contribute substantially to food security, rural poverty alleviation, and conservation of biological diversity notwithstanding the problems they encounter in respect of accessing inputs and service delivery. There is, however, widespread use of chemical fertilizers on these small farms leading to great pressure on agrobiodiversity (NEPAC, 1997; Zaizhi, 2000). It is evident that the traditional agriculture and homegardens have helped in preservation of various landraces and cultivars (Kumar, 2011). In a typical homegarden, there are intimate, multi-story combinations of several trees and crops, often in association with livestock (Mohan Kumar & Nair, 2004), and they combine ecological and socioeconomic aspects of sustainability (Peyre *et al.*, 2006).

Agricultural ecosystems both provide and rely upon various nature's contributions to people to sustain production of food, fibre, and other harvestable goods (Garbach *et al.*, 2014; W. Zhang *et al.*, 2007). While many of these contributions benefit the farmers and other stakeholders on-site, broader community benefits and some contributions that benefit both groups are plausible (Garbach *et al.*, 2014). In general, greater innate biological diversity within a given agroecosystem is related to augmented levels of ecosystem services (Balvanera *et al.*, 2006; Cardinale *et al.*, 2012; Garbach *et al.*, 2014). Agroecosystems in the Asia-Pacific region include a diversity of meadows, pastures, arable lands, croplands, and agroforestry systems. Among them, 65.4 per cent consists of permanent meadows and pastures, 30.8 per cent is arable, and 4 per cent is used for permanent crops (FAO, 2014a).

Under the increasing global demand for food, fodder and bioenergy crops, many agricultural systems are facing risks of biodiversity loss as well as soil fertility depletion and water shortage (Beddington *et al.*, 2011). On the whole, agricultural lands in the Asia-Pacific region suffer from two potential problems: intensification and abandonment. Intensive agriculture currently in vogue has caused degradation of some ecosystem services (H. Sandhu *et al.*, 2013; H. S. Sandhu *et al.*, 2012; Settele *et al.*, 2015) and exerts a range of negative impacts on the environment (T. W. Reynolds *et al.*, 2015). While these trends are widely found in the Asia-Pacific region, those are particularly well documented in Japan. First, intensification of rice farming, such as chemical usage and efficient drainage systems, has threatened aquatic plants, invertebrates, frogs, fish and birds since the 1960s in Japan (Ministry of the Environment, 2014). Second, abandonment of flooded rice fields in Japan has adversely impacted farmland species diversity, due to loss of habitat heterogeneity and altered vegetation successional pathways (Katayama, Osawa, *et al.*, 2015). Despite these problems, organic or wildlife friendly farming has increased in some parts of Japan and it has led to recovery of threatened species

(Miyashita, Yamanaka, *et al.*, 2014). However, organic farming is practised in <1 per cent of geographical area of Japan and there is a decline in winter-flooding of rice fields which is known to provide foraging and resting habitats for waterfowl. Moreover, abandoned farmlands are increasing in Japan (10 per cent of agricultural lands) and South Korea since the 1980s, where vegetation succession has often changed the dominant species in rice fields from aquatic to terrestrial species, including invasive grasses (Katayama, Baba, *et al.*, 2015; Queiroz *et al.*, 2014). On the other hand, there was recovery of the threatened species at up to 40 per cent abandoned sites where citizen volunteers managed and monitored biodiversity under the "Monitoring sites 1000 SATOYAMA" program (Ministry of the Environment, 2014). Thus, restoration of old fields, especially those in a degraded state, poses a major ecological and policy challenge (Cramer *et al.*, 2008). Without restoration, however, such degraded systems are less likely to contribute to the sustainability of biodiversity and ecosystem services.

Agriculture development ('high inputs/high outputs' model of industrial agriculture) has also resulted in the loss of crop genetic diversity such as rice land races which have been replaced by relatively few high yielding varieties (HYVs) of rice (Rerkasem *et al.*, 2009). A study by Young (2007) revealed that 30 traditional rice varieties grown in swidden systems have been lost due to shift towards HYVs of rice in South-East Asia. Likewise, commercial plantations have increased cash crops and decreased plant diversity in the Indonesian (Abdoellah *et al.*, 2006) and southern Indian home garden systems (Kumar & Nair, 2004).

There has been a growing concern about gradual degradation and loss of production potential of agricultural soils in many parts of Asia-Pacific region. In India alone, currently about 121 million hectares of land is facing various kinds of degradation (Eswaran *et al.*, 2001; ICAR - NAAS, 2010). In northern China, the river basins of Hei and Tarim have seen disruption in hydrology and degradation in the form of salinization, low water tables and reduced discharge volumes (UNEP, 2011). Use of heavy machinery, exhaustive cropping, short crop rotations, over grazing, and improper management allied with intensive farming has led to soil compaction in many parts of the Asia-Pacific region (Hamza & Anderson, 2005). A solution to this problem is to increase soil organic matter content and reduce tillage or grazing at high soil moisture content (Hamza & Anderson, 2005). Conservation Agriculture (CA), emerging as a promising strategy to sustainably manage agroecosystems for improved productivity and profitability (Valbuena *et al.*, 2012), is based on three cardinal principles: (i) minimum mechanical soil disturbance, (ii) adequate surface soil cover and (iii) crop diversification. This has significance for several subregions of the Asia-Pacific region and is considered as an alternative to conventional agricultural production systems in India (Srinivasarao *et al.*, 2015), China (Zheng *et al.*, 2014), Australia and New Zealand (Bellotti & Rochecouste, 2014).

While pesticide and fertiliser contributed to the increase of crop yield, those had some negative effects on biodiversity and also agriculture itself. First, excessive use of pesticides in parts of the Asia-Pacific region triggered pest outbreaks as in the classic example of the brown plant hopper (*Nilaparvata lugens*) (Kenmore *et al.*, 1984; Naylor & Ehrlich, 1997). Subsequently, farmers in some Asian countries adopted an integrated pest management approach that advocates use of natural pesticides which have to be used only when damage exceeds critical economic thresholds (Naylor & Ehrlich, 1997). More recently, there is increasing awareness on sustainable pest regulation by enhancing diversity of natural enemies (Bianchi *et al.*, 2006). Second, pesticide is regarded as a driver of global pollinator decline (Potts *et al.*, 2016), although wild pollinator data is lacking in the Asia-Pacific region (IPBES, 2016) and the effects of pesticide remain to be assessed. Third, biodiversity of soil has been severely affected by fertiliser and pesticide use, changing the natural rhizosphere microbiomes that assist plant growth by absorbing minerals and preventing colonization by pathogens (Berendsen *et al.*, 2012). Conversely, organic farming increased diversity of the soil microbiota in comparison to soils solely under mineral fertilization (Hartmann *et al.*, 2015).

There is a rising demand for managing agricultural landscapes as 'multifunctional' systems, which creates novel obligations and prospects, to preserve and augment nature's contributions to people as part of productive agroecosystems (Kremen *et al.*, 2002; W. Zhang *et al.*, 2007). The Asia-Pacific region, however, has undergone a major shift in land use patterns from diverse croplands including the swidden fields to monocultures of rubber, palm oil and cloves that have led to decline of agrobiodiversity (V. K. Bhatt & Singh, 2009; Mahendra Dev, 2011; Rerkasem *et al.*, 2009). In particular, the large-scale transformation of natural rainforest into plantation of oil palm and others is regarded as a major driver of the current biodiversity loss in South-East Asia (Fitzherbert *et al.*, 2008; Immerzeel *et al.*, 2014), further driving losses in ecosystem functioning (Edwards *et al.*, 2014), degradation of ecosystem functions such as pollination success, and the impairment of soil fertility and water quality (Cardinale *et al.,* 2012; Dislich *et al.*, 2017).

A promising feature of agriculture in the Asia-Pacific region is the increasing interest in organic farming practices. The region with largest organic agricultural land in the world is Oceania with 17.3 million ha, which accounts for about 40 per cent of the total organic agriculture area in the world (Willer & Lernoud, 2016). Asia accounts for 3.6 million ha of organic agricultural land (8 per cent) with China and India leading the group with 1.9 million ha and 0.9 million ha respectively (Willer & Lernoud, 2016). Growth in organic industry in the region is driven by rapidly growing overseas and domestic demands. Awareness of the health problems caused by the contaminated food products and environment degradation, and appropriate support by the governments and organizations like the International Federation of Organic Agriculture Movements (IFOAM) also contribute to the relatively high success of organic farming in some countries (P. K. Ramachandran Nair, 2014). Apart from the organic agricultural land, there are further organic areas such as wild collection areas.

Climate smart agriculture

Effects of climate change on agriculture are being experienced all over the world. In the Asia-Pacific region, such impacts will differ by region, with several areas experiencing a drop in crop productivity. Many studies have reported a high sensitivity of major cereal and tree crops to differential temperature, moisture, and carbon dioxide regimes (Aggarwal & Swaroopa Rani, 2009; Byjesh *et al.*, 2010; Devendra, 2012; Knox *et al.*, 2012; Srivastava *et al.*, 2010). Simulation models, using an array of General Circulation Models (GCMs) and Special Report on Emission Scenarios (SRES), demonstrate that increasing temperature regimes will reduce paddy yields due to reduced length of growing periods (e.g., (Aggarwal & Mall, 2002; Krishnan *et al.*, 2007; Soora *et al.*, 2013). Climate-smart agriculture (CSA) represents an approach for transforming and repositioning farming under the new challenges of climate change (Lipper *et al.*, 2014). The three main pillars of CSA are productivity, adaptation and mitigation. Furthermore, to evolve and focus suitable adaptation strategies to areas that are increasingly affected by climatic variability, district level vulnerability atlases were prepared in several countries in the region, e.g., India (O'Brien *et al.*, 2004; Rama Rao *et al.*, 2016) and Bangladesh (Shahid & Behrawan, 2008). There also exists significant potential for increasing the adaptive capacity of agricultural systems through agroforestry, which promotes integration of trees and crops on the agricultural landscape (van Noordwijk *et al.*, 2014).

Trees outside forests and agroforestry

Trees outside forests represent trees on land not demarcated as forest or other wooded areas (Bellefontaine *et al.*, 2002). This may include agricultural land as meadows and pasture, built-on land as settlements and infrastructure, and barren land as sand dunes and rocky areas. Trees outside forests abound in all ecoregions of the world and play crucial environmental, economic, and social functions at all scales (i.e., local, national, and global scales; de Foresta *et al*., 2013). Zomer *et al*. (2014) estimated that about 40 per cent of agricultural lands all over the world possesses more than 10 per cent tree cover and in most parts of the Asia-Pacific region, the percentage of tree cover on agricultural lands has increased in the recent past. For example, in South Asia, the area of >10 per cent tree cover increased by 6.7 per cent, in East Asia by 5 per cent, in Oceania by 3.2 per cent and in South-East Asia by 2.7 per cent between 2000 and 2010 (Zomer *et al.*, 2014). Many of these are smallholder production systems. Significantly, in Bangladesh, the total extent of trees outside forests on small holdings roughly corresponded to the total extent of trees outside forests on larger operational holdings (de Foresta *et al.*, 2013).

Trees outside forests represent a significant natural resource that augments nature's contributions to people including biomass stocks and carbon sequestration and improves the livelihood security of people (George *et al.*, 2012; Schnell, Altrell, *et al.*, 2015; Schnell, Kleinn, *et al.*, 2015). For instance, in Kerala State, India, trees outside forests accounted for about 90 per cent of the local timber production, besides providing 89.2 per cent of the rural fuelwood supply (Krishnankutty *et al.*, 2008). However, rapid urbanization in the post-economic liberalization era (between 2000 and 2010) has led to a 12.54 per cent decline in the suite of trees in the urban homegardens of Kozhikode city in Kerala, implying the loss of urban sustainability (Balooni *et al.*, 2014), despite the increasing role of homegardens in complementing urban livelihood sustainability.

The estimated contribution of trees outside forests to the total aboveground tree biomass, however, vary widely among countries (for e.g., 72.8 per cent in Bangladesh and 26.5 per cent in Philippines), owing mainly to differences in overall forest cover (Schnell, Altrell, *et al.*, 2015). Significantly, the contribution of trees outside forests to national biomass stocks and C stocks has been increasing since late 1970s. For example, China’s total biomass C stock of trees outside forests grew from 823 Tg C (1 Tg=10^{12} g) in 1977–1981 to 1339 Tg C in 2004–2008, which corresponded to a 62.7 per cent increase, and the country’s annual biomass C sink of trees outside forests accounted for 19.1 Tg C yr^{-1}, counterbalancing 2.1 per cent of the current fossil-fuel CO_2 emissions (Guo *et al.*, 2014).

The practice of managing and integrating trees outside forests with crops and livestock is known as agroforestry, implying significant overlap between trees outside forests and agroforestry (FAO, 2014b). Agroforestry systems abound in the Asia-Pacific region. The South- and South-East Asian region is often described as the cradle of agroforestry in its long history of the practice under diverse agroecological conditions (Mohan Kumar *et al.*, 2012). Prominent systems in the Hindu Kush Himalaya include improved fallows, alley cropping, scattered trees on cropland, live fences, wind breaks, trees along boundaries, contour vegetation strips, trees and shrubs on terraces, shifting cultivation, and cultivation of tea, cardamom, coffee and medicinal plants under trees (Bhattarai *et al.*, 2016). Most agroforestry systems provide an array of products such as food, fuel, fodder, green manure, timber, and medicines (P. K. Ramachandran Nair & Garrity, 2012). Agroforestry systems are, however, not only the sources of household food, but also provide supplementary incomes to the land managers and enhance their dietary quality (Jamnadass *et al.*, 2013). Homegardens in West Java and elsewhere are reported to provide up to 56.0 per cent of the family’s income (Kumar & Nair, 2004). Maintenance of soil fertility, erosion control, watershed protection, and microclimate modification are generally associated with agroforestry practices (Van Noordwijk *et al.*, 2015). Asdak *et al*. (2005) reported that the average surface runoff in bamboo-tree garden was 0.40 litre/m^2 compared to 0.99 litre/m^2 in cash crop gardens in West Java. Yet another contribution from the homegardens and bamboo-tree gardens of West Java is biodiversity conservation (Kaya *et al.*, 2002; Okubo *et al.*, 2010). Various domesticated and wild plant species originated from the forest usually inhabit the different vegetation strata of these unique land use systems. Floristic and structural complexity of homegardens and bamboo-tree gardens also provide resources for wildlife as well as livestock (Gunawan *et al.*, 2004). It is probable that a complex vegetation assemblage provides habitat for bird species too (Parikesit *et al.*, 2005).

In many parts of the Asia-Pacific region, indigenous agroforestry systems harbour an array of food plants and other culturally and ecologically cherished trees, within the milieu of basic food crops and vegetables (Thaman, 2008; Thaman *et al.*, 2014). However, there has been a collapse of the indigenous tree-dominated agroforestry systems in many parts of the Asia-Pacific region. This process, termed as ‘agro-deforestation’, is considered by many communities as the main reasons for the endangerment or loss of economically or ecologically important flora and fauna associated with agro-ecosystems (Thaman, 2008). For a large proportion of people in the Asia-Pacific region, the remaining trees and the diverse range of agroecosystems, remain the most important foundation for the delivery of diverse and irreplaceable nature's contribution to people. Growing trees in the agricultural landscape also helps to promote the livelihoods of smallholder farmers and to modify micro-climate (van Noordwijk *et al.*, 2014). Apart from this, agroforestry is now perceived as an approach for implementing REDD-plus concepts which will ultimately help meet the commitments made under the Nationally Determined Contribution (NDC) plans (Bhattarai *et al.*, 2016).

Agroforestry is being increasingly acknowledged as an advantageous route for offsetting greenhouse gases under the Kyoto Protocol, an important mechanism to enhance carbon sequestration (Kumar & Nair, 2011). Even at low densities, trees aggregate carbon to help combat climate change owing to the great spatial coverage (Verchot *et al.*, 2007). In India, the National Climate Change Action Plan through the Greening India Mission envisages 1.5 million ha of degraded agricultural lands and fallows to be brought under agroforestry (Ministry of Environment and Forests, Government of India., 2010). The prospects of extending the ideas of nature and natural resources conservation that existed in Japan to other parts of Asia and even globally are focused under the Satoyma Initiative. It is now recognized as a source of public goods e.g., scenic beauty with considerable recreational values and potential for biodiversity conservation (Fukamachi *et al.*, 2001; Mohan Kumar & Takeuchi, 2009; Takeuchi *et al.*, 2003, 2016). While the traditional agroforestry systems conserving site resources and agrobiodiversity are sustainable production systems , these are not always supported by comprehensive public policies (Guillerme *et al.*, 2011). Indeed, the commodity-centric agricultural policies and the forestry policies favouring exotic species have negatively affected the prospects of agroforestry as a land management system (P. K. Ramachandran Nair, 2014; Nath *et al.*, 2016). India, however, has recently launched a National Agroforestry Policy to overcome such shortcomings (Chavan *et al.*, 2015).

Integration of crop and animal production is widespread in the farming systems of Asia, especially in small-holder agriculture (Devendra & Thomas, 2002). Livestock (cattle, sheep, goats, poultry, hogs, etc.) is also intentionally combined with trees or other woody perennials. Silvopastoralism is a sustainable production system symbolized by greater biodiversity and multi-functionality, than other livestock production systems (Jose *et al.*, 2017). Although silvopastoralism is most commonly practiced in the developed countries (Sharrow, 1999), it constitutes a significant land management activity in the Asia-Pacific region. For example, in South-East Asia alone, the potential for tree crop-ruminant systems exists over an estimated 210 million ha of tree crops like coconut, oil palm and rubber that could be used also for animal production (Alexandratos, 1995). In India, the rainfed agroecosystem accounts for 68 per cent of the total cultivated lands and provides support for 40 per cent of the human and 65 per cent of the livestock population (A. K. Misra *et al.*, 2009), producing 44 per cent of dietary needs (H. P. Singh *et al.*, 2004).

3.2.1.6 Urban ecosystem and biodiversity

Approximately half of the population of the Asia-Pacific region lives in urban areas, but urbanization varies greatly within and between regions (United Nations, 2015). Oceania and Western Asia are currently most urbanized and Southern Asia least, while Eastern Asia has urbanized most rapidly in the last 25 years (Figure 3.4). In Australia, Israel, Japan, Republic of Korea, Lebanon, New Zealand, and several smaller countries, more than 80 per cent of the population is urban, while in Nepal, Papua New Guinea, Samoa, and Sri Lanka it is less than 20 per cent (United Nations, 2015). Five countries in the Asia-Pacific region, Bhutan, China, Indonesia, Lao PDR, and Nepal, were among the ten fastest urbanizing countries in the world for 1990-2014. Of the world's 28 biggest cities (having over 10 million population), more than half are in Asia, with six in China, three in India, two in Japan, and one each in Bangladesh, Indonesia, Pakistan, and the Philippines. The world's three biggest cities, namely, Tokyo, Delhi, and Shanghai, are all in Asia.

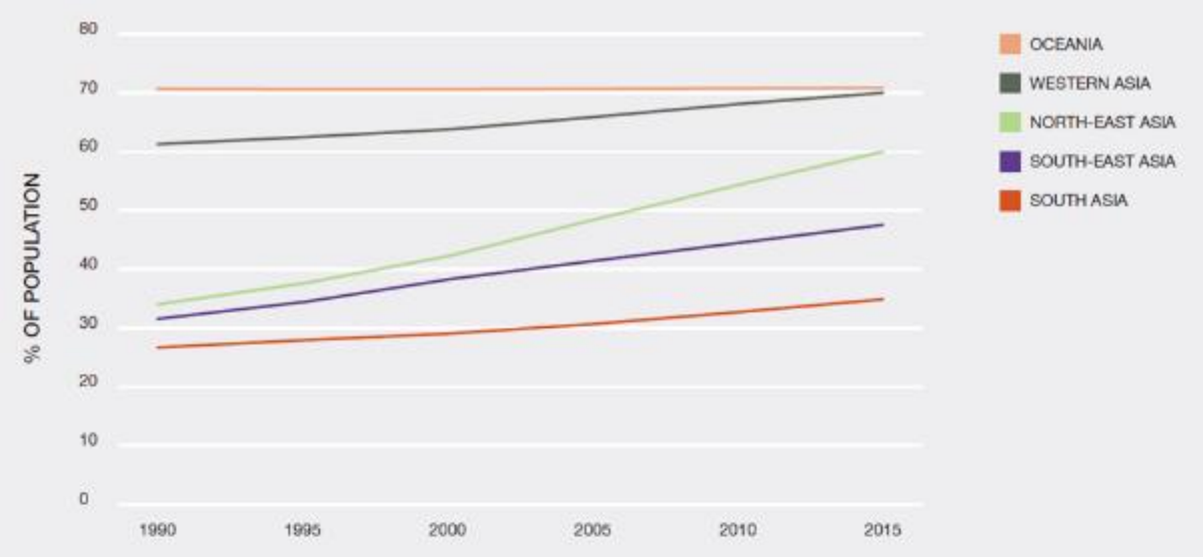


Figure 3.4 Trends in human populations in urban areas of the Asia-Pacific region. Source: United Nations (2015).

Unfortunately, there is no detailed regional map of urban areas in the Asia-Pacific region and the statistics on changes in urban land from different countries are based on a variety of different methodologies, making comparisons difficult. In China the total area of urban and industrial land more than doubled between 1990 and 2010, with growth concentrated in the megacities of the coastal zone (Kuang *et al.*, 2016), while in Vietnam the built-up area increased 880 per cent from 1992 to 2010 (Ouyang *et al.*, 2016). India, in contrast, has seen relatively slow urban growth overall, although expansion was 4.0 and 4.9 per cent per year, respectively, in the southern cities of Hyderabad and Bangalore (Gibson *et al.*, 2015). Even in China and Vietnam, however, the total area of urban land is still less than one per cent of the total land area (Kuang *et al.*, 2016; Ouyang *et al.*, 2016).

Urban growth interacts with global climate change to influence urban climates. The 'urban heat island effect', resulting from a combination of dark heat-absorbing surfaces, heat storage by day and release at night, reduced evaporative cooling from vegetation, waste heat from machinery, and canyon-like streets that trap heat, has contributed a variable proportion to observed urban warming over recent decades. While this proportion is generally less than half, with the rest attributed to global climate change (Jin *et al.*, 2015), it appears to have been as high as 80-85 per cent in Shenzhen, China, which was probably Asia's fastest growing city (L. Li *et al.*, 2015). Rapid urban warming, in turn, has resulted in increased discomfort and health risks for people (Son *et al.*, 2016) and a longer growing seasons for urban plants (D. Zhou *et al.*, 2016).

Biodiversity in cities is concentrated in the remaining green spaces. Because urban green space can provide important ecosystem services and sometimes supports threatened species, balancing conservation and development is becoming an urgent issue (Lonsdale & Fuller, 2005; Tan & Abdul Hamid, 2014). Early urbanization sometimes destroyed primary forests in tropical and subtropical regions, but recent urban sprawl has largely converted agricultural lands into built-up areas (Bagan & Yamagata, 2012; Han *et al.*, 2009; Tan *et al.*, 2013; Zhao *et al.*, 2006; X. Zhou & Wang, 2011). In the last several decades, due to maturation of urban policies, urban green space is increasing in most of the megacities, occupying occasionally up to 30 per cent of urban areas (V. S. Singh *et al.*, 2010; J. Yang *et al.*, 2014). Nonetheless, per capita urban green space generally remains at low levels in megacities in Asian countries, where it is often <10 m^2 (Jim & Chen, 2008; Thaiutsa *et al.*, 2008; Yamamoto, 2010), in comparison to the standard determined by developed countries (20 m^2). Also, because of the huge expansion of built-up areas into suburbs, increasing urban green space in the middle of the cities appears to make little contribution to increasing vegetation areas at the regional scale (J. Yang *et al.*, 2014).

Urban green spaces also differ in quality. Non-native species make up a significant portion of total plant species richness in urban green space, sometimes reaching more than 80 per cent (W. Li *et al.*, 2006; Nagendra & Gopal, 2011; G. Wang *et al.*, 2007). Old urban parks in core city areas occasionally harbour unique native tree species (Nagendra & Gopal, 2011; Zhang & Jim, 2013), but newly established city parks located in peripheral areas often have low native species richness and highly homogeneous species compositions (Thaiutsa *et al.*, 2008). Plant species richness in some Australian cities appears to have an extinction debt, with some existing species predicted to go extinct in the near future (Hahs *et al.*, 2009). Urban residents in the Asia-Pacific region also depend heavily on resources provided by biodiversity and ecosystems in distant locations around the world (Furukawa *et al.*, 2015; Moore, 2015). These resources include timber and other wood products from natural forests, wild-caught fish and other aquatic animals, and products from crops dependent on wild pollinators. Efforts to reduce these "biodiversity footprints" (Lenzen *et al.*, 2012) are required for the sustainability of global biodiversity. Species adapted to human built environments have adapted and spread around the world as urban invasive alien species and also has negative contribution to people, including direct and indirect damages to human health (McNeely, 2001).

Studies of urban birds have shown that open-habitat generalists and non-native species are generally common, while forest specialists are rare. Higher bird diversity in urban green spaces in the Asia-Pacific region is associated with area, complex vertical vegetation structure, native plant richness, nearness to water, and the intensity of human use (Chang & Lee, 2016; Khera *et al.*, 2009; Sasaki *et al.*, 2016; Threlfall *et al.*, 2016; Xie *et al.*, 2016; G. Yang *et al.*, 2015). The status of invertebrates in the Asia-Pacific region is less well known, but old urban parks harbour higher species richness of ants (Yamaguchi, 2004), and species richness of spiders is poorer in isolated urban woodlots (Miyashita *et al.*, 1998). Butterfly communities can be diverse in urban parks and may have some conservation value, as well as contributing to human enjoyment (Jain *et al.*, 2016; Sing *et al.*, 2016; Tam & Bonebrake, 2016). Evidence for an extinction debt in butterflies was found in Tokyo (Soga & Koike, 2013).

Urban and suburban food production in farms, back-yards, community gardens, and on roof tops and balconies, can make a significant contribution to the urban food supply, as well as plant and animal habitats (Gómez-Baggethun *et al.*, 2005). Many cities also depend on freshwater supplies from vegetated catchments on the periphery. Within cities, plants and vegetation contribute to quality of human life by moderating the urban heat island effect, reducing noise, removing atmospheric pollutants, and reducing run-off and flooding(Gómez-Baggethun *et al.*, 2013). Many studies have also shown large health benefits from contact with nature in and around cities (Hartig *et al.*, 2014).

3.2.1.7 Islands

The Asia-Pacific region includes tens of thousands of small islands. Most are oceanic islands in the vast Pacific Ocean that have never been connected to the mainland, but there are also tens of thousands in the Philippines, Indonesia and Japan, which are all island archipelagos, and in the Indian Ocean (Andaman and Nicobar Islands, Maldives, and others). The Hawaiian archipelago—3,200 km from the nearest continent—is the most isolated group of islands on earth. This Archipelago includes volcanic islands and atolls with tremendous landscape diversity endowing it with as many as 10 ecozones – from alpine systems to tropical rainforests – within a 40 km span. Some of the highest concentration of endemic species in the world is brought about by this isolation and landscape diversity. The state of Hawaii is home to approximately 1.4 million people who descend from Polynesian, Asian, and European cultures.

Although the total land area of the small islands in the Asia-Pacific region is small, high rates of endemism and isolated human populations mean that they contribute disproportionately to the region's biological and cultural diversity. Although plant diversities are lower on individual islands, endemism is higher than on continents (Kier *et al.*, 2009) and around 50,000 species of vascular plants globally are island endemics (Sharrock *et al.*, 2014). Moreover, despite their very low tree diversity, Pacific Island forests are similar in density and aboveground biomass to the much more diverse tropical forests in other areas (Ostertag *et al.*, 2014). High endemism is also shown by the animal groups that dispersed to remote islands, including bats, birds, and many groups of invertebrates (Corlett & Primack, 2011). However the diversity is highly threatened with more than half of all recent extinctions occurring on islands, which are haven to over a third of all terrestrial species facing imminent extinction (Ricketts *et al.*, 2005). The signature tree of the Hawaiian forest is the `Ohi`a lehua (*Metrosideros polymorpha*) which grows from sea level to 2900 meters. Genomic analyses of the ohia taken from different environments have shown some genes leading to adaptive divergence along altitudes (Izuno *et al.*, 2017). The forest ecosystems in most of the islands serve as reserves of freshwater and help prevention of sediment runoff that would adversely impact its coastal coral reefs.

Human colonization of the Pacific Islands resulted in the extinction of around 2000 bird species—about 20 per cent of the global avifauna, mostly due to introduced invasive alien species (Blackburn *et al.*, 2004) —and extinctions are still continuing (Arcilla *et al.*, 2015). Since 1500 AD, 95 per cent of all bird extinctions have occurred on islands. Bird species losses on individual Pacific islands range from 15.4 per cent to 87.5 per cent for those with good fossil records, and these extinctions have resulted in the loss of many ecological functions previously performed by birds, including grazing, seed dispersal, and the pollination of endemic plants (Boyer & Jetz, 2014). The services performed by Pacific Island fruit bats also include both pollination and seed dispersal, and studies in Fiji have shown a large overlap between the native plants serviced by bats and those valued by humans for various purposes (Scanlon *et al.*, 2014), highlighting the vulnerability of nature's contribution to people on small islands. Extraordinary rates of extinction have also been experienced by some endemic invertebrates, such as the partulid tree snails (T. Lee *et al.*, 2014).

High human population densities supported by coastal and marine resources can put extreme pressures on terrestrial island ecosystems and the services that these provide. Not surprisingly, therefore, the impacts of global change drivers (climate change, sea-level rise, invasive alien species etc.; See Chapter 4) on small island ecosystems have frequently been greater and more rapid than the impacts of the same drivers on mainland ecosystems. Major current threats include biological invasions, to which naïve island species and ecosystems show little resistance (Pyšek *et al.*, 2017), and climate change (Courchamp *et al.*, 2014). Island floras are accumulating invasive plant species much more rapidly than similar sized mainland regions (Van Kleunen *et al.*, 2015), but exotic plants has caused few native plant extinctions, probably due to presence of dormant stages enabling plants to escape unfavourable conditions over time (Pyšek *et al.*, 2017; Sax & Gaines, 2008). Exotic fungal pathogens in New Zealand and Hawaii are however an increasing threat to iconic native tree species on islands (Mortenson *et al.*, 2016; P. Scott & Williams, 2014). Invasive alien animals are implicated in 86 per cent of island plant and vertebrate extinctions (Bellard *et al.*, 2015; IUCN, 2015). Vulnerability to climate change is greater on smaller, low elevation islands with more homogenous topography, where there is literally nowhere for species to retreat to (Harter *et al.*, 2015). Recent global analyses suggest that thousands of islands are threatened with total immersion in the coming decades, while tens of thousands more risk losing over 50 per cent of their habitat (Bellard *et al.*, 2013, 2014). The Asia-Pacific region has more low-lying islands and atolls vulnerable to sea-level rise than any other region e.g., Maldives, Kiribati, Tuvalu, Marshall Islands and the Tuamotu Archipelago.

3.2.1.8 Special ecosystems

Terrestrial ecosystems that are distinct from the regional type expected for that particular climate, as a result of unusual and extreme geology and/or soils, can make a major contribution to the regional diversity of plants and animals. Whereas these ecosystems have often been treated as wasteland and given no protection, those are now under rapidly increasing threats due to the demand for cement and other products.

Limestone karsts

Limestone karsts are widespread in the Asia-Pacific region, with 408,000 km^2 in South-East Asia (Clements *et al.*, 2006) and 430,000 km^2 in southwest China (S. J. Wang *et al.*, 2004). In South-East Asia, approximately 13 per cent or 52,650 km^2 of karsts are protected (Clements *et al.*, 2006). Karsts in this subregion are mostly found in Indonesia, Thailand and Vietnam and have interesting geological features (Clements *et al.*, 2006). Their complex structures, distinctive chemistry, and isolation from a non-karst matrix have resulted in unique flora and fauna with high endemism. In Peninsular Malaysia alone, nearly 21 per cent of 1216 karst-associated plant species are endemic to limestone hills (BirdLife International *et al.*, 2014; Davison *et al.*, 1991). Caves sustain unique subterranean ecosystems including groundwater animals (Gibert & Deharveng, 2002). Caves also provide nature's contribution to people, such as water, guano as fertilizer, cave-roosting bats as important pollinators of many crops, and cultural and religious sites. Maintaining limestone karsts can also help attract more pollinators for agricultural areas (Sritongchuay *et al*., 2016). Wanger *et al*. (2014) quantified the importance of bats that roost in limestone caves for pest control of rice fields which is crucial for sustaining food security. Until recently, the biodiversity of limestone karsts in the Asia-Pacific region had been protected by the low suitability of these areas for agriculture or by default of being located within the boundaries of protected areas such as national parks or have been accredited World Heritage status (Liew *et al.*, 2016). However, there has been an exponential increase in the demand for cement and marble products in recent decades which is derived largely from the karsts (Clements *et al.*, 2006; Liew *et al.*, 2016). In SE Asia, limestone karsts are often found in areas near development and support remnants of ecosystems which previously had wider distributions but have since been lost to development. The major threat to the survival of karst-associated species is quarrying (Sodhi & Brook, 2006). A conservative figure of globally threatened karst-associated species listed by IUCN as critically endangered, endangered, or vulnerable stood at 143 species and of these 31 species (ca. 21 per cent) occur in South-East Asia (Clements *et al.*, 2006). With good financial returns from karst quarrying for cement manufacturing, it is unlikely this exploitation will be slowed down or halted, more so in some SE Asia countries where karst protection is minimal or non-existent (e.g., Myanmar, Cambodia). Current laws for the protection of limestone karst in several countries in the Asia-Pacific region, if any, are lacking, lax and ineffective (Kiew, 2001; Lim & Cranbrook, 2002). An example is the case of Malaysia, where majority of the limestone hills are classified as State Forest Land and do not have protected area status hence vulnerable to anthropogenic disturbances (Clements *et al.*, 2006; Liew *et al.*, 2016).

Ultramafic outcrops

Other special ecosystems occur on ultramafic rock outcrops in the Asia-Pacific region, particularly in New Caledonia, where ultramafic rocks cover a third of the land area, Sulawesi, the Philippines, and Sabah, and in scattered patches throughout the Asia-Pacific region (Galey *et al*., 2017). Soils derived from these rocks tend to be shallow and drought prone, low in fertility, and to have high concentrations of nickel, cobalt, chromium, and magnesium (Isnard *et al.*, 2016). Ultramafic rocks outcrop over less than 1 per cent of the Earth's surface and their distinctive chemical and physical characteristics, coupled with their isolation, result in plant species adapted to these conditions with very high levels of endemism (van der Ent & Lambers, 2016). The presence of ultramafic outcrops contributes to the exceptional plant diversities of Mt. Kinabalu, Sabah (van der Ent & Lambers, 2016), and New Caledonia where they support around half the total flora (Isnard *et al.*, 2016). As with limestone karsts, ultramafic outcrops were protected until recently by their unsuitability for agriculture, but some are now threatened by mining for nickel (Losfeld *et al.*, 2014).

Heath forests (Kerangas or white-sand forests) and scrub/heathlands (Kwongan Mediterranean Sandplains)

Heath forests (Kerangas or white-sand forests) are forests developed on soils derived from sand or sandstone, and are most common near the coast (Corlett, 2014). In the Asia-Pacific region they are most extensive in Borneo, but also occur scattered throughout SE Asia and, less well documented, elsewhere. It is not clear whether susceptibility to drought or shortages of nutrients, particularly nitrogen, are the most important reason for their distinctiveness (Brearley *et al.*, 2011). They are characterized by a lower, more uniform, small-leaved canopy and relatively lower tree diversity than non-Kerangas rain forests, but also harbor high tree diversity including many endemic species (Corlett, 2014). Depending on the soil depth and variability of water and drainage heath forests can be recognised in a series of different types (Brunig, 1965; Wong *et al.*, 1987). Their soils are unsuitable for agriculture, but they are prone to apparently irreversible degradation by logging and/or fire, and some are being mined for sand gold. The Mediterranean sandplains of Western Australia support open, species-rich "kwongan" shrublands on similar nutrient-poor soils derived from eroded sandstone. These communities support over 7000 species of vascular plants with an 80 per cent rate of endemism (L. C. R. Silva, 2014). Over 80 per cent of the original ecosystem has been lost to agriculture and development, and the ecoregion is classed as endangered under the Australian Environmental Protection and Biodiversity Conservation Act.

3.2.2 Inland freshwater and wetlands

3.2.2.1 Status and trends in fresh water biota

Freshwater ecosystems include lakes, ponds, rivers, streams and inland wetlands and peatlands (Ramsar Convention, 2012). Freshwater ecosystems provide several services, of which some are extensively exploited (Vörösmarty *et al.*, 2010). As a consequence of the dense human population, freshwater resources in the Asia-Pacific region is undergoing the most rapid rate of decline globally (McLellan, 2014). Freshwater biodiversity, which represents almost 6 per cent (>163,000 species) of all species on earth contained in 0.01 per cent of the world's water in ecosystems, appears to be disproportionately at risk (Dudgeon *et al.*, 2006). "The paradox of freshwater biodiversity" (Martens, 2010) is characterized by the fact that freshwater habitats comprise only 0.8 per cent of the earth surface, but harbour 9.5 per cent of all known animal species, including one third of all vertebrate species (Strayer & Dudgeon, 2010). Furthermore, the geographic distribution range of freshwater species is often restricted to small areas, such as river and lake basins (e.g., Dudgeon *et al*., 2006). Habitat loss and fragmentation have reduced genetic diversity and variability within the declining populations (e.g., Ezard & Travis, 2006). Consequently, global extinction rates and extirpations (local/regional extinctions) of freshwater species are roughly twice that of terrestrial and marine ecosystems (Strayer & Dudgeon, 2010; The Millennium Ecosystem Assessment, 2005). Some regional biodiversity data are summarised by Brooks *et al*. (2016).

Of all animal life forms in freshwater ecosystems, arthropods (particularly insects) are by far the most diverse. More than 28 per cent of freshwater species (>35,300) have been recorded in the Asia-Pacific [areas of the Palaearctic Realm that are part of the IPBES Asia-Pacific region are not included in this number] (Balian *et al.*, 2008). The true number of extant animal freshwater species is likely to be distinctly higher, for some groups by one order of magnitude. The taxonomic coverage of research efforts is insufficient, including even comparably enigmatic groups such as amphibians (Shabani *et al.*, 2017). This applies to invertebrates in even higher extent, due to lower awareness, or even negative perception in the public and among policymakers (Cardoso *et al.*, 2011).

Hotspots of notably high species diversity of selected key freshwater taxa are: the Philippine archipelago, Sulawesi and coastal areas of China for freshwater shrimps (De Grave *et al.*, 2015); the Sundashelf (Indonesia, Malaysia, Brunei), the river basins of the Ganges, Brahmaputra and Irrawaddy as well as the coastal lowlands of southern China and northern Vietnam for freshwater turtles (Carrizo, 2016); Indo-Burma and the Sundashelf for Amphibians (IUCN Global Species Programme Freshwater Biodiversity Unit, 2013). According to the IUCN (2009), about 37 per cent of freshwater species are facing threats of extinction. These including ecologically important predators (e.g., key stone species) like several otters (*Amblonyx cinereus, Lutra sumatrana, Lutrogale perspicillata*), two wetland cat species (*Prionailurus planiceps, P. viverrinus*), the baiji (*Lipotes vexillifer*),the south Asian river dolphin (*Platanista gangetica*), the Chinese alligator (*Alligator sinensis*, the Philippine and Siamese crocodiles (*Crocodylus mindorensis, C. siamensis*) and the gharial (*Gavialis gangeticus*)

(Aadrean *et al.*, 2015; Bezuijen *et al.*, 2012; Malla, 2015; Mukherjee *et al.*, 2016; B. D. Smith *et al.*, 2008; B. D. Smith & Braulik, 2012; van Weerd *et al.*, 2016; Wilting *et al.*, 2015; Wright *et al.*, 2015). This alarming trend does probably not even fully reflect the actual decline of freshwater species, since comprehensive data are hardly available for many parts of the Asia-Pacific region. Across the Asia-Pacific region, roughly one third of freshwater fish species is threatened (Closs *et al.*, 2016). Projected freshwater fish extinction rates are highest in (semi-)arid areas throughout the Asia-Pacific region (especially parts of Australia, Afghanistan, China, Iran, Mongolia and the Arabian Peninsula) due to increasing water ability loss (Tedesco *et al.*, 2013). Land conversion without riparian forest reserves reduces fish diversity substantially (Giam *et al.*, 2015), e.g. in Singapore, deforestation and canalization has caused extinction of 11 (out of 46) native freshwater fish species (Giam *et al.*, 2011).

Recently, chytridiomycosis, an infectious disease in amphibians caused by the fungus *Batrachochytrium dendrobatidis*, has caused dramatic population declines and extinctions of amphibian species in Australia and other parts of the world. However, this has not (yet) affected Asian and New Guinean amphibians in the same extent, either because this threat is newly emerging or its impact was (2011) still at low prevalence (Swei *et al.*, 2011). Habitat destruction through deforestation and land conversion (see Chapter 4) remains to be major threat and cause for population decline in amphibians (Stuart *et al.*, 2004). Water bird populations show the largest decline in the Asia-Pacific region compared to the rest of the world . Freshwater inhabiting reptiles are threatened throughout the Asia-Pacific region by wildlife trade, bushmeat hunting, degradation of habitat, pollution, bycatch mortality, and persecution (e.g. Nijman, 2010; Pacini & Harper, 2008; Shanker & Pilcher, 2003). A massive threat of overexploitation is evident in the South and South-East Asian subregions, were freshwater turtles and other reptiles are excessively traded for decades. Immediate actions were recommended by an expert team (Horne *et al.*, 2012) to prevent the about 64 species (80 per cent threatened) in the region (IUCN Red List, 2017) from extinction.

Threatened species data coverage across the Asia-Pacific region varies widely for freshwater invertebrates. Japan has probably the widest and longest coverage (50+ years). Except for the arthropod orders Decapoda (decapods), Odonata (dragonflies & damselflies), and Mollusca (mollusks), which account together for 4312 out of 4374 freshwater invertebrates assessed, almost no freshwater invertebrate taxa are listed for the Asia-Pacific region (IUCN Red List 2017). However, even for the groups mentioned, population trends are mostly unknown, 137 species of Odonata (8 per cent), 292 Decapoda (20 per cent), and 226 Mollusca (19 per cent) are threatened. More than 1200 truly aquatic vascular macrophyte species (> 46 per cent of 2614 worldwide recognized) are recorded from the Asia-Pacific region [areas of the Palaearctic Realm that are part of the IPBES Asia-Pacific region are not included in this number], with highest diversity in the Oriental realm (25 per cent of world diversity). Most diverse families here are Cyperaceae, Poaceae, Haloragaceae for Australasia and Araceae for the Oriental Region). Their endemism rates are lower than in aquatic animals, with an endemism of 46 per cent for Australia, 43 per cent for the Oriental region and 7.4 per cent for the Pacific Islands (Chambers *et al.*, 2008).

70 per cent of the 256 native freshwater fish species of Australia are endemic, but 37 alien freshwater fish species were introduced, the most impactful being European carp, Nile tilapia and red finned perch (Darwall & Freyhof, 2015). Of 74 (29 per cent) fish taxa listed as threatened, the Galaxiidae are the most threatened (18 of 23 described taxa) (Lintermans, 2013a). Given current trends, extinctions are predicted particularly at northern Australian sites within the next 30 years (Lintermans, 2013b). Roughly half of New Zealand’s distinctive fish species are threatened, including 18 endemic species (Allibone *et al.*, 2014). About one fourth each of the 223 Australian amphibians and of the ca. 20 freshwater inhibiting reptiles (5 turtle species) are threatened (IUCN Red List, 2017). The status of freshwater fish fauna of the Asia-Pacific region is summarised in the following Table (Table 3.2).

Table 3.2 Summary of the level of threat and state of knowledge in 2013 for freshwater fishes in the Asia-Pacific loosely ordered according to their state of coverage for the IUCN Red List
Note: ? = unknown. Source: Darwall & Freyhof (2015), with updates and additions for China and the Philippines based on Froese & Pauly (2017), IUCN Red List (2017), C. Liu *et al*. (2017), and Xing *et al.* (2016)

Parameters / Region	Estimated No. of Species in the region	Estimated No. of Endemic species	No. of species in RL	No. of globally threatened species	No. of species thought to be extinct in the wild	State of Coverage for IUCN Red List
Peninsular India	290	189	290	97	0	Good
Eastern Himalayas	520	?	520	70	0	Good
lndo-Burma	1178	~630	1178	112	1 (4 possibly)	Good
New Zealand	41	33	41	20	1	Good
Western Asia	~300	~245	245	105	7	Good
Japan - National RL	~297	~125	?	144	4	Good
Japan - IUCN RL	~297	~125	129	11	4	Medium
Australia	256	~190	169	32	0	Medium
Pacific Islands	?	?	167	12	0	Medium
Central Asia	?	?	82	17	1	Poor
China	1513[3]	877[4]	545	76	2	Poor
Indonesia	1189	125	389	72	0	Poor
Philippines	361[1]	~100[1]	176[2]	28[2]	32[2]	Medium

In South-East Asia, the Indo-Burma subregion and Indonesia have a particularly rich freshwater fish fauna (Darwall & Freyhof, 2015). Indonesia harbours a very high diversity of freshwater fishes for its land area, currently 1230 species are recognized, including 20 recently introduced (Froese & Pauly, 2014). However, the freshwater fish fauna is still poorly documented, with many additional species awaiting discovery. The individual conservation status of all the species of the mega-diverse fish fauna of Indonesia remains to be assessed (Darwall & Freyhof, 2015). In the Philippine archipelago, about 100 (28 per cent) of the freshwater fish species are endemic, 50 introduced and 25 (most of them cyprinids) threatened based on the current IUCN Red List (Froese & Pauly, 2017).

Many freshwater finfish across the SE Asian subregion are vulnerable (S. S. De Silva *et al*., 2007). *Platytropius siamensis*, the Siamese flat-barbelled catfish, is the oly species of fish from the region considered to be extinct (Ng, 2011). Invasive alien fishes and their likely impacts have been a strong driver of the Indonesian and other governments developing a National Strategy on Invasive Alien Species (CBD COP 9). The amphibian fauna of the SE Asian archipelagoes is also particularlyn diverse; e.g., there are 112 species recorded in the Philippines, 94 (84 per cent) of which are endemic (Diesmos *et al*., 2015), several of them with unique evolutionary lineages (R. M. Brown *et al*., 2013). About 45 per cent are threatened and their populations are suspected to be in decline (Diesmos *et al*., 2014). A special threat has also emerged for water snakes (mostly homalopsids) which are excessively overexploited in some areas of the subregion, e.g. Tonle Sap Lake, Cambodia (S. E. Brooks *et al.*, 2007). Most freshwater turtles and top predatory reptiles in freshwaters of the subregion, such as the Philippine crocodile (*Crocodylus mindorensis*), the Siamese Crocodile (*Crocodylus siamensis*) and the false gharial (*Tomistoma schlegelii*) are particularly threatened and have highly fragmented populations by now (Bezuijen *et al.*, 2012, 2014; van Weerd *et al.*, 2016).

Freshwater resources across island nations in the Asia-Pacific region are limited to rainwater, limited surface waters and shallow groundwater. Freshwater ecosystems – in quantity and quality - are largely in decline due to deforestation in the headwaters, flow alteration (damming), agricultural intensification, invasive species, and fisheries exploitation downstream (SOCO 2013). Freshwater biodiversity data are generally limited for the Pacific Islands but the overall trend is declining for native and endemic species. In the Pacific Islands of Oceania (excl. the Hawaiian archipeago), most freshwater fish (91 species) are widely distributed and 12 are threatened (Pippard, 2012; IUCN Red List, 2017). The amphibian diversity of Oceania is exceptionally low (but also data deficient); among them are three threatened frog taxa that suffer from habitat fragmentation and invasive alien species (IUCN Red List, 2017). In New Zealand, 74 per cent of all native freshwater taxa and 76 per cent of all non-diadromous taxa (i.e. only in fresh water) are threatened. (Elston *et al.*, 2015).

In north-east Asia, there is a high degree of freshwater fish endemism. For example, endemic fish represent 16.9 per cent of the native freshwater species in South Korea (S. S. De Silva *et al.*, 2007) with protected areas tending to have higher fish diversity than more populous regions (Jang *et al.*, 2003). In China, Yunnan Province, including the upper reaches of the Yangtze, Red, Mekong and Salween rivers, has the highest species richness (373) and country-endemic species (216), many of which are specially adapted to high-altitude habitats of this part of the world (Kang *et al.*, 2013). 409 amphibians are listed from north-east Asia by the IUCN Red List (2017) of which 30 per cent are considered threatened. The situation is even more dramatic for freshwater reptiles, with at least 24 threatened out of 66 assessed species (IUCN Red List, 2017). Many taxa need updates on their status. Japan's national Red List of freshwater fishes (Ministry of the Environment - Government of Japan, 2017) indicates that around half of all species are threatened and three extinct. Significant losses of freshwater fish diversity have been observed between the 1950s–2010 and is projected to continue. For example, shoreline reed beds in Lake Biwa were reduced by roughly 50 per cent between the 1950s and the 1990s, resulting in a substantial loss of habitat for many fish species. In the Korean peninsula, a total of 213 freshwater fish species have been recorded. Of these, 61 species (28.6 per cent) are endemic, and occur predominantly in mountain areas; there are also 12 exotic species (Kim & Park, 2002).

In south Asia, the eastern Himalaya and adjacent flood plains including Ganges–Brahamaputra, Chinwin–Irrawaddy, and Kaladan/Kolodyne catchments represent freshwater turtle diversity hotspots (Carrizo, 2016). This also applies to freshwater fish (Allen *et al.*, 2010). The centres of richness are the Tista, Kameng, Dikrong, Subansiri and Siang basins of the Ganges–Brahmaputra system. The critically endangered sawfishes are primarily threatened through overfishing in the marine parts of their ranges. Further critically endangered species are snow trouts (*Schizothorax* spp.), both endemic to Lake Rara in Nepal, where they are threatened by overfishing, pollution and siltation (Darwall & Freyhof, 2015).

India has a distinct freshwater fish fauna (Dahanukar *et al.*, 2004; Kottelat & Whitten, 1996; Lal Mohan & Rema Devi, 2000). An assessment of all known freshwater fish in peninsular India recorded 290 described species (Molur *et al.*, 2011) with 37 per cent of 97 assessed species threatened. No species are known to have gone extinct in the recent past. However, *Batagur baska* (northern river terrapin) has been reported only from Mechua Island and is extinct in large parts of its former range (Bhupathy, 1997). The Western Ghats are considered the centre of species diversity, endemism and threatened species, the area holds the highest number (7) of critically endangered species, all of which are restricted to Kerela State. Of the 96 threatened species endemic to peninsula India, 50 are endemic to the Western Ghats region.

In Iran (and probably in surrounding countries too), the endemism rate of freshwater fish is relatively high (roughly 30 per cent), presumably due to the isolated character of several freshwater basins (Coad, 2006). About 17 per cent of the Iranian freshwater fish are threatened (IUCN Red List, 2017). A high diversity of 405 amphibian species is reported from India, almost half of them just described since 2000 especially from the Western Ghats (Dinesh *et al.*, 2017), 75 of those amphibians assessed are threatened, with decline in populations for very most of them (IUCN Red List, 2017).
Out of 24 species in Pakistan, one fourth are restricted to altitudes above 2000m (M. S. Khan, 2014); 22 species are reported from Iran of which 6 are endemic and 3 critically endangered (Safaei-Mahroo *et al.*, 2015),

In general, the freshwater biodiversity of Western Asia is poorly documented , with few exceptions such as a taxonomic inventory project in the UAE which covers several aquatic arthropods (van Harten, 2008, 2009, 2010, 2011), but has been discontinued. At least 100 species of freshwater fish of Western Asia, possibly many more, are still undescribed (Darwall & Freyhof, 2015). As a consequence of the mainly arid character of this subregion, combined with a dense human population, the fish fauna is highly threatened (Darwall & Freyhof, 2015) and at least 13 species are already thought to be extinct (Closs *et al.*, 2016). Due to its climate, the amphibian and freshwater reptile fauna is not very diverse in western Asia, but probably also not well studied in many parts of the subregion, since many taxa are data-deficient and their status needs to be updated. The IUCN Red List (2017) regards three of the 17 assessed amphibian species and one of approximately four freshwater reptiles as threatened, including the critically endangered tree frog *Hyla heinzsteinitzi* in Palestine and the endangered Euphrates Softshell Turtle (*Rafetus euphraticus*).

3.2.2.2 Lakes and ponds

A survey of Asian lakes showed exceptional biodiversity richness (fish, crustaceans, plankton, amphibians, reptiles), especially in so-called ‘ancient lakes’; e.g. Malili, Poso, and Biwa lakes (Kottelat & Whitten, 1996). Major threats for lakes are pollution by domestic and industrial waste, unsustainable quantities of aquaculture (fish cages), and introduction of exotic, or even invasive species, e.g. Nile tilapia (*Oreochromis niloticus*). Invasive aquatic macrophytes like water hyacinth (*Eichhornia crassipes*) are a serious threat for shallow lakes over most of the region. The status in various subregions is summarized below:

In New Zealand, over 32 per cent of the lakes larger than 1 ha in area (n=4000) are reported to have undergone rapid eutrophication resulting in poor water quality (Verburg *et al.*, 2010). Trends were assessed for 30 lakes, located mainly in Northland and Bay of Plenty. From 2004 to 2013, the eutrophication status increased significantly for 11 lakes (37 per cent), but decreased only for four lakes (13 per cent) (Stats NZ, 2017). In Australia inland lakes include coastal lakes and lagoons including perched lakes; freshwater inland lakes, often ephemeral or swamp areas; glacial lakes; natural lakes (mainly Tasmania); dry, salt lakes in central regions; and old volcanic lakes. Much of northern and remote areas, such as the lake Eyre Basin systems are relatively intact (Cresswell & Murphy, 2017).

The biodiversity of lakes and ponds in Indo-Burma is affected by pollution, overexploitation, habitat modifications that threaten fish, mollusk, crustacean and insect species. However, the indirect impact of habitat loss and degradation in the catchments through logging and land conversion are the major threats for lentic water bodies (Allen *et al.*, 2012). The same applies to insular south-east Asia, where land conversion into oil palm plantation is a major current threat. Ponds in such converted landscapes are reported to support only anuran communities of mainly wide-spread and common taxa (Konopik *et al.*, 2015).

The Sulawesian Lakes viz., Malili and Poso are known to harbour a high number of endemic taxa such as 53 species of *Tylomelania* (endemic snails), 8 Gecarcinucidae (crabs), 18 Caridina (shrimps), 31 Telmatherinidae (sailfin silverside fish) and several freshwater sponges e.g., *Pachydictyum globosum*, *Nudospongilla vasta* (Meixner *et al.*, 2007; von Rintelen *et al.*, 2012). In the Philippines, several animal species are locally endemic in lakes, especially cyprinid fish (Froese & Pauly, 2017). These endemics, also including the Garman's sea snake (*Hydrophis semperi*), one of only two sea snake species known to live in freshwater, are reported to be under pressure by unsustainable fish aquaculture and eutrophication, such as in Lake Taal (Gatus, 2010).

The ancient Lake Biwa (c. 4m years old), the largest lake in Japan (670km^2), not only supports the lives of 14 million people, but also provides a variety of nature's contribution to people. It harbors about 2400 aquatic species, 61 of them endemic including 29 mollusks and 16 fish species (44 species are on Red Lists (Nishino, 2012). It is estimated that 45 introduced exotic species are major threats to the endemic fauna and flora (Nakai & Kaneko, 2012). Global warming is likely to impact the endemic bottom dwelling fauna through reduced dissolved oxygen levels (Ishikawa & Kumagai, 2012). Fish stock and fish species richness has declined over 50 years in lakes of Japan. Invasion of exotic piscivore species is one of the most influential drivers of this decline (S. I. S. Matsuzaki & Kadoya, 2015; S. ichiro S. Matsuzaki *et al.*, 2016). Most of the ponds that were still present in Japan in the 1950s have disappeared due to land conversion and many of the remaining ponds are affected by eutrophication, concrete obstructions, and the invasion of the exotic blue-gill *Lepomis macrochirus* causing continuous loss of biodiversity in these habitats (Kadoya *et al.*, 2011). The demand for sport fishing has increased the spread of invasive fishes in Japan (Kizuka *et al.*, 2014).

In China, thousands of lakes alone were originally found along the Yangtze River (Zeng, 1990), but their number and extent has undergone a dramatic reduction since the 1950s due to imploding for reclamation of additional agricultural land (Fang *et al.*, 2006). Contemporaneously, biodiversity of aquatic plants, fish, and waterfowl decreased substantially at community, population, and species levels, attributed to the integrated effects of habitat degradation, water pollution, eutrophication, and overfishing, as well as the disconnection of rivers and lakes (Fang *et al.*, 2006). In India, the freshwater systems of the Western Ghats, such as the Periyar Lake-Stream System and small lakes in Maharashtra, have been assessed by IUCN standards a decade ago (Molur *et al.*, 2011). Effects of household and agricultural effluents, tourism, fisheries, and particularly introduced and invasive fish species are serious threats to endemic fish species, among them the Critically Endangered species, the Deccan Barb (*Puntius deccanensis*) (Raghavan & Ali, 2013). Though data deficient, the macrophyte *Bonnayodes limnophiloides* endemic to Lake Bhushi may already be extinct (Molur *et al.*, 2011).

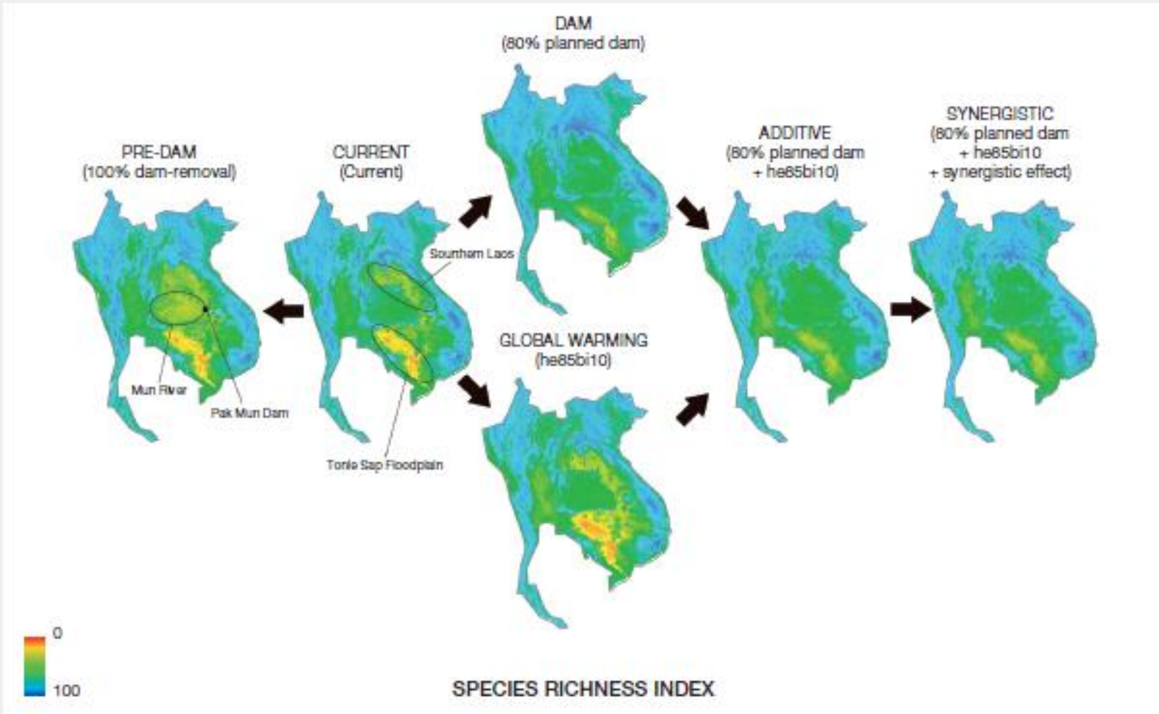
The genetic and species diversity of endemic freshwater invertebrates in glacial lakes of the Tibetan Plateau (and possibly other alpine freshwater habitats in the Asia-Pacific region) is presumed to be fostered by historic separation in glacial freshwater refugia and sub-refugia (Clewing *et al.*, 2016).

3.2.2.3 Rivers and streams

Rivers and streams across the Asia-Pacific region are under heavy anthropogenic pressure due to excessive diversion of water, pollution, habitat degradation and loss (Dudgeon *et al.*, 2006; Yule *et al.*, 2010) The distribution of historic (Pleistocene) and current river basins has shaped the genetic and species diversity of freshwater organisms (Bentley *et al.*, 2010; Bolotov *et al.*, 2017; Qing *et al.*, 2010) and contributed to the high biodiversity in various areas of the Asia-Pacific region. Allopatric speciation processes and thus species diversity and endemism are usually high in riverine freshwater habitats (Ribera & Vogler, 2000) due to reduced gene flow as a consequence of temporal and spatial continuity.

A large fraction of the freshwater-associated large mammals and reptiles, but also endemic fish species, are native to river systems of the Asia-Pacific region and many of them are highly endangered.

Aquatic insects, especially mayflies (Ephemeroptera), stoneflies (Plecoptera), caddisflies (Trichoptera), beetles (Coleoptera), and dipterans (Diptera) are important biodiversity components in streams and rivers and commonly used as indicators of ecosystem health in lotic freshwaters (e.g., Blakely *et al*., 2014; Mustow, 2002; Ofenböck *et al*., 2008; Varnosfaderany *et al*., 2010). However, aquatic insects are not assessed herein in detail, due to vast data gaps within the region, except for north-east Asia and Australia (e.g., Bae, 2001; Jäch & Ji, 1995, 1998, 2003; Neboiss, 1986) and some exceptions in tropical countries and subregions of the Asia-Pacific region (e.g., Freitag *et al*., 2016; Jäch, M. A., & Balke, 2010; Malicky, 2010). Figure 3.5 depicts the cumulative impacts of various drivers on the inland freshwater ecosystems in South-East Asia.



Fish biodiversity index	PRE-DAM	CURRENT	DAM	GLOBAL WARMING	ADDITIVE	SYNERGISTIC
Mean species richness index	39.6	37.3	32.8	41.1	36.1	34.2
Mean habitable area index (km²)	637,097	613,626	564,744	586,691	546,480	511,394
Proportion of threatened species	0.0%	4.7%	16.0%	35.0%	39.7%	40.5%

Figure 3.5 Cumulative impacts of various drivers on freshwater fish diversity in the Mekong Basin. Source: Kano *et al*. (2016).

General status and trends in various subregions are as follows:

The largest threats to rivers and streams in Australia, New Zealand and the Pacific islands include water diversion, animal translocations and invasive species (Jenkins *et al.,* 2011). As with other regions in the Asia-Pacific region, there is a significant impact of dams on biodiversity and nature's contribution to people (e.g., Ligon *et al*., 1995). Globally, New Zealand is reported to have the highest percentage of threatened species (Elston *et al.,* 2015). The side-effects of rapid development, IAS and increasing demand for water are the common drivers responsible for the decline.

Australia might have the most complete data coverage including states and trends for key rivers. For example, the Murray-Darling basin is of high concern for freshwater biodiversity with 40 per cent of the river length being impaired, 10 per cent of river length being severely impaired with 50 per cent of species lost. Most rivers have low biodiversity compared to baseline conditions. Despite local trends, there is no overall trend over a ten-year period (Cresswell & Murphy, 2017). Non-arid zone northern Australian rivers are in good condition, while cattle, large feral animals have led to endemic fish and invertebrate losses in the arid zone. In southern Australia where water has been extracted for agricultural or urban use and natural river flows have been altered, significant biodiversity declines have occurred (Department of the Environment and Energy, 2016). Water management for increasing environmental flow benefits is actively managed in the Murray Darling basin from 2012, following major condition decline (1996-2010), but benefits are not systematically assessed (Grafton & Connell, 2013). Native fish are found in only 43 per cent of the rivers where they previously occured (Chapman, 2009).

The Mekong river system is particularly diverse in fish (898 indigenous species) and gastropod mollusks (Lower Mekong: ca. 140 species, 79 per cent endemic), but increasingly fragmented, causing severe biodiversity loss (Darwall & Freyhof, 2015; Strong *et al.*, 2008; Valbo-Jørgensen *et al.*, 2009). The creation of 78 dams across the Mekong River Basin has negatively impacted fish productivity and biodiversity (Ziv *et al.*, 2011). Furthermore, habitat shifts associated with dam creation synergistically enhances the impacts on fish diversity when coupled with global warming (Kano *et al.*, 2016). In most of south-east Asia, agricultural and mining run-offs, untreated municipal and industrial wastes pose additional threats to river biodiversity (e.g. Thailand State of Pollution Report Group, 2011; Yule *et al*., 2010). Iwata *et al*. (2003) reported increased sedimentation and declines in benthic biodiversity (periphyton, invertebrates and fish) associated with riparian deforestation due intensive slash-and-burn agricultural practices.

With exceptional riverine fish diversity and endemism, China has at least 717 freshwater fish species in 33 families inhabiting rivers (Dudgeon, 2000). At the Yangtze River Basin, which is globally significant for aquatic biodiversity with 419 native and 322 endemic fish species (C. Liu *et al.*, 2017; Xing *et al.*, 2016), of which 65 are threatened and included in the China Species Red List (S. Wang & Xie, 2009). Along with anthropogenic disturbance in water pollution, overexploitation, invasive species and habitat degradation, hydrological alterations (such as damming and river-lake disconnection) are the largest threat to fish diversity in Yangtze River Basin (Cheng *et al.*, 2015; L. Huang & Li, 2016; Lu *et al.*, 2016). The Chinese government is making efforts to the ecological restoration of the Three Gorges Reservoir, as well paying salvaging endeavor for aquatic biodiversity protection and conservation (Fu *et al.*, 2010). Japan has the fourth highest dam density in the world (Gleick *et al.*, 2002). However, the Government of Japan has initiated an ambitious project "River Works for Fish Migration" to restore habitat contiguity (Ikeuchi & Kanao, 2003).

The Himalayan mountain ranges are characterised by glacier-fed river systems and the largest river run-off from a single location (UNEP/GRID-Arendal, 2007). Here, biodiversity across freshwater ecosystems of the Eastern Himalaya region is especially diverse and of great importance to local communities. Development pressures in this region are likely to underestimate biodiversity values in planning process due to a lack of readily available information on the status and distribution of freshwater biodiversity, their ecological significance and connection to human health and well-being (Allen *et al.*, 2010).

3.2.2.4 Inland wetlands

Inland freshwater wetlands such as marshes, fens and peatlands are found across the Asia-Pacific region in lowlands and mountainous regions. Due to climate change, land conversion, and other human drivers, wetland habitats are disappearing worldwide (globally 69-75 per cent lost in the past century; (Davidson, 2014)). Unsurprisingly, wetland biodiversity and nature's contribution to people are declining globally and the trend is similar for the Asia-Pacific region (WWAP, 2015). Shallow lentic water bodies of the Asia-Pacific region are mostly prone to conversion into farmland, loss of ecological connectivity, eutrophication, and resulting degradation. For some wetland types (e.g., alpine wetlands) biodiversity is highly related to wetland size so any losses in wetlands will result in a loss of species. Inland wetlands in general support aquatic and wetland-adapted plant communities and lentic animal communities, including endangered water birds and fish (Wetlands International, 2012), some of them exclusively associated with wetland habitats (e.g., 46 per cent of all aquatic macrophyte species are found in wetlands). Rice species and varieties (*Oryza* spp.) have high economic importance in wetlands converted into paddy fields (Chambers *et al.*, 2008).

Across the Asia-Pacific region, trends in biodiversity and ecosystem functioning are following a similar pattern. In the Pacific Islands, tropical freshwater wetlands are often located upland of mangrove forests and under threat from climate change and human activities. Examples of wetland biodiversity and ecosystem service losses have been reported for Kosrae in Micronesia (Drew *et al.*, 2005). As a result, losses in upland forested wetlands may also impact coastal mangrove forests and the biodiversity therein. In Western Asia, water scarcity, climate change, political instability and human/land-use modifications in the region are threatening wetland habitats. Despite this instability, UAE established their first Wetland Protected Area and RAMSAR site, Wadi Wurayah National Park, which has helped to protect the endemic and endangered native fish *Garra barreimiae* found there (UNEP-WCMC, 2016a).

Box 3.1 Alpine wetlands of the Asia-Pacific region

Alpine wetlands are found in the mountainous regions across the Asia-Pacific region and biodiversity attributes have been reported for the Qinghai-Tibetan Plateau, China (Xue *et al.*, 2014), Yunnan Region of China (Y. Yang *et al.*, 2004), northern India (Panigrahy *et al.*, 2012), the upper Yarkund Valley, Pakistan (H. Khan & Baig, 2017), southeastern Australia and alpine valleys of New Zealand (Brinson & Malvárez, 2002; Wissinger *et al.*, 2016). Though typically small in size, they represent swamps, marsh - meadows, fen or peat. Many alpine wetlands across the Asia-Pacific region are of International Importance and identified RAMSAR sites (e.g. Bitahai wetland, Yunnan Province and Gansu Gahai Wetlands Nature Reserve, Xizang, China). The alpine wetlands are also hydrologically significant as major rivers in South-East Asia originate here.

The high altitude lakes in Ladakh, India are the only known breeding grounds for some waterfowl such as the Black-necked Crane (*Grus nigricollis*) and Bar-headed Goose (*Anser indicus*). The lakes and wetlands themselves contribute to local socioeconomies of both settled and nomadic populations in the region with pasture lands surrounding wetlands used for grazing. Nomadic communities generate as much as 90 per cent of their livelyhood from grazing sheep, horses and yak on these wetland pastures. Unfortunately, multiple stressors are threatening these alpine wetland habitats and their biodiversity. Threats include climate change, grazing, eutrophication and introduced fishes. Elsewhere in the Tibetan Plateau, alpine wetlands have high biodiversity values comprised of high rates of endemism spanning fish, birds, amphibian and mammal taxa. Alpine wetlands are the most vulnerable freshwater ecosystem to climate change with impacts to water quality, biological productivity and ecosystem functioning (Chatterjee *et al.*, 2010; WWF, 2006). For example, alpine wetlands of the Tibetan Plateau are predicted to decline by 37.5 per cent with all wet meadow and saltmarsh habitats predicted to disappear completely (Xue *et al.*, 2014). This has implications for flora and fauna that are highly-specialised to these specific climatic conditions, and the ecosystem functions, such as carbon sequestration, water and habitat provisioning which are critical for the wider region. Migratory waterfowl that use these habitats and endemic plants and animals are at risk. A combination of pressures including human activities, cattle grazing, agricultural development, mining and climate change are all contributing to loss of habitat and biodiversity.

The review of wetlands as defined by the Ramsar Convention on Wetlands of the Pacific Islands region revealed that the natural species diversity is highest in the western Pacific region (e.g. Papua New Guinea), and declines towards the eastern Pacific Islands, French Polynesia (Figure 3.6). However, there are still large gaps in the knowledge on drivers of freshwater biodiversity declines. Nevertheless, the community structure is unique in each island nation, with endemic species due to the habitat isolation that is characteristic of Oceania. The Red List Index shows that extinction risk has increased after 2010 in this subregion. Accordingly, biodiversity in freshwater ecosystem of the Pacific islands has experienced drastic decline (Ellison, 2009).

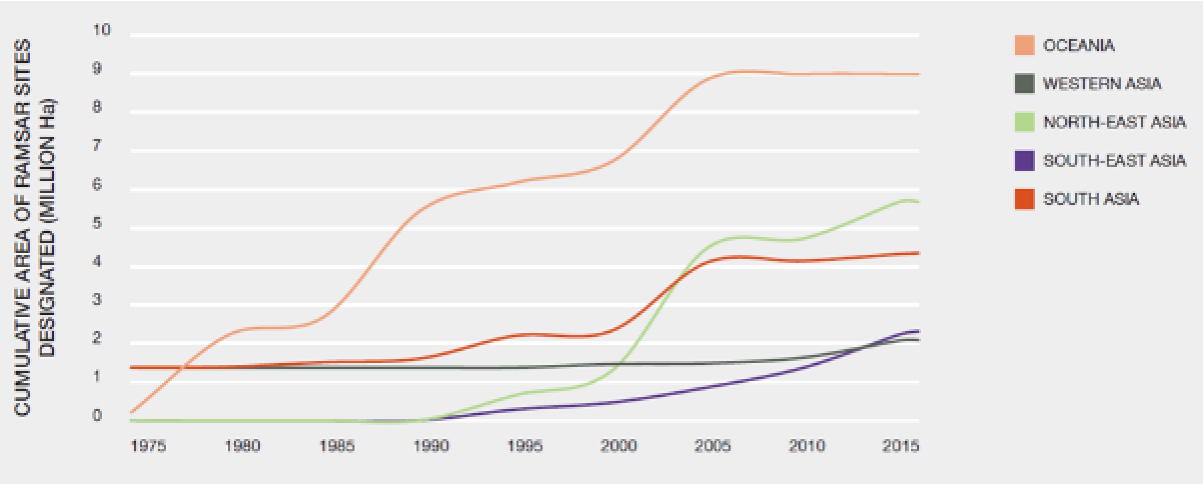


Figure 3.6 Trends in Ramsar site designation in the Asia-Pacific region during the past 40 years. Source: Ramsar Convention Secretariat (2017).

Sixty five Australian wetlands are Ramsar listed covering >8.3 million hectares. The condition of Australian wetlands has deteriorated due to increased water regulation and extraction for increasing levels irrigation agriculture, urban and industrial use. Two wetland ecosystems were listed as endangered and critically endangered since 2011 (Department of the Environment and Energy, 2016). Water bird communities are a good indicator of their condition (Kingsford *et al.*, 2013), and these have been in decline for 33 years and are concentrated in few sites (Cresswell & Murphy, 2017). The cause of decline and deterioration of wetland condition and biodiversity is driven increased water use and extraction for intensifying irrigation agriculture, urban and industrial use across the country. For example, in 2001 almost one-third of the 851 nationally important wetlands were threatened by altered flow regimes. This resulted in the loss of floodplain wetlands in the Murray-Darling Basin (90 per cent loss), coastal wetlands in New South Wales (50 per cent) and Swan Coastal Plain wetlands in southwest Western Australia (75 per cent loss). Unsurprisingly, extensive losses in habitat wetland extent have reduced flood frequency and biodiversity in remaining ones. Waterbirds have been especially impacted (1.1 million 1983 to 0.2 million in 2004) as both population numbers and breeding success of native species are highly dependent on flooding events and associated replenishment of the wetlands. Declines in population numbers and species ranges for macroinvertebrates, freshwater fish and amphibians have also been reported (Davis *et al.*, 2001).

Peatlands such as those in South-East Asia are responsible for storing considerable amounts of carbon while also providing habitat for flora and fauna that include vulnerable taxa such as the false gharial (*Tomistoma schlegelii*) (Bezuijen *et al.*, 2014; Rose *et al.*, 2011). Wetlands of the Philippines (e.g. Naujan Lake, Mindoro; Candava Swamp, Luzon; Agusan Marsh, Mindanao), are important resting and wintering areas for migratory and domestic bird populations (Republic of the Philippines, 2014). Peat swamp forests (PSFs) are inhabited by a highly unique and endemic fish and insect fauna, adapted to the acidic blackwater (Giam *et al.*, 2012; Rose *et al.*, 2011). However, PSFs are deforested at a higher rate (–3.7 per cent per year) than other forests, with highest rates of loss in Sarawak (-8.1 per cent per year) and Sumatra (-5.2 per cent per year) (Miettinen *et al.*, 2011; Wilcove *et al.*, 2013). Only 36 per cent of the original PSF area has remained in South-East Asia. Conversion of low land swamp forests into banana and oil palm plantations in Peninsular Malaysia is a major concern. If current rates of peat swamp forest conversion in Sundaland continues, it is projected that by 2050, 16 per cent of PSF fish species are likely to go extinct (Rose *et al.*, 2011; Wilcove *et al.*, 2013). Paoli *et al.* (2010) have recommended that Indonesian peatlands must be managed and protected under post-Kyoto framework which will in turn help conservation of many endangered vertebrates. The extant peatlands which are still intact in these areas are likely to be logged and drained in the next few decades (Verhoeven & Setter, 2010). Likewise, peatlands of inland Central Asia and Tibetan plateau are facing serious threats due to climate change and intensive land use (Box 3.2).

In Japan, 61.1 per cent of wetlands (not including paddy fields) had been lost from 1920 to 2000 (Geospatial Information Authority of Japan, 2000) as a result of human activities. Irrigation ponds, mostly constructed in 17-19 centuries became refuge for many lentic endangered species (Takamura, 2012). Most of the wetlands on Hokkaido Island, Japan are peat-forming mires of which more than 70 per cent have been lost due to drainage and receiving eutrophic water from rivers and agricultural lands. Mire vegetation has undergone retrogressive succession, affecting further biodiversity components (Fujita, 2007). In Arabian Peninsula, of the 17.5 per cent of assessed species, 8 species of fish, 15 species of Odonata, 5 molluscs and 23 species of aquatic plants are reported to be threatened. Here one species of damselfly is Regionally Extinct due to habitat loss (García *et al.*, 2015).

Box 3.2 Peatlands of continental highland Asia

Peatlands occur in a variety of wetlands and comprise accumulated surface peat with incompletely decomposed plant matter (Joosten & Clarke, 2002; Parish *et al.*, 2008; Rydin & Jeglum, 2013). Peats generally contain at least 30 per cent dead organic matter (by mass) with a minimum depth of 30cm. A peatland with actively accumulating peat is termed as mire. They play a vital role in regulating hydrology, supporting biodiversity and livelihoods, ecosystem functioning and climate regulation (Joosten *et al.*, 2016). Other functions include buffering microclimate of adjacent areas, accumulation and carbon storage and providing unique habitats to several species of fauna especially resident and migratory birds (Minayeva *et al.*, 2017; Parish *et al.*, 2008). The Global Peatland Database[60] reveals that Mongolia, the Tibetan Plateau, and other parts of China have extensive peatlands. Despite an arid climate, Mongolia has diverse and extensive peatlands covering an area of about 27,000 km^2 or over 1.7 per cent of the country (Minayeva *et al.*, 2004, 2005, 2017). They are susceptible to desertification due to low annual precipitation and high summer temperatures. Originally formed in cooler climatic conditions, peatlands in the upland and forest steppe zones have undergone rapid degradation over recent decades. They are also prone to soil erosion and CO_2 emission due to grazing, mining and other human activities (Minayeva *et al.*, 2017). Land use changes, infrastructure development and pollution especially of water greatly affect their resilience.

Increasing aridity in many parts of Mongolia and Central Asia is likely to exert more pressure on moist and peat rich habitats in future especially due to greater concentration of domestic livestock in such areas (Y. Liu *et al.*, 2013). Conversely, intensive use of other habitats such as steppe and woodland, excessive use and diversion of water would make the peatlands more vulnerable. Some areas have become devoid of vegetation and are rapidly losing peat. Adequate attention is required in terms of raising conservation awareness and long term monitoring of peatlands. Other important adaptation measures could be introduction of nature-friendly tools and techniques, excluding of peatlands from economic use and restoration of damaged peatlands (Biancalani & Avagyan, 2014).

Contributed by Andrey Sirin, Tatiana Minayeva, & Chultemin Dugardzhav

3.2.3 Coastal

Though the biodiversity of nearshore coastal and shelf zones is relatively well understood in the Asia-Pacific region, even in the well-known areas of Japan, Australia and New Zealand, more than 70 per cent of estimated biodiversity remains un-described (Butler *et al.*, 2010; Fujikura *et al.*, 2010; Gordon *et al.*, 2010; Y. Liu *et al.*, 2013). Three coastal ecosystems have been listed as threatened doubling the number in Australia since 2011 (Department of the Environment and Energy, 2016). However, one of the important and distinctive landforms that remains least documented along coastal areas of the Asia-Pacific region is 'Beaches and Rocky Shores'. They include rick shingle beaches and sandbars, rocky headlands and cliffs along subtidal and intertidal habitats. These habitats are reported to be more

[60] Accessible from: http://www.greifswaldmoor.de/global-peatland-database-en.html

threatened due to sand and gravel mining compared to others (Butler & Bax, 2014; Peduzzi, 2014; Thaman, 2013; UNEP/UNCTAD, 2014).

A strong indicator of coastal habitat loss and condition are shore bird communities and these are considered to be in a poor state in Australia declining over the last 5 years. Marine and Estuarine IAS continue to increase in diversity and abundance across the region, with evidence of continued expansion, however the baseline knowledge in parts of Oceania (Australia, New Zealand, Guam and North Asia) is higher than other subregions of the Asia-Pacific region. Marine and Estuarine IAS have highest diversity in temperate regions with lower recognised diversity in the tropics (Byers *et al.*, 2015; M. L. Campbell *et al.*, 2007; Hewitt, 2002). Coastal littoral deforestation including loss of mangroves due to overexploitation or conversion to agricultural, aquaculture and urbanization and industrial uses are major concerns in the region. The following sections deal with the current status of biodiversity and nature's contribution to people in coastal and nearshores.

3.2.3.1 Mangroves

Mangroves represent a unique ecosystem in coastal area supporting a rich biodiversity and providing a range of nature's contribution to people including provisioning, regulating and supporting, crucial for the sustenance of local communities (Thu & Populus, 2007). South-East Asian mangroves are among the most species diverse in the world, having 268 plant species including 52 taxa growing exclusively in mangrove habitat (Giesen *et al.*, 2007; Giesen & Wulffraat, 1998). Recent changes in land use primarily for aquaculture has led to transformation of mangroves (up to 75 per cent in last 3 decades (Primavera, 1997; J. B. Smith *et al.*, 2001). In Oceania alone, there has been a decrease in mangrove area by 9.5 per cent during last 25 years (FAO, 2007). Most of the mangroves have suffered due to rapid urbanization especially in Philippines, Thailand and Vietnam (Giri *et al.*, 2011; Spalding *et al.*, 1997). In other areas anthropogenic pressures as well as changing climate continue to affect the mangrove (Blasco *et al.*, 2001). During the period 2000-2012, South-East Asia lost its mangrove forests at an average rate of 0.18 per cent per year (Richards *et al.*, 2016) with 30 per cent loss due to aquaculture. Other drivers causing the decline in mangrove forests include paddy farming along the coastal habitats of Myanmar and the expansion of oil palm in Malaysia and Indonesia (Figure 3.7). Oil palm is expected to threat the mangrove forests more with new frontiers opening up in Papua, Indonesia (Richards *et al.*, 2016). The die-back of some 7000 hectares of mangroves in the Gulf of Carpentaria, Australia, in November-December 2016 is most likely caused by an extended drought period (Duke *et al.*, 2017). It is projected that rise in sea level due to global warming could pose biggest threat to mangroves especially in Bangladesh, New Zealand, Viet Nam and China (Giri *et al.*, 2011; Polidoro *et al.*, 2010). Although several efforts of conservation and recovery have been conducted recently, the conservation agencies have achieved partial success in Sri Lanka and New Zealand (Thrush *et al.*, 2013).

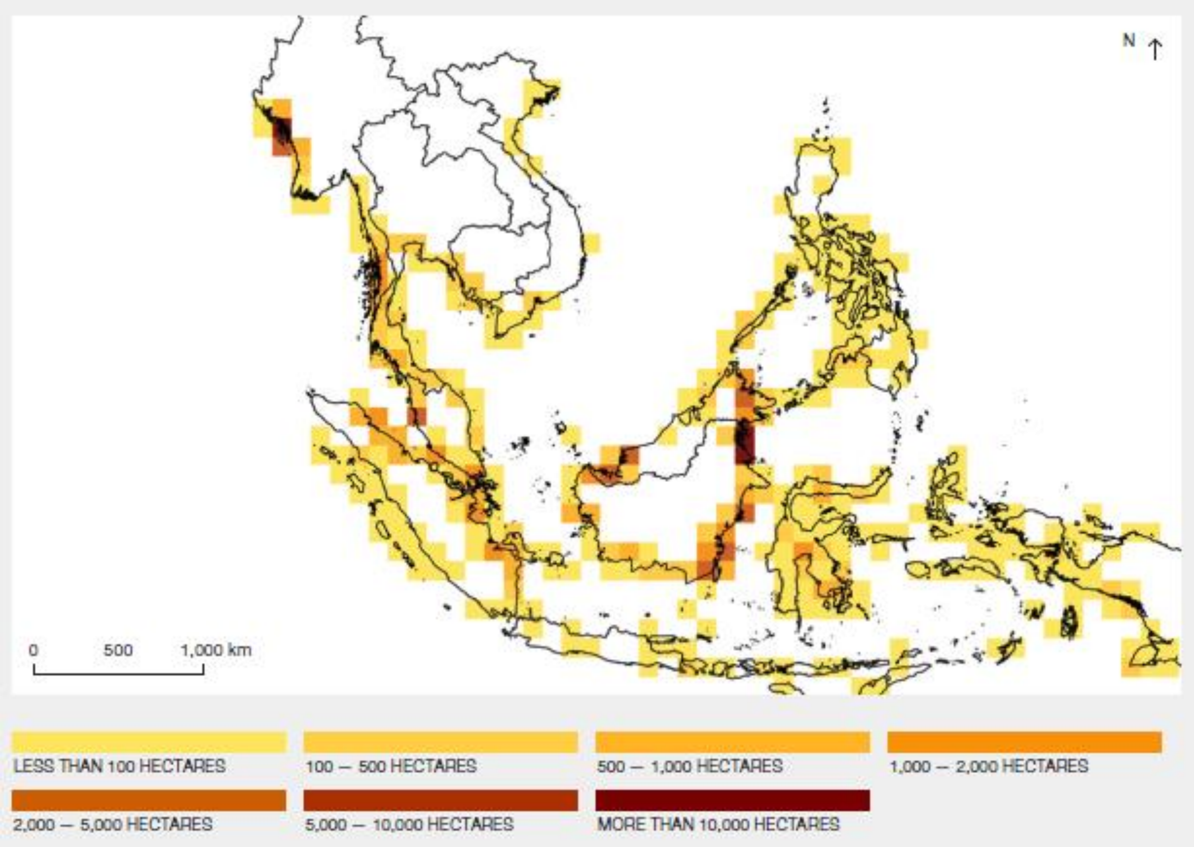


Figure 3.7 Mangrove deforestation between 2000 and 2012. Source: Richards *et al*. (2016).

3.2.3.2 Other intertidal habitats

Both intertidal habitats and mangroves not only provide spawning areas and nurseries for numerous species of fish and crustaceans that provide seafood to the coastal and inland population but also consolidate sediments into fertile new lands protecting offshore coral reefs from siltation and hence increasing the productivity of reefs and inland seas. The intertidal zones along the coasts are very narrow and fragile yet rapidly deteriorating and vanishing due to various anthropogenic factors. Many migrant bird species that travel annually along the East Asian-Australasian Flyway inhabit intertidal habitats. There are indications of serious problems along the Flyway as 89 per cent of all monitored populations of Arctic breeding shorebirds in north eastern Russia now show a decline. Monitoring on beaches of Australia There is a decline in the numbers of monitored Flyway migrant shorebirds wintering on the beaches of Australia (D. I. Rogers *et al*., 2010). Japanese shorebirds between 1975 to 2008 also show declines in most species but interestingly a much higher proportion among species that are dependent on Yellow Sea stopover sites (Amano *et al.*, 2010). Two extreme habitat specialists: Red Knot (Amano *et al.*, 2010; Wilson *et al.*, 2011) and Spoon-billed Sandpiper (Zöckler *et al.*, 2010) are the fastest declining migratory shorebirds in the Flyway. With the current rates it is projected that for every 100 Red Knots migrating along the Flyway in 1992, only seven will be left in 2020. Despite the ongoing conservation action, Spoon-billed Sandpipers will likely go extinct (Pain *et al.*, 2011). The rate of intertidal habitat loss in Asia are equal to or greater than recorded losses of mangroves (Giri *et al.*, 2011), tropical forest (Achard, 2002) and sea grasses (Waycott *et al.*, 2009). For example, some 51 per cent of coastal wetlands including marshes in China was lost over the past 50 years (An *et al.*, 2007), 40 per cent in Japan, more than 70 per cent in Singapore (Hilton & Manning, 1995), and at least 40 per cent in the Republic of Korea (Koh & Khim, 2014).

3.2.3.3 Seagrass beds

Many of the seagrasses in the Asia-Pacific regions are confined to sheltered areas in the shallow intertidal associated ecosystems, semi-enclosed lagoons and subtidal zones, between mangrove and coral reef ecosystems. Seagrasses are also found around offshore islands with fringing reefs. The seagrass beds measure several hundred metres in width and up to several kilometres long along the coast (UNEP, 2008). The highest seagrass diversity in the world with 24 species is found in Tropical Indo-Pacific (East Africa, south Asia and tropical Australia to the eastern Pacific) (Fortes, 2012; Short *et al.*, 2007; UNEP, 2008).

Loss of the seagrass beds are recorded in many areas, especially in Oceania and South East Asia (Kawaguchi & Hayashizaki, 2011; Waycott *et al.*, 2009). The rate of decrease was over 20 per cent in Vietnam and the Philippines, due to human activities as well as natural disasters such as typhoon, storm, and Tsunami (Coles *et al.*, 2003; Seddon *et al.*, 2000; Thangaradjou *et al.*, 2010). In case of temperate regions of Japan a considerable decrease has been reported during last 30 years (Takehisa Yamakita *et al.*, 2011). Associated with these habitats are the dugong populations in the Southern Great Barrier Reef, which have to very lowest levels in the last 50 years (in the year 2011) along with other species (Department of the Environment and Energy, 2016).

3.2.3.4 Kelp forests and other algal communities

Kelp forests are distributed from temperate to arctic zones and are commercially important especially in north East Asia, both as edible Kelp and fish habitat. Although local sustainable management are on-going in northern pacific side of East Asia (Hokkaido Japan), decreasing trend was recorded from 2080 km^2 in 1978 ha to 1250 km^2 in 2007 in Japan. North east Asia, especially west pacific side of Japan and urban areas of Australia exhibit drastic decrease in Kelp forests (FRA Japan, 2009; Wernberg *et al.*, 2011). In addition, the distribution of Kelp forest is expanding northward, probably due to global warming (Wernberg *et al.*, 2011). Other algal beds are also reported from temperate to tropical areas and most of them are important both culturally as well as commercially (Japar Sidik *et al.*, 2012; Kawaguchi & Hayashizaki, 2011). In Australia a recent assessment of giant kelp forests was done in South-East part. These are reported to be suffering from increased sea temperatures and it is projected that in future the kelp forests will become increasingly concentrated away from equator in any remaining suitable habitats (Department of the Environment and Energy, 2016).

3.2.3.5 Coral and other reefs

Coral reefs are the most diverse coastal ecosystems on earth and of disproportionate ecological, economic and food security importance to the Asia-Pacific region which has an inordinate proportion of the world's healthy coral reefs (Chapter 1). The death of reef-forming corals undermines resilience of coastal communities, and can lead to the collapse of important coastal ecosystems. According to a recent assessment (Huang & Roy, 2015) one third of reef-building corals in the region are threatened, with serious evolutionary consequences. Coral diversity is highest in the Asia-Pacific region, with unique genetic diversity (D. Huang & Roy, 2015). Loss of habitat quality, heavy damage to entire reefs are major threats in the region (Bellwood *et al.*, 2004; Bruno & Selig, 2007; Côté *et al.*, 2005; De'ath *et al.*, 2012; UNISDR/UNDP, 2012; Wilkinson, 2008). In the case of El Niño event in 1998, 16 per cent of the world's coral reefs and 50 per cent of those in the Indian Ocean were destroyed (UNISDR/UNDP, 2012). Increase in sea temperature and ocean acidification have been projected as major drivers of change along coastal environments which may lead to decline in coral reefs (Burke *et al.*, 2011; Chin *et al.*, 2011). In the north western Pacific, distribution of reef-building coral species is expanding toward poleward (Hiroya Yamano *et al.*, 2011). Species associated with corals also expand their distribution with expansion of distribution of their host corals (H. Yamano *et al.*, 2012). However, ocean acidification (OA) may limits its poleward expansion as the cold water regions are strongly affected by OA (Yara *et al.*, 2012).

In the Philippines, patterns of coral reef fish disappearances revealed as much as 88 per cent decline in catch per unit effort since the 1950s for large reef fishes like bumphead parrotfish, humbhead wrasse and giant grouper. Aside from being significant target fish, these fishes are ecologically important. For example, Bumphead parrotfish is very important species to keep coral reefs healthy. While this study is at the country level, but the reef fish species covered are widely distributed within the Indo-Pacific region (Lavides *et al.*, 2016). Increasing outbreaks of crown of thorns starfish, a native predator that has boom bust cycles linked to environmental pollution from farm lined estuaries affected The Great Barrier Reef (Wooldridge & Brodie, 2015). Coral bleaching events are also increasingly devastating to the northern two thirds of the reef over the last few years where coral-algae associations are disrupted by high sea temperature (Ainsworth *et al.*, 2016). Prior to recent bleaching in Australia, there has been an increase of coral reef area which is attributed to establishment of several protected areas (Waycott *et al.*, 2009). Habitats and communities in the Great Barrier Reef ranged from poor to worsening at the end of 2015, although some species like green turtle populations improved (Department of the Environment and Energy, 2016).

Among the most serious emerging threats to coral reefs are coral diseases, which have devastated coral populations throughout the Caribbean since the 1980s and accompanied the mass coral bleaching there in 2005 and 2006 (Wilkinson, 2008). Over 90 per cent of the main reef forming corals in the Caribbean have now died due to coral disease with the severity of disease outbreaks commonly correlated with corals stressed by bleaching (Wilkinson, 2008). Coral diseases are also being observed more frequently on Indo-Pacific reefs in heretofore unrecorded places such the Great Barrier Reef, areas of Marovo Lagoon in the Solomon Islands and the Northwestern Hawaiian Islands. The outbreaks seem to be related to bacterial infections and other introduced disease organisms, increasing pollution, human disturbance and increasing sea temperature, all of which have put reef-forming corals at serious risk.

Several studies have demonstrated that mussels play an important role in building the reefs and ecosystem functioning in reef areas (Dittmann, 1990; Markert *et al.*, 2009; Norling & Kautsky, 2008). Reefs themselves are important foraging grounds for avian species (Caldow *et al.*, 2003; Nehls *et al.*, 1997), blue mussel (*Mytilus edulis*), and Pacific oysters (*Crassostrea gigas*) which are sensitive to changes in habitat conditions (J. L. Gutiérrez *et al.*, 2003; Kochmann *et al.*, 2008; Kröncke, 1996). At a regional scale effects of climate change and other drivers have not been assessed. The black mussel (*Mytilus crassitesta*) is also an important bivalve species actively cultured in Korea with a highest annual production of 69,375 MT in 1980. However, from 1981 to 1987 the output had been gradually decreasing and only 29,813 MT was produced in 1987 (FAO, 2015b). Highest diversity of species among mussel beds have been reported along western part of Pacific Ocean (Kochmann *et al.*, 2008). Though the decline of black mussel, an increase in population of green mussel has been reported from temperate region of Japanese Pacific water (Ohgaki *et al.*, 2011).

Oysters play important role in regulating the food chain and nutrient cycling in coastal areas (Schulte *et al.*, 2009). They have supported civilizations for millennia, from Romans to California railroad workers (MacKenzie *et al.*, 1997). Oyster reefs have experienced the largest global loss of any marine habitat type, and are expected to decrease by 85 per cent compared to their historic extent (Beck *et al.*, 2011). Harmful fishing techniques affected the oysters negatively (Pollack *et al.*, 2012) besides overharvesting, water pollution, invasions of commercial hybrids, and other factors (L. A. Brown *et al.*, 2014). Extensive cultivation of oysters is considered one of the drivers that may affect the biodiversity and nature's contribution to people in these areas and reported in at least 60 countries (Ruesink *et al.*, 2005). Despite being highly important locally, introduced oyster only contributed 6 per cent of the world's annual oyster harvest which is approximately 3.3 million tons (Ruesink *et al.*, 2005). Some commercial oyster farms have been affected by introduced pathogens such as *Bonamia ostreae* (New South Wales and Tasmania in Australia, and New Zealand), but native oysters are less affected (Whittington *et al.*, 2016).

3.2.3.6 Aquaculture and other artificial substrata

About ninety per cent of world Aquaculture production is from the Asia-Pacific region (Funge-Smith *et al.*, 2012) and the top 10 countries of the world in aquaculture production belongs to this region (Lymer *et al.*, 2010). The major targeted aquaculture species belongs to the fin fishes (fresh water species: 60 per cent; Marine species: 32 per cent and Brackish water species: 8 per cent of total production) accounts about 49 per cent of the total aquaculture production ; molluscs about 19 per cent; crustaceans about 7 per cent, echinoderms (Sea cucumbers) in trace and Aquatic plants about 22 per cent by production of total aquaculture in this regions. The species used for aquaculture are very limited in comparison to the available species in the region. The major stake of marine and brackish water aquaculture is from China, Indonesia, Philippines, Japan, Viet Nam, Republic of Korea and Bangladesh in this region. The marine and brackish water aquaculture in this region is intensive and the production from the Brackish water and marine sector is growing in rate of 3 per cent per annum and all together the Aquaculture growth in this region is about 6.7 per cent, whereas, some countries like India, Indonesia, Vietnam, Myanmar the production growth rate is about 9-24 per cent. The major challenges for Aquaculture in the management of Biodiversity of the subregions due to introduction of Invasive/Alien species for profitable over production, improper management of Bio-security measures, diseases etc.

In addition, increasing urbanization in coastal area and resultant modification of habitats (e.g., shift from soft sediment to hard benthos) is likely to change the biodiversity and nature's contribution to people in the area.

3.2.4 Marine

In this assessment, marine area means the area both in the euphotic and aphotic zones. It is however very difficult to separate status and trends of biodiversity and ecosystem service in the coastal and marine areas. Therefore, in this assessment, the distinction is not rigid.

3.2.4.1 Pelagic (euphotic)

The primary production and the total biomass supported by it in the pelagic ecosystem (<200m depth in euphotic zone) are not uniform in the marine area. It is mostly regulated by the supply of nutrients. In the marine areas, upwelling and vertical mixing play the most important role as a supplying mechanism of nutrients to the pelagic area, and the status has been continuously monitored using satellite for decades. The status of pelagic ecosystem is influenced largely by the large scale status change of ocean, e.g. El Niño, La Niña, Indian Dipole, decadal oscillation and “regime shift” (Litzow *et al.*, 2014). Recently, primary production of marine area measured by Chlorophyll *a* concentration abundance is decreasing is various parts of marine area such as Indian Ocean and Western Pacific (Boyce *et al.*, 2010).

Species composition of marine pelagic animals has changed dramatically in the North and South western pacific areas. This change is characterized by increase of gelatinous zooplankton such as jelly fishes and planktonic tunicates (Lilley *et al.*, 2011). Typical events has been observed in the north western Pacific region, where big blooms of huge Nomura's Jellyfish were observed and it impacted fisheries activity (A. J. Richardson & Gibbons, 2008; Uye, 2014). Harmful Algal blooms are also warned issues in highly populated area especially in a bay (Anderson *et al.*, 2012).

3.2.4.2 Pelagic (aphotic) and benthic

The aphotic zone includes the areas which are more than 200m deep in the ocean, including the ocean shelf and slope, abyssal zone (sea floor), trench, and trough. There are significant information gaps regarding status and trends of marine biodiversity and ecosystems in the Asia-Pacific region (Webb *et al.*, 2010). Figure 3.8 shows the number of records and completeness of information existing in the Ocean Biogeography Information System (OBIS) regarding marine biodiversity (http://www.iobis.org). In the Asia-Pacific region, areas in the western Pacific are comparatively well surveyed, but the knowledge of biodiversity remains below 50 per cent in most areas of the Indian Ocean. Nevertheless, it is obvious that tropical to temperate western Pacific areas and the eastern Indian Ocean area are hotspots of marine biodiversity (Tittensor *et al.*, 2010).

It has been known that biodiversity and body structure of benthic animals has a specific pattern (known as mid-slope diversity hypothesis) with depth in the marine environment (Levin *et al.*, 2001; Rex & Etter, 1998). This pattern has well been known in the Atlantic but same pattern has been known from Western Pacific (Shirayama & Kojima, 1994) and Indian Ocean area too (Raman *et al.*, 2015). Sediment grain size, productivity and water flow is hypothesized cause of this pattern. Submarine canyons are typically incident in the continental slope. Increase in geographical heterogeneity and their effect to the current and other material flow are considered to increase diversity and productivity (Levin & Sibuet, 2012). Terrestrial input of organic materials also affects this area however artificial debris also accumulated. The Asia-Pacific region is characterized by the highest species richness of brittle stars in the world. It is the frequently dominant species of muddy plains and also present in hard substrates. Among depth gradient bathyal zones, the highest number of brittle star species are observed in the Asia-Pacific region (Thuy *et al.*, 2012). In the case of the southern hemisphere, the distribution of brittle stars are separated into latitudinal clusters. Dispersal limitation was also an important factor to differentiate species (O'Hara *et al.*, 2011).

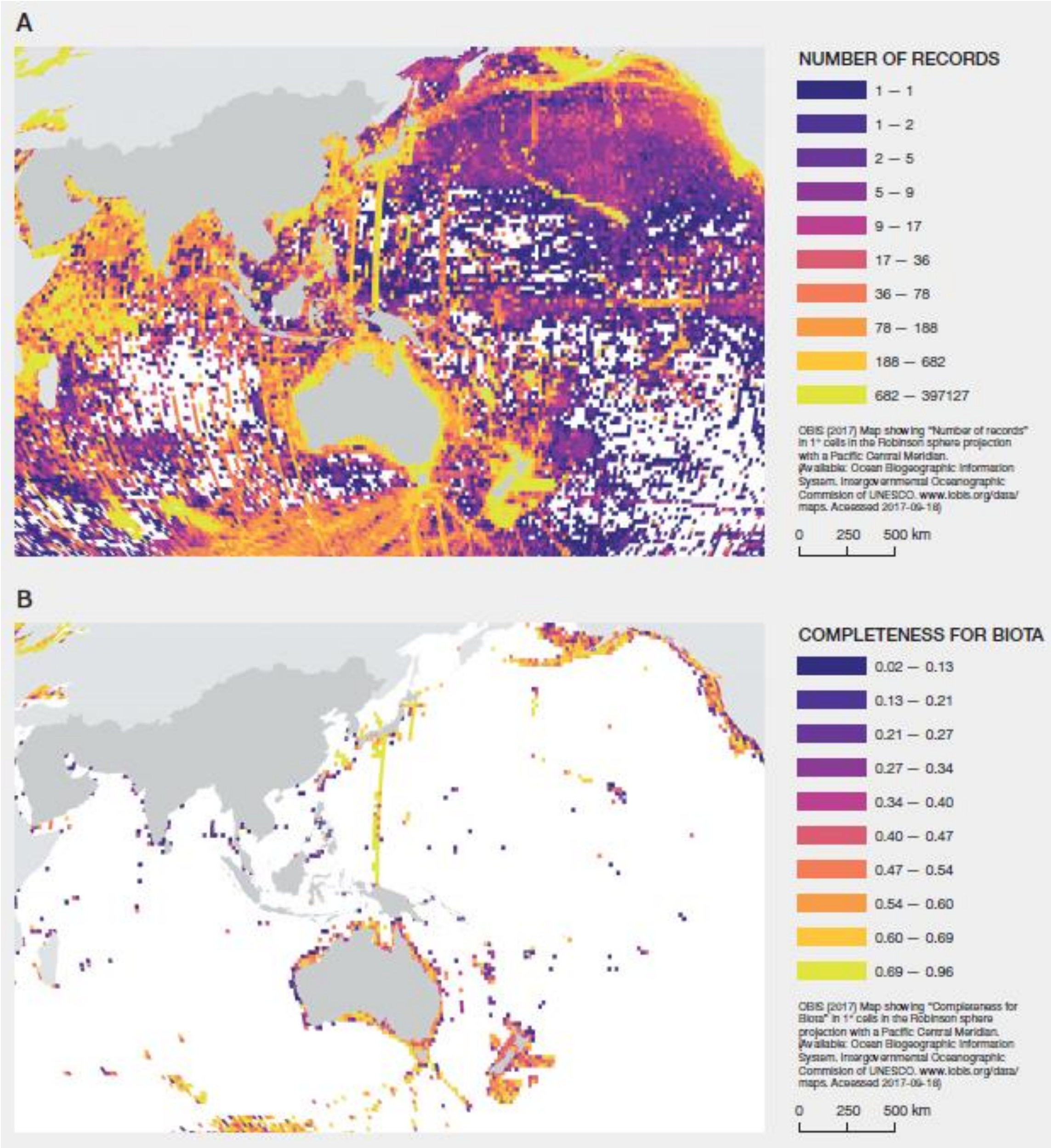


Figure 3.8 Number of records (A) and completeness of data (B) in the coastal and marine biomes of the Asia-Pacific region in the Ocean Biogeography Information System (OBIS). Good records exist in Oceania and some parts of North-East Asia, but data in the remaining subregions are incomplete. Source: OBIS (2017a, 2017b).

Good records exist in Oceania and some parts of North-East Asia, but data in the remaining subregions are incomplete. The abyssal zone is the most common habitat in bottom marine environments and the abundance and diversity of macro benthic organisms are very low in this area. However, research on meiofauna and microbial organisms has revealed their high endemism, diversity, and distribution (e.g. Shirayama, 1984). Trench areas have higher benthic biomass compared to abyssal zones (e.g. Itoh *et al*., 2011). Recently, pelagic ecosystems, especially for the microbial community, have also been found to have a vertical pattern (Nunoura *et al.*, 2015). The biodiversity of deep pelagic zones in the world's oceans remains largely unknown despite the significant provision of a range of nature's contribution to people (O'Dor & Gallardo, 2005).

3.2.4.3 Shipwrecks, debris and other substrates

Shipwrecks accumulated at the ocean floors eventually serve as special 3D habitat for a number of marine species. These sites function as fish aggregators and thereby increase the local biodiversity. Such artificial habitats are prominent in southern oceans especially closer to Australia (Stieglitz, 2012). Likewise, other marine debris accumulated near shores and between islands especially at the junctions of oceanic currents and underwater valleys greatly influence the marine habitats (Lebreton *et al.*, 2012; McIlgorm *et al.*, 2011). Although such artificial habitats play positive role in marine environments, increase in inorganic substances and toxic plastic based pollutants is a major concern (Kako *et al.*, 2014). Massive pulses of labile organic matter to the deep-sea floor was due to falls of large whales. The interest in whale fall ecology began with the discovery of a chemoautotrophic assemblage on a whale skeleton in the North-East Pacific in 1989 (C. R. Smith, 1992). It has been observed that whale falls share 11 species with hydrothermal vents and 20 species with cold seeps, and thus may provide dispersal stepping stones for a subset of the vent and seep faunas (C. R. Smith & Baco, 2003).

3.2.4.4 Seamount and rise

Survey of seamounts was carried out extensively in the Asia-Pacific region during the project of Census of marine life (Stocks *et al.*, 2012). There are thousands of seamounts in the Asia-Pacific region and they are the focus of exploration for seabed minerals, especially polymetallic sulphides in the Southwest Pacific (S. D. Scott, 2007) and cobalt-rich crusts in the central Pacific Ocean (Hein, 2002). There are significant differences in the structural complexity of benthic habitats, species numbers and abundance, and the composition and structure of assemblages between fished and unfished seamounts off Australia and New Zealand (Koslow *et al.*, 2001). Especially information from South-East to Western Asia is very limited. Same situation occurred on the species identification. In some area, 30 per cent of species are newly recorded and most of them are expected to have any specialty to seamount habitat (de Forges *et al.*, 2000).

Higher production and diversity have been recorded in some seamounts compared to surrounding habitats (de Forges *et al.*, 2000). Lower rate of the overlap on the species composition was observed between different cramps of the seamount (Glover & Smith, 2003). Changes of the productivity of the seamounts can be evaluated by fishery survey. However, there is limited published information on seamounts except a few survey reports from Australia and New Zealand. Expansion of the oxygen minimum zone in the east tropical Pacific and Indian Oceans has also been recorded with limited information on biological response (Stramma *et al.*, 2010).

3.2.4.5 Chemosynthetic ecosystem

Chemosynthetic ecosystem is the generic term of the ecosystem based on bacteria which using the oxidation of Inorganic compound as a source of energy. Hydrothermal vents, cold seeps or gas hydrates are abundant in both Pacific and Indian oceans of the Asia-Pacific region. These ecosystems have been studied extensively under the Census of Marine Life project (German *et al.*, 2011). Chemosynthetic sites have also been recorded for each curie (Tokeshi, 2011). However, the number of the newly found chemosynthetic sites has been increasing. Research about temporal observation or geographical comparison on this habitat is rare in the Asia-Pacific region. By the geographical comparison, endemism of the chemosynthetic sites are high and it is decided in the local scale (Nakajima *et al.*, 2014). Similarity of the macro benthos community is distance dependent and might be affected by the chemical composition of the vent (Nakajima *et al.*, 2014). The effect of the chemical of the vent was especially true for smaller species (Urabe *et al.*, 2015). The characterization of deep-sea vent communities in Manus Basin (Bismarck Sea, Papua New Guinea) was made to test the hypothesis whether there was any difference in macrofaunal community structure between the sites using macrofaunal data sets from a proposed reference site (South Su) and a proposed mine site (Solwara 1) (Collins *et al.*, 2012).

By the global comparison, importance of the consideration of the geographical event (such as eruption from vent) is pointed as near future trend in some active vent site (Glover *et al.*, 2010). Researches related to the impact assessment for the drilling resources are also getting increase but not yet summarized as integrated way (M. R. Clark *et al.*, 2010).

3.2.4.6 Status and trends of Asia-Pacific fisheries

There are several hotspots of faunal diversity in the coastal and marine areas of the Asia-Pacific region. Such hotspots are mainly located in the tropical western Pacific and eastern Indian ocean[61] (T. Yamakita *et al.*, 2017). According to the distribution of potentially extinct species in the Asia-Pacific region, threats to the marine biodiversity is high in the coasts of South Asia and central Indian Ocean. Biodiversity and abundance of large predators, such as tuna species, is reported to have decreased constantly in the Asia-Pacific region over the past 50 years (R. A. Myers & Worm, 2003; Worm *et al.*, 2003). This trend is especially strong in the Indian ocean and the southern Pacific ocean around Australia and New Zealand. It is known to have resulted in increase of cawnose ray that consequently impacts the fisheries of shell fishes (R. A. Myers *et al.*, 2007). Diversity of predators such as sharks, tunas and turtles are reported to be highest between 20–30° N and S latitudes, where tropical and temperate species ranges overlap in the south-western Pacific Ocean (Worm *et al.*, 2003). Figure 3.9 shows the pattern of marine and coastal biodiversity and threats on it. It is noteworthy that biodiversity of coastal region is high in Oceania, South East Asia, North East Asia and Indian Ocean. On the other hand, threats on biodiversity is especially high in Oceania, South Asia and Central Indian Ocean.

In South-East Asia Humpbacked whale populations have increased recently in Australian waters (Department of the Environment and Energy, 2016). Another species of major conservation concern in the Asia-Pacific region is the Dugong which are found in tropical and sub-tropical waters of the Indo-Pacific region. Dugong occurs in more than 40 countries but many are developing countries that have limited capacity to contain impacts on dugongs within sustainable levels that lead to population declines and local extinction from a number of areas within their range (Helene Marsh *et al.*, 2011). Approximately 85,000 of the world's dugongs are found in the inshore waters of northern Australia (H Marsh & Lefebvre, 1994) and accounts for at least three quarters of the global population, perhaps more (Helene Marsh, 2002). The International Union for the Conservation of Nature (IUCN) rates their extinction risk as Vulnerable on a global scale based on an inferred or suspected reduction of 30-50 per cent over the last three generations (90 years; Lawler, *et al*., 2002). This classification describes a taxon that faces a moderate risk of extinction in the wild within 50 years (Marsh & Sobtzick, 2015). A regional assessment of the Dugong (Helene Marsh *et al.*, 2011) has concluded that the populations of Indian sub-continent (Andaman and Nicobar Islands) and East African populations fall under 'Endangered' category. Further, according to this assessment, populations of Palau and the Japan (Ryukyus) are said to be 'Critically Endangered' while those of Red Sea, Gulf of Aden, Arabians Gulf, archipelagic East and South East Asia, and Western Pacific Islands are 'Data Deficient'. According to more recent assessment, Dugong population of Australia is 'Near Threatened' (J. Woinarski *et al.*, 2014). Dugongs are vulnerable to two broad classes of threats viz., direct persecution by netting, traditional hunting or large-scale losses of seagrass, and those that decrease the calving rate by reducing feeding opportunities due to habitat degradation and boat traffic (Helene Marsh *et al.*, 2011). Globally dugongs are included in Appendix I of CITES (Helene Marsh & Sobtzick, 2015).

[61] http://www.iobis.org

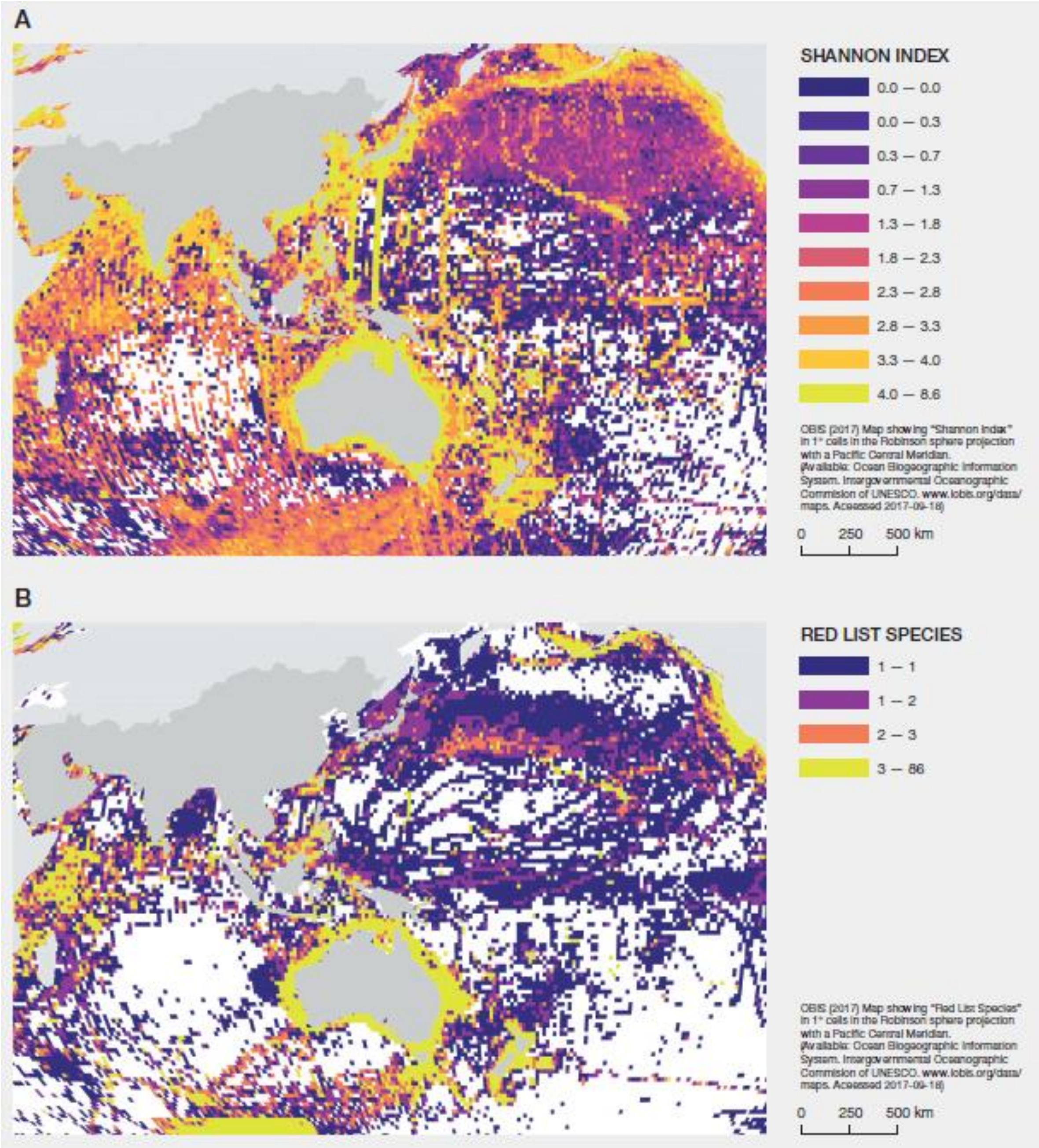


Figure 3.9 Distribution of marine and coastal biodiversity (A: Shannon Index) and threats to it (B: number of Red List species) in the Asia-Pacific region. Source: OBIS (2017d, 2017c)

To date, the Asia-Pacific region has been among the top producers of global fisheries (Funge-Smith *et al.*, 2012; Pauly & Zeller, 2017). However, detailed analyses of fisheries production in the region have shown severe declines in recent decades (Kronen *et al.*, 2010; McManus, 1997; Pauly, 1994; Pauly *et al.*, 2005; Pauly & Zeller, 2017; Russ & Alcala, 1998; Stobutzki *et al.*, 2006; Teh & Sumaila, 2007; R. Watson & Pauly, 2001). Evidence shows that the level of commercial fishing in the Asia-Pacific region has increased leading to steady declines in fish stocks (Anticamara *et al.*, 2011; Bell *et al.*, 2017; R. A. Watson *et al.*, 2013). Local extirpation of a few highly sought after species, such as Groupers (Epinephelinae) (about 20 species at risk of extinction and another 22 species near threatened) and Humphead wrasse (*Cheilinus undulatus*) has already been observed in the region (Chen & Ng, 2009; Sadovy de Mitcheson *et al.*, 2013; Y. Sadovy *et al.*, 2003; Yvonne Sadovy, 2005). Similarly, systematic assessments of fisheries and fish densities in some countries within the region have shown severely depleted status (Anticamara & Go, 2016; Funge-Smith *et al.*, 2012; Go *et al.*, 2015; Teh & Sumaila, 2007).

In addition to overfishing, the Asia-Pacific region has also experienced high levels of habitat degradation from destructive fishing (Bailey & Sumaila, 2015; Pauly *et al.*, 1989), crown-of-thorns starfish (*Acanthaster planci*) population explosions (Hutchings, 1986; Lane, 1996; Moran *et al.*, 1988), super-typhoons (Anticamara & Go, 2017; Gouezo *et al.*, 2015; Reyes *et al.*, 2015), sea-filling of land reclamation (Madin, 2015), pollution (Reopanichkul *et al.*, 2009; Todd *et al.*, 2010), and climate-change related coral bleaching and erosion events (Ainsworth *et al.*, 2016; De'ath *et al.*, 2009; Munday *et al.*, 2008). Based on these continuing threats and trends it is projected that at the current level of extraction, most, if not all, of the exploitable fish stocks in the region could be lost by 2048 (Renton, 2008; R. A. Watson *et al.*, 2013; Worm, 2016; Worm *et al.*, 2006; Worm & Branch, 2012; Zeller *et al.*, 2015). Although, the plausibility of losing commercial fisheries by 2048 is widely debated (Branch, 2008; Hilborn, 2007, 2010), the overall scenario of fisheries in the Asia-Pacific region, especially in the South East Asia and South Asia subregions is bleak due to cumulative effects of (a) illegal, unreported, and unregulated fishery; (b) use of big nets and trawlers, (c) damming of rivers, (d) use of explosives such as dynamites, (e) climate change induced ocean warming and acidification, and (f) coastal pollution .(Saito *et al.*, 2016; Teh *et al.*, 2017; Toba *et al.*, 2016; Yonezaki *et al.*, 2015). It should also be considered that even after management interventions are put in place, recovery of depleted stocks may take a significant period of time. (J. B. C. Jackson *et al.*, 2001; Roberts, 2007) .

Although some progress has been made, there is an urgent need to improve the effectiveness of fisheries management, coastal habitat recovery, and reduction of fishing effort in the Asia-Pacific region, in order to prevent further fisheries decline and the loss of many fisheries stocks. Furthermore, there is a need to conduct systematic and region-wide assessments of fisheries stocks and coastal habitat in the region to aid conservation, management and restoration.

3.2.5 Biocultural diversity

3.2.5.1 General

Biocultural diversity is defined in context here as "the total variety exhibited by the world's natural and cultural systems, explicitly considers the idea that culture and nature are mutually constituting" (Díaz *et al.*, 2015) and incorporates ethno-biodiversity. It captures three elements: i) diversity of life including human cultures and languages; ii) the existing links between biodiversity and cultural diversity; and iii) the coevolution of biodiversity and bio-cultural diversity over time. A global map of bio-cultural diversity (Loh & Harmon, 2014) shows that it is focussed in the tropical areas with a number of hotspots in the Asia-Pacific region, particularly SE Asia. Bio-cultural diversity is assessed globally using the Global Index of Bio-cultural Diversity (Loh & Harmon, 2005).

This assessment of the status and trends of bio-cultural diversity across the Asia-Pacific region tries to assess:

- language diversity, diversity of philosophical, spiritual and/or religious perceptions of biodiversity and nature's contribution to people and the degree to which indigenous and non-indigenous peoples are still culturally and spiritually linked to nature;
- the importance of indigenous local knowledge (ILK) in the region for understanding and contributing or able to contribute to improved management of biodiversity and nature's contribution to people;
- the value of nature to the peoples of the region in the context of exploitation, sustainable and unsustainable use and as some other source of livelihood or basis for human well-being not already considered, and;

- trends in the relationship between cultural and scientific approaches to biodiversity conservation and the connections across different knowledge systems

3.2.5.2 Linguistic diversity

Of the eleven largest language families (Loh & Harmon, 2014), the Asia-Pacific region includes the following language families: Afro-Asiatic, Indo-European, Altaic, Sino-Tibetan, Austro-Asiatic, Austronesian, Trans-New Guinean, and Australian. Using Index of Linguistic Diversity (Harmon & Loh, 2010; Loh & Harmon, 2014) described the status of the languages in each of these language families. The percentages of languages in each of these families that are extinct or critically endangered / endangered respectively, are 11 per cent and 9 per cent in the Afro-Asiatic family, 2 per cent and 2 per cent in the Indo-European family, 0 per cent and 18 per cent in the Altaic family, 0 per cent and 4 per cent in the Sino-Tibetan family, 0 per cent and 11 per cent in the Austro-Asiatic family, 2 per cent and 11 per cent in the Austronesian family, 2 per cent and 22 per cent in the Trans-New Guinean family, and 33 per cent and 59 per cent in the Australian family. Loh & Harmon (2014) concluded that linguistic diversity and biodiversity are equally threatened, both showing about 30 per cent decline since 1970. Within the Asia-Pacific region, declines in linguistic diversity have been catastrophic in the Australian and Trans- New Guinean families, resulting from language shift away from small indigenous languages towards larger, national or regional languages. Loh & Harmon (2014) stated “Australia and the island of New Guinea deserve particularly close attention: Australia because its indigenous languages are the most highly threatened in the world, and New Guinea because it is the most linguistically diverse place on Earth. Most of the 1,000 or so languages of New Guinea are threatened, but their decline is not as rapid as in Australia where more than 90 per cent are threatened with extinction”. Linguists predicted that 50–90 per cent of the world’s languages will disappear by the end of this century (Gorenflo *et al.*, 2012). Gorenflo *et al.* (2012) also showed that two countries of high biodiversity, Indonesia and Papua New Guinea, account for 70 per cent of all languages in the Asia-Pacific region. This allows parallel strategies to be developed in these subregions targeting conservation of both indigenous languages and biological diversity.

3.2.5.3 Biocultural diversity

In their global biocultural diversity assessment, Loh & Harmon (2005) ranked country level biocultural diversity indices by country area and population size. Based on these assessments, these authors ranked the following countries of the Asia-Pacific region as most vulnerable top 2 countries globally for biocultural diversity are in order of declining diversity: By area - Indonesia, Papua New Guinea, Malaysia, Brunei, India, Philippines, Vietnam, Lao PDR and Solomon Islands and By-population – Papua New Guinea, Indonesia, Brunei, Solomon Islands, Australia, Lao PDR and Malaysia. Biocultural approach to conservation provides a humanistic approach for conservation through appreciation of biocultural diversity and heritage, social-ecological systems theory, and different models of people-centred conservation (Chapter 2). It also provides effective and culturally sensitive conservation outcomes and assists in recognising the impacts of eroding biocultural as well as biological diversity (Berkes, 2007; Garnett *et al.*, 2007; McCarter & Gavin, 2015). The Australian Institute of Aborigines and Torres Strait Islander Studies (AIATSIS) produced a map for the whole of Australia to show the language, cultural, trade boundaries and relationship of these groups (AIATSIS, 1996). Ens *et al*. (2015) showed how indigenous biocultural knowledge has informed research and management of biodiversity, fire, threatened species, invasive species, aquatic ecosystems and climate change. The inclusion of culture is one of the ways to enhance the role of indigenous people, knowledge and land into national conservation priorities. Areas that are bioculturally and biologically rich which are facing exceptional threats would be appropriate to be targeted for conservation (N. Myers *et al.*, 2000) or extremely remote areas such as islands (Chander *et al.*, 2014; Girardi *et al.*, 2015).

Like other parts of South-East Asia, the Hawaiian Islands exhibit immense biocultural significance of native ecosystems and species. The same ecological richness of the Hawaiian ecoregion that create the unique Hawaiian biota shaped indigenous Hawaiian culture into one that formed an intimate, familial relationship with their ecosystems and species. The strong sense of familial reciprocal connection created a sustainable human-nature system that stood for a millennium, independent from the rest of the world, with a remarkably small human ecological footprint[62] (15 per cent of the land area displaced with human infrastructure and agriculture) that provided for 100 per cent of the needs of a thriving Polynesian civilization (Kirch, 2011; Ladefoged *et al.*, 2009). The benefits of nature to native Hawaiian society ran the gamut from food, medicine, shelter, tools for agriculture, and all other trappings of material culture, and extended into intellectual, ethical and spiritual well-being. These contributions of nature to people cannot be adequately expressed in terms of monetary or service economics. They were the basis of a human-nature relationship that is a model for sustainability, and ultimately is needed for humanity's survival in a finite planetary biosphere (Gon, 2014).

3.2.5.4 Indigenous and local knowledge

Aichi target 18 aims to ensure that traditional knowledge (TK), innovations and practices of Indigenous local communities (ILCs) are respected, protected and encouraged. Several indicators, including ILC's tenure right to land, traditional occupations, ILC-based management, and linguistic diversity, were suggested for consideration to measure the target (CBD/COP/DEC/XIII/28). These indicators on ILC, however, could give indirect information of status and trends in ILK. Moreover, these indicators could not be widely applied to global, regional, or national assessments for data deficiency except for the linguistic diversity.

Direct measurement of TK is a challenging task. For example, the VITEK (the Vitality Index of Traditional Environmental Knowledge) directly access the retention or loss of TK along successive generations within a given local community. The VITEK, however, has been applied to limited number of cases. The results of the pilot studies indicated 30 per cent decline between the eldest to the youngest cohorts. Women in the community have been able to retain more TK across generations than men have (UNEP-WCMC, 2016b). VITEK approach is recommended to estimate changes in TK of ILC.

3.2.5.5 Status and trends in biocapacity[63]

Overexploitation and unsustainable use of natural resources for economic benefits are major factors degrading habitats in low-income countries. In the Asia-Pacific region, the per capita ecological footprint in 2008 was 1.6 gha which exceeds the per capita biocapacity by 0.8 gha. In addition, the biocapacity per person in 2008 had decreased to only two thirds of that available in 1961 (WWF & ADB, 2012). The average biocapacity per person will decline as populations grow rapidly in the Asia-Pacific region.

Socio-economic growth at some point does improve the attitude of people and implementation measures towards conservation. However, it also increases demands for natural resources and environment for production. Mongolia entered into market economy with democracy since 1992, and the herds were privatized. The new way of pasturage for cashmere production gradually prevailed in Mongolia, however, it looks to be unsustainable for its impact to vegetation loss and land degradation than that of sheep herd has.

[62] Ecological footprint has a variety of definitions, but is defined by the Global Footprint Network the as "a measure of how much area of biologically productive land and water an individual, population or activity requires to produce all the resources it consumes and to absorb the waste it generates, using prevailing technology and resource management practices. The ecological footprint indicator used in this report is based on the Global Footprint Network unless otherwise specified.

[63] The definition that follows is for the purpose of this assessment only: "Biocapacity" has a variety of definitions, but is defined by the Global Footprint Network the as "the ecosystems' capacity to produce biological materials used by people and to absorb waste material generated by humans, under current management schemes and extraction technologies". The 'biocapacity' indicator used in this report is based on the Global Footprint Network unless otherwise specified.

Slash-and-burn or swidden agriculture is a traditional farming style in many ethnic communities settled in mountainous area. Under the condition of small population, it has not destroyed local vegetation and has less impact on biodiversity (Oh & Kang, 2013; van Vliet *et al.*, 2012). With population increase and socio-economic development, however, slash-and-burn is gradually replaced by ordinal agriculture. Although the transformation of slash-and-burn into more intensive land uses improve household incomes, it often leads to permanent deforestation, biodiversity loss, increased weed pressure, declines in soil fertility, and accelerated soil erosion (van Vliet *et al.*, 2012).

3.2.5.6 Cultural and scientific approaches

Both cultural and bio-scientific approaches are needed to implement biodiversity conservation. For example, recognition of ILC's contribution and role to conserve nature is very important to resolve the existing scientific and technical gaps for the implementation of Aichi target 11. The target 11 for protected area is 17 per cent for terrestrial and inland waters and 10 per cent for marine areas. Protected area coverage in the Asia-Pacific region has been increased steadily to 13.3 per cent of terrestrial and inland waters and 15.3 per cent marine and coastal areas (IUCN & UNEP-WCMC, 2014). Especially, trends in marine protected area showed sharp increase since 2005, largely due to increases in the South Pacific. It is partly due to the locally managed marine areas (LMMAs) in the South Pacific which shows community-based management based on cultural and bio-scientific approaches.

Various types of Community Conserved Areas (CCAs) are prevalent in the region. Study from South Asia has revealed that the tradition of CCAs, which are managed and guided by traditional knowledge, belief systems and local customary laws, have contributed significantly for conservation and livelihoods promotion (S. Bhatt *et al.*, 2012). Religious beliefs worshiping the sacred lands, animals or trees are very popular and traditional way of nature protection in ethnic people of the Asia-Pacific region. For instance, the 25 ethnic groups settled in Yunnan are worshiping the sacred mountain and sacred tree and they all have the idea of protecting the forest and nature (Oh & Kang, 2013). Sacred natural sites are also distributed throughout the state of Uttarakhand in northern India (Negi, 2010). The value of sacredness in conservation and maintenance of bio-physical diversity in the landscape surrounding Mt. Kailash, and that spans in adjacent areas of three countries -China, India and Nepal, has been recognized for promotion of transboundary cooperation through "Kailash Sacred Landscape Conservation and Development Initiative" (Rawal *et al.*, 2012).

The amount of information within traditional knowledge is also matter of interest. These information, however, are largely unknown to developing or underdeveloped countries. In the Asia-Pacific region, China, India, and New Zealand are the countries to have records of TK of ILC. The Traditional Knowledge Digital Library (Traditional Knowledge Digital Library) database of India is well-known for its exceptional amount of information for preservation of traditional knowledge, prevention of its misappropriation, and creating its linkages with modern science. India, as mandated under the Biological Diversity Act, is also in the process of developing legally accepted documentation of the local knowledge as PBRs (People's Biodiversity Registers), and has registered 1901 PBRs in 14 states (Ministry of Environment and Forests Government of India., 2014).

The Apatani tribe in Arunachal Pradesh, North-East India make a unique case study wherein cultural diversity is a very effective method for protecting both natural resources and the cultural integrity and survival. This ethnic tribe is known for their unique eco-cultural traditions that has strongly influenced the sustainable use of natural resources and livelihood of these ethnic tribes in an otherwise remote, and environmentally fragile landscape in the region. The unique 'Wet-Rice Cultivation' system which combines rice, millet and fish cultivation in the form of 'sedentary agriculture' is a classic example of indigenous knowledge system which is not only highly productive but also energy efficient (Barua & Slowik, 2009).

At the same time, rural forestry as part of their community natural resource management to maintain several natural resource plantations like bamboo forest, pine plantations and mixed broad-leaved forest not only signifies a traditional institutional arrangement but also a value system that has strong socio-cultural interconnections with the landscape in which they are placed.

Recent new discoveries of lesser known taxa (e.g. discovery of Apatani Glory moth and range extension of Bhutan Glory butterfly) clearly signifies the fact that wild biodiversity is also well conserved in landscapes where livelihood systems are sustainable. The Apatani cultural landscape is currently recognized as GIAHS (Globally Important Ingenious Agricultural Heritage Systems) for the conservation of multi-species (including cultivars), complex agroecosystems maintained by traditional societies (Koohafkan & Cruz, 2011; Ramakrishnan, 2004) and is also tentatively listed on the UNESCO World Heritage site list.

Community based natural resource management as found amongst the Apatanis could significantly contribute towards the integration of 'Traditional Ecological Knowledge' into biodiversity conservation and this could prove to be a very useful tool in conserving and managing an otherwise environmentally fragile tropical landscape in developing tropics while at the same time focusing on the sustainable livelihoods of these traditional developing societies. Among the various cultural approaches, the village forest managements have been widely accepted throughout the Asia-Pacific region. Japanese term for socio-ecological production in landscapes is Satoyama (Fukamachi *et al.*, 2001; Takeuchi *et al.*, 2003, 2016). The Satoyama Initiative was established in 2009 as a global program to protect traditional landscapes and lifestyles in rural areas. The International Partnership for the Satoyama Intitiative (IPSI), launched in 2010 at the CBD COP10, holds many conferences, events, other activities and collects case studies of work. Box 3.3 provides more information on sacred natural sites which link culture with nature and thereby promote biodiversity conservation.

Box 3.3 Sacred natural sites

Sacred natural sites are the natural areas that receive protection because of religious beliefs or cultural practices of the local communities (Dudley *et al.*, 2010). In the Asia-Pacific region they include freshwater habitats of various types (Gupta *et al.*, 2016; R. P. B. Singh & Rana, 2016), single trees (Caughlin *et al.*, 2012), forest patches of various sizes (Allendorf *et al.*, 2014; L. Hu *et al.*, 2011; Ormsby & Bhagwat, 2010; L. Zeng & Reuse, 2016), or entire landscape, including sacred valleys and mountains (Shen *et al.*, 2015). They occur in most, if not all, countries in the Asia-Pacific region and form part of the culture of numerous different ethnic groups. Well-documented examples include the sacred forest groves in India (Ormsby & Bhagwat, 2010), the Dai holy hills of Xishuangbanna in southwest China (Zeng & Reuse, 2016), the fengshui woods of southern China (L. Hu *et al.*, 2011), the Shinto shrine forests of Japan (Omura 2004; Rots, 2015), and the sacred mountains of Tibet (Shen *et al.*, 2015). It has been estimated that there are >100,000 sacred groves in India (Ormsby & Bhagwat, 2010) and that more than 25 per cent of the Tibetan plateau falls under sacred land (Shen *et al.*, 2015).

Although local people may benefit from resources provided by these sites, such as the availability of medicinal plants, this is not usually the main motivation for their protection and, in most cases, direct exploitation is rather restricted (Ma *et al.*, 2015; Ormsby & Bhagwat, 2010; Shen *et al.*, 2015). As a result, sacred sites often preserve not only plants but also animals that has disappeared from the surrounding landscape (Brandt *et al.*, 2013; Dudley *et al.*, 2010; Gao *et al.*, 2013; Junsongduang *et al.*, 2014; Ormsby & Bhagwat, 2010; Shen *et al.*, 2015). This is particularly the case where sacred forests are the only forest left in a human-dominated landscape (L. Hu *et al.*, 2011; Ormsby & Bhagwat, 2010). Although often assumed to be remnants of earliest continuous forest cover, there is limited evidence for this and at least some sacred groves and fengshui woods were apparently established in deforested areas (Ge *et al.*, 2015).

Sacred natural sites may be the earliest form of habitat protection, but most are not part of formal protected area systems. As a consequence, their continued protection depends on the continuation of local beliefs and local control over their fates (Allendorf *et al.*, 2014; Ormsby & Bhagwat, 2010). Recent threats include loss of customary rights, encroachment by cash crops, demand for timber and other forest resources, social and religious change, generational change, cultural assimilation, immigration, and urbanization (Allendorf *et al.*, 2014; Ormsby & Bhagwat, 2010). Many sacred forests and other sacred sites in the Asia-Pacific region have been lost or badly degraded in recent decades (Ormsby & Bhagwat, 2010; L. Zeng & Reuse, 2016), but others are still respected and protected (Shen *et al.*, 2015; Verschuuren, 2016), suggesting that they will continue to have a role in the future.

Contributor: Richard Corlett

3.2.6 Protected area coverage

Protected area coverage is documented in Protected Planet (www.protectedplanet.net), an online platform maintained by United Nations Environment World Conservation Monitoring Centre (UNEP-WCMC) and IUCN. As shown in Figure 3.10a, 3.10b the Asia-Pacific region as a whole has 14.6 per cent of its area under Protected Area (PA) coverage, with slightly less under terrestrial protected areas (13.3 per cent) than under marine protected areas (15.3 per cent). However, there are noticeable subregional variations in total protected area coverage, terrestrial protected area coverage and marine protected area coverage.

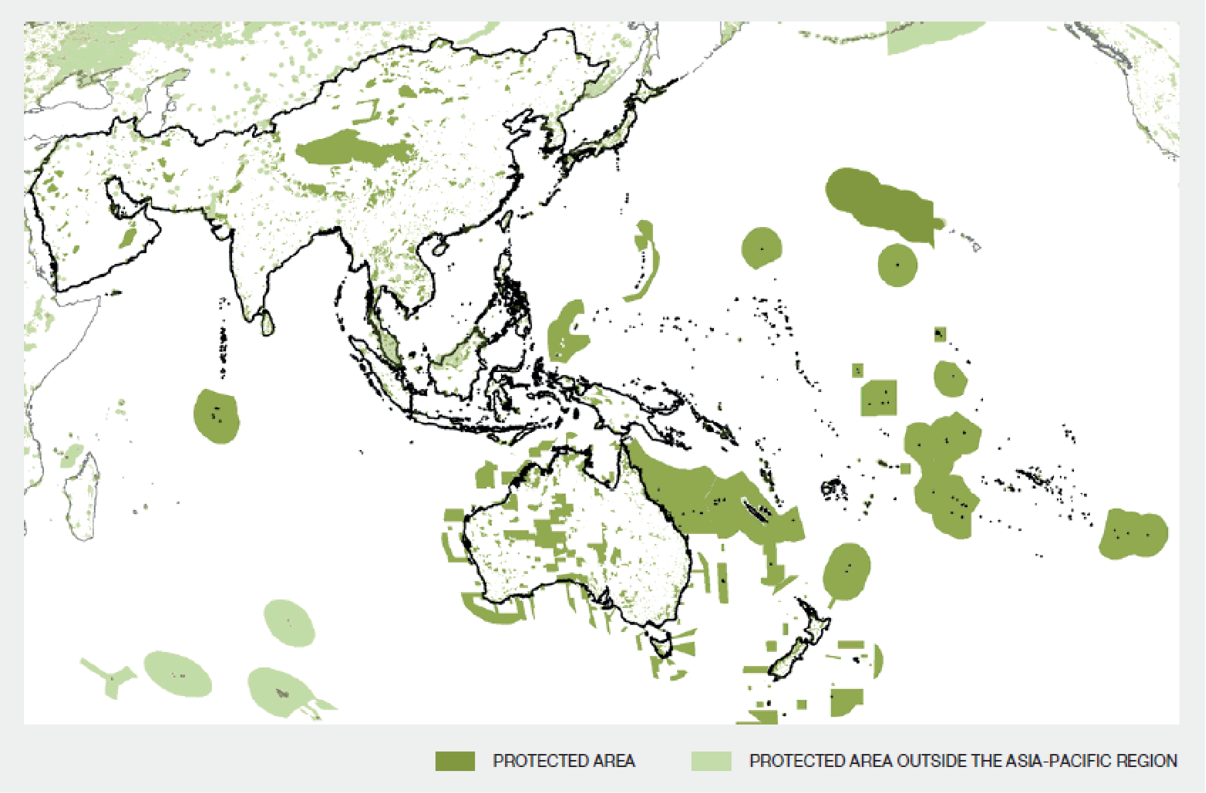


Figure 3.10 A. Protected area coverage in the Asia-Pacific region. Source: UNEP-WCMC & IUCN (2018).

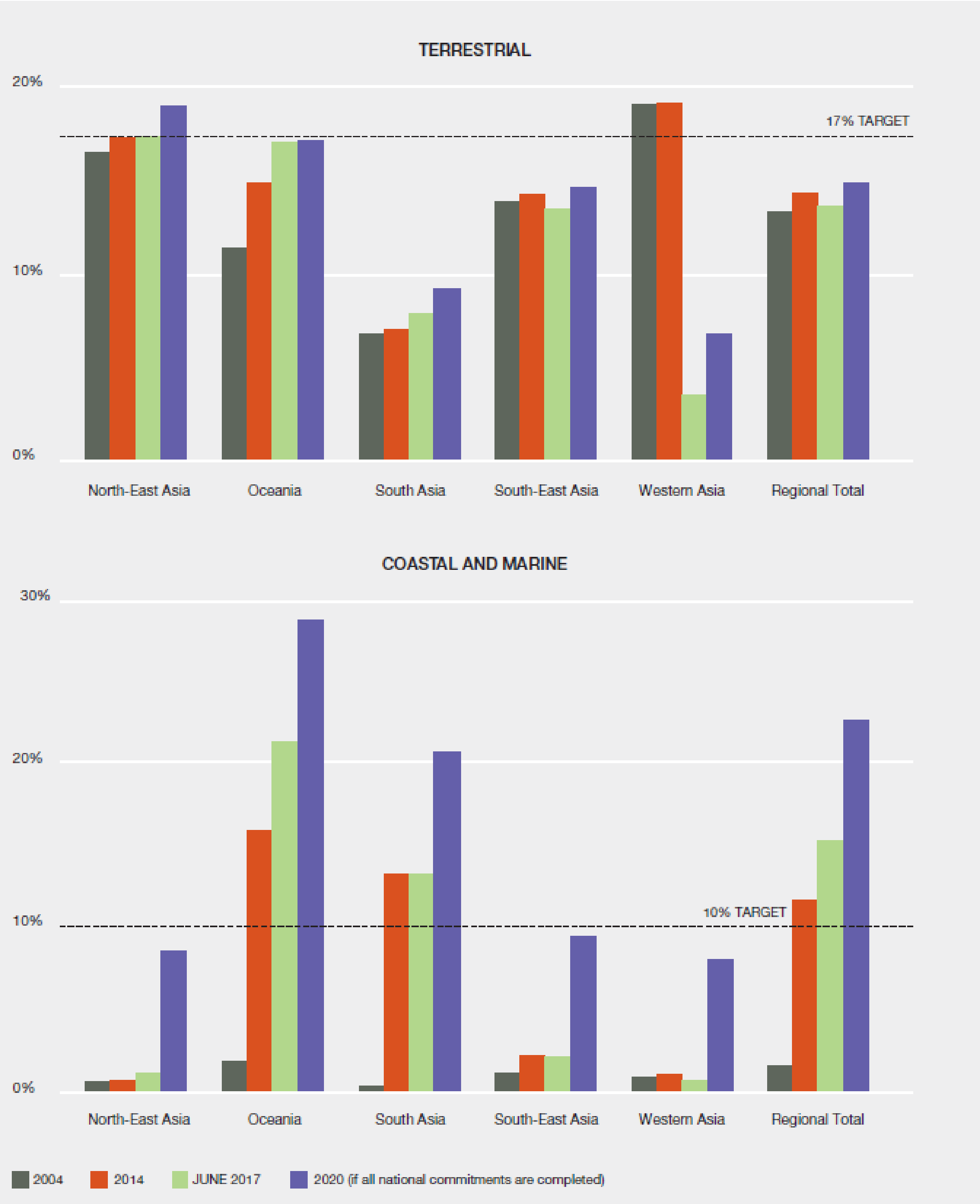


Figure 3.10 B. Proportion (%) of terrestrial and marine protected area coverage in the Asia-Pacific region and subregions.
Note: The large shift in the Western Asia data between 2014 and June 2017 is due to the correction of protected area coverage data in the World Database on Protected Areas. Data source: World Database on Protected Areas in 2004, 2014 and June 2017 (UNEP-WCMC & IUCN, 2017).

Oceania has the greatest protected area coverage in the region with 18 per cent total protected area coverage, followed by 13 per cent in Western Asia, and 11 per cent in North-East Asia. South-East Asia has only 5 per cent of its total area protected (terrestrial and marine areas combined). The protected area systems of North-East Asia and Western Asia are overwhelmingly dominated by terrestrial areas (17 per cent and 18 per cent respectively), while the Oceania and South Asia subregions have greater marine protected area coverage (18 per cent and 13 per cent respectively) than terrestrial protected area coverage. The high marine protected area coverage in South Asia is largely driven by the 640,000 km^2 British Indian Ocean Territory marine protected area (De Santo *et al.*, 2011; Sheppard *et al.*, 2012).

Much of the region's 13 per cent marine protected area coverage can be attributed to the large area dedicated to marine protected areas in Oceania (Australia, New Zealand and other Pacific countries). Once Oceania is excluded, the total marine protected area coverage for Asia is only 4 per cent, although this is a significant increase from the 1.4 per cent cited earlier in the *Asia Protected Planet Report* (Juffe-Bignoli *et al.*, 2014). As for wetlands registered as Ramsar sites (https://rsis.ramsar.org/), 319 and 80 sites are located in Asia and Oceania, respectively, contributing to sustainable management of wetlands, although its effectiveness is often lower in urban wetlands (Hettiarachchi *et al.*, 2015).

3.2.6.1 Regional and subregional trends

While absolute protected area coverage provides important context, protected area coverage of Key Biodiversity Areas (KBAs) are more appropriate indicators for safeguarding nature (BirdLife International, 2017b; Butchart *et al.*, 2012). These are globally important sites that are large enough or sufficiently interconnected to support viable populations of the species for which they are important (Bibby, 1998). KBAs include Important Bird and Biodiversity Areas (IBAs) identified by BirdLife International using data on birds, and Alliance for Zero Extinction (AZE) sites holding the last remaining population of one or more Critically Endangered or Endangered species (Ricketts *et al.*, 2005), among other important sites identified for different taxonomic, ecological and thematic subsets of biodiversity. Since the 1980s, the Asia-Pacific region has seen a rapid increase in the proportion of Alliance for Zero Extinction (AZE) sites under protection. The region has also experienced a steady - but less marked increase - in the proportion of Important Bird Areas (IBA) under protected area coverage. Approximately 25 per cent of AZE sites are completely covered by protected areas region-wide, as opposed to 18 per cent in the case of IBAs (Figure 3.11). This makes an interesting comparison to the global pattern, in which 28 per cent of IBAs are completely covered by protected areas, compared to only 22 per cent of AZE sites (Butchart *et al.*, 2012); it may be driven by the low protected area coverage of IBAs in South, South-East, and Western Asia.

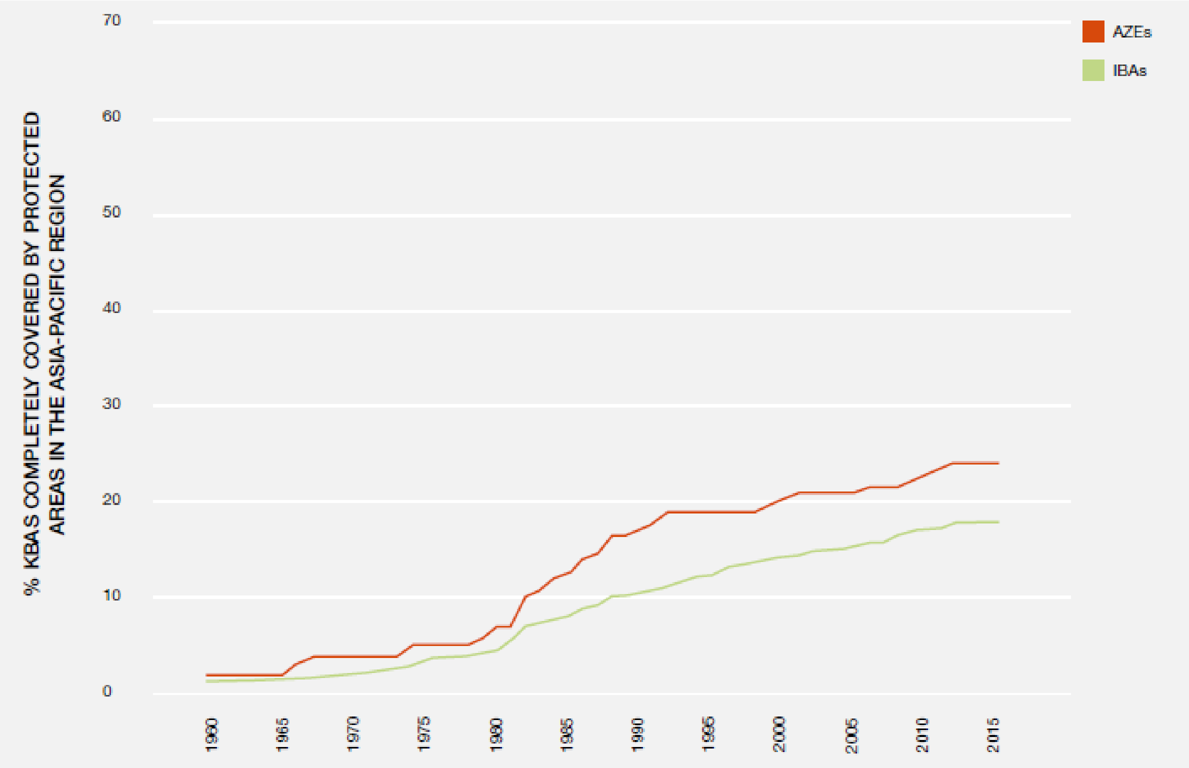


Figure 3.11 Growth in the proportion of Key Biodiversity Areas completely covered by protected areas in the Asia-Pacifi c region..

Data for two types of key biodiversity areas (KBAs) are shown here: Alliance for Zero Extinctions sites (AZEs) and Important Bird and Biodiversity Areas (IBAs). Data source: UNEP-WCMC & IUCN (2015) and World Database on Key Biodiversity Areas (www.keybiodiversityareas.org).

Taking a closer look at the protected area coverage of IBAs at the subregional level, it is apparent that North-East Asia and Oceania have a substantially higher proportion of their IBAs under protection (>25 per cent) than the other three subregions (10-12 per cent) (Figure 3.12). The growth pattern over time is also different among the subregions. Oceania experienced particularly rapid growth over the last decade, with its IBAs under protected area coverage rising from 16 per cent in 2000 to 27 per cent in 2015. In contrast, the most rapid growth in the coverage of IBAs in North-East Asia started in the 1980s, with 12 per cent of the subregion's IBAs being added to the protected area estate between 1981-1990. However, this growth levelled off in the 1990s, with only 4 per cent of the subregion's IBAs gaining protected area coverage between 1991-2000, and fewer than 3 per cent between 2001-2015. In Western Asia, the peak growth period occurred during the 1990s, with a particularly significant expansion occurring in the space of just two years (1994-1996), when coverage rose from 3 per cent to 9 per cent. The other regions (South Asia and South-East Asia) have maintained a modest but steady expansion over time, but have not experienced much growth in the last decade.

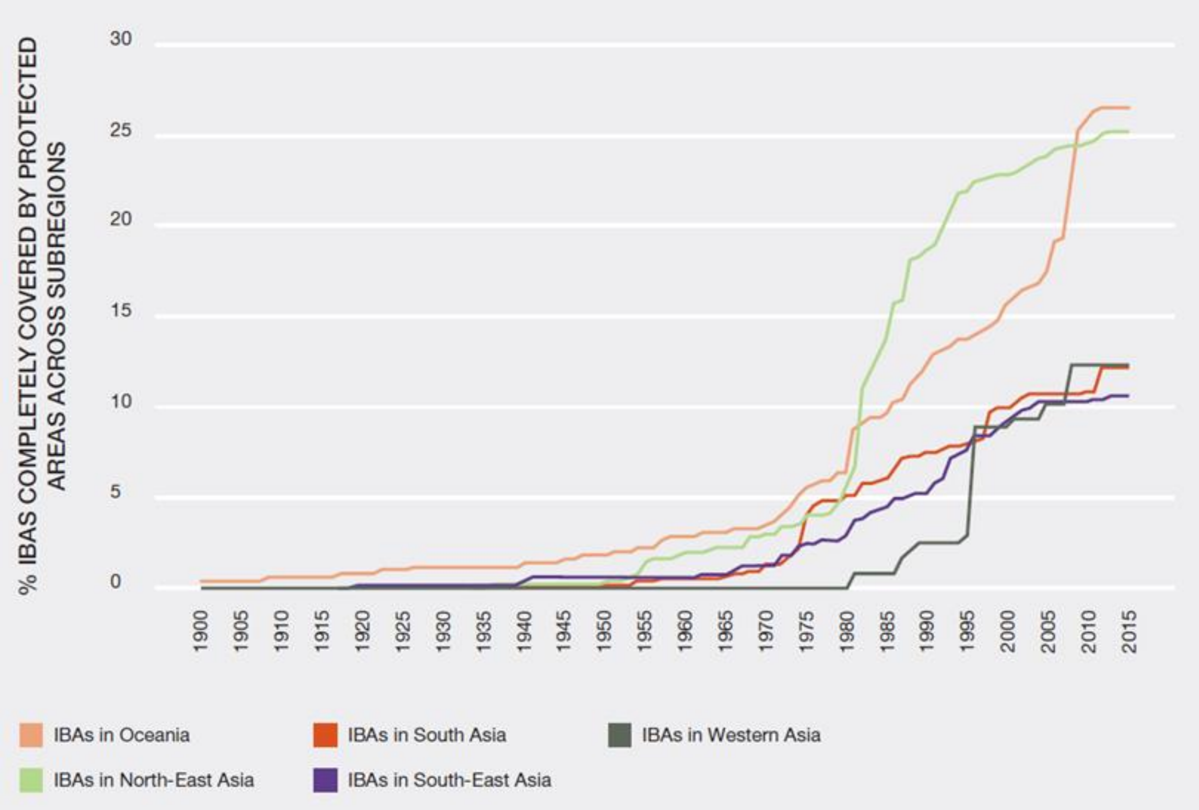


Figure 3.12 Growth in the proportion of Important Bird and Biodiversity Areas (IBAs) completely covered by protected areas in the Asia-Pacific subregions. Data source: UNEP-WCMC & IUCN (2015) and World Database on Key Biodiversity Areas (www.keybiodiversityareas.org).

Similar variations among subregions are also observed in the protected area coverage of AZEs (Figure 3.13), with North-East Asia (37 per cent) having more than double of the percentage of AZEs under protection than South-East Asia (15 per cent). Notably, the peak growth in North-East Asia occurred between 1980 and 1993, similar to the protected area coverage of IBA in this subregion. This growth may be in part contributed by the growth in protected area coverage during the same period in China, because the main objective for protected area establishment is the conservation of threatened species and natural ecosystems (Wu *et al.*, 2011; Zong *et al.*, 2007).

In summary, although there has been a significant increase in the coverage of IBAs and AZEs over the last several decades, the overall proportion of KBAs completely covered by protected areas in the Asia-Pacific region remains alarmingly low (25 per cent or less). This suggests that the region is not on track to protect areas of particular importance for biodiversity, as called for under Aichi Target 11.

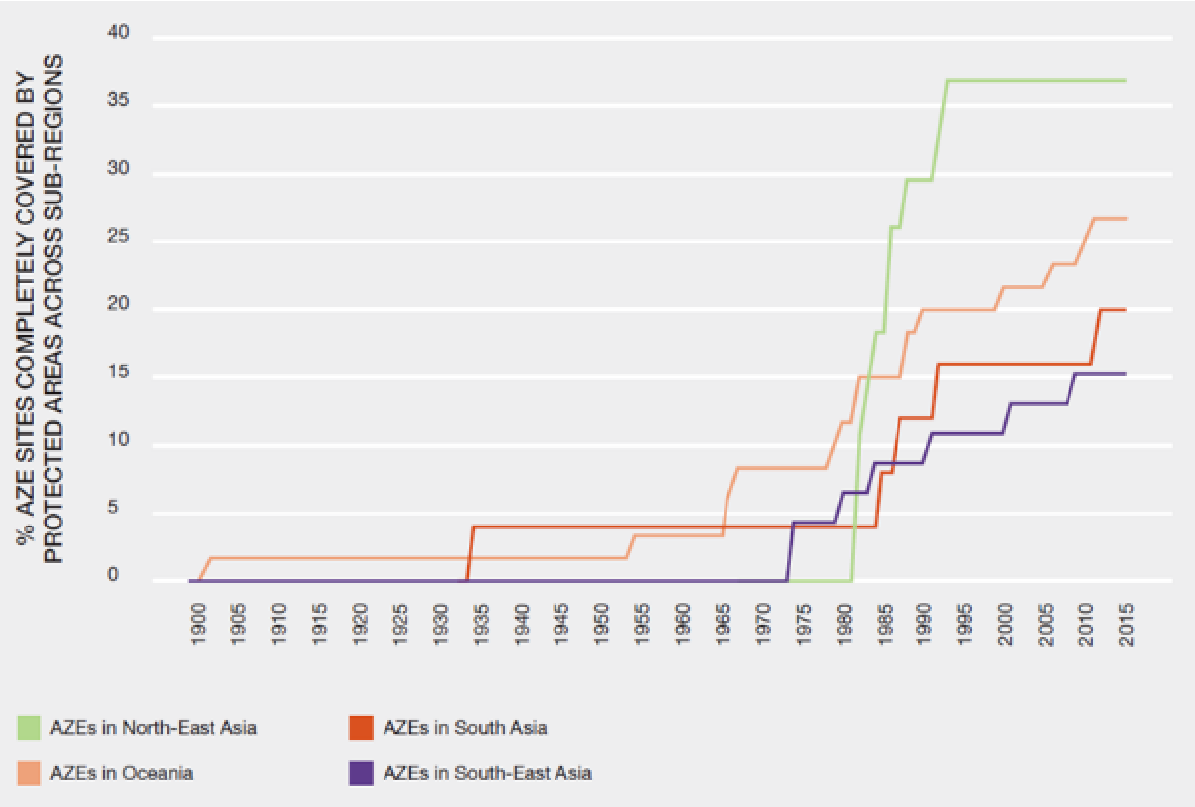


Figure 3.13 Growth in the proportion of Alliance for Zero Extinction (AZE) sites completely covered by protected areas in the Asia-Pacific subregions. Source: UNEP-WCMC & IUCN (2015) and World Database on Key Biodiversity Areas (www.keybiodiversityareas.org).

3.2.6.2 Species extinction risks

The IUCN Red List of Threatened Species (www.iucnredlist.org) documents species extinction risk. Overall, a very high proportion of the species found in the Asia-Pacific region is endemic, so the best estimate of extinction risk prevalence for endemics (25 per cent threatened) is only slightly higher than that for all species (21 per cent threatened) (Figure 3.14); these estimates assume that Data Deficient species (16 per cent of occurring species, and 19 per cent of endemic species) are threatened in the same proportion as non- Data Deficient species. The extinction risk for species occurring in the subregions is relatively similar (16-19 per cent threatened), except for Western Asia (11 per cent threatened). The extinction risk for species occurring in the Asia-Pacific region ranges from 18 per cent (if no DD species are threatened) to 34 per cent (if all DD species are threatened), and between 20 per cent to 39 per cent for endemic species.

Among endemics, the highest extinction risk is found in South Asia (best estimate of 46 per cent threatened) and North-East Asia (36 per cent threatened). However, the extinction risk for endemic species at the subregional level could be as high as 49 per cent threatened (South-East Asia) and 59 per cent threatened (South Asia and North-East Asia), if all endemic DD species are threatened. The lowest extinction risk occurs in Oceania and Western Asia (22 and 23 per cent threatened respectively), even though Oceania has the largest numbers of species actually extinct (73 extinct species in Oceania out of 106 extinct species for the region as a whole).

South-East Asia has the largest number of threatened species (1,182, including CR, EN and VU), and threatened endemic species (748). This is the result of high biodiversity (number of species occurring and assessed, 7,409), high endemism (3,069) and the highest extinction risk in the Asia-Pacific region (nearly 19 per cent threatened). The number of threatened species in South-East Asia is double that in South Asia and six times the figure for Western Asia. Similarly, the absolute number of threatened endemic species in South-East Asia is more than double that of South Asia, even though the latter has the highest percentage extinction risk for endemic species in the Asia-Pacific region. The extinction risk in South Asia is much more prevalent for endemic species (46 per cent threatened, compared to the overall risk for all species of 17 per cent threatened).

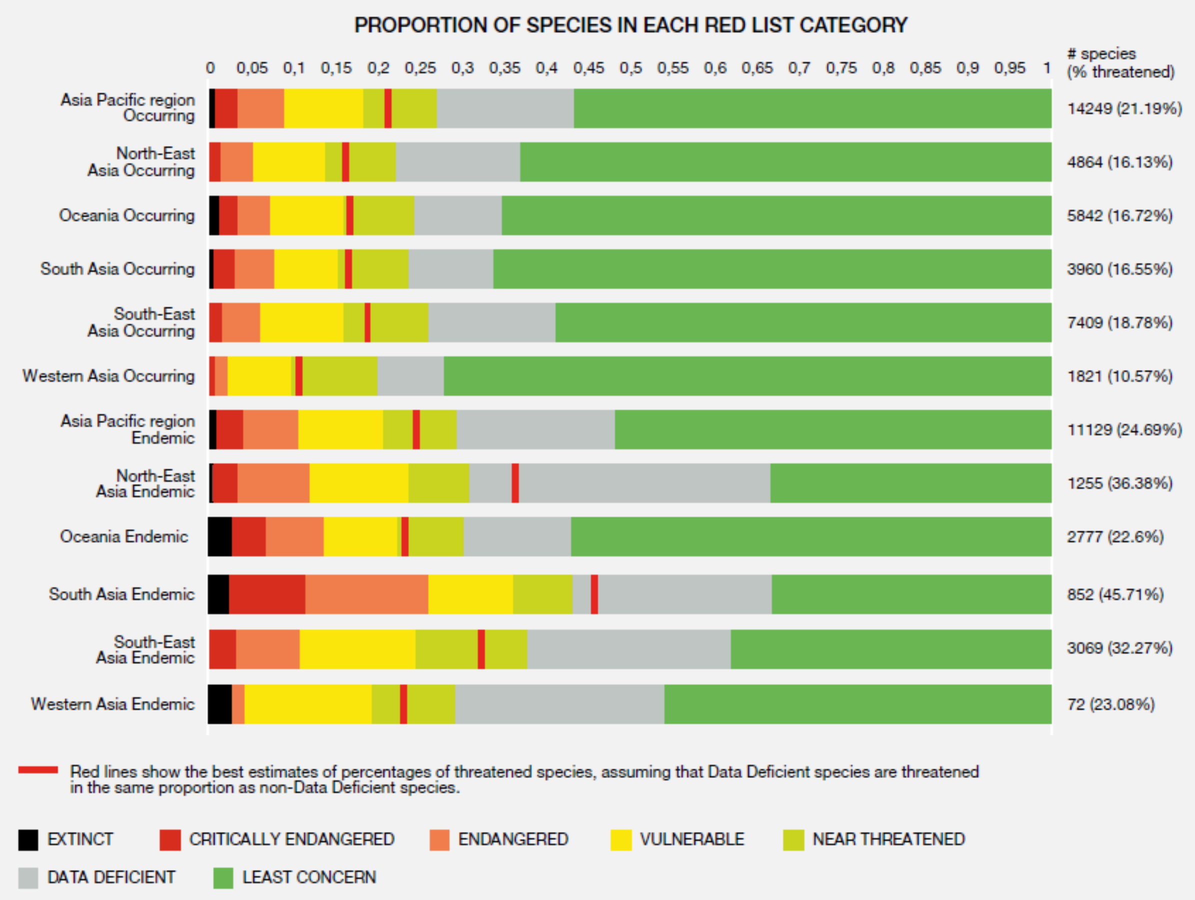


Figure 3.14 Overall extinction risk of species in the Asia-Pacific region. Source: IUCN Red List of Threatened Species (2017).

Figure 3.15 looks at Red List Indices, based on repeated assessments of extinction risk of all mammals, birds, amphibians, corals and cycads, weighted by species occurrence in the different subregions (Rodrigues *et al.*, 2014). The position on the y-axis indicates the aggregate extinction risk facing species in the region overall, while the slope represents how rapidly this extinction risk is changing. The Red List Indices show similar rates of decline across each of the subregions, with the fastest decline observed in South-East Asia, possibly driven by the recent conversion of the Sundaic lowlands to oil palm (Sodhi *et al.*, 2009).

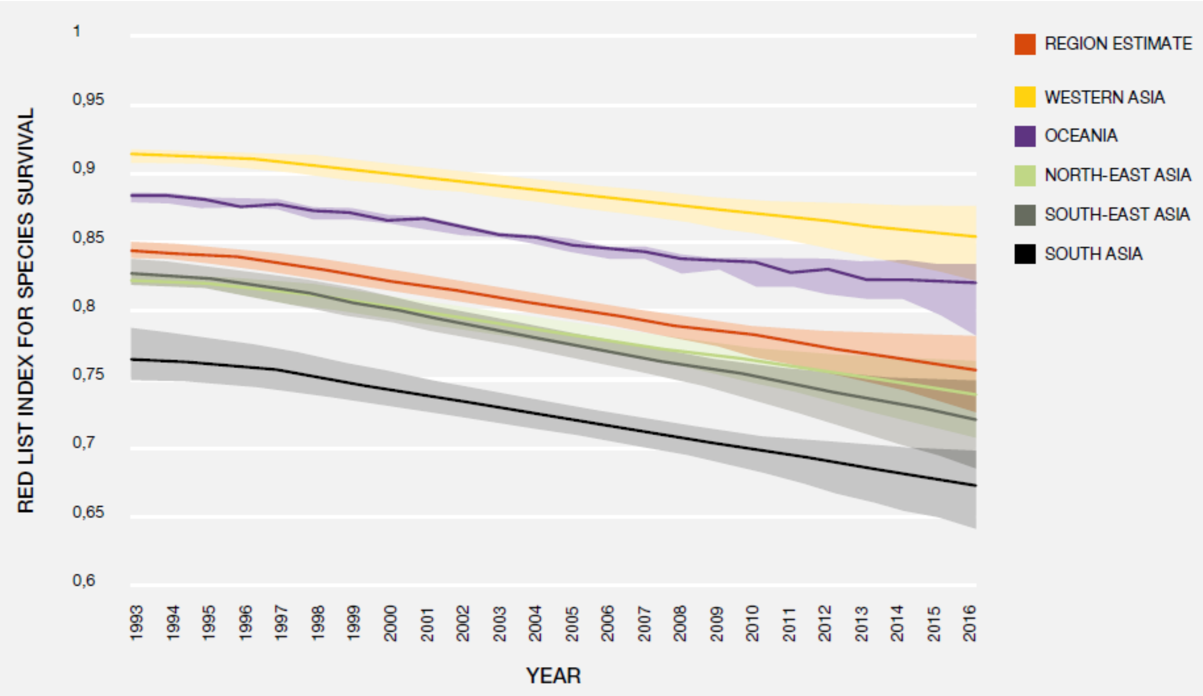


Figure 3.15 Red List Indices of species survival in the Asia-Pacific region, weighted by the fraction of each species' distribution occurring within each region/subregion in the Asia-Pacific region. Data from the IUCN Red List of Threatened Species (2017).

The foregoing analysis reveals that the Aichi Target 11 is achieved for coastal and marine areas in the Asia-Pacific region, but not for terrestrial and inland water. Other targets viz., Aichi Target 12 (by 2020, the extinction of known threatened species has been prevented); Aichi Target 14 (by 2020, the genetic diversity of cultivated plants and farmed and domesticated animals and of wild relatives, including other socio-economically as well as culturally valuable species, is maintained) and Aichi Target 15 (by 2020, ecosystems that provide essential services, including services related to water, and contribute to health, livelihoods and well-being, are restored and safeguarded, taking into account the needs of women, indigenous and local communities, and the poor and vulnerable) have not been analysed comprehensively.

Because species differs in evolutionary history, there is increasing awareness for the importance of protecting "phylogenetic diversity" (Faith, 1992) and "Evolutionarily Distinct and Globally Endangered (EDGE)" species (Isaac *et al.*, 2007; Jetz *et al.*, 2014). Chapter 2 assessed the imperilled PD of the Asia-Pacific region as a portion of the estimated global imperilled PD for multiple taxonomic groups (cycads, amphibians, corals, mammals, birds and squamates). Over these major taxonomic groups, the estimated global per cent of phylogenetic diversity that is imperilled varies from less than 10 per cent (squamates) to more than 60 per cent (cycads) and for these six taxonomic groups, the fraction of global imperilled PD represented by species in the Asia-Pacific region is approximately 38 per cent (Chapter 2, Table 2.2). Pollock *et al.* (2017) calculated global and regional priorities for expanding protected areas to benefit the bird and mammal phylogenetic diversity. Among the four IPBES regions, the Asia-Pacific region has the greatest number of high priority areas for protection of mammal and bird PD (closely followed by the Americas). Mouillot *et al.* (2016) assessed current global protection of fish and corals phylogenetic diversity to be poor, and identified hotspot areas with the potential for conservation of poorly conserved PD for these taxonomic groups. These priority places span the global marine realm, but the Asia-Pacific region is significant in that nearly every 5 degree by 5 degree marine grid cell in this region offers opportunity for improving the conservation of both fish and coral PD.

3.2.6.3 Protected area management effectiveness

Protected Areas have been known to effectively aid in *in-situ* conservation of wild biodiversity through their management and conservation practices. Independent studies indicate that parks are an effective means to protect tropical biodiversity with majority of parks being successful at stopping land clearing, and to a lesser degree effective at mitigating logging, hunting, fire, and grazing (Bruner *et al.*, 2001). Because park effectiveness was associated with activities of guards, logging and clearing deterrent, demarcation of park border, and direct compensation to local communities, park's ability to protect tropical biodiversity is expected to increase with even modest increases in funding (Bruner *et al.*, 2001). Thus, the Management Effectiveness evaluation (MEE) can be employed as a tool to assess how well a protected area is being managed has evolved to meet the goals of protected area management as per IUCN- WCPA Guidelines and also aiding policymakers and practitioners (Leverington *et al.*, 2008). The main objectives of the MEE are for accountability by auditing (including reporting to Parliament) to improve management (adaptive management) for prioritization and resource allocation. The WCPA Framework assumes that good Protected Area management follows a process with six distinct phases or elements:

i. It begins with understanding the context of existing values and threats,
ii. Progress through planning and,
iii. Allocation of resources (inputs) and ,
iv. As a result of management actions (processes),
v. Eventually produces products and services (outputs),
vi. That result in impacts or outcomes.

India has more than 4.8 per cent of its total geographical area under the Protected Area network and has successfully adopted the MEE framework to come up with a systematic evaluation of the country's Protected Areas (Mathur *et al.*, 2011). The MEE-India assessment methodology is based on the IUCNWCPA Framework which is done at three levels: national, state and site level. It uses all the six Framework elements, each with a set of indicators . All criteria are scored on a four point scale with a numeric value (Very Good: 10; Good: 7.5; Fair: 5; Poor: 2.5) and subtotals for each element calculated. An overall management effectiveness score (in percentage) is assigned to each site and state with the results presented graphically. Expert committees comprising wildlife experts and scientists carry out the assessment to review management in each region of India and at the national level; the ultimate aim is to apply the management effectiveness evaluation framework on a regional basis. Some 10 per cent of the geographical area under Protected Area in the region has been randomly selected for review annually.

So far the MEE-India cycle has been successfully undertaken for Country's 40 Tiger Reserves (PA category accorded with highest protection as per law) and other National Parks and Wildlife Sanctuaries. These reports are available in a periodic manner with results available for the period 2005-06 and 2010-11 and 2014-15. The fourth cycle of MEE is currently ongoing.

3.3 Future trends in biodiversity and nature's contribution to people

Within the Asia-Pacific region, continued human population growth, increase in per capita consumption, conversion of natural ecosystems into intensive farming and crop monocultures, distortion of traditional agricultural systems, expansion of urban and industrial areas, overexploitation of wild plants and animals, pollution, and climate change will continue to adversely affect major ecosystems in the coming decades. Sensitive species and ecosystems will become increasingly confined to areas protected by law, by local communities, or by remoteness. Outside these areas, arable cropping has been extended to sites which were not entirely suitable for it, resulting in widespread soil degradation and erosion.

Future of biodiversity and nature's contribution to people in the Asia-Pacific region will depend on both inertia in the direct and indirect drivers and our proactive efforts for changing those drivers towards conservation and sustainable use of biodiversity. Therefore, to project future of biodiversity in the Asia-Pacific region, we need to consider both trends in drivers and possible options for conservation and sustainable use. One measure of biodiversity conservation status relates to the performance of Asia-Pacific countries to their Aichi target commitments, particularly Aichi target 11 for protected areas. Few countries in the Asia-Pacific region have had their performance assessed. According to the assessment of Australia's National Reserve System in 2011 (Taylor *et al.*, 2011) and 2016 (Taylor, 2017), Australia is less than halfway to achieving the target; only 36 of 85 Australian bioregions have reached the 2020 commitment of 17 per cent of total area protected and 1,691 Australian ecosystems and 121 species of national significance lack representation in the protected areas. This is in a back drop where 7 per cent of native plant species are rare endangered or vulnerable and the numbers of animals species per year being categorised as critically endangered has doubled over the last 10 years (Department of the Environment and Energy, n.d., 2016).

While detailed assessments on drivers are reported in Chapter 4, here we summarize future trends and possible impacts of key drivers on status and trends of biodiversity and nature's contribution to people in future.

3.3.1 Expected trends in forest cover

Rapid loss of tropical lowland forests is one of the most serious threats to biodiversity and nature's contribution to people in the Asia-Pacific region. This loss is most rapid in Indonesia (-0.68 M ha/yr) and Myanmar (-0.54 M ha/yr). However, forest cover is increasing in some tropical countries including Philippines and Vietnam. Imai *et al*. (2018) analyzed drivers contributing to the changes (losses and gains) of forest cover in SE Asian countries and found that major changes in forest cover took place between 1980s and 2000s. In 1980s, food and wood productions were considered major drivers of forest loss, but during 2000s food production had no significant effect on forest loss while wood production remains to be a major driver of forest loss. This was due to increase of investments to agricultural sector that improved productivity of good farms and decreased interests in expanding less productive farms. It was found that road density had significant negative impact on forest cover from 1990s to 2000s, suggesting that it led to rapid increase in logging and land use changes. However, increase in human population density during this period had no significant impact on overall forest cover which could be due to concentration of human populations in cities and increase of forest cover in rural areas. These findings agree with the forest transition hypothesis that predicts a national-scale shift from a shrinking to an expanding stage of forest area (Mather, 1992; Meyfroidt & Lambin, 2011), and a more general idea known as Environmental Kuznets Curve hypothesis (Figure 3.16) postulating that environmental pressure increases up to a certain level as income or GDP goes up but decreases after that (Dinda, 2004). Of course, this trajectory is not guaranteed uniformly across the Asia-Pacific region and forest loss may continue if we fail to control drivers promoting forest loss.

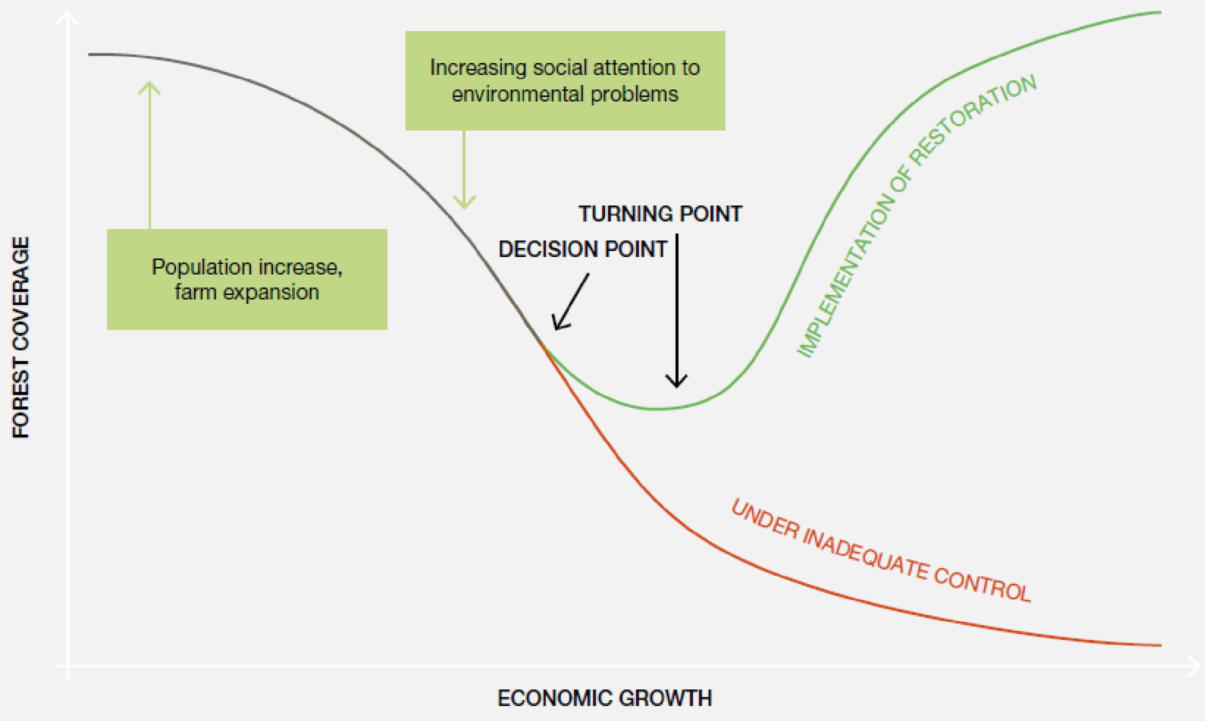


Figure 3.16 A scheme of forest transition under some key drivers. Based on Meyfroidt & Lambin (2011).

While the forest transition hypothesis and the Environmental Kuznets Curve hypothesis assume changes of drivers with a national-scale economic growth, our society is now tightly linked in a global market and international trades are imposing increasing levels of environmental pressure from one country to others. Thus, forest transition may not occur if incentives for land use change would continue under increasing demands of international trades. This may be the case of the expansion of oil palm plantation in SE Asia. There is an increasing demand for palm oil in a global market and hence tropical forests may continue to be converted to oil palm plantations. This expansion of the oil palm plantations is a major threat to not only terrestrial (Abood *et al.*, 2015; Edwards *et al.*, 2014) but also freshwater biodiversity (Konopik *et al.*, 2015).

Demand for timber in developed countries is another driver affecting land use change in tropical lowlands. Nishijima *et al.* (2016) examined the effects of timber extraction on bird extinction risks and showed that a few Asian countries including China, Japan and Korea are imposing dominant effects as large wood importers on the forests of Indonesia that is suffering large risks of species extinction as a major wood exporter. Future dynamics of tropical lowland forests in SE Asia will be affected by changing demands of such goods as palm oil and wood that provide strong incentives for land use change. Policy options for improving forest managements under those demands have been assessed in Chapter 6.

3.3.2 Land degradation and habitat loss

With increasing demands of infrastructure development, agricultural expansion and increased per capita consumption, it is projected that rate of land degradation in much of the Asia-Pacific region will increase in coming decades. Habitat fragmentation and loss in most of the ecosystems has taken the toll of a number of species. For example, a large number of obligate mammalian herbivores such as Eld's deer (*Cervus eldi eldi*), swamp deer (*Cervus duvauceli*), hog deer (*Cervus porcinus*), and a number of avifauna including threatened Great Indian Bustard (*Ardeotis nigriceps*), Lesser Florican (*Sypheotides indica*), Siberian crane (*Grus leucogeranus*) have declined at an alarming rate due to habitat degradation and loss (Dutta *et al.*, 2011, 2013).

Saving terrestrial fauna especially big mammals and other fauna such as Asian elephants, gaur, Sumatran rhinoceros, tiger, Orangutan, proboscis monkey, and hornbills that require large roaming areas can be achieved by protection as well as connecting large tracts of forests with wildlife corridors and through rehabilitation projects. Same goes for other wildlife species in other parts of the Asia-Pacific region. Conservation of long distance migratory species such as Siberian crane, Amur falcon, sea turtles, whales, dugongs and a number of water birds would require regional cooperation and enabling policies on part of all the countries in the region (Somveille *et al.*, 2013). Vegetation types are also estimated as declining in quality, the major causes being habitat fragmentation leading to unsustainable species populations (so called extinction debt). At least 22 per cent of major vegetation communities in Australia have >50 per cent of their remaining extent in fragments <1000 ha. Four communities have >25 per cent per cent of their remaining distribution in fragments <10 ha a proportion increases with each assessment for all coommunities (Department of the Environment and Energy, 2016).

Poor understanding due to data deficiency in certain cases, such as savannahs ecosystems, and conflicting policy environment (e.g. transhumance to sedentary pastoral practices in high altitude grazing lands) has contributed for increased vulnerability of these ecosystems to land-use changes thereby threatening biodiversity.

3.3.3 Pollution and excessive use of water

Freshwater biodiversity and nature's contribution to people are suffering disproportionately large risks under various pressures associated with economic developments including excessive use of water for industries, dam construction, and heavy use of fertilizers in agricultural fields in and around wetlands leading to rapid eutrophication. While water quality once much polluted has improved in some countries, following the trajectory suggested by the Environmental Kuznets Curve hypothesis (Dinda, 2004), losses of biodiversity by dam construction and wetland development are almost irreversible. In the Mekong basin, for example, many dams are being planned to construct and a model-based analysis projects show that dam construction will cause significant loss of fish diversity (Kano *et al.*, 2016) that will be irreversible. Governmental and inter-governmental efforts for avoiding such irreversible loss of biodiversity are highly desirable conforming with Aichi Biodiversity Targets 10 and 11.

3.3.4 Climate change and future of biodiversity and nature's contribution to people

Projected impacts of climate change on biodiversity and nature's contribution to people vary considerably across the Asia-Pacific region. IPCC (2014) predicts that certain ecosystems are likely to be affected more severely in coming decades due to climate change compared to others, e.g., alpine ecosystems, peatlands, coral reefs and mangroves. Rise in atmospheric temperature and increased length of dry season has several implications for the Asia-Pacific region including more forest fires, forest die back due to eruption of insect pests and fungal pathogens, other vector borne diseases, shrubbification of alpine habitats, reduced soil moisture and productivity and increase in IAS. Both climate change and increased frequency of extreme weather events could affect populations of restricted range species in terms of vigor, population size and viability, especially in case of reptiles and amphibians (Bickford *et al.*, 2010). Increased rate of glacial recession in the Greater Himalaya and Central Asia, degradation of permafrost will affect mountain hydrology and water discharge in much of the Hindu Kush Himalayan region and downstream areas. Increased hazards due to glacial lake outburst floods have been projected in some parts of the Hindu Kush Himalayas. This will have direct implications for alpine biodiversity elements, especially the endemics. Studies in parts of the Himalaya have predicted considerable loss of endemic plant species habitats. Also, trends of expansion of shrub lands at the cost of alpine meadows are evident both in Himalayan and Tibetan plateau. However, at the regional level there are inconsistencies and varying responses. This calls for standard and harmonized monitoring programme at regional scales and also long term ecological studies covering different eco-regions in the Asia-Pacific region (R. B. Harris, 2010).

Growing evidence from multiple pilot sites in Himalaya and Tibetan plateau has suggested that species are responding to increasing temperature with trends of range extension towards higher altitudes. While considering models of biome level shifts in Indian sub-continent, study reveals that tropical and sub-tropical grasslands, savannahs and shrublands are specifically vulnerable to shifts and predicting considerably large potential reduction in their size. A few studies have demonstrated that several species will shift their distributional range towards higher altitudes or latitudes due to global warming. Such shifts are already evident in case of certain coral species in Western Pacific and East China Sea, range extension of a predatory fish one of the s in the sea of eastern China and Western Pacific ocean, and of a few predatory fishes and sardines in the region (Hiroya Yamano *et al.*, 2011; Yara *et al.*, 2012). Wetzel *et al.* (2013) have projected that 15-62 per cent of islands in the Asia-Pacific region are likely to be totally inundated and up to 24 per cent will reduce to half or over one tenth of their present size in the event of 1-6 m rise in sea level. Further, these authors predict that species (especially listed under IUCN threat categories) in Pacific islands are much more (2-3 times) vulnerable as compared to those of Australasian and Indo-Malayan region and that rise in sea level due to global warming will increase the vulnerability of most islands in the Asia-Pacific region.

Cumulative effects of climate change and population growth are likely to threaten the food security in the Asia-Pacific region in the future. Increased temperature could reduce production of staple crops such as wheat (Nelson *et al.*, 2009). Agroforestry (AF) is considered important in the quest for a low-carbon future, and for designing a future society living in harmony with nature. Studies have indicated that many native plants along with monospecific crop fields are more environment friendly (Guillerme *et al.*, 2011). A few countries have adopted the policies on agroforestry (e.g., National Agroforestry Policy of India, 2014) as an adaptation strategy that links forestry, agriculture, environment and commerce (Mohan Kumar *et al.*, 2012).

3.3.5 Invasive alien species

Invasive alien species (IAS) are serious threats to biodiversity, the economy and human health. Invasive mosquito disease vectors, aggressive ants and venomous marine species such as jelly fish can have high impacts of human health (Nentwig *et al.*, 2016). A recent paper in *Nature* highlighted that the rate of exotic species establishment globally is increasing each year and does not appear to be slowing down (Seebens *et al.*, 2017). Increasing risks of invasive alien animals are also associated with increasing risks of emerging diseases.

Annual impacts of IAS in South-East Asia are estimated at a cost of $33.5 billion to the environment, human health, and agricultural production, among which the impacts of weeds, insects and pathogens are the highest, imposing a loss of $21.6 billion (Nghiem *et al.*, 2013). The number of IAS causing impacts in China agro-ecosystems has been growing at about 3 species a year since 1900, with a faster rate of increase in the last 15 years (Wan *et al.*, 2017a, 2017b). There are currently 618 IAS in China (45 per cent plants, 21 per cent insects, 8.3 per cent fish and range of other animals, fungi and microbes), 60 per cent in farmlands, 27 per cent in north western deserts and grasslands, 16 per cent in aquatic ecosystems (12 spp. of invasive fish and 6 weeds in inland waterways), 14 per cent in forests and at least 8 per cent in nature reserves (Wan *et al.*, 2017a, 2017b). Most were unintentionally introduced except for invasive plants. Urbanisation has promoted spread and human movement of native fish is also causing biodiversity decline. IAS are considered as one key biological threats to China's social development and ecological security. There are economic (US$17 B p.a.), social (impacts on economic viability in poor farming areas) environmental (biodiversity through degradation in multiple ecosystems) and human health impacts (plant and ant sting allergies affecting 14.5M people) (Wan *et al.*, 2017a, 2017b). IAS abundance is highest at lower altitudes and in the sub-tropical south-east and coastal regions and lowest in the north-west of the country. Eighty IAS species are actively monitored and a few key agricultural pests actively contained.

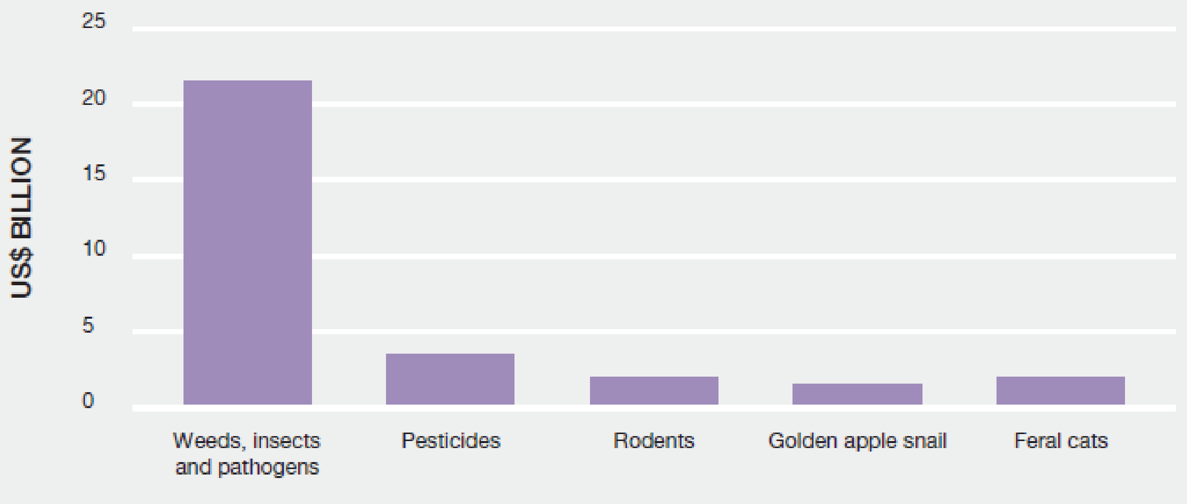


Fig. 3.17 Economic costs of invasive alien species in South-East Asia (estimated mean annual losses). Adapted from Nghiem *et al.* (2013).

Australia has the highest number of woody invaders (D. M. Richardson & Rejmánek, 2011) and invasive vertebrate IAS globally. The highest proportion of exotic flora in the region exists on oceanic islands and island states like New Zealand, but even in Australia 15 per cent of its recognised flora are now exotic (Department of the Environment and Energy, 2016). Australia, which has strong IAS import prevention legislation and regulation however, is showing no evidence that rates of naturalisation of exotic species are increasing (Caley *et al.*, 2016; Department of the Environment and Energy, 2016; Dodd *et al.*, 2015). Beyond such simple global trends and breakdowns for some specific groups there are few sources on information on biogeographic details on invasive species trends across the Asia-Pacific region. Where there are trends are in recognition of the negative impacts of IAS across the region as evidenced by growing international targets (e.g. CBD Aichi target 9) and national strategies for addressing these targets and starting to manage invasion progression and impacts across the region. An example of where more details do exist on status and trends of IAS is from the most recent Australian State of the Environment report (Department of the Environment and Energy, 2016), where such reports have been done roughly every five years since 1999.

IAS have been identified as a key threat to biodiversity generally and to threatened species in particular in Australian terrestrial and aquatic ecosystems, which are having very high impacts that are getting worse (Department of the Environment and Energy, 2016) . Specifically diseases, invasive animals and plants are all having high impacts and getting worse. Extensive grazing from exotic livestock (managed exotic species impacts) for agricultural production in Australia is also now a driver of biodiversity loss in plants and small mammals and ground active birds where grazing has been implicated in a few species extinctions. Where grazing has been removed such populations show a rapid increase (Department of the Environment and Energy, 2016) . The state and trends of IAS generally were considered poor to very poor with a deteriorating trend. Also the impact of IAS is the most frequently cited cause of listed species decline in Australia. All countries have insufficient data to assess the abundance and trends of most invasive animals although in countries like Australia which have reasonable data, distributions and abundances appear to be increasing. In marine environments quantitative information on trends is the most lacking, even though lists of assessed IAS get longer. Marine IAS impacts and trends therefore are highly uncertain except in a few individual species at well studied sites. In Australia widespread species include the New Zealand screw shell and the northern Pacific starfish (Department of the Environment and Energy, 2016) .

On Pacific islands IAS have been particularly impactful. The brown tree snake has caused the extinction of the endemic birds, fruit bats and geckos and the reduction of bird-dispersal and reproduction of new trees by as much as 60—90 per cent in Guam (CGAPS, 1996; Rodda & Fritts, 1993; H. S. Rogers *et al.*, 2017). French Polynesia, Rotuma, Hawaii and many other islands have experienced widespread extinction and drastic population declines of native birds, land snails and land crabs due to invasive avian malaria, rats, mongooses, cats, pigs, goats, ants, predatory land snails, flatworms and habitat degradation (G. Brodie *et al.*, 2014; Howarth, 1985). Increasing alien ant introductions have caused widespread biodiversity loss, human discomfort and increases in crop pests (Auina *et al.*, 2011; Fasi *et al.*, 2013; Jourdan, 1997; O'Dowd *et al.*, 2003; Vaqalo *et al.*, 2014). Critically important taro production in the region has been compromised by introduction of the taro leaf blight (*Phytophthora colocasiae*) and the taro beetle (*Papuana* spp.) (Aloalii *et al.*, 1992; Helen Tsatsia & Jackson, 2017). Abandonment of cultivation of the most important green vegetable and cash crop in Solomon Islands, hibiscus spinach (*Abelmoschus manihot*), resulted from the accidental introduction from PNG in the early 1980s of the aibkia beetle (*Nisotra basselae*) and the giant African snail (*Lissachatina fulica*) in 2007 (H. Tsatsia & Jackson, 2009). Introduced invasive insects and plant pathogens are threatening the existence of several culturally iconic and environmentally important trees in Hawaii, New Zealand, Fiji, Samoa, Nanumea Atoll, Tuvalu and other countries (e.g. Campbell, 2010; Thaman, 2011; Thaman & O'Brien, 2011).

Eight National Parks in Java have 67 invasive alien plant (IAP) species, two of which (*Chromolaena odorata* and *Lantana camara*) occurred in all. Histories of species introduction appeared as important as environmental factors (e,g, low canopy cover and altitude) in increasing IAS distribution and spread away from trails (e.g. *Acacia nilotica* in Baluran National Park (Padmanaba *et al.*, 2017)).

3.3.6 Natural resource governance

Overexploitation and unsustainable use of natural resources for economic benefits are major factors degrading habitats and common property resources in low-income countries. In the Asia-Pacific region, the per capita ecological footprint in 2008 was 1.6 gha which exceeds the per capita biocapacity by 0.8 gha. In addition, the bio-capacity per person in 2008 had decreased to only two thirds of that available in 1961 (WWF & ADB, 2012). The average biocapacity per person will decline as populations grow rapidly in the Asia-Pacific region. The report on Living Planet Index (LPI) shows a decline of 64 per cent in key populations of terrestrial and freshwater species over a period of nearly 4 decades (1970-2008) in the Asia-Pacific region as against global fall of LPI by 28 per cent during same period, suggesting serious degradation of these ecosystems in the region. Given the current rate of human population growth, expansion of urban industrial environments, transformation of agriculture in favour of HYV and cash crops and consumption pattern, transforming of forestry in favour of forest plantations, the biodiversity in the Asia-Pacific region are likely to be adversely affected in the coming decades. It is plausible that most of the biodiversity especially the ecosystem biodiversity in the next century may be confined to protected areas or in places where the local communities have taken the lead in local level conservation *in lieu* of economic incentives and equitable compensation. On the one hand, the unprecedented increase in human population of Asia has stressed the fragile ecosystems to their limits; and on the other, arable cropping has been extended to sites, which were not entirely suitable for it, resulting in soil degradation and erosion (Eswaran *et al.*, 2001).

In China and Vietnam, increase in forest area was caused by the mobilised reforestation policy/program such as Grain for Green project and Program 661(5million reforestation programme). That is quite unique feature of this region (Hyakumura *et al.*, 2007). The natural resource managers in most countries of the region have increasingly realized that community based co-management and strong leadership are the best ways to prevent depletion of bio-resources and degradation of ecosystems. Citing example from the fisheries sector, Guttierrez *et al.* (2011) have also demonstrated that co-management is the best strategy to achieve sustainable management of aquatic resources and securing rural livelihoods. Need for effective natural resource governance is needed at local, national and regional scales. In recent years transboundary cooperation has gained much significance in various parts of the Asia-Pacific region for achieving conservation goals and targets (Box 3.4).

Box 3.4 Improved transboundary cooperation for achieving conservation goals

Recognizing that environment and ecosystem boundaries transcend administrative and political boundaries, the concept of transboundary cooperation is being advocated increasingly to achieve conservation goals globally. Several initiatives in the Asia-Pacific region demonstrate growing interest in transboundary cooperation for protecting areas of high biodiversity values. Some of the initiatives include: (i) Cooperation among Cambodia, China, Lao PDR, Myanmar, Thailand, and Viet Nam in Greater Mekong Subregion (GMS), that fosters regional cooperation after long period of conflict in the area of poverty alleviation and ecological security; (ii) The Heart of Borneo (HoB) Initiative, led by Brunei, Indonesia and Malaysia governments, aims at conservation of biodiversity for the benefit of over 11 million people, including a million forest-dwelling indigenous communities, of Borneo; (iii) The Sulu-Sulawesi Seascape partnership for globally important Coral Triangle, across the waters of Indonesia, Malaysia and Philippines has helped enhancing local governments and community engagement in stewardship of marine areas leading to significant increase in no-take zone area and improved management of seascape’s marine resources; and (iv) Landscape level conservation by way of integrating conservation of endangered Snow Leopard with local and global economies is being focused under Global Snow Leopard & Ecosystem Protection Programme that engages with 12 range countries from Central Asia and Asia-Pacific region.

More recently, the International Center of Integrated Mountain Development (ICIMOD) has been facilitating transboundary conservation and development programme in the Hindu Kush Himalayan region with cooperation from its regional member countries,. Seven such potential landscapes, viz., Wakhan, Karakorum-Pamir, Kailash Sacred Landscape, Everest, Kangchenjunga, the Far Eastern Landscape and Cherrapunjee-Chittagong have been identified across west to east extent of the Hindu Kush Himalayas. Of these, Karakorum-Pamir, Kailash, Kangchenjunga and Far Eastern Landscape are in various stages of implementation by member countries through regional cooperation frameworks with a strong focus on developing knowledge base for informed management and policy decisions on landscape conservation and development. These initiatives are expected to enhance strong regional cooperation for economic development and environmental conservation and provide science based evidences to policy and practice forums at national and regional levels.

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3.4 Policy relevant messages

Biodiversity at the genetic, species, community and ecosystem levels is currently under threats almost everywhere in the Asia-Pacific region, and in many areas the situation is critical. Though, loss of biodiversity and nature's contribution to people are of global concerns, it is not necessarily of common concerns on the ground in many countries of the Asia-Pacific region. Hence, mainstreaming biodiversity conservation and utilisation in every aspect of sustainable development needs to be given high priority and should cascade from the highest level in the government to the local authorities and all stakeholders. This would empower the central, state/provincial and local governments as well all the stakeholders in equitable sharing of benefits and long term conservation of biodiversity.

Terrestrial, inland freshwater, coastal and marine ecosystems across the Asia-Pacific region are degraded and fragmented, compromising their ongoing viability and the provision of nature's contribution to people. Many species of flora and fauna are highly threatened and confined to isolated protected areas which face increasing anthropogenic pressures and conflicts. Currently 14 per cent of the land area of the Asia-Pacific region is in areas protected for the conservation of nature, which is equal to the global mean (T. M. Brooks *et al.*, 2016).

Food availability per capita has increased in the Asia-Pacific region over the last two decades. There are, however, many challenges that still confront this region such as population growth, rapid urbanization, new food demands by a rising middle class, and the effects of global climate change. Furthermore, the area of arable land available per capita in the region is very low (0.17 ha), implying the predominance of smallholder production systems. This has led to increasing land use intensification. At the same time, abandoned farmlands are increasing in countries such as Japan (10 per cent of agricultural lands) and Korea since the 1980s, which needs to be restored for providing nature's contribution to people. This region has the world's highest rates of mineral fertilizer use despite having limited cropland available to feed a large population. Agriculture development ('high inputs/high outputs' model of industrial agriculture) has resulted in the loss of crop genetic diversity such as land races which have been replaced by relatively few high yielding varieties (HYVs). The Asia-Pacific region has undergone a massive shift in land use patterns as croplands and have been converted into monocultures. Monoculture crops such as rubber, palm oil and cloves have replaced the swidden fields and have led to decline of agrobiodiversity. One such concern is the breakdown of traditional tree-rich agroforestry systems in the Pacific islands and elsewhere. However, there are indications that trees outside forests still abound in the Asia-Pacific region and play crucial economic, social, and environmental functions on local, national, and global scales. Significantly, the percentage of tree cover on agricultural lands has increased modestly in the recent past. For example, in South Asia, the area of >10 per cent tree cover increased by 6.7 per cent, along with East Asia (5 per cent), Oceania (3.2 per cent) and South-East Asia (2.7 per cent) between 2000 and 2010.

There has been a steady (up to 70 per cent) decline in the native varieties of plants and crop genetic resources in the Asia-Pacific region due to intensification of agriculture, widespread use of chemical fertilizers and a shift towards high yielding varieties. This trend will impinge on food security of indigenous people and affect local knowledge and practices. The assessment reveals that freshwater is a critical hotspot of biodiversity and nature's contribution to people and freshwater resources in the Asia-Pacific region is undergoing the most rapid rate of decline globally. Freshwater across the Asia-Pacific region are under heavy anthropogenic pressure due to excessive diversion of water, pollution, habitat degradation and loss. Biodiversity – including the abundance and distribution of freshwater taxa – has been affected by human activities. The Asia-Pacific region ranks high among the global hotspots of coastal and marine biodiversity. Biodiversity and nature's contribution to people in this region are highly threatened due to unsustainable commercial aquaculture, overfishing, and pollution, adversely affecting biodiversity and nature's contribution to people. Furthermore, with the push for organic agriculture and integrated farming systems in several parts of the region (e.g. India), the area under these land use practices is likely to increase in future. Yet, the proportional area of organic farming is still very low, for example, in Japan, it is <1 per cent and in India, it is about 3 per cent (certified organic production).

Steady increase in human population and rapid economic development of the Asia-Pacific region, has stressed the various ecosystems to their limits with some being critical. Despite the burgeoning anthropogenic pressures, the Asia-Pacific region continues to provide diverse biodiversity and ecosystem services to the human populations. It is likely that most of the biodiversity in the next few decades may be confined to protected areas or in places where the local communities have taken the lead in local level conservation in lieu of economic incentives and equitable compensation by the governments. Creating continuous awareness at all levels in society and capacity building of community based organizations for conservation are deemed important if the nature's benefits to mankind are to be sustained in the long run. Some countries have taken important steps forward by formulating their own national biodiversity policies but most lack proper mechanisms for implementation, monitoring, regular reviews and system of disincentives for not following wise and standard practices of conservation. Without adequate protection, remediation and proper policies, the current decline in biodiversity and nature's contribution to people on land, in freshwaters, and in the sea will threaten the quality of life of future generations in the Asia-Pacific region.

Creating continuous awareness at all levels in society and capacity building at local levels for conservation are deemed important if the nature's benefits to mankind are to be sustained in the long run. Some countries have taken important steps forward by formulating their own national biodiversity policies but most lack proper mechanisms for implementation, monitoring, regular reviews and system of disincentives for not following wise and standard practices of conservation. Both land sparing (high-yield farming combined with protecting natural habitats) and wildlife friendly farming can be effective for minimizing negative impacts of food production on biodiversity, given appropriate context (Miyashita, Tsutsui., *et al.*, 2014).

There has been a nearly 30 per cent decline in bio-cultural diversity in the Asia-Pacific region since the 1970s (well established). Decline of regional languages has been catastrophic in the indigenous Australian and Trans-New Guinean families, as a result of a shifting away from small indigenous languages towards larger, national or regional languages. Linguistic and biological diversity often coincide in the Asia-Pacific region and parallel strategies need to be developed for their conservation. The national governments need to give high priority to identify bio-culturally rich areas and develop strategies to document and mainstream the traditional knowledge and wise practices in the management of natural resources.

3.5 References

Aadrean, A., Kanchanasaka, B., Heng, S., Reza Lubis, I., de Silva, P., & Olsson, A. (2015). Lutra sumatrana. The IUCN Red List of Threatened Species 2015: e.T12421A21936999. Retrieved November 7, 2017, from http://dx.doi.org/10.2305/IUCN.UK.2015-2.RLTS.T12421A21936999.en.

Abahussain, A. A., Abdu, A. S., Al-Zubari, W. K., El-Deen, N. A., & Abdul-Raheem, M. (2002). Desertification in the Arab Region: Analysis of current status and trends. *Journal of Arid Environments*, *51*(4), 521–545. https://doi.org/10.1016/S0140-1963(02)90975-4

Abdoellah, O. S., Hadikusumah, H. Y., Takeuchi, K., Okubo, S., & Parikesit. (2006). Commercialization of homegardens in an Indonesian village: Vegetation composition and functional changes. *Agroforestry Systems*, *68*(1), 1–13. https://doi.org/10.1007/s10457-005-7475-x

Abood, S. A., Lee, J. S. H., Burivalova, Z., Garcia-Ulloa, J., & Koh, L. P. (2015). Relative Contributions of the Logging, Fiber, Oil Palm, and Mining Industries to Forest Loss in Indonesia. *Conservation Letters*, *8*(1), 58–67. https://doi.org/10.1111/conl.12103

Achard, F. (2002). Determination of Deforestation Rates of the World's Humid Tropical Forests. *Science*, *297*(5583), 999–1002. https://doi.org/10.1126/science.1070656

ACSAD, CAMRE, & UNEP. (2004). *State of Desertification in the Arab World (Updated Study) (In Arabic)*.

Adeel, Z. (2005). *Ecosystems & human well-being : desertification synthesis*. Washington: World Resources Institute. Retrieved from http://edepot.wur.nl/94174

Aggarwal, P. K., & Mall, R. K. (2002). Climate change and rice yields in diverse agroenvironments of India. II. Effect of uncertainties in scenarios and crop models o impact assessment. *Clim. Change*, (52), 331–343.

Aggarwal, P. K., & Swaroopa Rani, D. N. (2009). Assessment of climate change impacts on wheat production in India. In P. K. Aggarwal (Ed.), *Global Climate Change and Indian Agriculture – Case Studies from ICAR Network Project.* (pp. 5–12). ICAR, New Delhi.

AIATSIS. (1996). The AIATSIS map of Indigenous Australia. (D. R. Horton, Ed.). Australian Institute of Aboriginal and Torres Strait Islander Studies. Retrieved from https://aiatsis.gov.au/explore/articles/aiatsis-map-indigenous-australia

Ainsworth, T. D., Heron, S. F., Ortiz, J. C., Mumby, P. J., Grech, A., Ogawa, D., Eakin, C. M., & Leggat, W. (2016). Climate change disables coral bleaching protection on the Great Barrier Reef. *Science*, *352*(6283), 338–342. https://doi.org/10.1126/science.aac7125

Alexandratos, N. (1995). *The world agriculture towards 2010*. Rome, Italy.

Allen, D. J., Molur, S., & Daniel, B. A. (2010). *The Status and Distribution of Freshwater Biodiversity in the Eastern Himalaya*. *IUCN Cambridge and Zoo Outreach Organisation, Coimbatore*. Cambridge, UK and Gland, Switzerland: IUCN, and Coimbatore, India: Zoo Outreach Organisation.

Allen, D. J., Smith, K. G., & Darwall, W. R. T. (2012). The status and distribution of freshwater biodiversity in Indo-Burma. In W. R. T. Allen, D. J., Smith, K. G. & Darwall (Ed.), *The Status and Distribution of Freshwater Biodiversity in Indo-Burma* (pp. 38–65). Cambridge, UK and Gland, Switzerland: IUCN.

Allendorf, T. D., Brandt, J. S., & Yang, J. M. (2014). Local perceptions of Tibetan village sacred forests in northwest Yunnan. *Biological Conservation*, *169*, 303–310. https://doi.org/10.1016/j.biocon.2013.12.001

Allibone, R., David, B., Hitchmough, R., Jellyman, D., Ling, N., Ravenscroft, P., & Waters, J. (2014). Conservation status of New Zealand freshwater fish, 2013. *New Zealand Journal of Marine and Freshwater Research*, *New Zealan*(December 2011), 12. https://doi.org/10.1080/00288330.2010.514346

Aloalii, I., Masamdu, R., Theunis, W., & Thistleton, B. (1992). Prospects for biological control of taro beetles, Papuana spp. (Coleoptera: Scarabaeidae) in the South Pacific. In L. Ferentinos (Ed.), *The sustainable taro culture for the Pacific Conference* (pp. 66–70). Honolulu: College of Tropical Agriculture and Human Resources, University of Hawai'i.

Amagai, Y., Kaneko, M., & Kudo, G. (2015). Habitat-specific responses of shoot growth and distribution of alpine dwarf-pine (Pinus pumila) to climate variation. *Ecological Research*, *30*(6), 969–977. https://doi.org/10.1007/s11284-015-1299-6

Amano, T., Székely, T., Koyama, K., Amano, H., & Sutherland, W. J. (2010). A framework for monitoring the status of populations: An example from wader populations in the East Asian-Australasian flyway. *Biological Conservation*, *143*(9), 2238–2247. https://doi.org/10.1016/j.biocon.2010.06.010

Amiraslani, F., & Dragovich, D. (2011). Combating desertification in Iran over the last 50 years: An overview of changing approaches. *Journal of Environmental Management*, *92*(1), 1–13. https://doi.org/10.1016/j.jenvman.2010.08.012

An, S., Li, H., Guan, B., Zhou, C., Wang, Z., Deng, Z., Zhi, Y., Liu, Y., Xu, C., Fang, S., Jiang, J., & Li, H. (2007). China's natural wetlands: Past problems, current status, and future challenges. *Ambio*, *36*(4), 335–342. https://doi.org/10.1579/0044-7447(2007)36[335:CNWPPC]2.0.CO;2

Anderson, D. M., Cembella, A. D., & Hallegraeff, G. M. (2012). Progress in Understanding Harmful Algal Blooms: Paradigm Shifts and New Technologies for Research, Monitoring, and Management. *Annu. Rev. Mar. Sci*, *4*(1), 143–176. https://doi.org/10.1146/annurev-marine-120308-081121

Anticamara, J. A., & Go, K. T. B. (2016). Spatio-Temporal Declines in Philippine Fisheries and its Implications to Coastal Municipal Fishers' Catch and Income. *Frontiers in Marine Science*, *3*(March), 1–10. https://doi.org/10.3389/fmars.2016.00021

Anticamara, J. A., & Go, K. T. B. (2017). Impacts of super-typhoon Yolanda on Philippine reefs and communities. *Regional Environmental Change*, *17*(3), 703–713. https://doi.org/10.1007/s10113-016-1062-8

Anticamara, J. A., Watson, R., Gelchu, A., & Pauly, D. (2011). Global fishing effort (1950-2010): Trends, gaps, and implications. *Fisheries Research*, *107*(1–3), 131–136. https://doi.org/10.1016/j.fishres.2010.10.016

Arcilla, N., Choi, C., Ozaki, K., & Lepczyk, C. A. (2015). Invasive species and Pacific island bird conservation : a selective review of recent research featuring case studies of Swinhoe ' s storm petrel and the Okinawa and Guam rail. *Journal of Ornithology*, *156*(1), 199–207. https://doi.org/10.1007/s10336-015-1256-8

Asdak, C., Takeuchi, K., Tamura, T., & Okubo, S. (2005). *Hydrological Implication of Bamboo and Mixed Gardens: A case study in Soreang, Upper Citarum Watershed, West Java*. *Paper presented at International seminar 1 on Plantation forest research and development: achieving sustainable forest through strengthening the role of R & D, Yogyakarta.* Retrieved from https://www.academia.edu/6136831/Hydrological_implication_of_Bamboo_Garden_in_the_Upper_Citarum_Watershed_West_Java

Atchison, J. (2009). Human impacts on Persoonia falcata. Perspectives on post-contact vegetation change in the Keep River region, Australia, from contemporary vegetation surveys. *Vegetation History and Archaeobotany*, *18*(2), 147–157. https://doi.org/10.1007/s00334-008-0198-y

Auina, S. S. A., Stanley., M., & Hoffman, B. (2011). Impacts of Anoplolepis gracilipes (yellow crazy ant) on invertebrate communities in Nu'utele, Samoa. *AGRIS*. Retrieved from http://agris.fao.org/agris-search/search.do?recordID=AV2012084108

Auld, T. D., Denham, A., Tozer, M., Porter, J., Mackenzie, B., & Keith, D. (2015). Saving arid and semi-arid southern Australia after over 150 years of exotic grazing pressure: Have we got the time and the will?. *Australasian Plant Conservation: Journal of the Australian Network for Plant Conservation*, *24*(2), 3.

Bae, Y. J. (2001). No Title. In *Trends in research in Ephemeroptera and Plecoptera (Proc. IX Int. Conf. on Ephemeroptera & XIII Int. Symp. on Plecoptera, 16–23 Aug. 1998, Tafi de Valle, Tucuman, Argentina)* (pp. 3–6).

Bagan, H., & Yamagata, Y. (2012). Landsat analysis of urban growth: How Tokyo became the world's largest megacity during the last 40years. *Remote Sensing of Environment*, *127*, 210–222. https://doi.org/10.1016/j.rse.2012.09.011

Bai, Y., Wu, J., Clark, C. M., Naeem, S., Pan, Q., Huang, J., Hang, L., & Han, X. (2010). Tradeoffs and thresholds in the effects of nitrogen addition on biodiversity and ecosystem functioning:

Evidence from inner Mongolia Grasslands. *Global Change Biology*, *16*(1), 358–372. https://doi.org/10.1111/j.1365-2486.2009.01950.x
Bailey, M., & Sumaila, U. (2015). Destructive fishing and fisheries enforcement in eastern Indonesia. *Marine Ecology Progress Series*, *530*, 195–211. https://doi.org/10.3354/meps11352
Balian, E. V., Segers, H., Lévèque, C., & Martens, K. (2008). The Freshwater Animal Diversity Assessment: An overview of the results. *Hydrobiologia*, *595*(1), 627–637. https://doi.org/10.1007/s10750-007-9246-3
Balooni, K., Gangopadhyay, K., & Mohan Kumar, B. (2014). Governance for private green spaces in a growing Indian city. *Landscape and Urban Planning*, *123*, 21–29.
Balvanera, P., Pfisterer, A. B., Buchmann, N., He, J. S., Nakashizuka, T., Raffaelli, D., & Schmid, B. (2006). Quantifying the evidence for biodiversity effects on ecosystem functioning and services. *Ecology Letters*, *9*(10), 1146–1156. https://doi.org/10.1111/j.1461-0248.2006.00963.x
Bannikov, A. G. (1974). Wild Camels in Mongolia. *Oryx*, *13*(01), 2012. https://doi.org/10.1017/S0030605300012928
Barua, K. K., & Slowik, J. (2009). Traditional ecological knowledge and community based sustainable natural resource management in the eastern Himalayas - A case study of the Apatani tribe. In *International DAAD Alumni Summer School Tropentag 2009 Conservation and Management of Biodiversity in the Tropics*. Göttingen, Germany: Universität Göttingen. Retrieved from https://www.uni-goettingen.de/en/international+daad+alumni+summer+school+tropentag+2009+conservation+and+management+of+biodiversity+in+the+tropics/164523.html
Batsaikhan, N., Buuveibaatar, B., Chimed, B., Enkhtuya, O., Galbrakh, D., Ganbaatar, O., Lkhagvasuren, B., Nandintsetseg, D., Berger, J., Calabrese, J. M., Edwards, A. E., Fagan, W. F., Fuller, T. K., Heiner, M., Ito, T. Y., Kaczensky, P., Leimgruber, P., Lushchekina, A., Milner-Gulland, E. J., Mueller, T., Murray, M. G., Olson, K. A., Reading, R., Schaller, G. B., Stubbe, A., Stubbe, M., Walzer, C., Von Wehrden, H., & Whitten, T. (2014). Conserving the World's Finest Grassland Amidst Ambitious National Development. *Conservation Biology*, *28*(6), 1736–1739. https://doi.org/10.1111/cobi.12297
Beck, M. W., Brumbaugh, R. D., Airoldi, L., Carranza, A., Coen, L. D., Crawford, C., Defeo, O., Edgar, G. J., Hancock, B., Kay, M. C., Lenihan, H. S., Luckenbach, M. W., Toropova, C. L., Zhang, G., & Guo, X. (2011). Oyster Reefs at Risk and Recommendations for Conservation, Restoration, and Management. *BioScience*, *61*(2), 107–116. https://doi.org/10.1525/bio.2011.61.2.5
Beddington, J., Asaduzzaman, M., Clark, M., Fernández, A., Guillou, M., Jahn, M., Erda, L., Mamo, T., Bo, N. Van, Nobre, C. A., Scholes, R., Sharma, R., & Wakhungu, J. (2011). *Achieving food security in the face of climate change: Summary for policy makers from the Commission on Sustainable Agriculture and Climate Change*. Copenhagen, Denmark. https://doi.org/Available online at: www.ccafs.cgiar.org/commission.
Bell, J. D., Watson, R. A., & Ye, Y. (2017). Global fishing capacity and fishing effort from 1950 to 2012. *Fish and Fisheries*, *18*(3), 489–505. https://doi.org/10.1111/faf.12187
Bellard, C., Leclerc, C., & Courchamp, F. (2013). Potential impact of sea level rise on French islands worldwide. *Nature Conservation*, *5*, 75–86. https://doi.org/10.3897/natureconservation.5.5533
Bellard, C., Leclerc, C., & Courchamp, F. (2014). Impact of sea level rise on the 10 insular biodiversity hotspots. *Global Ecology and Biogeography*, *23*(2), 203–212. https://doi.org/10.1111/geb.12093
Bellard, C., Russell, J., Hoffmann, B. D., Leclerc, C., & Courchamp, F. (2015). Adapting island conservation to climate change. Response to Andréfouët et al. *Trends in Ecology and Evolution*. https://doi.org/10.1016/j.tree.2014.11.003
Bellefontaine, R., Petit, S., Pain-Orcet, M., Deleporte, P., & Bertault, J. G. (2002). *Trees outside forests*. *FAO Conservation Guide 35*. Rome.
Bellotti, B., & Rochecouste, J. F. (2014). The development of Conservation Agriculture in Australia Farmers as innovators. *International Soil and Water Conservation Research*, *2*(1), 21–34.
Bellwood, D. R., Hughes, T. P., Folke, C., & Nyström, M. (2004). Confronting the coral reef crisis. *Nature*, *429*(6994), 827–833. https://doi.org/10.1038/nature02691

Bentley, A. I., Schmidt, D. J., & Hughes, J. M. (2010). Extensive intraspecific genetic diversity of a freshwater crayfish in a biodiversity hotspot. *Freshwater Biology*, *55*, 1861–1873. https://doi.org/DOI 10.1111/j.1365-2427.2010.02420.x

Berendsen, R. L., Pieterse, C. M. J., & Bakker, P. A. H. M. (2012). The rhizosphere microbiome and plant health. *Trends in Plant Science*, *17*(8), 478–486. https://doi.org/https://doi.org/10.1016/j.tplants.2012.04.001.

Berger, J., Buuveibaatar, B., & Mishra, C. (2013). Globalization of the Cashmere Market and the Decline of Large Mammals in Central Asia. *Conservation Biology*, *27*(4), 679–689. https://doi.org/10.1111/cobi.12100

Berkes, F. (2007). Community-based conservation in a globalized world. *Proc Natl Acad Sci U S A*, *104*(39), 15188–15193. https://doi.org/10.1073/pnas.0702098104

Betts, M. G., Wolf, C., Ripple, W. J., Phalan, B., Millers, K. A., Duarte, A., Butchart, S. H. M., & Levi, T. (2017). Global forest loss disproportionately erodes biodiversity in intact landscapes. *Nature*, *547*(7664), 441–444. https://doi.org/10.1038/nature23285

Bezuijen, M. R., Shwedick, B., Simpson, B. K., Staniewicz, A., & Stuebing, R. (2014). Tomistoma schlegelii. https://doi.org/http://dx.doi.org/10.2305/IUCN.UK.2014-1.RLTS.T21981A2780499.en

Bezuijen, M. R., Simpson, B., Behler, N., Daltry, J., & Tempsiripong, Y. (2012). Siamese Crocodile (Crocodylus siamensis). *The IUCN Red List of Threatened Species 2012: E.T5671A3048087*, *2*, 120–126. https://doi.org/http://dx.doi.org/10.2305/IUCN.UK.2012.RLTS.T5671A3048087.en

Bharti, R. R., Rai, I. D., Adhikari, B. S., & Rawat, G. S. (2011). Timberline change detection using topographic map and satellite imagery: a critique. *Tropical Ecology*, *52*(1), 133–137.

Bhatt, S., Pathak Broome, N., Kothari, A., & Balasinorwala, T. (2012). *Community Conserved Areas in South Asia: Case studies and analyses from Bangladesh, India, Nepal, Pakistan & Sri Lanka*. (S. Bhatt, N. Pathak Broome, A. Kothari, & T. Balasinorwala, Eds.). Kalpavriksh, New Delhi, India. Retrieved from www.kalpavriksh.org

Bhatt, V. K., & Singh, H. R. (2009). Biodiverse agriculture and associated resilience in Uttarakhand: An overview. In V. Shiva & V. K. Bhatt (Eds.), *Climate change at the third pole: The impact of climate instability on Himalayan ecosystem and Himalayan communities* (pp. 116–152). New Delhi, India: Navdanya & Research Foundation for Science, Technology & Ecology.

Bhattarai, N., Joshi, L., Karky, B. S., Windhorst, K., & Ning, W. (2016). *Potential synergies for agroforestry and REDD+ in the Hindu Kush Himalaya* (No. 2016/11). Kathmandu.

Bhupathy, S. (1997). Conservation of the endangered river terrapin Batagur baska in the Sunderban of West Bengal, India. *Journal of The Bombay Natural History Society*, *94*(1), 27–35. Retrieved from http://direct.biostor.org/reference/152679

Biancalani, R., & Avagyan, A. (Eds.). (2014). *Toward climate-responsible peatlands management*. *Mitigation of Climate Change in Agriculture Series* (Vol. 9).

Bianchi, F., Booij, C., & Tscharntke, T. (2006). Sustainable Pest Regulation in Agricultural Landscapes: A Review on Landscape Composition, Biodiversity and Natural Pest Control. *Proceedings: Biological Sciences*, *273*(1595), 1715–1727. Retrieved from http://www.jstor.org/stable/25223515

Bibby, C. J. (1998). Selecting areas for conservation. In W. J. Sutherland (Ed.), *Conservation Science and Action.* (p. 378). John Wiley & Sons. Retrieved from https://www.wiley.com/en-jp/Conservation+Science+and+Action-p-9780865427624

Bickford, D., Howard, S. D., Ng, D. J. J., & Sheridan, J. A. (2010). Impacts of climate change on the amphibians and reptiles of Southeast Asia. *Biodiversity and Conservation*, *19*(4), 1043–1062. https://doi.org/10.1007/s10531-010-9782-4

BirdLife International. (2016). Vanellus gregarius. https://doi.org/http://dx.doi.org/10.2305/IUCN.UK.2016-3.RLTS.T22694053A93435982.en

BirdLife International. (2017a). Falco cherrug. Retrieved July 27, 2017, from http://dx.doi.org/10.2305/IUCN.UK.2017-1.RLTS.T22696495A110525916.en.

BirdLife International. (2017b). World Database of Key Biodiversity Areas. Retrieved August 31, 2017, from http://www.keybiodiversityareas.org/home

BirdLife International, FFI, IUCN, & WWF. (2014). *Extraction and Biodiversity in Limestone Areas* (Joint Briefing Paper).

Blackburn, T. M., Cassey, P., Duncan, R. P., Evans, K. L., & Gaston, K. J. (2004). Avian extinction and mammalian introductions on oceanic islands. *Science*, *305*(5692), 1955–1958.

Blakely, T. J., Eikaas, H., & Harding, J. (2014). The Singscore: A macroinvertebrate biotic index for assessing the health of Singapore's streams and canals. *The Raffles Bulletin of Zoology*, *62*, 540–548.

Blasco, F., Aizpuru, M., & Gers, C. (2001). Depletion of the mangroves of Continental Asia. *Wetlands Ecology and Management*, *9*, 245–256. https://doi.org/10.1023/a:1011169025815

Bolotov, I. N., Kondakov, A. V., Vikhrev, I. V., Aksenova, O. V., Bespalaya, Y. V., Gofarov, M. Y., Kolosova, Y. S., Konopleva, E. S., Spitsyn, V. M., Tanmuangpak, K., & Tumpeesuwan, S. (2017). Ancient River Inference Explains Exceptional Oriental Freshwater Mussel Radiations. *Scientific Reports*, *7*(1), 1–14. https://doi.org/10.1038/s41598-017-02312-z

Borer, E. T., Seabloom, E. W., Gruner, D. S., Harpole, W. S., Hillebrand, H., Lind, E. M., Adler, P. B., Alberti, J., Anderson, T. M., Bakker, J. D., Biederman, L., Blumenthal, D., Brown, C. S., Brudvig, L. A., Buckley, Y. M., Cadotte, M., Chu, C., Cleland, E. E., Crawley, M. J., Daleo, P., Damschen, E. I., Davies, K. F., DeCrappeo, N. M., Du, G., Firn, J., Hautier, Y., Heckman, R. W., Hector, A., HilleRisLambers, J., Iribarne, O., Klein, J. A., Knops, J. M. H., La Pierre, K. J., Leakey, A. D. B., Li, W., MacDougall, A. S., McCulley, R. L., Melbourne, B. A., Mitchell, C. E., Moore, J. L., Mortensen, B., O'Halloran, L. R., Orrock, J. L., Pascual, J., Prober, S. M., Pyke, D. A., Risch, A. C., Schuetz, M., Smith, M. D., Stevens, C. J., Sullivan, L. L., Williams, R. J., Wragg, P. D., Wright, J. P., & Yang, L. H. (2014). Herbivores and nutrients control grassland plant diversity via light limitation. *Nature*, *508*(7497), 517–520. https://doi.org/10.1038/nature13144

Boyce, D. G., Lewis, M. R., & Worm, B. (2010). Global phytoplankton decline over the past century. *Nature*, *466*(7306), 591–596. https://doi.org/10.1038/nature09268

Boyer, A. G., & Jetz, W. (2014). Extinctions and the loss of ecological function in island bird communities. *Global Ecology and Biogeography*, *23*(6), 679–688. https://doi.org/10.1111/geb.12147

Branch, T. A. (2008). Not all fisheries will be collapsed in 2048. *Marine Policy*, *32*(1), 38–39. https://doi.org/10.1016/j.marpol.2007.04.001

Brandt, J. S., Wood, E. M., Pidgeon, A. M., Han, L. X., Fang, Z., & Radeloff, V. C. (2013). Sacred forests are keystone structures for forest bird conservation in southwest China's Himalayan Mountains. *Biological Conservation*, *166*, 34–42. https://doi.org/10.1016/j.biocon.2013.06.014

Brearley, F. Q., Fine, P. V. a, & Perreijn, K. (2011). Does nitrogen availability have greater control over the formation of tropical heath forests than water stress?A hypothesis based on nitrogen isotope ratios. *Acta Amazonica*, *41*(4), 589–592. https://doi.org/10.1590/S0044-59672011000400017

Brinson, M. M., & Malvárez, A. I. (2002). Temperate freshwater wetlands: Types, status, and threats. *Environmental Conservation*, *29*(2), 115–133. https://doi.org/10.1017/S0376892902000085

Brodie, G., Barker, G. M., Stevens, F., & Fiu, M. (2014). Preliminary re-survey of the land snail fauna of Rotuma: Conservation and biosecurity implications. *Pacific Conservation Biology*, *20*(1), 94–107.

Brodie, J. F., Giordano, A. J., Zipkin, E. F., Bernard, H., Mohd-Azlan, J., & Ambu, L. (2015). Correlation and persistence of hunting and logging impacts on tropical rainforest mammals. *Conservation Biology*, *29*(1), 110–121. https://doi.org/10.1111/cobi.12389

Brooks, M. L., D'antonio, C. M., Richardson, D. M., Grace, J. B., Keeley, J. E., Ditomaso, J. M., Hobbs, R. J., Pellant, M., & Pyke, D. (2004). Effects of Invasive Alien Plants on Fire Regimes. *BioScience*, *54*(7), 677. https://doi.org/10.1641/0006-3568(2004)054[0677:EOIAPO]2.0.CO;2

Brooks, S. E., Allison, E. H., & Reynolds, J. D. (2007). Vulnerability of Cambodian water snakes: Initial assessment of the impact of hunting at Tonle Sap Lake. *Biological Conservation*, *139*(3–4), 401–414. https://doi.org/10.1016/j.biocon.2007.07.009

Brooks, T. M., Akçakaya, H. R., Burgess, N. D., Butchart, S. H. M., Hilton-Taylor, C., Hoffmann, M., Juffe-Bignoli, D., Kingston, N., MacSharry, B., Parr, M., Perianin, L., Regan, E. C., Rodrigues, A. S. L., Rondinini, C., Shennan-Farpon, Y., & Young, B. E. (2016). Analysing biodiversity and conservation knowledge products to support regional environmental assessments. *Scientific Data*, *3*, 160007. https://doi.org/10.1038/sdata.2016.7

Brown, L. A., Furlong, J. N., Brown, K. M., & La Peyre, M. K. (2014). Oyster reef restoration in the northern gulf of Mexico: Effect of artificial substrate and age on nekton and benthic macroinvertebrate assemblage use. *Restoration Ecology*, *22*(2), 214–222. https://doi.org/10.1111/rec.12071

Brown, R. M., Siler, C. D., Oliveros, C. H., Esselstyn, J. A., Diesmos, A. C., Hosner, P. A., Linkem, C. W., Barley, A. J., Oaks, J. R., Sanguila, M. B., Welton, L. J., Blackburn, D. C., Moyle, R. G., Townsend Peterson, A., & Alcala, A. C. (2013). Evolutionary Processes of Diversification in a Model Island Archipelago. *Annual Review of Ecology, Evolution, and Systematics*, *44*(1), 411–435. https://doi.org/10.1146/annurev-ecolsys-110411-160323

Brueckner, M., Durey, A., Mayes, R., & Pforr, C. (2013). The mining boom and Western Australia's changing landscape: Towards sustainability or business as usual? *Rural Society*, *22*(2), 111–124. https://doi.org/10.5172/rsj.2013.22.2.111

Brummitt, N. A., Bachman, S. P., Griffiths-Lee, J., Lutz, M., Moat, J. F., Farjon, A., Donaldson, J. S., Hilton-Taylor, C., Meagher, T. R., Albuquerque, S., Aletrari, E., Andrews, A. K., Atchison, G., Baloch, E., Barlozzini, B., Brunazzi, A., Carretero, J., Celesti, M., Chadburn, H., Cianfoni, E., Cockel, C., Coldwell, V., Concetti, B., Contu, S., Crook, V., Dyson, P., Gardiner, L., Ghanim, N., Greene, H., Groom, A., Harker, R., Hopkins, D., Khela, S., Lakeman-Fraser, P., Lindon, H., Lockwood, H., Loftus, C., Lombrici, D., Lopez-Poveda, L., Lyon, J., Malcolm-Tompkins, P., McGregor, K., Moreno, L., Murray, L., Nazar, K., Power, E., Tuijtelaars, M. Q., Salter, R., Segrott, R., Thacker, H., Thomas, L. J., Tingvoll, S., Watkinson, G., Wojtaszekova, K., & Lughadha, E. M. N. (2015). Green plants in the red: A baseline global assessment for the IUCN Sampled Red List Index for Plants. *PLoS ONE*, *10*(8), 1–22. https://doi.org/10.1371/journal.pone.0135152

Bruner, A. G., Gullison, R. E., Rice, R. E., & da Fonseca, G. A. (2001). Effectiveness of parks in protecting tropical biodiversity. *Science (New York, N.Y.)*, *291*(5501), 125–128. https://doi.org/10.1126/science.291.5501.125

Brunig, E. F. (1965). A Guide and Introduction to the Vegetation of the Kerangas Forests and the Padangs of the Bako National Park. In R. Misra & B. Gopal (Eds.), *Proceedings of the symposium of recent advances in humid tropics vegetation, 1963* (p. 82). Kuching: UNESCO.

Bruno, J. F., & Selig, E. R. (2007). Regional decline of coral cover in the Indo-Pacific: Timing, extent, and subregional comparisons. *PLoS ONE*, *2*(8). https://doi.org/10.1371/journal.pone.0000711

Burbidge, A. A., Johnson, K. A., Fuller, P. J., Southgate, R. I., Burbidge, A. A., Johnson, K. A., Fuller, P. J., & Southgate, R. I. (1988). Aboriginal Knowledge of the Mammals of the Central Deserts of Australia. *Wildlife Research*, *15*(1), 9. https://doi.org/10.1071/WR9880009

Burke, L., Reytar, K., Spalding, M., & Perry, A. (2011). *Reefs at Risk Revisited Executive Summary*. *Reefs at Risk Revisited*. Washington, DC. https://doi.org/10.1016/0022-0981(79)90136-9

Burrows, N., Ward, B., & Robinson, A. (1991). Fire behavior in spinifex fuels on the Gibson desert nature-reserve, western-Australia. *Journal of Arid Environments*, *20*(2), 189–204.

Butchart, S. H. M., Scharlemann, J. P. W., Evans, M. I., Quader, S., Aricò, S., Arinaitwe, J., Balman, M., Bennun, L. A., Bertzky, B., Besançon, C., Boucher, T. M., Brooks, T. M., Burfield, I. J., Burgess, N. D., Chan, S., Clay, R. P., Crosby, M. J., Davidson, N. C., De Silva, N., Devenish, C., Dutson, G. C. L., Fernández, D. F. D. z, Fishpool, L. D. C., Fitzgerald, C., Foster, M., Heath, M. F., Hockings, M., Hoffmann, M., Knox, D., Larsen, F. W., Lamoreux, J. F., Loucks, C., May, I., Millett, J., Molloy, D., Morling, P., Parr, M., Ricketts, T. H., Seddon, N., Skolnik, B., Stuart, S. N., Upgren, A., & Woodley, S. (2012). Protecting Important Sites for Biodiversity Contributes to Meeting Global Conservation Targets. *PLoS ONE*, *7*(3), e32529. https://doi.org/10.1371/journal.pone.0032529

Butler, A. J., & Bax, N. J. (2014). Temperate marine ecosystems. In *Ten commitments revisited : securing Australia's future environment* (pp. 71–82). Collingwood, Australia: CSIRO Publishing. https://doi.org/10.1371/journal.pone.0011831

Butler, A. J., Rees, T., Beesley, P., & Bax, N. J. (2010). Marine biodiversity in the Australian region. *PLoS ONE*, *5*(8). https://doi.org/10.1371/journal.pone.0011831

Byers, J. E., Smith, R. S., Pringle, J. M., Clark, G. F., Gribben, P. E., Hewitt, C. L., Inglis, G. J., Johnston, E. L., Ruiz, G. M., Stachowicz, J. J., & Bishop, M. J. (2015). Invasion Expansion:

Time since introduction best predicts global ranges of marine invaders. *Scientific Reports*, *5*, 12436. https://doi.org/10.1038/srep12436

Byjesh, K., Kumar, S. N., & Aggarwal, P. K. (2010). Simulating impacts, potential adaptation and vulnerability of maize to climate change in India. *Mitn. Adaptn. Strat. Global Change*, *15*, 413–431.

Caldow, R. W. G., Beadman, H. A., McGrorty, S., Kaiser, M. J., Goss-Custard, J. D., Mould, K., & Wilson, A. (2003). Effects of intertidal mussel cultivation on bird assemblages. *Marine Ecology Progress Series*, *259*, 173–183. https://doi.org/10.3354/meps259173

Caley, P., Heersink, D. K., Barry, S., & DeBarro, P. (2016). Inferring rates of pest and pathogen incursion into Australia. In *Forum Math-for-Industry November 21-23, 2016*. Brisbane, Australia: Queensland University of Technology.

Campbell, D., Stafford Smith, M., Davies, J., Kuipers, P., Wakerman, J., & McGregor, M. J. (2008). Responding to health impacts of climate change in the Australian desert. *Rural and Remote Health*, *8*, 1008. Retrieved from http://www.rrh.org.au/articles/subviewnew.asp?ArticleID=1008

Campbell, F. (2010). Erythrina gall wasp: Quadrastictus erythrinae. Retrieved March 26, 2018, from https://www.dontmovefirewood.org/pest_pathogen/erythrina-gall-wasp-html/

Campbell, M. L., Gould, B., & Hewitt, C. L. (2007). Survey evaluations to assess marine bioinvasions. *Marine Pollution Bulletin*, *55*(7–9), 360–378. https://doi.org/10.1016/j.marpolbul.2007.01.015

Cao, H., Zhao, X., Wang, S., Zhao, L., Duan, J., Zhang, Z., Ge, S., & Zhu, X. (2015). Grazing intensifies degradation of a Tibetan Plateau alpine meadow through plant-pest interaction. *Ecology and Evolution*, *5*(12), 2478–2486. https://doi.org/10.1002/ece3.1537

Cardinale, B. J., Duffy, J. E., Gonzalez, A., Hooper, D. U., Perrings, C., Venail, P., Narwani, A., Mace, G. M., Tilman, D., Wardle, D. A., Kinzig, A. P., Daily, G. C., Loreau, M., Grace, J. B., Larigauderie, A., Srivastava, D. S., & Naeem, S. (2012). Biodiversity loss and its impact on humanity. *Nature*, *489*(7415), 326–326. https://doi.org/10.1038/nature11373

Cardoso, P., Erwin, T. L., Borges, P. A. V., & New, T. R. (2011). The seven impediments in invertebrate conservation and how to overcome them. *Biological Conservation*, *144*(11), 2647–2655. https://doi.org/10.1016/j.biocon.2011.07.024

Carnegie, A. J., Kathuria, A., Pegg, G. S., Entwistle, P., Nagel, M., & Giblin, F. R. (2016). Impact of the invasive rust Puccinia psidii (myrtle rust) on native Myrtaceae in natural ecosystems in Australia. *Biological Invasions*, *18*(1), 127–144. https://doi.org/10.1007/s10530-015-0996-y

Carrizo, S. (2016). Global Freshwater Turtle Species Richness. Retrieved from atlas.freshwaterbiodiversity.eu

Caughlin, T. T., Ganesh, T., & Lowman, M. D. (2012). Sacred fig trees promote frugivore visitation and tree seedling abundance in South India. *Current Science*, *102*(6), 918–922.

CGAPS. (1996). The Silent Invasion. Honolulu: Coordinating Group on Alien Pest Species.

Chambers, P. A., Lacoul, P., Murphy, K. J., & Thomaz, S. M. (2008). Global diversity of aquatic macrophytes in freshwater. *Hydrobiologia*, *595*(1), 9–26. https://doi.org/10.1007/s10750-007-9154-6

Chander, M. P., Kartick, C., Gangadhar, J., & Vijayachari, P. (2014). Ethno medicine and healthcare practices among Nicobarese of Car Nicobar - An indigenous tribe of Andaman and Nicobar Islands. *Journal of Ethnopharmacology*, *158*(PART A), 18–24. https://doi.org/10.1016/j.jep.2014.09.046

Chang, H. Y., & Lee, Y. F. (2016). Effects of area size, heterogeneity, isolation, and disturbances on urban park avifauna in a highly populated tropical city. *Urban Ecosystems*, *19*(1), 257–274. https://doi.org/10.1007/s11252-015-0481-5

Chapman, A. D. (2009). Numbers of Living Species in Australia and the World. https://doi.org/10.1177/135

Chatterjee, A., Blom, E., Gujja, B., Jacimovic, R., Beevers, L., O'Keeffe, J., Beland, M., & Biggs, T. (2010). WWF Initiatives to Study the Impact of Climate Change on Himalayan High-altitude Wetlands (HAWs). *Mountain Research and Development*, *30*(1), 42–52. https://doi.org/10.1659/MRD-JOURNAL-D-09-00091.1

Chavan, S. B., Keerthika, A., Dhyani, S. K., Handa, A. K., Newaj, R., & Rajarajan, K. (2015). National Agroforestry Policy in India: A low hanging fruit. *Current Science*, *108*(10), 1826–1834.
Chen, J., & Ng, S. (2009). Regulating the Humphead Wrasse (*Cheilinus undulatus*) Trade in Sabah, Malaysia. *AMBIO: A Journal of the Human Environment*, *38*(2), 123–125. https://doi.org/10.1579/0044-7447-38.2.122
Cheng, F., Li, W., Castello, L., Murphy, B. R., & Xie, S. (2015). Potential effects of dam cascade on fish: lessons from the Yangtze River. *Reviews in Fish Biology and Fisheries*, *25*(3), 569–585. https://doi.org/10.1007/s11160-015-9395-9
Chin, A., Lison De Loma, T., Reytar, K., Planes, S., Gerhardt, K., Clua, E., Burke, L., Wilkinson, C., Adams, T., Berger, M., Clark, T., Depaune, M., Fenner, D., Goldberg, J., Golbuu, Y., Halstead, B., Henry, M., Morris, C., Pascal, N., Passfield, K., & Sykes, H. (2011). *Status of Coral reefs of the Pacific and Outlook: 2011*.
Chisholm, R. A., Wijedasa, L. S., & Swinfield, T. (2016). The need for long-term remedies for Indonesia's forest fires. *Conservation Biology*, *30*(1), 5–6. https://doi.org/10.1111/cobi.12662
Clark, C. M., Cleland, E. E., Collins, S. L., Fargione, J. E., Gough, L., Gross, K. L., Pennings, S. C., Suding, K. N., & Grace, J. B. (2007). Environmental and plant community determinants of species loss following nitrogen enrichment. *Ecology Letters*, *10*(7), 596–607. https://doi.org/10.1111/j.1461-0248.2007.01053.x
Clark, M. R., Rowden, A. A., Schlacher, T., Williams, A., Consalvey, M., Stocks, K. I., Rogers, A. D., O'Hara, T. D., White, M., Shank, T. M., & Hall-Spencer, J. M. (2010). The ecology of seamounts: Structure, function, and human impacts. *Annual Review of Marine Science*, *2*(1), 253–278. https://doi.org/10.1146/annurev-marine-120308-081109
Clements, R., Sodhi, N. S., & Schilthuizen, M. (2006). Limestone Karsts of Southeast Asia : Imperiled Arks of Biodiversity. *BioScience*, *56*(9), 733–742. https://doi.org/10.1641/0006-3568(2006)56[733:LKOSAI]2.0.CO;2
Clewing, C., Albrecht, C., & Wilke, T. (2016). A complex system of glacial sub-refugia drives endemic freshwater biodiversity on the Tibetan Plateau. *PLoS ONE*, *11*(8), e0160286. https://doi.org/10.1371/journal.pone.0160286
Closs, G. P., Krkosek, M., & Olden, J. D. (Eds.). (2016). *Conservation of Freshwater Fishes*. *Cambridge University Press*. https://doi.org/10.1007/s10531-008-9396-2
Coad, B. W. (2006). Endemicity in the Freshwater Fishes of Iran. *Iranian Journal of Animal Biosystematics (IJAB)*, *1*(1), 1–13.
Coles, R., McKenzie, L., & Campbell, S. (2003). The seagrasses of eastern Australia. In P. Green, E & T. Short, F (Eds.), *World atlas of seagrasses* (pp. 119–133). Berkeley, California.: University of California Press.
Collins, P. C., Kennedy, R., & Van Dover, C. L. (2012). A biological survey method applied to seafloor massive sulphides (SMS) with contagiously distributed hydrothermal-vent fauna. *Marine Ecology Progress Series*. Inter-Research Science Center. https://doi.org/10.2307/24875944
Corlett, R. T. (2014). *The Ecology of Tropical East Asia* (2nd ed.). Oxford University Press. https://doi.org/10.1093/acprof:oso/9780199681341.001.0001
Corlett, R. T., & Primack, R. B. (2011). *Tropical Rain Forests: An Ecological and Biogeographical Comparison, 2nd Edition*. Oxford, UK.: Wiley-Blackwell.
Costin, A. B., Gray, M., Totterdell, C. J., & Wimbush, D. J. (2000). *Kosciuszko Alpine Flora*. CSIRO publishing. Retrieved from http://www.publish.csiro.au/book/2540/
Côté, I. M., Gill, J. A., Gardner, T. A., & Watkinson, A. R. (2005). Measuring coral reef decline through meta-analyses. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences*, *360*(February), 385–395. https://doi.org/10.1098/rstb.2004.1591
Courchamp, F., Hoffmann, B. D., Russell, J. C., Leclerc, C., & Bellard, C. (2014). Climate change, sea-level rise, and conservation: Keeping island biodiversity afloat. *Trends in Ecology and Evolution*, *29*(3), 127–130. https://doi.org/10.1016/j.tree.2014.01.001
Cramer, V. A., Dziminski, M. A., Southgate, R., Carpenter, F. M., Ellis, R. J., & van Leeuwen, S. (2016). A conceptual framework for habitat use and research priorities for the greater bilby

(Macrotis lagotis) in the north of Western Australia. *Australian Mammalogy*, *20*(10), 271–305. https://doi.org/10.1071/AM16009

Cramer, V. A., Hobbs, R. J., & Standish, R. J. (2008). What's new about old fields? Land abandonment and ecosystem assembly. *Trends in Ecology and Evolution*, *23*(2), 104–112. https://doi.org/10.1016/j.tree.2007.10.005

Cresswell, I. D., & Murphy, H. (2017). *Australia State of the Environment 2016: BiodiAustralia state of the environment 2016: biodiversity, independent report to the Australian Government Minister for the Environment and Energy*. Canberra, Australia. Retrieved from https://soe.environment.gov.au/theme/biodiversity/topic/2016/freshwater-species-and-ecosystems, DOI 10.4226/94/58b65ac828812

Dahanukar, N., Raut, R., & Bhat, A. (2004). Distribution, Endemism and Threat Status of Freshwater Fishes in the Western Ghats of India. *Journal of Biogeography*, *31*(1), 123–136. https://doi.org/10.1046/j.0305-0270.2003.01016.x

Darwall, W. R. T., & Freyhof, J. (2015). Lost fishes, who is counting? The extent of the threat to freshwater fish biodiversity. *Conservation of Freshwater Fishes*, 1. https://doi.org/10.1017/CBO9781139627085

Davidson, N. C. (2014). How much wetland has the world lost? Long-term and recent trends in global wetland area. *Marine and Freshwater Research*, *65*(10), 934–941. https://doi.org/10.1071/MF14173

Davis, J., Froend, R., Hamilton, D., Horwitz, P., McComb, A., & Oldham, C. (2001). *Environmental Water Requirements to Maintain Wetlands of National and International Importance, Environmental Flows Initiative Technical Report No. 1*. Commonwealth of Australia, Canberra.

Davison, G. W. H., Kiew, R., Jaffar, W. A. L. W., Tan, Y., & Loh, H. (1991). *A conservation assessment of limestone hills in the Kinta Valley - Final Report MNS Project 1/90*.

De'ath, G., Fabricius, K. E., Sweatman, H., & Puotinen, M. (2012). The 27-year decline of coral cover on the Great Barrier Reef and its causes. *Proceedings of the National Academy of Sciences of the United States of America*, *109*(44), 17995–17999. https://doi.org/10.1073/pnas.1208909109

De'ath, G., Lough, J. M., & Fabricius, K. E. (2009). Declining coral calcification on the Great Barrier Reef. *Science (New York, N.Y.)*, *323*(5910), 116–119. https://doi.org/10.1126/science.1165283

de Foresta, H., Somarriba, E., Temu, A., Boulanger, D., Feuilly, H., & Gauthier, M. (2013). *Towards the Assessment of Trees Outside Forests*. *FAO Resources Assessment Working Paper* (Vol. 183). Rome, Italy.

de Forges, B. R., Koslow, J. A., & Poore, G. C. (2000). Diversity and endemism of the benthic seamount fauna in the southwest Pacific. *Nature*, *405*(June), 944–947. https://doi.org/10.1038/35016066

De Grave, S., Smith, K. G., Adeler, N. A., Allen, D. J., Alvarez, F., Anker, A., Cai, Y., Carrizo, S. F., Klotz, W., Mantelatto, F. L., Page, T. J., Shy, J.-Y., Villalobos, J. L., & Wowor, D. (2015). Dead Shrimp Blues: A Global Assessment of Extinction Risk in Freshwater Shrimps (Crustacea: Decapoda: Caridea). *PLOS ONE*, *10*(3), e0120198. https://doi.org/10.1371/journal.pone.0120198

De Santo, E. M., Jones, P. J. S., & Miller, A. M. M. (2011). Fortress conservation at sea: A commentary on the Chagos marine protected area. *Marine Policy*, *35*(2), 258–260. https://doi.org/10.1016/J.MARPOL.2010.09.004

De Silva, S. S., Abery, N. W., & Nguyen, T. T. T. (2007). Endemic freshwater finfish of Asia: Distribution and conservation status: Biodiversity research. *Diversity and Distributions*, *13*(2), 172–184. https://doi.org/10.1111/j.1472-4642.2006.00311.x

Department of the Environment. (2015). *Threat abatement plan for predation by feral cats*. Canberra. Retrieved from http://www.environment.gov.au/system/files/resources/78f3dea5-c278-4273-8923-fa0de27aacfb/files/tap-predation-feral-cats-2015.pdf

Department of the Environment and Energy. (n.d.). Species Profile and Threats Database. Retrieved from http://www.environment.gov.au/cgi-bin/sprat/public/publicthreatenedlist.pl

Department of the Environment and Energy. (2016). Australia State of the Environment 2016. Retrieved from https://soe.environment.gov.au/

Devendra, C. (2012). *Climate Change Threats and Effects: Challenges for Agriculture and Food Security*. Retrieved from https://www.agrilinks.org/sites/default/files/resource/files/climate_change_threats_effects_strategies.pdf

Devendra, C., & Thomas, D. (2002). Crop–animal interactions in mixed farming systems in Asia. *Agricultural Systems*, *71*(1–2), 27–40. https://doi.org/10.1016/S0308-521X(01)00034-8

Dexter, K. G., Smart, B., Baldauf, C., Baker, T. R., Balinga, M. P. B., Brienen, R. J. W., Fauset, S., Feldpausch, T. R., Silva, L. F.-D., Muledi, J. I., Lewis, S. L., Lopez-Gonzalez, G., Marimon-Junior, B. H., Marimon, B. S., Meerts, P., Page, N., Parthasarathy, N., Phillips, O. L., Sunderland, T. C. H., Theilade, I., Weintritt, J., Affum-Baffoe, K., Araujo, A., Arroyo, L., Begne, S. K., Neves, E. C.-D., Collins, M., Cuni-Sanchez, A., Djuikouo, M. N. K., Elias, F., Foli, E. G., Jeffery, K. J., Killeen, T. J., Malhi, Y., Maracahipes, L., Mendoza, C., Monteagudo-Mendoza, A., Morandi, P., Santos, C. O.-D., Parada, A. G., Pardo, G., Peh, K. S.-H., Salomão, R. P., Silveira, M., Sinatora–Miranda, H., Slik, J. W. F., Sonke, B., Taedoumg, H. E., Toledo, M., Umetsu, R. K., Villaroel, R. G., Vos, V. A., White, L. J. T., & Pennington, R. T. (2015). Floristics and biogeography of vegetation in seasonally dry tropical regions. *International Forestry Review*, *17*(2), 10–32. https://doi.org/10.1505/146554815815834859

Díaz, S., Demissew, S., Carabias, J., Joly, C., Lonsdale, M., Ash, N., Larigauderie, A., Adhikari, J. R., Arico, S., B??ldi, A., Bartuska, A., Baste, I. A., Bilgin, A., Brondizio, E., Chan, K. M. A., Figueroa, V. E., Duraiappah, A., Fischer, M., Hill, R., Koetz, T., Leadley, P., Lyver, P., Mace, G. M., Martin-Lopez, B., Okumura, M., Pacheco, D., Pascual, U., P??rez, E. S., Reyers, B., Roth, E., Saito, O., Scholes, R. J., Sharma, N., Tallis, H., Thaman, R. R., Watson, R., Yahara, T., Hamid, Z. A., Akosim, C., Al-Hafedh, Y., Allahverdiyev, R., Amankwah, E., Asah, T. S., Asfaw, Z., Bartus, G., Brooks, A. L., Caillaux, J., Dalle, G., Darnaedi, D., Driver, A., Erpul, G., Escobar-Eyzaguirre, P., Failler, P., Fouda, A. M. M., Fu, B., Gundimeda, H., Hashimoto, S., Homer, F., Lavorel, S., Lichtenstein, G., Mala, W. A., Mandivenyi, W., Matczak, P., Mbizvo, C., Mehrdadi, M., Metzger, J. P., Mikissa, J. B., Moller, H., Mooney, H. A., Mumby, P., Nagendra, H., Nesshover, C., Oteng-Yeboah, A. A., Pataki, G., Rou??, M., Rubis, J., Schultz, M., Smith, P., Sumaila, R., Takeuchi, K., Thomas, S., Verma, M., Yeo-Chang, Y., & Zlatanova, D. (2015). The IPBES Conceptual Framework - connecting nature and people. *Current Opinion in Environmental Sustainability*, *14*, 1–16. https://doi.org/10.1016/j.cosust.2014.11.002

Diesmos, A. C., Alcala, A. C., Siler, C. D., & Brown, R. M. (2014). Status and conservation of Philippine Amphibians. In H. Heatwole & I. Das (Eds.), *Conservation Biology of Amphibians of Asia*. Borneo, Indonesia: Natural History Publications.

Diesmos, A. C., Watters, J. L., Huron, N. A., Davis, D. R., Alcala, A. C., Crombie, R. I., Afuang, L. E., Gee-Das, G., Sison, R. V., Sanguila, M. B., Penrod, M. L., Labonte, M. J., Davey, C. S., Leone, E. A., Diesmos, M. L., Sy, E. Y., Welton, L. J., Brown, R. M., & Siler, C. D. (2015). Amphibians of the Philippines, Part I: Checklist of the Species. In *the California Academy of Sciences, Series 4. 62(3)* (pp. 457–539).

Dinda, S. (2004). Environmental Kuznets Curve hypothesis: A survey. *Ecological Economics*, *49*(4), 431–455. https://doi.org/10.1016/j.ecolecon.2004.02.011

Dinesh, K. P., Radhakrishnan, C., Channakeshavamurthy, B. H., Deepak, P., & Kulkarni, N. U. (2017). *Checklist of Amphibia of India*. Retrieved from http://mhadeiresearchcenter.org/resources

Dislich, C., Keyel, A. C., Salecker, J., Kisel, Y., Meyer, K. M., Auliya, M., Barnes, A. D., Corre, M. D., Darras, K., Faust, H., Hess, B., Klasen, S., Knohl, A., Kreft, H., Meijide, A., Nurdiansyah, F., Otten, F., Pe'er, G., Steinebach, S., Tarigan, S., Tölle, M. H., Tscharntke, T., & Wiegand, K. (2017). A review of the ecosystem functions in oil palm plantations, using forests as a reference system. *Biological Reviews*, *92*(3), 1539–1569. https://doi.org/10.1111/brv.12295

Dittmann, S. (1990). Mussel beds—amensalism or amelioration for intertidal fauna? *Helgoländer Meeresuntersuchungen*, *352*(3), 335–352. Retrieved from http://link.springer.com/article/10.1007/BF02365471

Dixon, A. P., Faber-Langendoen, D., Josse, C., Morrison, J., & Loucks, C. J. (2014). Distribution mapping of world grassland types. *Journal of Biogeography*, *41*(11), 2003–2019. https://doi.org/10.1111/jbi.12381

Dodd, A. J., Burgman, M. A., McCarthy, M. A., & Ainsworth, N. (2015). The changing patterns of plant naturalization in Australia. *Diversity and Distributions*, *21*(9), 1038–1050. https://doi.org/10.1111/ddi.12351
Drake, N. (2015). Scramble to save Borneo's orangutans. *Nature*, 2015.
Drew, W. M., Ewel, K. C., Naylor, R. L., & Sigrah, A. (2005). A tropical freshwater wetland: III. Direct use values and other goods and services. *Wetlands Ecology and Management*, *13*(6), 685–693. https://doi.org/10.1007/s11273-005-0966-8
Dudgeon, D. (2000). The Ecology of Tropical Asian Rivers and Streams in Relation to Biodiversity Conservation. *Annual Review of Ecology and Systematics*, *31*(1), 239–263. https://doi.org/10.1146/annurev.ecolsys.31.1.239
Dudgeon, D., Arthington, A. H., Gessner, M. O., Kawabata, Z.-I., Knowler, D. J., Lévêque, C., Naiman, R. J., Prieur-Richard, A.-H., Soto, D., Stiassny, M. L. J., & Sullivan, C. A. (2006). Freshwater biodiversity: importance, threats, status and conservation challenges. *Biological Reviews of the Cambridge Philosophical Society*, *81*(2), 163–182. https://doi.org/10.1017/S1464793105006950
Dudley, N., Bhagwat, S., Higgins-zogib, L., Lassen, B., Verschuuren, B., & Wild, R. (2010). Conservation of biodiversity in sacred natural sites in Asia and Africa : A review of the scientific literature. *Sacred Natural Sites: Conserving Nature and Culture*, *6*(April 2017), 19–32. https://doi.org/10.4324/9781849776639
Duke, N. C., Kovacs, J. M., Griffiths, A. D., Preece, L., Hill, D. J. E., van Oosterzee, P., Mackenzie, J., Morning, H. S., & Burrows, D. (2017). Large-scale dieback of mangroves in Australia. *Marine and Freshwater Research*, *68*(10), 1816. https://doi.org/10.1071/MF16322
Dutta, S., Rahmani, A., Gautam, P., Kasambe, R., Narwade, S., Narayan, G., & Jhala, Y. (2013). *Guidelines for State Action Plan for Resident Bustards' Recovery Programme*. New Delhi.
Dutta, S., Rahmani, A. R., & Jhala, Y. V. (2011). Running out of time? The great Indian bustard Ardeotis nigriceps—status, viability, and conservation strategies. *European Journal of Wildlife Research*, *57*(3), 615–625. https://doi.org/10.1007/s10344-010-0472-z
Edgell, H. S. (2006). *Arabian Deserts*. Dordrecht: Springer Netherlands. https://doi.org/10.1007/1-4020-3970-0
Edwards, D. P., Magrach, A., Woodcock, P., Ji, Y., Lim, N. T. L., Edwards, F. A., Larsen, T. H., Hsu, W. W., Benedick, S., Khen, C. V., Chung, A. Y. C., Reynolds, G., Fisher, B., Laurance, W. F., Wilcove, D. S., Hamer, K. C., & Yu, D. W. (2014). Selective-logging and oil palm: Multitaxon impacts, biodiversity indicators, and trade-offs for conservation planning. *Ecological Applications*, *24*(8), 2029–2049. https://doi.org/10.1038/nature11318
El-Juhany, L. I. (2010). Degradation of Date Palm Trees and Date Production in Arab Countries: Causes and Potential Rehabilitation. *Australian Journal of Basic and Applied Sciences*, *4*(8), 3998–4010.
El-Showk, S. (2016). How a flow of people affects the flow of water. *Nature Middle East*. https://doi.org/10.1038/nmiddleeast.2016.221
Ellison, J. C. (2009). Wetlands of the pacific island region. *Wetlands Ecology and Management*, *17*(3), 169–206. https://doi.org/10.1007/s11273-008-9097-3
Elston, E., Anderson-Lederer, R., Death, R. G., & Joy, M. K. (2015). The Plight of New Zealand ' s Freshwater Biodiversity, (1), 1–14.
Ens, E. J., Daniels, C., Nelson, E., Roy, J., & Dixon, P. (2016). Creating multi-functional landscapes: Using exclusion fences to frame feral ungulate management preferences in remote Aboriginal-owned northern Australia. *Biological Conservation*. https://doi.org/10.1016/j.biocon.2016.03.007
Ens, E. J., Pert, P., Clarke, P. A., Budden, M., Clubb, L., Doran, B., Douras, C., Gaikwad, J., Gott, B., Leonard, S., Locke, J., Packer, J., Turpin, G., & Wason, S. (2015). Indigenous biocultural knowledge in ecosystem science and management: Review and insight from Australia. *Biological Conservation*, *181*, 133–149. https://doi.org/10.1016/J.BIOCON.2014.11.008
Environmental Protection Authority. (2008). *State of the environment report : Western Australia : 2007*. Perth : Dept. of Environment and Conservation. Retrieved from https://web.archive.org/web/20080307200421/http://www.soe.wa.gov.au

Eswaran, H., Lal, R., & Reich, P. F. (2001). Land degradation: An overview. In M. Bridges, E, D. Hannam, I, R. Oldeman, L, T. Pening de Vries, F, W, J. Scherr, S, & S. Sompatpanit (Eds.), *Responses to Land Degradation*. New Delhi, India: Oxford Press. Retrieved from http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/use/?cid=nrcs142p2_054028

Ewers, R. M., Boyle, M. J. W., Gleave, R. a, Plowman, N. S., Benedick, S., Bernard, H., Bishop, T. R., Bakhtiar, E. Y., Chey, V. K., Chung, A. Y. C., Davies, R. G., Edwards, D. P., Eggleton, P., Fayle, T. M., Hardwick, S. R., Homathevi, R., Kitching, R. L., Khoo, M. S., Luke, S. H., March, J. J., Nilus, R., Pfeifer, M., Rao, S. V., Sharp, A. C., Snaddon, J. L., Stork, N. E., Struebig, M. J., Wearn, O. R., Yusah, K. M., & Turner, E. C. (2015). Logging cuts the functional importance of invertebrates in tropical rainforest. *Nature Communications*, *6*(April 2016), 6836. https://doi.org/10.1038/ncomms7836

Ezard, T. H. G., & Travis, J. M. J. (2006). The impact of habitat loss and fragmentation on genetic drift and fixation time. *Oikos*, *114*(2), 367–375. https://doi.org/10.1111/j.2006.0030-1299.14778.x

Ezcurra, E. (2006). *Global deserts outlook*. UNEP/Earthprint. https://doi.org/10.1016/j.envsci.2003.12.005

Faith, D. P. (1992). Conservation evaluation and phylogenetic diversity. *Biological Conservation*, *61*(1), 1–10. https://doi.org/10.1016/0006-3207(92)91201-3

Fang, J., Wang, Z., Zhao, S., Li, Y., Tang, Z., Yu, D., Ni, L., Liu, H., Xie, P., Da, L., Li, Z., & Zheng, C. (2006). Biodiversity changes in the lakes of the Central Yangtze. *Frontiers in Ecology and the Environment*, *4*(7), 369–377. https://doi.org/10.1890/1540-9295(2006)004[0369:BCITLO]2.0.CO;2

FAO. (2007). *The world's mangroves 1980–2005: a thematic study prepared in the framework of the Global Forest Resource Assessment 2005*. *FAO Forestry Paper 153*. Rome, Italy.

FAO. (2009). FAOSTAT data. Retrieved from http://faostat3.fao.org/home/E

FAO. (2014). *Assessing and promoting trees outside forests (TOF) in Asian rice production landscapes*. Rome.

FAO. (2015a). FAO-STAT data base. Retrieved from http://faostat3.fao.org/browse/R/RL/E

FAO. (2015b). FAO - Fisheries and Aquaculture Information and Statistics Branch. http://www.fao.org/fishery/statistics/global-aquaculture-production/query/en. Retrieved November 4, 2015, from http://www.fao.org/fishery/statistics/en

FAO. (2015c). *Global Forest Resources Assessment 2015* (Vol. 2005). Retrieved from http://www.fao.org/forestry/fra2005/en/

Fasi, J., Brodie, G., & Vanderwoude, C. (2013). Increases in crop pests caused by Wasmannia auropunctata in Solomon Islands subsistence gardens. *Journal of Applied Entomology*, *137*(8), 580–588. https://doi.org/10.1111/jen.12033

Fensham, R. J., Silcock, J. L., & Firn, A. J. (2014). Managed livestock grazing is compatible with the maintenance of plant diversity in semidesert grasslands. *Ecological Applications*, *24*(3), 503–517.

Fernández-Giménez, M. E., Venable, N. H., Angerer, J., Fassnacht, S. R., Reid, R. S., & Jamyansharav, K. (2017). Exploring Linked Ecological and Cultural Tipping Points in Mongolia. *Anthropocene*. https://doi.org/10.1016/j.ancene.2017.01.003

Fitzherbert, E. B., Struebig, M. J., Morel, A., Danielsen, F., Brühl, C. A., Donald, P. F., & Phalan, B. (2008). How will oil palm expansion affect biodiversity? *Trends in Ecology & Evolution*, *23*(10), 538–545. https://doi.org/10.1016/J.TREE.2008.06.012

Fleming, P. A., Anderson, H., Prendergast, A. S., Bretz, M. R., Valentine, L. E., & Hardy, G. E. S. J. (2014). Is the loss of Australian digging mammals contributing to a deterioration in ecosystem function? *Mammal Review*, *44*(2), 94–108. https://doi.org/10.1111/mam.12014

Fortes, M. D. (2012). Historical review of seagrass research in the Philippines - Section II. Historical review of coastal research in Southeast Asia. In *Proceedings of the Horiba International Conference. Coastal Marine Science* (pp. 178–181).

FRA Japan. (2009). Guideline to protect algal bed resource. Retrieved from http://www.jfa.maff.go.jp/j/gyoko_gyozyo/g_hourei/pdf/sub7941.pdf

Frank, A. S. K., Johnson, C. N., Potts, J. M., Fisher, A., Lawes, M. J., Woinarski, J. C. Z., Tuft, K., Radford, I. J., Gordon, I. J., Collis, M. A., & Legge, S. (2014). Experimental evidence that feral cats cause local extirpation of small mammals in Australia's tropical savannas. *Journal of Applied Ecology*. https://doi.org/10.1111/1365-2664.12323

Freitag, H., Jäch, M. A., & Wewalka, G. (2016). Diversity of aquatic and riparian Coleoptera of the Philippines: checklist, state of knowledge, priorities for future research and conservation. *Aquatic Insects*, 1–37. https://doi.org/10.1080/01650424.2016.1210814

Froese, R., & Pauly, D. (2014). FishBase version 06/2014. Retrieved from www.fishbase.org

Froese, R., & Pauly, D. (2017). Fishbase. World Wide Web Electronic Publication. Ver. (2/2017). Retrieved from www.fishbase.org

Fu, B. J., Wu, B. F., Lü, Y. H., Xu, Z. H., Cao, J. H., Niu, D., Yang, G. S., & Zhou, Y. M. (2010). Three Gorges Project: Efforts and challenges for the environment. *Progress in Physical Geography*, *34*(6), 741–754. https://doi.org/10.1177/0309133310370286

Fujikura, K., Lindsay, D., Kitazato, H., Nishida, S., & Shirayama, Y. (2010). Marine biodiversity in Japanese waters. *PLoS ONE*, *5*(8). https://doi.org/10.1371/journal.pone.0011836

Fujita, H. (2007). Outline of Mires in Hokkaido , Japan , and Their Ecosystem Conservation and Restoration. *Global Enviromental Research*, *11*(1961), 187–194.

Fukamachi, K., Oku, H., & Nakashizuka, T. (2001). The change of a satoyama landscape and its causality in Kamiseya, Kyoto Prefecture, Japan between 1970 and 1995. *Landscape Ecology*, *16*(8), 703–717. https://doi.org/10.1023/A:1014464909698

Funge-Smith, S., Briggs, M., & Miao, W. (2012). *Regional overview of fisheries and aquaculture in Asia and the Pacific 2012* (RAP Publication 2012/26). *RAP publication*. Bangkok, Thailand. Retrieved from http://www.fao.org/documents/card/en/c/951b0503-aece-5bdf-a4fa-500b868b55a1/

Furukawa, T., Kayo, C., Kadoya, T., Kastner, T., Hondo, H., Matsuda, H., & Kaneko, N. (2015). Forest harvest index: accounting for global gross forest cover loss of wood production and an application of trade analysis. *Global Ecology and Conservation*, *4*(November), 150–159. https://doi.org/10.1016/j.gecco.2015.06.011

Galey, M. L., van der Ent, A., Iqbal, M. C. M., & Rajakaruna, N. (2017). Ultramafic geoecology of South and Southeast Asia. *Botanical Studies*, *58*(1), 18. https://doi.org/10.1186/s40529-017-0167-9

Gao, H., Ouyang, Z., Chen, S., & van Koppen, C. S. A. (2013). Role of culturally protected forests in biodiversity conservation in Southeast China. *Biodiversity and Conservation*, *22*(2), 531–544. https://doi.org/10.1007/s10531-012-0427-7

Garbach, K., Milder, J. C., Montenegro, M., Karp, D. S., & DeClerck, F. A. J. (2014). Biodiversity and Ecosystem Services in Agroecosystems. *Encyclopedia of Agriculture and Food Systems*, *2*, 21–40. https://doi.org/10.1016/B978-0-444-52512-3.00013-9

García, N., Harrison, I., Cox, N., & Tognelli, M. F. (2015). *The Status and Distribution of Freshwater Biodiversity in the Arabian Peninsula*. Cambridge, UK and Gland, Switzerland: IUCN, and Coimbatore, India: Zoo Outreach Organisation. Retrieved from https://portals.iucn.org/library/sites/library/files/documents/RL-53-003.pdf#page=32

Gardner, A., & Howarth, B. (2009). Urbanisation in the United Arab Emirates: The challenges for ecological mitigation in a rapidly developing country. *BioRisk*, *3*, 27–38. https://doi.org/10.3897/biorisk.3.18

Garnett, S., Sayer, J., & Toit, J. T. Du. (2007). Improving the effectiveness of interventions to balance conservation and development: a conceptual framework. *Ecology and Society*, *12*(1), 2. Retrieved from https://works.bepress.com/johan%7B_%7Ddutoit/18/

Gatus, J. (2010). Hydrophis semperi. https://doi.org/http://dx.doi.org/10.2305/IUCN.UK.2010-4.RLTS.T176747A7296443.en

Ge, Y. J., Liu, Y. J., Shen, A. H., & Lin, X. C. (2015). Fengshui forests conserve genetic diversity: A case study of Phoebe bournei (Hemsl.) Yang in southern China. *Genetics and Molecular Research*, *14*(1), 1986–1993. https://doi.org/10.4238/2015.March.20.8

George, S. J., Harper, R. J., Hobbs, R. J., & Tibbett, M. (2012). A sustainable agricultural landscape for Australia: A review of interlacing carbon sequestration, biodiversity and salinity management in agroforestry systems. *Agriculture, Ecosystems and Environment*, *163*, 28–36. https://doi.org/10.1016/j.agee.2012.06.022

Geospatial Information Authority of Japan. (2000). Changes in wetland area of Japan. Retrieved May 8, 2018, from http://www.gsi.go.jp/kankyochiri/shicchimenseki2.html

German, C. R., Ramirez-Llodra, E., Baker, M. C., & Tyler, P. A. (2011). Deep-water chemosynthetic ecosystem research during the census of marine life decade and beyond: A proposed deep-ocean road map. *PLoS ONE*, *6*(8). https://doi.org/10.1371/journal.pone.0023259

Giam, X., Hadiaty, R. K., Tan, H. H., Parenti, L. R., Wowor, D., Sauri, S., Chong, K. Y., Yeo, D. C. J., & Wilcove, D. S. (2015). Mitigating the impact of oil-palm monoculture on freshwater fishes in Southeast Asia. *Conservation Biology*, *29*(5), 1357–1367. https://doi.org/10.1111/cobi.12483

Giam, X., Koh, L. P., Tan, H. H., Miettinen, J., Tan, H. T. W., & Ng, P. K. L. (2012). Global extinctions of freshwater fishes follow peatland conversion in Sundaland. *Frontiers in Ecology and the Environment*, *10*(9), 465–470. https://doi.org/10.1890/110182

Giam, X., Ng, T. H., Lok, A. F. S. L., & Ng, H. H. (2011). Local geographic range predicts freshwater fish extinctions in Singapore. *Journal of Applied Ecology*, *48*(2), 356–363. https://doi.org/10.1111/j.1365-2664.2010.01953.x

Gibert, J., & Deharveng, L. (2002). Subterranean Ecosystems: A Truncated Functional Biodiversity. *BioScience*, *52*(6), 473–481. https://doi.org/10.1641/0006-3568(2002)052[0473:SEATFB]2.0.CO;2

Gibson, J., Boe-Gibson, G., & Stichbury, G. (2015). Urban land expansion in India 1992-2012. *Food Policy*, *56*, 100–113. https://doi.org/10.1016/j.foodpol.2015.08.002

Giese, M., Brueck, H., Gao, Y. Z., Lin, S., Steffens, M., Kögel-Knabner, I., Glindemann, T., Susenbeth, A., Taube, F., Butterbach-Bahl, K., Zheng, X. H., Hoffmann, C., Bai, Y. F., & Han, X. G. (2013). N balance and cycling of Inner Mongolia typical steppe: A comprehensive case study of grazing effects. *Ecological Monographs*, *83*(2), 195–219. https://doi.org/10.1890/12-0114.1

Giesen, W., & Wulffraat, S. (1998). Indonesian mangroves part I: Plant diversity and vegetation. *Tropical Biodiversity*, *5(2)*(2), 11–23.

Giesen, W., Wulffraat, S., Zieren, M., & Scholten, L. (2007). *Mangrove Guidebook for Southeast Asia*. *Mangrove guidebook for Southeast Asia*. Bangkok, Thailand: Food and Agriculture Organization of the United Nations, Regional Office for Asia and the Pacific. https://doi.org/10.1086/346169

Girardi, C., Butaud, J. F., Ollier, C., Ingert, N., Weniger, B., Raharivelomanana, P., & Moretti, C. (2015). Herbal medicine in the Marquesas Islands. *Journal of Ethnopharmacology*, *161*(April 2016), 200–213. https://doi.org/10.1016/j.jep.2014.09.045

Giri, C., Ochieng, E., Tieszen, L. L., Zhu, Z., Singh, A., Loveland, T., Masek, J., & Duke, N. (2011). Status and distribution of mangrove forests of the world using earth observation satellite data. *Global Ecology and Biogeography*, *20*(1), 154–159. https://doi.org/10.1111/j.1466-8238.2010.00584.x

Gleick, P. H., Burns, W. C. G., Chalecki, E. L., Cohen, M., Cushing, K. K., Mann, A. S., Reyes, R. R., Wolff, G. H., & Wong, A. K. (2002). Number of dams, by country. Pages 296–299. In G. PH (Ed.), *The World's Water 2002–2003: The Biennial Report on Freshwater Resources*. Washington (DC): Island Press.

Glover, A. G., Gooday, A. J., Bailey, D. M., Billett, D. S. M., Chevaldonné, P., Colaco, A., Copley, J., Cuvelier, D., Desbruyeres, D., Kalogeropoulou, V., Klages, M., Lampadariou, N., Lejeusne, C., Mestre, N. C., Paterson, G. L. J., Perez, T., Ruhl, H., Sarrazin, J., Soltwedel, T., Soto, E. H., Thatje, S., Tselepides, A., Van Gaever, S., & Vanreusel, A. (2010). Temporal Change in Deep-Sea Benthic Ecosystems. A Review of the Evidence From Recent Time-Series Studies. *Advances in Marine Biology*, *58*(C), 1–95. https://doi.org/10.1016/B978-0-12-381015-1.00001-0

Glover, A. G., & Smith, C. R. (2003). The deep-sea floor ecosystem: current status and prospects of anthropogenic change by the year 2025. *Environmental Conservation*, *30*(3), 219–241. https://doi.org/10.1017/S0376892903000225

Go, K. T. B., Anticamara, J. A., de Ramos, J. A. J., Gabona, S. F., Agao, D. F., Hererra, E. C., & Bitara, A. U. (2015). Species richness and abundance of non-cryptic fish species in the Philippines: a global center of reef fish diversity. *Biodiversity and Conservation*, *24*(10), 2475–2495. https://doi.org/10.1007/s10531-015-0938-0

Gómez-Baggethun, E., Gren, E., Barton, N. D., Langemeyer, J., Mcphearson, T., O'Farrell, P., Andersson, E., Hamstead, Z., & Kremer, P. (2013). Urban Ecosystem Services. In T. Elmqvist, M. Fragkias, J. Goodness, B. Güneralp, P. J. Marcotullio, R. I. McDonald, S. Parnell, M. Schewenius, M. Sendstad, K. C. Seto, & C. Wilkinson (Eds.), *Urbanization, Biodiversity and Ecosystem Services: Challenges and Opportunities* (pp. 175–251). Dordrecht: Springer Netherlands. https://doi.org/10.1007/978-94-007-7088-1

Gon, S. M. I. (2014). Lessons from a Thousand Years of Island Sustainability. Retrieved from http://tedxmaui.com/sam-ohu-gon-iii-phd-lessons-from-a-thousand-years-of-island-sustainability/

Gongbuzeren, Li, Y., & Li, W. (2015). China's Rangeland Management Policy Debates: What Have We learned? *Rangeland Ecology & Management*, *68*(4), 305–314. https://doi.org/10.1016/J.RAMA.2015.05.007

Gordon, D. P., Beaumont, J., MacDiarmid, A., Robertson, D. A., & Ahyong, S. T. (2010). Marine biodiversity of Aotearoa New Zealand. *PLoS ONE*, *5*(8). https://doi.org/10.1371/journal.pone.0010905

Gorenflo, L. J., Romaine, S., Mittermeier, R. A., & Walker-Painemilla, K. (2012). Co-occurrence of linguistic and biological diversity in biodiversity hotspots and high biodiversity wilderness areas. *Proceedings of the National Academy of Sciences*, *109*(21), 8032–8037. https://doi.org/10.1073/pnas.1117511109

Gouezo, M., Golbuu, Y., van Woesik, R., Rehm, L., Koshiba, S., & Doropoulos, C. (2015). Impact of two sequential super typhoons on coral reef communities in Palau. *Marine Ecology Progress Series*, *540*, 73–85. https://doi.org/10.3354/meps11518

Grafton, R. Q., & Connell, D. (2013). *Basin futures: water reform in the Murray-Darling basin. Canberra: ANU Press.* Canberra: ANU Press.

Guillerme, S., Mohan Kumar, B., Menon, A., Hinnewinkel, C., Maire, E., & Santhoshkumar, A. V. (2011). Impacts of public policies and farmer preferences on agroforestry practices in Kerala, India. *Environmental Management*, *48*(2), 351–364. https://doi.org/10.1007/s00267-011-9628-1

Gunawan, B., Takeuchi, K., Tsunekawa, A., & Abdoellah, O. S. (2004). Communitybdependency on forest resources in West Java, Indonesia: the need to re-involve local people in forest management. *Journal of Sustainable Forestry*, *18*(4), 29–46. https://doi.org/10.1300/J091v18n04

Guo, Z. D., Hu, H. F., Pan, Y. D., Birdsey, R. A., & Fang, J. Y. (2014). Increasing biomass carbon stocks in trees outside forests in China over the last three decades. *Biogeosciences*, *11*(15), 4115–4122. https://doi.org/10.5194/bg-11-4115-2014

Gupta, N., Kanagavel, A., Dandekar, P., Dahanukar, N., Sivakumar, K., Mathur, V. B., & Raghavan, R. (2016). God's fishes: religion, culture and freshwater fish conservation in India. *Oryx*, *50*(02), 244–249. https://doi.org/10.1017/S0030605315000691

Gutiérrez, J. L., Jones, C. G., Strayer, D. L., & Iribarne, O. O. (2003). Mollusks as ecosystem engineers: the role of shell production in aquatic habitats. *Oikos*, *101*(1), 79–90. https://doi.org/10.1034/j.1600-0706.2003.12322.x

Gutiérrez, N. L., Hilborn, R., & Defeo, O. (2011). Leadership, social capital and incentives promote successful fisheries. *Nature*, *470*(7334), 386–389. https://doi.org/10.1038/nature09689

Haddad, N. M., Brudvig, L. a., Clobert, J., Davies, K. F., Gonzalez, A., Holt, R. D., Lovejoy, T. E., Sexton, J. O., Austin, M. P., Collins, C. D., Cook, W. M., Damschen, E. I., Ewers, R. M., Foster, B. L., Jenkins, C. N., King, a. J., Laurance, W. F., Levey, D. J., Margules, C. R., Melbourne, B. a., Nicholls, a. O., Orrock, J. L., Song, D.-X., & Townshend, J. R. (2015). Habitat fragmentation and its lasting impact on Earth's ecosystems. *Science Advances*, *1*(2), 1–9. https://doi.org/10.1126/sciadv.1500052

Hahs, A. K., McDonnell, M. J., McCarthy, M. A., Vesk, P. A., Corlett, R. T., Norton, B. A., Clemants, S. E., Duncan, R. P., Thompson, K., Schwartz, M. W., & Williams, N. S. G. (2009). A global synthesis of plant extinction rates in urban areas. *Ecology Letters*, *12*(11), 1165–1173. https://doi.org/10.1111/j.1461-0248.2009.01372.x

Hamza, M. A., & Anderson, W. K. (2005). Soil compaction in cropping systems: A review of the nature, causes and possible solutions. *Soil and Tillage Research*, *82*(2), 121–145. https://doi.org/10.1016/j.still.2004.08.009

Han, J., Hayashi, Y., Cao, X., & Imura, H. (2009). Evaluating Land-Use Change in Rapidly Urbanizing China: Case Study of Shanghai. *Journal of Urban Planning and Development-Asce*, *135*(4), 166–171. https://doi.org/10.1061/(asce)0733-9488(2009)135:4(166)
Hao, S., Wang, S., Cease, A., & Kang, L. (2015). Landscape level patterns of grasshopper communities in Inner Mongolia: interactive effects of livestock grazing and a precipitation gradient. *Landscape Ecology*, *30*(9), 1657–1668. https://doi.org/10.1007/s10980-015-0247-8
Hare, J. (2008). Camelus ferus. https://doi.org/http://dx.doi.org/10.2305/IUCN.UK.2008.RLTS.T63543A12689285.en
Harmon, D., & Loh, J. (2010). The Index of Linguistic Diversity : A New Quantitative Measure of Trends in the Status of the World ' s Languages. *Language Documentation & Conservation*, *4*, 97–151.
Harris, R. B. (2010). Rangeland degradation on the Qinghai-Tibetan plateau: A review of the evidence of its magnitude and causes. *Journal of Arid Environments*, *74*(1), 1–12. https://doi.org/10.1016/j.jaridenv.2009.06.014
Harris, R. B., & Reading, R. (2008). Ovis ammon. https://doi.org/http://dx.doi.org/10.2305/IUCN.UK.2008.RLTS.T15733A5074694.en
Harrison, R. D., Sreekar, R., Brodie, J. F., Brook, S., Luskin, M., O'Kelly, H., Rao, M., Scheffers, B., & Velho, N. (2016). Impacts of hunting on tropical forests in Southeast Asia. *Conservation Biology*, *30*(5), 972–981. https://doi.org/10.1111/cobi.12785
Harrison, R. D., Tan, S., Plotkin, J. B., Slik, F., Detto, M., Brenes, T., Itoh, A., & Davies, S. J. (2013). Consequences of defaunation for a tropical tree community. *Ecology Letters*, *16*(5), 687–694. https://doi.org/10.1111/ele.12102
Harter, D. E. V., Irl, S. D. H., Seo, B., Steinbauer, M. J., Gillespie, R., Triantis, K. A., Fernandez-Palacios, J. M., & Beierkuhnlein, C. (2015). Impacts of global climate change on the floras of oceanic islands - Projections, implications and current knowledge. *Perspectives in Plant Ecology, Evolution and Systematics*, *17*(2), 160–183. https://doi.org/10.1016/j.ppees.2015.01.003
Hartig, T., Mitchell, R., de Vries, S., & Frumkin, H. (2014). Nature and Health. *Annual Review of Public Health*, *35*(1), 207–228. https://doi.org/10.1146/annurev-publhealth-032013-182443
Hartmann, M., Frey, B., Mayer, J., Mäder, P., & Widmer, F. (2015). Distinct soil microbial diversity under long-term organic and conventional farming. *The ISME Journal*, *9*(5), 1177–1194. https://doi.org/10.1038/ismej.2014.210
Hautier, Y., Niklaus, P. A., & Hector, A. (2009). Competition for light causes plant biodiversity loss after eutrophication. *Science*, *324*(5927), 636–638. https://doi.org/10.1126/science.1169640
Hein, J. (2002). Cobalt-rich ferromanganese crusts: Global distribution, composition, origin and research activities. *ISA Technical Study*.
Hettiarachchi, M., Morrison, T. H., & McAlpine, C. (2015). Forty-three years of Ramsar and urban wetlands. *Global Environmental Change*, *32*, 57–66. https://doi.org/10.1016/J.GLOENVCHA.2015.02.009
Hewitt, C. L. (2002). Distribution and Biodiversity of Australian Tropical Marine Bioinvasions. *Pacific Science*, *56*(1), 213–222. https://doi.org/10.1353/psc.2002.0016
Hilborn, R. (2007). Reinterpreting the state of fisheries and their management. *Ecosystems*, *10*(8), 1362–1369. https://doi.org/10.1007/s10021-007-9100-5
Hilborn, R. (2010). Apocalypse Forestalled: Why All the World's Fisheries Aren't Collapsing. *The Science Chronicles*. Retrieved from https://www.conservationgateway.org/Documents/Science Chronicles 2010-11.pdf
Hilton, M. J., & Manning, S. S. (1995). Conversion of Coastal Habitats in Singapore: Indications of Unsustainable Development. *Environmental Conservation*, *22*(4), 307–322. https://doi.org/10.1017/S0376892900034883
Holtmeier, F.-K., & Broll, G. (2007). Treeline advance - driving processes and adverse factors. *Landscape Online*, 1–32. https://doi.org/10.3097/LO.200701
Hope, G. (2014). The Sensitivity of the High Mountain Ecosystems of New Guinea to Climatic Change and Anthropogenic Impact. *Arctic, Antarctic, and Alpine Research*, *46*(4), 777–786. https://doi.org/10.1657/1938-4246-46.4.777

Horne, B. D., Poole, C. M., Walde, A. D., Castellano, C., Chan, B., Heng, C. E., Chansue, N., Nyok, C. P., Tien-hsi, C., Chuaynkern, Y., Georges, A., Goode, E., Shiping, G., Ha, H. Van, Hagen, C., Heacox, S., Hendrie, D., Heng, S., Holloway, R., Hudson, R., Juvik, J., Kaiser, H., Kamsi, M., Kanari, K., Kitimasak, W., Ko, W. K., Kuchling, G., Lafebre, S., Landrey, C., Lau, M., Lee, B., Ming, L. T., Shunqing, L., Maneeorn, P., Mccormack, T., Mould, A., Myo, K. M., Pasha, K., Pipatsawasdikul, K., Platt, K., Poole, C., Praschag, P., & Raphael, B. (2012). *Conservation of Asian Tortoises and Freshwater Turtles : Setting Priorities for the Next Ten Years. Recommendations and Conclusions from the Workshop in Singapore*.

Howarth, F. G. (1985). Impacts of alien land arthropods and mollusks on native plants and animals in Hawai'i. In C. P. Stone and J. Michael Scott (Ed.), *Hawai'i's terrestrial ecosystems: preservation and management* (1st ed., pp. 149–179). Honolulu: Cooperative National Park Resources Study Unit University of Hawai'i.

Hu, L., Li, Z., Liao, W. B., & Fan, Q. (2011). Values of village fengshui forest patches in biodiversity conservation in the Pearl River Delta, China. *Biological Conservation*, *144*(5), 1553–1559. https://doi.org/10.1016/j.biocon.2011.01.023

Hu, Z., Li, S., Guo, Q., Niu, S., He, N., Li, L., & Yu, G. (2016). A synthesis of the effect of grazing exclusion on carbon dynamics in grasslands in China. *Global Change Biology*, *22*(4), 1385–1393. https://doi.org/10.1111/gcb.13133

Huang, D., & Roy, K. (2015). The future of evolutionary diversity in reef corals. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences*, *370*(1662), 20140010. https://doi.org/10.1098/rstb.2014.0010

Huang, J., Huang, J., Liu, C., Zhang, J., Lu, X., & Ma, K. (2016). Diversity hotspots and conservation gaps for the Chinese endemic seed flora. *Biological Conservation*, *198*, 104–112. https://doi.org/10.1016/j.biocon.2016.04.007

Huang, L., & Li, J. (2016). Status of Freshwater Fish Biodiversity in the Yangtze River Basin, China. In Nakano S., Yahara T., & Nakashizuka T. (Eds.), *Aquatic Biodiversity Conservation and Ecosystem Services. Ecological Research Monographs.* (pp. 13–30). Springer, Singapore. https://doi.org/10.1007/978-981-10-0780-4_2

Hughes, A. C. (2017). Understanding the drivers of Southeast Asian biodiversity loss. *Ecosphere*, *8*(1), e01624. https://doi.org/10.1002/ecs2.1624

Hutchings, P. A. (1986). Biological destruction of coral reefs. *Coral Reefs*, *4*(4), 239–252. https://doi.org/10.1007/BF00298083

Hyakumura, K., Seki, Y., & Lopez-Casero, F. (2007). *Designing Forestation Models Suited to Rural Asia: Avoiding Land Conflict as a Key to Success*. *IGES Policy Brief 6*.

ICAR - NAAS. (2010). *Degraded and Wastelands of India: Status and Spatial Distribution*. New Delhi, India. Retrieved from http://www.icar.org.in/files/Degraded-and-Wastelands.pdf

Ikeuchi, K., & Kanao, K. (2003). The approach and the issue to conservation and restoration for river environment in Japan [in Japanese with English abstract]. *Ecology and Civil Engineering*, *5*, 205–216. https://doi.org/citeulike-article-id:9333622

Imai, N., Furukawa, T., Tsujino, R., Kitamura, S., & Yumoto, T. (2018). Factors affecting forest area change in Southeast Asia during 1980-2010. *PLOS ONE*, *13*(5), e0197391. https://doi.org/10.1371/journal.pone.0197391

Immerzeel, D. J., Verweij, P. A., van der Hilst, F., & Faaij, A. P. C. (2014). Biodiversity impacts of bioenergy crop production: a state-of-the-art review. *GCB Bioenergy*, *6*(3), 183–209. https://doi.org/10.1111/gcbb.12067

IPBES. (2016). *Summary for policymakers of the assessment report of the Intergovernmental Science - Policy Platform on Biodiversity and Ecosystem Services on pollinators, pollination and food production.*

IPCC. (2014). *Climate change 2013: the physical science basis. Contribution of working group I to the fifth assessment report of the Intergovernmental Panel on Climate Change*. Cambridge: Cambridge University Press.

Isaac, N. J. B., Turvey, S. T., Collen, B., Waterman, C., & Baillie, J. E. M. (2007). Mammals on the EDGE: Conservation Priorities Based on Threat and Phylogeny. *PLoS ONE*, *2*(3), e296. https://doi.org/10.1371/journal.pone.0000296

Ishikawa, T., & Kumagai, M. (2012). Warming and hypoxia in Lake Biwa. In M. M. Kawanabe H, Nishino M (Ed.), *Lake Biwa: Interactions between Nature and People* (pp. 211–216). Springer. https://doi.org/10.1007/978-94-007-1783-1_3

Isnard, S., L'huillier, L., Rigault, F., & Jaffré, T. (2016). How did the ultramafic soils shape the flora of the New Caledonian hotspot? *Plant and Soil*, *403*(1–2), 53–76. https://doi.org/10.1007/s11104-016-2910-5

Itoh, M., Kawamura, K., Kitahashi, T., Kojima, S., Katagiri, H., & Shimanaga, M. (2011). Bathymetric patterns of meiofaunal abundance and biomass associated with the Kuril and Ryukyu trenches, western North Pacific Ocean. *Deep-Sea Research Part I: Oceanographic Research Papers*, *58*(1), 86–97. https://doi.org/10.1016/j.dsr.2010.12.004

IUCN. (2009). *The IUCN Red List of Threatened Species TM 2009 update Freshwater Fish Facts*. *Water* (Vol. 104).

IUCN. (2015). IUCN Red List of Threatened Species. Retrieved from www.iucnredlist.org

IUCN. (2017). IUCN Red List of Threatened Species. Version 2017.1. Retrieved from http://www.iucnredlist.org/

IUCN Global Species Programme Freshwater Biodiversity Unit. (2013). Global Distribution of Freshwater Dependent Amphibians. Accessed through the Global Freshwater Biodiversity Atlas. Retrieved from atlas.freshwaterbiodiversity.eu

IUCN SSC Antelope Specialist Group. (2011). Oryx leucoryx. https://doi.org/http://dx.doi.org/10.2305/IUCN.UK.2011-1.RLTS.T15569A4824960.en

IUCN, & UNEP-WCMC. (2014). The World Database on Protected Areas. Retrieved from https://doi.org/www.protectedplanet.net

IUCN, & UNEP-WCMC. (2015). The World Database on Protected Areas [Online], November/2015. *World Wide Web Electronic Publication, Www.Protectedplanet.Com*, (January), 1–5. https://doi.org/www.protectedplanet.net

Iwata, T., Nakano, S., & Inoue, M. (2003). Impacts of past Riparian Deforestation on Stream Communities in a Tropical Rain Forest in Borneo Published by : Ecological Society of America IMPACTS OF PAST RIPARIAN DEFORESTATION ON STREAM COMMUNITIES IN A TROPICAL RAIN FOREST IN BORNEO. *Ecological Applications*, *13*(2), 461–473.

Izuno, A., Kitayama, K., Onoda, Y., Tsujii, Y., Hatakeyama, M., Nagano, A. J., Honjo, M. N., Shimizu-Inatsugi, R., Kudoh, H., Shimizu, K. K., & Isagi, Y. (2017). The population genomic signature of environmental association and gene flow in an ecologically divergent tree species *Metrosideros polymorpha* (Myrtaceae). *Molecular Ecology*, *26*(6), 1515–1532. https://doi.org/10.1111/mec.14016

Jäch, M. A., & Balke, M. (Eds.). (2010). *Water beetles of New Caledonia (part 1)*. *Monographs on Coleoptera, 3*.

Jäch, M. A., & Ji, L. (1995). *Water Beetles of China. Vol. I,*. Wien: Zoologisch-Botanische Gesellschaft in Österreich and Wiener Coleopterologenverein.

Jäch, M. A., & Ji, L. (1998). *Water Beetles of China. Vol. II*. Wien: Zoologisch-Botanische Gesellschaft in Österreich and Wiener Coleopterologenverein.

Jäch, M. A., & Ji, L. (2003). *Water Beetles of China. Vol. III*. Wien: Zoologisch-Botanische Gesellschaft in Österreich and Wiener Coleopterologenverein.

Jackson, J. B. C., Kirby, M. X., Berger, W. H., Bjorndal, K. A., Botsford, L. W., Bourque, B. J., Bradbury, R. H., Cooke, R., Erlandson, J., Estes, J. A., Hughes, T. P., Kidwell, S., Lange, C. B., Lenihan, H. S., Pandolfi, J. M., Peterson, C. H., Steneck, R. S., Tegner, M. J., & Warner, R. R. (2001). Historical Overfishing and the Recent Collapse of Coastal Ecosystems. *Science*, *293*(5530), 629–637. https://doi.org/10.1126/science.1059199

Jackson, R., Mallon, D., McCarthy, T., Chundawat, R. A., & Habib, B. (2008). Panthera uncia. https://doi.org/http://dx.doi.org/10.2305/IUCN.UK.2008.RLTS.T22732A9381126.en

Jain, A., Kunte, K., & Webb, E. L. (2016). Flower specialization of butterflies and impacts of non-native flower use in a transformed tropical landscape. *Biological Conservation*, *201*, 184–191. https://doi.org/10.1016/j.biocon.2016.06.034

Jamnadass, R., Place, F., Torquebiau, E., Malézieux, E., Iiyama, M., Sileshi, G. W., Kehlenbeck, K., Masters, E., Mcmullin, S., Weber, J. C., & Dawson, I. K. (2013). *Agroforestry, food and nutritional security. Background paper for the International Conference on Forests for Food*

Security and Nutrition, FAO, Rome, 13–15 May, 2013 (ICRAF Working Paper No. 170). Nairobi, Kenya. https://doi.org/http://dx.doi.org/10.5716/WP13054.PDF.

Jang, M. H., Lucas, M. C., & Joo, G. J. (2003). The fish fauna of mountain streams in South Korean national parks and its significance to conservation of regional freshwater fish biodiversity. *Biological Conservation*, *114*(1), 115–126. https://doi.org/10.1016/S0006-3207(03)00016-8

Japar Sidik, B., Muta Harah, Z., & Kawaguchi, S. (2012). Historical review of seagrass research in Malaysia before 2001. *Coastal Marine Science*, *35*(1), 157–168. Retrieved from http://repository.dl.itc.u-tokyo.ac.jp/dspace/bitstream/2261/51701/1/CMS350125.pdf

Jenkins, K. M., Kingsford, R. T., Closs, G. P., Wolfenden, B. J., Matthaei, C. D., & Hay, S. E. (2011). Climate change and freshwater systems in Oceania: an assessment of vulnerability and adaptation opportunities. *Pacific Conservation Biology*, *17*(3), 201–219.

Jetz, W., Thomas, G. H., Joy, J. B., Redding, D. W., Hartmann, K., & Mooers, A. O. (2014). Global Distribution and Conservation of Evolutionary Distinctness in Birds. *Current Biology*, *24*(9), 919–930. https://doi.org/10.1016/J.CUB.2014.03.011

Jim, C. Y., & Chen, W. Y. (2008). Pattern and divergence of tree communities in Taipei ' s main urban green spaces. *Landscape and Urban Planning*, *84*, 312–323. https://doi.org/10.1016/j.landurbplan.2007.09.001

Jin, K., Wang, F., Chen, D., Jiao, Q., Xia, L., Fleskens, L., & Mu, X. (2015). Assessment of urban effect on observed warming trends during 1955–2012 over China: a case of 45 cities. *Climatic Change*, *132*(4), 631–643. https://doi.org/10.1007/s10584-015-1446-7

Joosten, H., & Clarke, D. (2002). *Wise Use of Mires and Peatlands*.

Joosten, H., Sirin, A., Couwenberg, J., Laine, J., & Smith, P. (2016). The role of peatlands in climate regulation. In *Peatland Restoration and Ecosystem Services: Science, Policy and Practice* (pp. 66–79). Cambridge University Press.

Jose, S., Walter, D., & Mohan Kumar, B. (2017). Ecological considerations in sustainable silvopasture design and management. *Agroforestry Systems*. https://doi.org/10.1007/s10457-016-0065-2

Jourdan, H. (1997). Threats on Pacific islands: The spread of the Tramp Ant *Wasmannia auropunctata* (Hymenoptera: Formicidae). *Pacific Conservation Biology*.

Jowkar, H., Hunter, L., Ziaie, H., Marker, L., Breitenmoser-Wursten, C., & Durant, S. (2008). Acinonyx jubatus ssp. venaticus. https://doi.org/http://dx.doi.org/10.2305/IUCN.UK.2008.RLTS.T220A13035342.en

Juffe-Bignoli, D., Bhatt, S., Park, S., Eassom, A., Belle, E. M. S., Murti, R., Buyck, C., Raza Rizvi, A., Rao, M., Lewis, E., MacSharry, B., & Kingston, N. (2014). *Asia Protected Planet 2014*. Cambridge, UK. Retrieved from https://www.unep-wcmc.org/system/dataset_file_fields/files/000/000/264/original/Asia_Protected_Planet_WEB.pdf?1415613854

Junsongduang, A., Balslev, H., Jampeetong, A., Inta, A., & Wangpakapattanawong, P. (2014). Woody Plant Diversity in Sacred Forests and Fallows in Chiang Mai, Thailand. *Chiang Mai J. Sci.*, *41*(5.1), 1132–1149.

Kaczensky, P., Adiya, Y., von Wehrden, H., Mijiddorj, B., Walzer, C., Güthlin, D., Enkhbileg, D., & Reading, R. P. (2014). Space and habitat use by wild Bactrian camels in the Transaltai Gobi of southern Mongolia. *Biological Conservation*, *169*(100), 311–318. https://doi.org/10.1016/j.biocon.2013.11.033

Kadoya, T., Akasaka, M., Aoki, T., & Takamura, N. (2011). A proposal of framework to obtain an integrated biodiversity indicator for agricultural ponds incorporating the simultaneous effects of multiple pressures. *Ecological Indicators*, *11*(5), 1396–1402. https://doi.org/10.1016/j.ecolind.2011.03.001

Kadoya, T., Takenaka, A., Ishihama, F., Fujita, T., Ogawa, M., Katsuyama, T., Kadono, Y., Kawakubo, N., Serizawa, S., Takahashi, H., Takamiya, M., Fujii, S., Matsuda, H., Muneda, K., Yokota, M., Yonekura, K., & Yahara, T. (2014). Crisis of Japanese vascular flora shown by quantifying extinction risks for 1618 taxa. *PLoS ONE*, *9*(6), 1–9. https://doi.org/10.1371/journal.pone.0098954

Kako, S., Isobe, A., Kataoka, T., & Hinata, H. (2014). A decadal prediction of the quantity of plastic marine debris littered on beaches of the East Asian marginal seas. *Marine Pollution Bulletin*, *81*(1), 174–184. https://doi.org/10.1016/j.marpolbul.2014.01.057

Kang, B., Deng, J., Wu, Y., Chen, L., Zhang, J., Qiu, H., Lu, Y., & He, D. (2013). Mapping China's freshwater fishes: Diversity and biogeography. *Fish and Fisheries*, *15*(2), 209–230. https://doi.org/10.1111/faf.12011

Kano, Y., Dudgeon, D., Nam, S., Samejima, H., Watanabe, K., Grudpan, C., Grudpan, J., Magtoon, W., Musikasinthorn, P., Nguyen, P. T., Praxaysonbath, B., Sato, T., Shibukawa, K., Shimatani, Y., Suvarnaraksha, A., Tanaka, W., Thach, P., Tran, D. D., Yamashita, T., & Utsugi, K. (2016). Impacts of dams and global warming on fish biodiversity in the Indo-Burma hotspot. *PLoS ONE*, *11*(8), 1–21. https://doi.org/10.1371/journal.pone.0160151

Katayama, N., Baba, Y. G., Kusumoto, Y., & Tanaka, K. (2015). A review of post-war changes in rice farming and biodiversity in Japan. *Agricultural Systems*, *132*, 73–84. https://doi.org/10.1016/j.agsy.2014.09.001

Katayama, N., Osawa, T., Amano, T., & Kusumoto, Y. (2015). Are both agricultural intensification and farmland abandonment threats to biodiversity? A test with bird communities in paddy-dominated landscapes. *Agriculture, Ecosystems and Environment*, *214*, 21–30. https://doi.org/10.1016/j.agee.2015.08.014

Kawaguchi, S., & Hayashizaki, K.-I. (2011). Biodiversity studies on seaweeds and sea grasses in the coastal waters of Southeast Asia (Project-3: Seaweed/ seagrass Group). In S. Nishida, M. D. Fortes, & N. Miyazaki (Eds.), *Coastal Marine Science in Southeast Asia —Synthesis Report of the Core University Program of the Japan Society for the Promotion of Science: Coastal Marine Science (2001–2010)* (pp. 49–57). TERRAPUB. Retrieved from http://www.terrapub.co.jp/e-library/nishida/

Kaya, M., Kammesheidt, L., & Weidelt, H. J. (2002). The forest garden system of Saparua island, Central Maluku, Indonesia, and its role in maintaining tree species diversity. *Agroforestry Systems*, *54*(3), 225–234. https://doi.org/10.1023/A:1016060808831

Keenan, R. J., Reams, G. A., Achard, F., de Freitas, J. V., Grainger, A., & Lindquist, E. (2015). Dynamics of global forest area: Results from the FAO Global Forest Resources Assessment 2015. *Forest Ecology and Management*, *352*, 9–20. https://doi.org/10.1016/j.foreco.2015.06.014

Kenmore, P. E., Carino, F. O., Perez, C. A., Dyck, V. A., & Gutierrez, A. P. (1984). Population regulation of the rice brown planthopper (NilaparvatalugensStal) within rice fields in the Philippines. *Journal of Plant Protection in the Tropics*, *1*(1), 19–37.

Khan, H., & Baig, S. High Altitude Wetlands of the HKH Region of Northern Pakistan – Status of Current Knowledge, Challenges and Research Opportunities, 37 Wetlands § (2017). Springer Netherlands. https://doi.org/10.1007/s13157-016-0868-y

Khan, M. S. (2014). Amphibians of Pakistan and their Conservation Status. In H. Heatwole & I. Das (Eds.), *Conservation Biology of Amphibians of Asia* (p. 35). Kota Kinabalu: Natural History Publications (Borneo). Retrieved from https://www.researchgate.net/publication/273380139

Khan, T. I., Dular, A. K., & Solomon, D. M. (2003). Biodiversity Conservation in the Thar Desert; with Emphasis on Endemic and Medicinal Plants. *The Environmentalist*, *23*(2), 137–144. https://doi.org/10.1023/A:1024835721316

Khera, N., Mehta, V., & Sabata, B. C. (2009). Interrelationship of birds and habitat features in urban greenspaces in Delhi, India. *Urban Forestry and Urban Greening*, *8*(3), 187–196. https://doi.org/10.1016/j.ufug.2009.05.001

Kier, G., Kreft, H., Lee, T. M., Jetz, W., Ibisch, P. L., Nowicki, C., Mutke, J., & Barthlott, W. (2009). A global assessment of endemism and species richness across island and mainland regions. *Proceedings of the National Academy of Sciences*, *106*(23), 9322–9327. https://doi.org/10.1073/pnas.0810306106

Kiew, R. (2001). Towards a limestone flora of Sabah. *Malayan Nature Journal*, *55*, 77–93.

Kim, I.S., Park, J. Y. (2002). *Freshwater Fish of Korea*. Seoul, Korea: Kyo-Hak Publishing Co.

Kingsford, R. T., Bino, G., Porter, J. L., & Brandis, K. (2013). Waterbird Communities in the Murray-Darling Basin (1983-2012).

Kingswood, S. C., & Blank, D. a. (1996). Gazella subgutturosa. https://doi.org/10.2307/3504241

Kirch, P. V. (Ed.). (2011). *Roots of Conflict: Soils, Agriculture, and Sociopolitical Complexity in Ancient Hawai'i*. Santa Fe: School for Advanced Research Press. Retrieved from https://sarweb.org/roots-of-conflict/

Kizuka, T., Akasaka, M., Kadoya, T., & Takamura, N. (2014). Visibility from roads predict the distribution of invasive fishes in agricultural ponds. *PLoS ONE*, *9*(6). https://doi.org/10.1371/journal.pone.0099709

Klein, J. A., Harte, J., & Zhao, X. Q. (2004). Experimental warming causes large and rapid species loss, dampened by simulated grazing, on the Tibetan Plateau. *Ecology Letters*, *7*(12), 1170–1179. https://doi.org/10.1111/j.1461-0248.2004.00677.x

Knox, J., Hess, T., Daccache, A., & Wheeler, T. (2012). Climate change impacts on crop productivity in Africa and South Asia. *Environmental Research Letters*, *7*(3), 034032. https://doi.org/10.1088/1748-9326/7/3/034032

Kochmann, J., Buschbaum, C., Volkenborn, N., & Reise, K. (2008). Shift from native mussels to alien oysters: Differential effects of ecosystem engineers. *Journal of Experimental Marine Biology and Ecology*, *364*(1), 1–10. https://doi.org/10.1016/j.jembe.2008.05.015

Koh, C. H., & Khim, J. S. (2014). The Korean tidal flat of the Yellow Sea: Physical setting, ecosystem and management. *Ocean and Coastal Management*, *102*(PB), 398–414. https://doi.org/10.1016/j.ocecoaman.2014.07.008

Konopik, O., Steffan-dewenter, I., & Grafe, T. U. (2015). Effects of Logging and Oil Palm Expansion on Stream Frog Communities on Borneo , Southeast Asia. *Biotropica*, *47*(5), 636–643. https://doi.org/10.1111/btp.12248

Koohafkan, P., & Cruz, M. J. Dela. (2011). Conservation and Adaptive Management of Globally Important Agricultural Heritage Systems (GIAHS). *Journal of Resources and Ecology*, *2*(1), 22–28. https://doi.org/10.3969/j.issn.1674-764x.2011.01.004

Koplitz, S. N., Mickley, L. J., Marlier, M. E., Buonocore, J. J., Kim, P. S., Liu, T., Sulprizio, M. P., DeFries, R. S., Jacob, D. J., Schwartz, J., Pongsiri, M., & Myers, S. S. (2016). Public health impacts of the severe haze in Equatorial Asia in September–October 2015: demonstration of a new framework for informing fire management strategies to reduce downwind smoke exposure. *Environmental Research Letters*, *11*(9), 094023. https://doi.org/10.1088/1748-9326/11/9/094023

Korea Forest Service. (2014). *Statistical yearbook of forestry*. Daejeon.

Koslow, J. A., Gowlett-Holmes, K., Lowry, J. K., O'Hara, T., Poore, G. C. B., & Williams, A. (2001). Seamount benthic macrofauna off southern Tasmania: community structure and impacts of trawling. *Marine Ecology Progress Series*, *213*, 111–125. https://doi.org/10.3354/meps213111

Kottelat, M., & Whitten, T. (1996). Freshwater biodiversity in Asia with special reference to fish. *World Bank Technical Paper*, *343*(343), XI-55. https://doi.org/10.1596/978-0-8213-3808-7

Kremen, C., Williams, N. M., & Thorp, R. W. (2002). Crop pollination from native bees at risk from agricultural intensification. *Proceedings of the National Academy of Sciences of the United States of America*, *99*(26), 16812–16816. https://doi.org/10.1073/pnas.262413599

Krishnan, P., Swain, D. K., Chandra Bhaskar, B., Nayak, S. K., & Dash, R. N. (2007). Impact of elevated CO2 and temperature on rice yield and methods of adaptation as evaluated by crop simulation studies. *Agriculture, Ecosystems & Environment*, *122*(2), 233–242. https://doi.org/10.1016/J.AGEE.2007.01.019

Krishnankutty, C. N., Thampi, K. B., & Chundamannil, M. (2008). Trees Outside Forests (TOF): A Case Study of the Wood Production- Consumption Situation in Kerala. *Int. Forest. Rev.*, *10*, 156–164.

Kröncke, I. (1996). Impact of biodeposition on macrofaunal communities in intertidal sandflats. *Marine Ecology*, *17*, 159–174. https://doi.org/10.1111/j.1439-0485.1996.tb00497.x

Kronen, M., Magron, F., McArdle, B., & Vunisea, A. (2010). Reef finfishing pressure risk model for Pacific Island countries and territories. *Fisheries Research*, *101*(1–2), 1–10. https://doi.org/10.1016/J.FISHRES.2009.08.011

Kuang, W., Liu, J., Dong, J., Chi, W., & Zhang, C. (2016). The rapid and massive urban and industrial land expansions in China between 1990 and 2010: A CLUD-based analysis of their trajectories, patterns, and drivers. *Landscape and Urban Planning*, *145*, 21–33. https://doi.org/10.1016/j.landurbplan.2015.10.001

Kudo, G., Amagai, Y., Hoshino, B., & Kaneko, M. (2011). Invasion of dwarf bamboo into alpine snow-meadows in northern Japan: pattern of expansion and impact on species diversity. *Ecology and Evolution*, *1*(1), 85–96. https://doi.org/10.1002/ece3.9

Kumar, B. M., & Nair, P. K. R. (Eds.). (2011). *Carbon Sequestration Potential of Agroforestry Systems: Opportunities and Challenges* (Vol. 8). Dordrecht: Springer Netherlands. https://doi.org/10.1007/978-94-007-1630-8

Ladefoged, T. N., Kirch, P. V., Gon, S. M., Chadwick, O. A., Hartshorn, A. S., & Vitousek, P. M. (2009). Opportunities and constraints for intensive agriculture in the Hawaiian archipelago prior to European contact. *Journal of Archaeological Science*, *36*(10), 2374–2383. https://doi.org/10.1016/J.JAS.2009.06.030

Lal Mohan, R. S., & Rema Devi, K. (2000). Fish Fauna of the Chaliyar River, North Kerala. In A. G. Ponniah & A. Gopalakrishnan (Eds.), *Endemic Fish Diversity of Western Ghats* (NBFGR-NA, pp. 155–156). Lucknow, U.P., India: National Bureau of Fish Genetic Resources.

Lane, D. J. W. (1996). A crown-of-thorns outbreak in the eastern Indonesian Archipelago, February 1996. *Coral Reefs*, *15*(4), 209–210. https://doi.org/10.1007/BF01787452

Lavides, M. N., Molina, E. P. V., de la Rosa, G. E., Mill, A. C., Rushton, S. P., Stead, S. M., & Polunin, N. V. C. (2016). Patterns of Coral-Reef Finfish Species Disappearances Inferred from Fishers’ Knowledge in Global Epicentre of Marine Shorefish Diversity. *PLOS ONE*, *11*(5), e0155752. https://doi.org/10.1371/journal.pone.0155752

Lawler, I., Marsh, H., McDonald, B., & Stokes, T. (2002). Dugongs in the Great Barrier Reef: Current state of knowledge April 2002. Queensland, Australia. Retrieved from http://www.seagrasswatch.org/publications.html

Lebreton, L. C. M., Greer, S. D., & Borrero, J. C. (2012). Numerical modelling of floating debris in the world’s oceans. *Marine Pollution Bulletin*, *64*(3), 653–661. https://doi.org/10.1016/j.marpolbul.2011.10.027

Lee, M., Manning, P., Rist, J., Power, S. A., & Marsh, C. (2010). A global comparison of grassland biomass responses to CO2 and nitrogen enrichment. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences*, *365*(1549), 2047–2056. https://doi.org/10.1098/rstb.2010.0028

Lee, T., Li, J., Churchill, C., & Ó Foighil, D. (2014). Evolutionary history of a vanishing radiation: isolation-dependent persistence and diversification in Pacific Island partulid tree snails. *BMC Evolutionary Biology*, *14*, 202. https://doi.org/10.1186/s12862-014-0202-3

Lehnert, L. W., Wesche, K., Trachte, K., Reudenbach, C., & Bendix, J. (2016). Climate variability rather than overstocking causes recent large scale cover changes of Tibetan pastures. *Scientific Reports*, *6*(October 2015), 24367. https://doi.org/10.1038/srep24367

Lenzen, M., Moran, D., Kanemoto, K., Foran, B., Lobefaro, L., & Geschke, a. (2012). International trade drives biodiversity threats in developing nations. *Nature*, *486*, 109–112. https://doi.org/10.1038/nature11145

Letnic, M. (2007). The impacts of pastoralism on the fauna of arid Australia. In *Animals of Arid Australia* (pp. 65–75). P.O. Box 20, Mosman NSW 2088, Australia: Royal Zoological Society of New South Wales. https://doi.org/10.7882/FS.2007.041

Leverington, F., Hockings, M., & Lemos Costa, K. (2008). *Management effectiveness evaluation in protected areas: Report of the project “Global study into management effectiveness evaluation of protected areas.”* Gatton, Australia. Retrieved from https://www.iucn.org/sites/dev/files/import/downloads/maangementeffectiveness2008.pdf

Levin, L. A., Etter, R. J., Rex, M. A., Gooday, A. J., Smith, C. R., Pineda, J., Stuart, C. T., Hessler, R. R., & Pawson, D. (2001). Environmental Influences on Regional Deep-Sea Species Diversity. *Annual Review of Ecology and Systematics*, *32*(1), 51–93. https://doi.org/10.1146/annurev.ecolsys.32.081501.114002

Levin, L. A., & Sibuet, M. (2012). Understanding Continental Margin Biodiversity: A New Imperative. *Annual Review of Marine Science*, *4*(1), 79–112. https://doi.org/10.1146/annurev-marine-120709-142714

Li, G., Yin, B., Wan, X., Wei, W., Wang, G., Krebs, C. J., & Zhang, Z. (2016). Successive sheep grazing reduces population density of Brandt???s voles in steppe grassland by altering food resources: a large manipulative experiment. *Oecologia*, *180*(1), 149–159. https://doi.org/10.1007/s00442-015-3455-7

Li, L., Chan, P., Wang, D., & Tan, M. (2015). Rapid urbanization effect on local climate: intercomparison of climate trends in Shenzhen and Hong Kong, 1968-2013. *Climate Research*, *63*(2), 145–155. https://doi.org/10.3354/cr01293

Li, W., Ouyang, Z., Meng, X., & Wang, X. (2006). Plant species composition in relation to green cover configuration and function of urban parks in Beijing, China. *Ecological Research*, *21*(2), 221–237. https://doi.org/10.1007/s11284-005-0110-5

Liew, T.-S., Price, L., & Clements, G. R. (2016). Using Google Earth to Improve the Management of Threatened Limestone Karst Ecosystems in Peninsular Malaysia. *Tropical Conservation Science*, *9*(2), 903–920. https://doi.org/10.1177/194008291600900219

Ligon, F. K., Dietrich, W. E., & Trush, W. J. (1995). Downstream Ecological Effects of Dams: A geomorphic perspective. *BioScience*, *45*(3), 183–192. https://doi.org/10.2307/1312557

Lilley, M. K. S., Beggs, S. E., Doyle, T. K., Hobson, V. J., Stromberg, K. H. P., & Hays, G. C. (2011). Global patterns of epipelagic gelatinous zooplankton biomass. *Marine Biology*, *158*(11), 2429–2436. https://doi.org/10.1007/s00227-011-1744-1

Lim, C. K., & Cranbrook, G. G.-H. (2002). *Swiftlets of Borneo: builders of edible nests*. Malaysia: Natural History Publications (Borneo).

Lintermans, M. (2011). Conservation status of Australian Fishes. *Australian Society for Fish Biology Newsletter*, *41*, 94–97.

Lintermans, M. (2013). *Conservation and management. In The Ecology of Australian Freshwater Fish*. (K. Humphries, P. & Walker, Ed.). Collingwood: CSIRO Publishing. Retrieved from http://doi.wiley.com/10.1111/aec.12186

Lipper, L., Thornton, P., Campbell, B. M., Baedeker, T., Braimoh, A., Bwalya, M., Caron, P., Cattaneo, A., Garrity, D., Henry, K., Hottle, R., Jackson, L., Jarvis, A., Kossam, F., Mann, W., McCarthy, N., Meybeck, A., Neufeldt, H., Remington, T., Sen, P. T., Sessa, R., Shula, R., Tibu, A., & Torquebiau, E. F. (2014). Climate-smart agriculture for food security. *Nature Climate Change*, *4*(12), 1068–1072. https://doi.org/10.1038/nclimate2437

Litzow, M. A., Mueter, F. J., & Hobday, A. J. (2014). Reassessing regime shifts in the North Pacific: Incremental climate change and commercial fishing are necessary for explaining decadal-scale biological variability. *Global Change Biology*, *20*(1), 38–50. https://doi.org/10.1111/gcb.12373

Liu, C., He, D., Chen, Y., & Olden, J. D. (2017). Species invasions threaten the antiquity of China's freshwater fish fauna. *Diversity and Distributions*, *23*(5), 556–566. https://doi.org/10.1111/ddi.12541

Liu, S., Yin, Y., Cheng, F., Yang, J., Li, J., Dong, S., & Zhu, A. (2017). Ecosystem Services and landscape change associated with plantation expansion in a tropical rainforest region of Southwest China. *Ecological Modelling*, *353*, 129–138. https://doi.org/10.1016/J.ECOLMODEL.2016.03.009

Liu, Y., Duan, M., & Yu, Z. (2013). Agricultural landscapes and biodiversity in China. *Agriculture, Ecosystems & Environment*, *166*, 46–54. https://doi.org/10.1016/j.agee.2011.05.009

Lkhagvasuren, B., Chimeddorj, B., & Sanjmyatav D. (2011). *BARRIERS TO MIGRATION: CASE STUDY IN MONGOLIA Analyzing the Effects of Infrastructure on Migratory Terrestrial Mammals in Mongolia*. Ulaanbaatar.

Loh, J., & Harmon, D. (2005). A global index of biocultural diversity. *Ecological Indicators*, *5*(3), 231–241. https://doi.org/10.1016/j.ecolind.2005.02.005

Loh, J., & Harmon, D. (2014). *Biocultural Diversity: threatened species, endangered languages*. Zeist, The Netherlands. Retrieved from http://wwf.panda.org/wwf_news/press_releases/?222890/Biocultural-Diversity-Threatened-Species-Endangered-Languages

Lohberger, S., Stängel, M., Atwood, E. C., & Siegert, F. (2018). Spatial evaluation of Indonesia's 2015 fire-affected area and estimated carbon emissions using Sentinel-1. *Global Change Biology*, *24*(2), 644–654. https://doi.org/10.1111/gcb.13841

Lonsdale, M., & Fuller, R. (2005). Cities and towns. In S. Morton, A. Sheppard, & M. Lonsdale (Eds.), *Biodiversity-Science and Solutions for Australia* (pp. 121–134). Collingwood, Australia: CSIRO Publishing. Retrieved from www.publish.csiro.au

Losfeld, G., L'Huillier, L., Fogliani, B., Jaffré, T., & Grison, C. (2014). Mining in New Caledonia: environmental stakes and restoration opportunities. *Environmental Science and Pollution Research*, (October 2015), 5592–5607. https://doi.org/10.1007/s11356-014-3358-x

Lovett-Doust, J., Hegazy, A., Hammouda, O., & Gomaa, N. (2009). Abundance-occupancy relationships and implications for conservation of desert plants in the northwestern Red Sea region. *Community Ecology*, *10*(1), 91–98. https://doi.org/10.1556/ComEc.10.2009.1.11

Lu, C. J., Duan, J. J., Junaid, M., Cao, T. W., Ding, S. M., & Pei, D. S. (2016). Recent status of fishes in the Yangtze river and its ecological health assessment. *American Journal of Environmental Sciences*. https://doi.org/10.3844/ajessp.2016.86.93

Lunt, I. D., Eldridge, D. J., Morgan, J. W., & Witt, G. B. (2007). Turner review no. 13. A framework to predict the effects of livestock grazing and grazing exclusion on conservation values in natural ecosystems in Australia. *Australian Journal of Botany*, *55*(4), 401–415. https://doi.org/10.1071/BT06178

Lymer, D., Funge-Smith, S., & Miao, W. (2010). *Status and potential of fisheries and aquaculture in Asia and the Pacific 2010*. Bangkok: FAO Regional Office for Asia and the Pacific. Retrieved from http://www.fao.org/docrep/013/i1924e/i1924e00.pdf

Ma, L., Huang, M., Shen, Y., Cao, H., Wu, L., Ye, H., Lin, G., & Wang, Z. (2015). Species Diversity and Community Structure in Forest Fragments of Guangzhou , South China, *27*(2), 148–157.

MacKenzie, C. L. J., Victor G. Burrell, J., Aaron Rosenfield, & Hobart, W. L. (1997). *The History, Present Condition, and Future of the molluscan Fisheries of North and Central America and Europe* (NOAA Technical Report NMFS 129). (C. L. J. MacKenzie, V. G. J. Burrell, A. Rosenfield, & W. Hobart, Eds.), *Technical report of the Fishery Bulletin*. Seattle, Washington. Retrieved from http://spo.nwr.noaa.gov/tr127.pdf

Madin, E. M. P. (2015). Land reclamation: Halt reef destruction in South China Sea. *Nature*, *524*, 291. Retrieved from http://dx.doi.org/10.1038/524291a

Maestre, F. T., Quero, J. L., Gotelli, N. J., Escudero, A., Ochoa, V., Delgado-baquerizo, M., García-gómez, M., Bowker, M. a, Soliveres, S., Escolar, C., García-palacios, P., Berdugo, M., Valencia, E., Gozalo, B., Gallardo, A., Aguilera, L., Arredondo, T., Blones, J., Boeken, B., Bran, D., Conceição, A. A., & Cabrera, O. (2012). Plant Species Richness and Ecosystems Multifunctionality in Global Drylands. *Science*, *335*(6065), 2014–2017. https://doi.org/10.1126/science.1215442

Mahendra Dev, S. (2011). *Climate change, rural livelihoods and agriculture (focus on food security) in Asia-Pacific region*.

Malicky, H. (2010). *Atlas of Southeast Asian Trichoptera*. Chiang Mai: Biology Department, Faculty of Science, Chiang Mai University.

Malla, G. (2015). Ecology and conservation of Fishing Cat in Godavari mangroves of Andhra Pradesh. In A. Appel & J. W. Duckworth. (Eds.), *Proceedings of the First International Fishing Cat Conservation Symposium* (pp. 25–29).

Mark, A. F., & Adams, N. M. (1995). *New Zealand Alpine Plants*. Auckland: Godwit Publishing Ltd.

Markert, A., Wehrmann, A., & Kroncke, I. (2009). Recently established Crassostrea-reefs versus native Mytilus-beds: Differences in ecosystem engineering affects the macrofaunal communities (Wadden Sea of Lower Saxony, southern German Bight). *Biological Invasions*, *12*(1), 15–32. https://doi.org/10.1007/s10530-009-9425-4

Marsh, H. (2002). *Dugong. Status report and action plans for countries and territories. UNEDP/DEWA/RS.02/1. Early warning and report series*.

Marsh, H., & Lefebvre, L. W. (1994). Sirenian Status and Conservation Efforts. *Aquatic Mammals*. Retrieved from http://geckodesign.biz/dugong/publications/JournalPapers/1994/Marsh and Lefebvre 1994 Aq. Mamm 20.3.pdf

Marsh, H., O'Shea, T. J., & Reynolds III, J. E. (2011). *Ecology and Conservation of the Sirenia: Dungons and Manatees*. Cambridge, United Kingdom: Cambridge University Press. Retrieved from http://www.cambridge.org/us/academic/subjects/life-sciences/ecology-and-conservation/ecology-and-conservation-sirenia-dugongs-and-manatees?format=HB

Marsh, H., & Sobtzick, S. (2015). Dugong dugon. https://doi.org/http://dx.doi.org/10.2305/IUCN.UK.2015-4.RLTS.T6909A43792211.en.

Martens, K. (2010). The International Year of Biodiversity, 1–2. https://doi.org/10.1007/s10750-009-0045-x
Mather, A. (1992). Forest transition. *Area*, *24*, 367–379.
Mathur, V. B., Gopal, R., Yadav, S. P., & Sinha, P. R. (2011). *Management Effectiveness Evaluation (MEE) of Tiger Reserves in India: Process and Outcomes*. New Delhi. Retrieved from http://projecttiger.nic.in/WriteReadData/userfiles/file/mee_tiger_2011.pdf
Matsuzaki, S. I. S., & Kadoya, T. (2015). Trends and stability of inland fishery resources in Japanese lakes: Introduction of exotic piscivores as a driver. *Ecological Applications*, *25*(5), 1420–1432. https://doi.org/10.1890/13-2182.1.sm
Matsuzaki, S. ichiro S., Sasaki, T., & Akasaka, M. (2016). Invasion of exotic piscivores causes losses of functional diversity and functionally unique species in Japanese lakes. *Freshwater Biology*, *61*(7), 1128–1142. https://doi.org/10.1111/fwb.12774
McCarter, J., & Gavin, M. C. (2015). Assessing Variation and Diversity of Ethnomedical Knowledge: A Case Study from Malekula Island, Vanuatu. *Economic Botany*, *69*(3), 251–261. https://doi.org/10.1007/s12231-015-9319-6
McIlgorm, A., Campbell, H. F., & Rule, M. J. (2011). The economic cost and control of marine debris damage in the Asia-Pacific region. *Ocean & Coastal Management*, *54*(9), 643–651. https://doi.org/10.1016/j.ocecoaman.2011.05.007
McIvor, J. G. (2005). Australian grasslands. In J. M. Suttie, S. G. Reynolds, & C. Batello (Eds.), *Grasslands of the World* (pp. 343–380). Rome: Food and Agriculture Organization of the United Nations.
McKay, J. (2009). Food and health considerations in Asia-Pacific regional security. *Asia Pacific Journal of Clinical Nutrition*, *18*(4), 654–663.
McKechnie, A. E., & Wolf, B. O. (2009). Climate change increases the likelihood of catastrophic avian mortality events during extreme heat waves. *Biology Letters*.
McLellan (eds), R. (2014). *The Living planet Report, 2014*. https://doi.org//
McManus, J. W. (1997). Tropical marine fisheries and the future of coral reefs: a brief review with emphasis on Southeast Asia. *Coral Reefs*, *16*(5), S121–S127. https://doi.org/10.1007/s003380050248
McNeely, J. A. (2001). *The great reshuffling : human dimensions of invasive alien species*. Gland, Switzerland and Cambridge, UK: IUCN.
Meixner, M. J., Lüter, C., Eckert, C., Itskovich, V., Janussen, D., von Rintelen, T., Bohne, A. V., Meixner, J. M., & Hess, W. R. (2007). Phylogenetic analysis of freshwater sponges provide evidence for endemism and radiation in ancient lakes. *Molecular Phylogenetics and Evolution*, *45*(3), 875–886. https://doi.org/10.1016/j.ympev.2007.09.007
Meyfroidt, P., & Lambin, E. F. (2011). *Global Forest Transition: Prospects for an End to Deforestation*. *Annual Review of Environment and Resources* (Vol. 36). https://doi.org/doi:10.1146/annurev-environ-090710-143732
Miettinen, J., Shi, C., & Liew, S. C. (2011). Deforestation rates in insular Southeast Asia between 2000 and 2010. *Global Change Biology*, *17*(7), 2261–2270. https://doi.org/10.1111/j.1365-2486.2011.02398.x
Mimura, M., Yahara, T., Faith, D. P., Vázquez-Domínguez, E., Colautti, R. I., Araki, H., Javadi, F., Núñez-Farfán, J., Mori, A. S., Zhou, S., Hollingsworth, P. M., Neaves, L. E., Fukano, Y., Smith, G. F., Sato, Y.-I., Tachida, H., & Hendry, A. P. (2017). Understanding and monitoring the consequences of human impacts on intraspecific variation. *Evolutionary Applications*, *10*(2), 121–139. https://doi.org/10.1111/eva.12436
Minayeva, T., Bragg, O. M., & Sirin, A. (2017). Towards ecosystem-based restoration of peatland biodiversity. *Mires and Peat*, *19*(1), 1–36.
Minayeva, T., Gunin, P., Sirin, A., Dugardzhav, C., & Bazha, S. (2004). *Peatlands in Mongolia: The typical and disappearing landscape*. *Peatlands International* (Vol. N2).
Minayeva, T., Sirin, A., Dorofeyuk, N., Smagin, V., Bayasgalan, D., Gunin, P., Dugardzhav, C., Bazha, S., Tsedendash, G., & Zoyo, D. (2005). *Mongolian Mires: from taiga to desert / Mires – from Siberia to Tierra del Fuego. Stapfia 85, zugleich Kataloge der OÖ. Landesmuseen Neue Series* (Vol. 35).

Ministry of Environment and Forests Government of India. (2010). *National Mission for a Green India*. Retrieved from http://www.moef.gov.in/sites/default/files/GIM_Mission Document-1.pdf
Ministry of Environment and Forests Government of India. (2014). India's Fifth National Report to the Convention on Biological Diversity. Retrieved from http://www.indiaenvironmentportal.org.in/content/393230/indias-fifth-national-report-to-the-convention-on-biological-diversity-2014/
Ministry of the Environment. (2014). *Integrated Assessment Report of Monitoring Sites 1000 Satoyama 2nd term survey (2007-2012) (in Japanese with English abstract)*. Tokyo, Japan. Retrieved from http://www.biodic.go.jp/moni1000/findings/reports/pdf/second_term_satoyama.pdf
Ministry of the Environment - Government of Japan. (2017). Red List of freshwater and brackish water fish (in Japanese). Retrieved May 5, 2018, from https://www.env.go.jp/press/files/jp/105449.pdf
Misra, A. K., Rao, C. A. R., Subramanyam, K. V., & Ramakrishna, Y. S. (2009). Improving dairy production in India's ranfed agroecosystem: constraints and strategies. *Outlook Agric*, *38*, 284–292.
Miyashita, T., Shinkai, A., & Chida, T. (1998). The effects of forest fragmentation on web spider communities in urban areas. *Biological Conservation*, *86*(3), 357–364. https://doi.org/10.1016/S0006-3207(98)00025-1
Miyashita, T., Tsutsui., M., & Yamanaka, M. (2014). Social-Ecological Restoration in Paddy-Dominated Landscapes. In N. Usio & T. Miyashita (Eds.), *Social-Ecological Restoration in Paddy-Dominated Landscapes* (pp. 283–294). Tokyo: Springer Japan. https://doi.org/10.1007/978-4-431-55330-4
Miyashita, T., Yamanaka, M., & Tsutsui, M. H. (2014). Distribution and Abundance of Organisms in Paddy-Dominated Landscapes with Implications for Wildlife-Friendly Farming. In *Social-Ecological Restoration Paddy-Dominated Landscapes* (pp. 45–65). Springer Japan. https://doi.org/10.1007/978-4-431-55330-4
Moehlman, P. D., Shah, N., & Feh, C. (2008). Equus hemionus. https://doi.org/http://dx.doi.org/10.2305/IUCN.UK.2015-4.RLTS.T7951A45171204.en
Mohan Kumar, B. (2011). Species richness and aboveground carbon stocks in the homegardens of central Kerala, India. *Agriculture, Ecosystems and Environment*, *140*(3–4), 430–440. https://doi.org/10.1016/j.agee.2011.01.006
Mohan Kumar, B., & Nair, P. K. R. (2004). The enigma of tropical homegardens. *Agroforestry Systems*, *61–62*(1–3), 135–152. https://doi.org/10.1023/B:AGFO.0000028995.13227.ca
Mohan Kumar, B., Singh, A. K., & Dhyani, S. K. (2012). South Asian Agroforestry: Traditions, Transformations, and Prospects. In P. K. R. Nair & D. P. Garrity (Eds.), *Agroforestry - The Future of Global Land Use* (Vol. 9, pp. 359–389). Springer Netherlands. https://doi.org/10.1007/978-94-007-4676-3_19
Mohan Kumar, B., & Takeuchi, K. (2009). Agroforestry in the Western Ghats of peninsular India and the satoyama landscapes of Japan: A comparison of two sustainable land use systems. *Sustainability Science*, *4*(2), 215–232. https://doi.org/10.1007/s11625-009-0086-0
Mokany, K., Prasad, S., & Westcott, D. A. (2014). Loss of frugivore seed dispersal services under climate change. *Nature Communications*, *5*(May), 1–7. https://doi.org/10.1038/ncomms4971
Molur, S., Smith, K. G., Daniel, B. A., & Darwall, W. R. T. (2011). *The Status and Distribution of Freshwater Biodiversity in the Western Ghats, India*. Retrieved from https://portals.iucn.org/library/sites/library/files/documents/RL-540-001.pdf
Moore, J. (2015). Ecological footprints and lifestyle archetypes: Exploring dimensions of consumption and the transformation needed to achieve urban sustainability. *Sustainability (Switzerland)*, *7*(4), 4747–4763. https://doi.org/10.3390/su7044747
Morales-Hidalgo, D., Oswalt, S. N., & Somanathan, E. (2015). Status and trends in global primary forest, protected areas, and areas designated for conservation of biodiversity from the Global Forest Resources Assessment 2015. *Forest Ecology and Management*, *352*, 68–77. https://doi.org/10.1016/j.foreco.2015.06.011

Moran, P. J., Bradbury, R. H., & Reichelt, R. E. (1988). Distribution of recent outbreaks of the crown-of-thorns starfish (Acanthaster planci) along the Great Barrier Reef: 1985?1986. *Coral Reefs*, *7*(3), 125–137. https://doi.org/10.1007/BF00300972
Moritsuka, E., Chhang, P., Tagane, S., Toyama, H., Sokh, H., Yahara, T., & Tachida, H. (2017). Genetic variation and population structure of a threatened timber tree Dalbergia cochinchinensis in Cambodia. *Tree Genetics & Genomes*, *13*(6), 115. https://doi.org/10.1007/s11295-017-1199-8
Mortenson, L. A., Flint Hughes, R., Friday, J. B., Keith, L. M., Barbosa, J. M., Friday, N. J., Liu, Z., & Sowards, T. G. (2016). Assessing spatial distribution, stand impacts and rate of Ceratocystis fimbriata induced ʻōhiʻa (Metrosideros polymorpha) mortality in a tropical wet forest, Hawaiʻi Island, USA. *Forest Ecology and Management*. https://doi.org/10.1016/j.foreco.2016.06.026
Morton, S., Lonsdale, M., Sheppard, A., & CSIRO (Eds.). (2014). *Biodiversity : science and solutions for Australia*. *Biodiversity : science and solutions for Australia*. Collingwood, Vic. CSIRO Publishing. Retrieved from www.csiro.au/biodiversitybook
Mouillot, D., Parravicini, V., Bellwood, D. R., Leprieur, F., Huang, D., Cowman, P. F., Albouy, C., Hughes, T. P., Thuiller, W., & Guilhaumon, F. (2016). Global marine protected areas do not secure the evolutionary history of tropical corals and fishes. *Nature Communications*, *7*, 10359. https://doi.org/10.1038/ncomms10359
Mubarak, F. A. (2004). Urban growth boundary policy and residential suburbanization: Riyadh, Saudi Arabia. *Habitat International*, *28*(4), 567–591. https://doi.org/10.1016/j.habitatint.2003.10.010
Mudd, G. M. (2007). Gold mining in Australia: linking historical trends and environmental and resource sustainability. *Environmental Science & Policy*, *10*(7), 629–644. https://doi.org/10.1016/j.envsci.2007.04.006
Mukherjee, S., Appel, A., Duckworth, J. W., Sanderson, J., Dahal, S., Wilcox, D. H. A., Herranz, M. V., Malla, G., Ratnayaka, A., Kantimhanti, M., Thudugala, A., Thaung, R., & Rahman, H. (2016). Prionailurus viverrinus , Fishing Cat, *8235*, 16.
Munday, P. L., Jones, G. P., Pratchett, M. S., & Williams, A. J. (2008). Climate change and the future for coral reef fishes. *Fish and Fisheries*, *9*(3), 261–285. https://doi.org/10.1111/j.1467-2979.2008.00281.x
Murphy, M. T., Garkaklis, M. J., & Hardy, G. E. S. J. (2005). Seed caching by woylies Bettongia penicillata can increase sandalwood Santalum spicatum regeneration in Western Australia. *Austral Ecology*, *30*(7), 747–755. https://doi.org/10.1111/j.1442-9993.2005.01515.x
Mustow, S. E. (2002). Biological monitoring of rivers in Thailand: Use and adaptation of the BMWP score. *Hydrobiologia*, *479*, 191–229. https://doi.org/10.1023/A:1021055926316
Mutke, J., & Barthlott, W. (2005). Patterns of vascular plant diversity at continental to global scales. *Biologiske Skrifter*, *55*, 521–537. https://doi.org/10.3112/erdkunde.2007.04.01
Myers, N., Mittermeier, R. A., Mittermeier, C. G., Da Fonseca, G. A. B., & Kent, J. (2000). Biodiversity hotspots for conservation priorities. *Nature*, *403*(6772), 853–858.
Myers, R. A., Baum, J. K., Shepherd, T. D., Powers, S. P., & Peterson, C. H. (2007). Cascading effects of the loss of apex predatory sharks from a coastal ocean. *Science*, *315*(2007), 1846–1850. https://doi.org/10.1126/science.1138657
Myers, R. A., & Worm, B. (2003). Rapid worldwide depletion of predatory fish communities. *Nature*, *423*(6937), 280–283. https://doi.org/10.1038/nature01610
Nagendra, H., & Gopal, D. (2011). Tree diversity, distribution, history and change in urban parks: Studies in Bangalore, India. *Urban Ecosystems*, *14*(2), 211–223. https://doi.org/10.1007/s11252-010-0148-1
Nair, P. K. R. (2014). Grand challenges in agroecology and land use systems. *Frontiers in Environmental Science*, *2*(January), 1–4. https://doi.org/10.3389/fenvs.2014.00001
Nair, P. K. R., & Garrity, D. (Eds.). (2012). *Agroforestry - The Future of Global Land Use*. *Agroforestry - The Future of Global Land Use* (Vol. 9). Dordrecht: Springer Netherlands. https://doi.org/10.1007/978-94-007-4676-3
Nakai, K., & Kaneko, Y. (2012). Non-indigenous species in and around Lake Biwa. In M. M. Kawanabe H, Nishino M (Ed.), *Lake Biwa: Interactions between Nature and People* (pp. 179–187). Springer.
Nakajima, R., Yamakita, T., Watanabe, H., Fujikura, K., Tanaka, K., Yamamoto, H., & Shirayama, Y. (2014). Species richness and community structure of benthic macrofauna and megafauna in the

deep-sea chemosynthetic ecosystems around the Japanese archipelago: An attempt to identify priority areas for conservation. *Diversity and Distributions*, *20*(10), 1160–1172. https://doi.org/10.1111/ddi.12204

Nater, A., Mattle-Greminger, M. P., Nurcahyo, A., Nowak, M. G., de Manuel, M., Desai, T., Groves, C., Pybus, M., Sonay, T. B., Roos, C., Lameira, A. R., Wich, S. A., Askew, J., Davila-Ross, M., Fredriksson, G., de Valles, G., Casals, F., Prado-Martinez, J., Goossens, B., Verschoor, E. J., Warren, K. S., Singleton, I., Marques, D. A., Pamungkas, J., Perwitasari-Farajallah, D., Rianti, P., Tuuga, A., Gut, I. G., Gut, M., Orozco-terWengel, P., van Schaik, C. P., Bertranpetit, J., Anisimova, M., Scally, A., Marques-Bonet, T., Meijaard, E., & Krützen, M. (2017). Morphometric, Behavioral, and Genomic Evidence for a New Orangutan Species. *Current Biology*, *27*(22), 3487–3498.e10. https://doi.org/10.1016/J.CUB.2017.09.047

Nath, C. D., Schroth, G., & Burslem, D. F. R. P. (2016). Why do farmers plant more exotic than native trees? A case study from the Western Ghats, India. *Agriculture, Ecosystems and Environment*, *230*, 315–328. https://doi.org/10.1016/j.agee.2016.05.013

Naylor, R. l., & Ehrlich, P. R. (1997). Natural Pest Control Services and Agriculture. In G. Daily (Ed.), *Nature's Services: Societal Dependence On Natural Ecosystems* (pp. 151–176). Washington: Island Press. Retrieved from http://books.google.com/books?hl=en&lr=&id=QYJSziDfTjEC&pgis=1

Neboiss, A. (1986). *Atlas of Trichoptera of the SW Pacific — Australian Region*. Dordrecht: Springer Netherlands.

Negi, C. S. (2010). Traditional Culture and Biodiversity Conservation: Examples From Uttarakhand, Central Himalaya. *Mountain Research and Development*, *30*(3), 259–265. https://doi.org/10.1659/MRD-JOURNAL-D-09-00040.1

Nehls, G., Hertzler, I., & Scheiffarth, G. (1997). Stable mussel Mytilus edulis beds in the Wadden Sea—They're just for the birds. *Helgoländer Meeresuntersuchungen*, *51*, 361–372. https://doi.org/10.1007/BF02908720

Nelson, G. C., Rosegrant, M. W., Koo, J., Robertson Sulser, R. T., Zhu, T., Ringler, C., Msangi, S., Palazzo, A., Batka, M., Magalhaes, M., Valmonte-Santos, R., Ewing, M., & Lee, D. (2009). *Climate change and impact on agriculture and cost of adaptation*. *IFPRI Report*. Washington D.C.

Nentwig, W., Bacher, S., Pyšek, P., Vilà, M., & Kumschick, S. (2016). The generic impact scoring system (GISS): a standardized tool to quantify the impacts of alien species. *Environmental Monitoring and Assessment*, *188*(5), 315. https://doi.org/10.1007/s10661-016-5321-4

NEPAC. (1997). *China's Biodiversity: A Country Study*. Beijing: National Environment Protection Agency of China China Environmental Science Press.

Ng, H. H. (2011). Platytropius siamensis. https://doi.org/http://dx.doi.org/10.2305/IUCN.UK.2011-1.RLTS.T180996A7657156.en

Nghiem, L. T. P., Soliman, T., Yeo, D. C. J., Tan, H. T. W., Evans, T. A., Mumford, J. D., Keller, R. P., Baker, R. H. A., Corlett, R. T., & Carrasco, L. R. (2013). Economic and Environmental Impacts of Harmful Non-Indigenous Species in Southeast Asia. *PLoS ONE*, *8*(8). https://doi.org/10.1371/journal.pone.0071255

Nicol, T. (2006). WA's mining boom: where does it leave the environment? *Ecos*, *Oct/Nov*(133), 12. Retrieved from http://connection.ebscohost.com/c/articles/23464320/was-mining-boom-where-does-leave-environment

Nijman, V. (2010). An overview of international wildlife trade from Southeast Asia. *Biodiversity and Conservation*, *19*(4), 1101–1114. https://doi.org/10.1007/s10531-009-9758-4

Nishijima, S., Furukawa, T., Kadoya, T., Ishihama, F., Kastner, T., Matsuda, H., & Kaneko, N. (2016). Evaluating the impacts of wood production and trade on bird extinction risks. *Ecological Indicators*, *71*, 368–376. https://doi.org/10.1016/j.ecolind.2016.07.008

Nishino, M. (2012). Biodiversity of Lake Biwa. In M. M. Kawanabe H, Nishino M (Ed.), *Lake Biwa: Interactions between Nature and People* (pp. 31–35). Springer. https://doi.org/10.1007/978-94-007-1783-1

Norling, P., & Kautsky, N. (2008). Patches of the mussel Mytilus sp. are islands of high biodiversity in subtidal sediment habitats in the Baltic sea. *Aquatic Biology*, *4*(1), 75–87. https://doi.org/10.3354/ab00096

Noroozi, J., Pauli, H., Grabherr, G., & Breckle, S.-W. (2011). The subnival–nival vascular plant species of Iran: a unique high-mountain flora and its threat from climate warming. *Biodiversity and Conservation*, *20*(6), 1319–1338. https://doi.org/10.1007/s10531-011-0029-9

Nunoura, T., Takaki, Y., Hirai, M., Shimamura, S., Makabe, A., Koide, O., Kikuchi, T., Miyazaki, J., Koba, K., Yoshida, N., Sunamura, M., & Takai, K. (2015). Hadal biosphere: Insight into the microbial ecosystem in the deepest ocean on Earth. *Proceedings of the National Academy of Sciences of the United States of America*, *112*(11), E1230-1236. https://doi.org/10.1073/pnas.1421816112

O'Brien, K., Leichenko, R., Kelkar, U., Venema, H., Aandahl, G., Tompkins, H., Javed, A., Bhadwal, S., Barg, S., Nygaard, L., & West, J. (2004). Mapping vulnerability to multiple stressors: climate change and globalization in India. *Global Environmental Change*, *14*(4), 303–313. https://doi.org/10.1016/J.GLOENVCHA.2004.01.001

O'Dor, R., & Gallardo, V. A. (2005). How to Census Marine Life : ocean realm field projects. *Scientia Marina*, *69*(1), 181–199. https://doi.org/10.3989/scimar.2005.69s1181

O'Dowd, D. J., Green, P. T., & Lake, P. S. (2003). Invasional "meltdown" on an oceanic island. *Ecology Letters*. https://doi.org/10.1046/j.1461-0248.2003.00512.x

O'Hara, T. D., Rowden, A. A., & Bax, N. J. (2011). A Southern Hemisphere bathyal fauna is distributed in latitudinal bands. *Current Biology*, *21*(3), 226–230. https://doi.org/10.1016/j.cub.2011.01.002

OBIS. (2017a). Map showing "Completeness for Biota" in 1 degree cells in the Robinson sphere projection with a Pacific Central Meridian. Retrieved September 18, 2017, from http://iobis.org/data/maps/

OBIS. (2017b). Map showing "Number of records" in 1 degree cells in the Robinson sphere projection with a Pacific Central Meridian. Retrieved September 18, 2017, from http://iobis.org/data/maps/

OBIS. (2017c). Map showing "Red List species" in 1 degree cells in the Robinson sphere projection with a Pacific Central Meridian. Retrieved September 18, 2017, from http://iobis.org/data/maps/

OBIS. (2017d). Map showing "Shannon index" in 1 degree cells in the Robinson sphere projection with a Pacific Central Meridian. Retrieved September 18, 2017, from http://iobis.org/data/maps/

Ofenböck, T., Moog, O., & Sharma, S. (2008). Development and application of the HKH Biotic Score to assess the river quality in the Hindu Kush-Himalaya. In *ASSESS-HKH: Proceeding of the Scientific Conference "Rivers in the Hindu Kush-Himalaya-Ecology & Environmental Assessment* (pp. 25–32). Springer. Retrieved from https://link.springer.com/article/10.1007/s10750-010-0289-5

Oh, I.-C., & Kang, Y. (2013). *Sustainable Development of Eco-Friendly Traditional Lifestyle in Rural Ethnic Minority Areas in Yunnan*.

Ohgaki, S., Komemoto, K., & Funayama, N. (2011). *A record of the intertidal malacofauna of Cape Bansho, Wakayama, Japan, from 1985 to 2010. Publications of the Seto Marine Biological Laboratory. Special publication series* (Vol. 11). Seto Marine Biological Laboratory.

Okubo, S., Parikesit, Harashina, K., Muhamad, D., Abdoellah, O. S., & Takeuchi, K. (2010). Traditional perennial crop-based agroforestry in West Java: the tradeoff between on-farm biodiversity and income. *Agroforestry Systems*, *80*(1), 17–31. https://doi.org/10.1007/s10457-010-9341-8

Olson, D. M., Dinerstein, E., Wikramanayake, E. D., Burgess, N. D., Powell, G. V. N., Underwood, E. C., D'amico, J. a., Itoua, I., Strand, H. E., Morrison, J. C., Loucks, C. J., Allnutt, T. F., Ricketts, T. H., Kura, Y., Lamoreux, J. F., Wettengel, W. W., Hedao, P., & Kassem, K. R. (2001). Terrestrial Ecoregions of the World: A New Map of Life on Earth. *BioScience*, *51*(11), 933. https://doi.org/10.1641/0006-3568(2001)051[0933:TEOTWA]2.0.CO;2

Ormsby, A. A., & Bhagwat, S. A. (2010). Sacred forests of India: a strong tradition of community-based natural resource management. *Environmental Conservation*, *37*(03), 320–326. https://doi.org/10.1017/S0376892910000561

Ostertag, R., Inman-Narahari, F., Cordell, S., Giardina, C. P., & Sack, L. (2014). Forest structure in low-diversity tropical forests: a study of Hawaiian wet and dry forests. *PloS One*, *9*(8), e103268. https://doi.org/10.1371/journal.pone.0103268

Osuri, A. M., Ratnam, J., Varma, V., Alvarez-Loayza, P., Astaiza, J. H., Bradford, M., Fletcher, C., Ndoundou-Hockemba, M., Jansen, P. A., Kenfack, D., Marshall, A. R., Ramesh, B. R., Rovero, F., & Sankaran, M. (2016). Contrasting effects of defaunation on aboveground carbon storage across the global tropics. *NATURE COMMUNICATIONS*, *7*(11351), 829–834. https://doi.org/10.1038/ncomms11351

Otsuka, K., Liu, Y., & Yamauchi, F. (2016). The future of small farms in Asia. *Development Policy Review*, *34*(3), 441–461. https://doi.org/10.1111/dpr.12159

Ouyang, Z., Fan, P., & Chen, J. (2016). Urban Built-up Areas in Transitional Economies of Southeast Asia: Spatial Extent and Dynamics. *Remote Sensing*, *8*(10), 819. https://doi.org/10.3390/rs8100819

Pacini, N., & Harper, D. M. (2008). Aquatic, semi-aquatic and riparian vertebrates. In *Tropical Stream Ecology* (pp. 147–197). https://doi.org/10.1016/B978-012088449-0.50008-X

Padmanaba, M., Tomlinson, K. W., Hughes, A. C., & Corlett, R. T. (2017). Alien plant invasions of protected areas in Java, Indonesia. *Scientific Reports*. https://doi.org/10.1038/s41598-017-09768-z

Pain, D., Green, R., & Clark, N. (2011). On the edge : can the Spoon-billed Sandpiper Eurynorhynchus pygmeus be saved ? *BirdingASIA*, *15*(July 2005), 26–35.

Panigrahy, S., Anitha, D., Kimothi, M. M., & Singh, S. P. (2010). Timberline change detection using topographic map and satellite imagery. *Tropical Ecology*, *51*(1), 87–91. Retrieved from http://www.scopus.com/inward/record.url?eid=2-s2.0-70449096294&partnerID=40&md5=6452b0d7c46212ce73106ebb4a52f962

Panigrahy, S., Patel, J. G., & Parihar, J. S. (Eds.). (2012). *National Wetland Atlas. High Altitude Lakes on India*. *Advances in Remote Sensing* (Vol. 18). https://doi.org/10.1016/B978-0-444-52734-9.50009-8

Paoli, G. D., Wells, P. L., Meijaard, E., Struebig, M. J., Marshall, A. J., Obidzinski, K., Tan, A., Rafiastanto, A., Yaap, B., Ferry Slik, J., Morel, A., Perumal, B., Wielaard, N., Husson, S., & D'Arcy, L. (2010). Biodiversity Conservation in the REDD. *Carbon Balance and Management*, *5*(1), 9. https://doi.org/10.1186/1750-0680-5-7

Parikesit, Takeuchi, K., Tsunekawa, A., & Abdoellah, O. S. (2005). Kebon tatangkalan: A disappearing agroforest in the Upper Citarum Watershed, West Java, Indonesia. *Agroforestry Systems*, *63*(2), 171–182. https://doi.org/10.1007/s10457-004-1182-x

Parish, F., Sirin, A., Charman, D., Joosten, H., Minayeva, T., & Silvius, M. (2008). *Assessment of Peatlands, Biodiversity and Climate Change: Main Report*. Wageningen. Retrieved from http://www.imcg.net/media/download_gallery/books/assessment_peatland.pdf

Parmesan, C. (2006). Ecological and Evolutionary Responses to Recent Climate Change. *Annual Review of Ecology, Evolution, and Systematics*, *37*(1), 637–669. https://doi.org/10.1146/annurev.ecolsys.37.091305.110100

Pauly, D. (1994). From growth to Malthusian overfishing: stages of fisheries resources misuse. *Traditional Marine Resource Management and Knowledge Information Bulletin 3*, 7–14.

Pauly, D., Silvestre, G., & Smith, I. R. (1989). On Development, Fisheries and Dynamite: a Brief Review of Tropical Fisheries Management. *Natural Resource Modeling*, *3*(3), 307–329. https://doi.org/10.1111/j.1939-7445.1989.tb00084.x

Pauly, D., Watson, R., & Alder, J. (2005). Global trends in world fisheries: impacts on marine ecosystems and food security. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences*, *360*(1453), 5–12. https://doi.org/10.1098/rstb.2004.1574

Pauly, D., & Zeller, D. (2017). Comments on FAOs State of World Fisheries and Aquaculture (SOFIA 2016). *Marine Policy*, *77*, 176–181. https://doi.org/https://doi.org/10.1016/j.marpol.2017.01.006

Peduzzi, P. (2014). Sand, rarer than one thinks. Article reproduced from United Nations Environment Programme (UNEP) Global Environmental Alert Service (GEAS). *Environmental Development*, *11*, 208–218. https://doi.org/10.1016/j.envdev.2014.04.001

Peyre, A., Guidal, A., Wiersum, K. F., & Bongers, F. (2006). Dynamics of homegarden structure and function in Kerala, India. *Agroforestry Systems*, *66*(2), 101–115. https://doi.org/10.1007/s10457-005-2919-x

Phelps, J., & Webb, E. L. (2015). “Invisible” wildlife trades: Southeast Asia’s undocumented illegal trade in wild ornamental plants. *Biological Conservation*, *186*(June), 296–305. https://doi.org/10.1016/j.biocon.2015.03.030
Phillips, H. R. P., Newbold, T., & Purvis, A. (2017). Land-use effects on local biodiversity in tropical forests vary between continents. *Biodiversity and Conservation*, *26*(9), 2251–2270. https://doi.org/10.1007/s10531-017-1356-2
Pimm, S. L., & Joppa, L. N. (2015). How Many Plant Species are There, Where are They, and at What Rate are They Going Extinct? *Annals of the Missouri Botanical Garden*, *100*(3), 170–176. https://doi.org/10.3417/2012018
Pippard, H. (2012). *The current status and distribution of freshwater fishes, land snails and reptiles in the Pacific Islands of Oceania*.
Polidoro, B. A., Carpenter, K. E., Collins, L., Duke, N. C., Ellison, A. M., Ellison, J. C., Farnsworth, E. J., Fernando, E. S., Kathiresan, K., Koedam, N. E., Livingstone, S. R., Miyagi, T., Moore, G. E., Nam, V. N., Ong, J. E., Primavera, J. H., Salmo, S. G., Sanciangco, J. C., Sukardjo, S., Wang, Y., & Yong, J. W. H. (2010). The loss of species: Mangrove extinction risk and geographic areas of global concern. *PLoS ONE*, *5*(4). https://doi.org/10.1371/journal.pone.0010095
Pollack, J. B., Cleveland, A., Palmer, T. A., Reisinger, A. S., & Montagna, P. A. (2012). A restoration suitability index model for the Eastern Oyster (Crassostrea virginica) in the Mission-Aransas Estuary, TX, USA. *PLoS ONE*, *7*(7). https://doi.org/10.1371/journal.pone.0040839
Pollock, L. J., Thuiller, W., & Jetz, W. (2017). Large conservation gains possible for global biodiversity facets. *Nature*, *546*(7656), 141–144. https://doi.org/10.1038/nature22368
Potts, S. G., Imperatriz-Fonseca, V., Ngo, H. T., Aizen, M. A., Biesmeijer, J. C., Breeze, T. D., Dicks, L. V., Garibaldi, L. A., Hill, R., Settele, J., & Vanbergen, A. J. (2016). Safeguarding pollinators and their values to human well-being. *Nature*, *540*(7632), 220–229. https://doi.org/10.1038/nature20588
Primavera, J. H. (1997). Socio-economic impacts of shrimp culture. *Aquaculture Research*, *28*(10), 815–827. https://doi.org/10.1111/j.1365-2109.1997.tb01006.x
Pyšek, P., Blackburn, T. M., García-Berthou, E., Perglová, I., & Rabitsch, W. (2017). Displacement and Local Extinction of Native and Endemic Species. In *Impact of Biological Invasions on Ecosystem Services* (pp. 157–175). Cham: Springer International Publishing. https://doi.org/10.1007/978-3-319-45121-3_10
Qing, N., Qiu, C. F., Liao, W. Q., Ma, T. F., Liang, X. X., & Lie, J. N. (2010). Population genetic variations and phylogeography of Micronoemacheilus pulcher Nichols based on mtDNA control region. *Acta Ecologica Sinica*, *30*(1), 258–264. Retrieved from http://www.ecologica.cn/stxb/ch/reader/view_abstract.aspx?flag=1&file_no=stxb200809130028&journal_id=stxb
Qu, T.-B., Du, W.-C., Yuan, X., Yang, Z.-M., Liu, D.-B., Wang, D.-L., & Yu, L.-J. (2016). Impacts of Grazing Intensity and Plant Community Composition on Soil Bacterial Community Diversity in a Steppe Grassland. *PloS One*, *11*(7), e0159680. https://doi.org/10.1371/journal.pone.0159680
Queiroz, C., Beilin, R., Folke, C., & Lindborg, R. (2014). Farmland abandonment: Threat or opportunity for biodiversity conservation? A global review. *Frontiers in Ecology and the Environment*, *12*(5), 288–296. https://doi.org/10.1890/120348
Race, D., Mathew, S., Campbell, M., & Hampton, K. (2016). Understanding climate adaptation investments for communities living in desert Australia: experiences of indigenous communities. *Climatic Change*, *139*(3–4), 461–475. https://doi.org/10.1007/s10584-016-1800-4
Raes, N., Roos, M. C., Slik, J. W. F., Van Loon, E. E., & Steege, H. Ter. (2009). Botanical richness and endemicity patterns of Borneo derived from species distribution models. *Ecography*, *32*(1), 180–192. https://doi.org/10.1111/j.1600-0587.2009.05800.x
Raes, N., Saw, L. G., van Welzen, P. C., & Yahara, T. (2013). Legume diversity as indicator for botanical diversity on Sundaland, South East Asia. *South African Journal of Botany*, *89*, 265–272. https://doi.org/10.1016/j.sajb.2013.06.004
Raghavan, R., & Ali, A. (2013). Puntius deccanensis. *The IUCN Red List of Threatened Species 2013: E.T172345A6872881*. Retrieved from http://dx.doi.org/10.2305/IUCN.UK.2011-1.RLTS.T172345A6872881.en

Rama Rao, C. A., Raju, B. M. K., Subba Rao, A. V. M., Rao, K. V., Rao, V. U. M., Ramachandran, K., Venkateswarlu, B., Sikka, A. K., Srinivasa Rao, M., Maheswari, M., & Srinivasa Rao, C. (2016). A district level assessment of vulnerability of Indian agriculture to climate change. *Current Science*, *110*(10). Retrieved from https://pdfs.semanticscholar.org/9e2c/74fa474cfe7a0a27d3c32513d2b2d9056165.pdf

Ramakrishnan, P. S. (2004). *Globally Important Ingenious Agricultural Heritage Systems (GIAHS): An Eco-Cultural Landscape Perspective*. Retrieved from http://www.fao.org/fileadmin/user_upload/giahs/docs/backgroundpapers_ramakrishnan.pdf

Raman, A. V., Damodaran, R., Levin, L. A., Ganesh, T., Rao, Y. K. V, Nanduri, S., & Madhusoodhanan, R. (2015). Macrobenthos relative to the oxygen minimum zone on the East Indian margin, Bay of Bengal. *Marine Ecology*, *36*(3), 679–700. https://doi.org/10.1111/maec.12176

Ramsar Convention. (2012). Classification System for Wetland Type: The Ramsar Convention definition of "wetland" and classification system for wetland type. Retrieved from http://ramsar.rgis.ch/cda/en/ramsar-documents-guidelines-classification-system/main/ramsar/1-31-105%5E21235_4000_0

Ramsar Convention Secretariat. (2017). The Ramsar Sites Information Service. Retrieved from https://rsis.ramsar.org/

Rasquinha, D. N., & Sankaran, M. (2016). Modelling biome shifts in the Indian subcontinent under scenarios of future climate change. *Current Science*, *111*(1), 147–156. https://doi.org/10.18520/cs/v111/i1/147-156

Ratnam, J., Tomlinson, K. W., Rasquinha, D. N., & Sankaran, M. (2016). Savannahs of Asia: antiquity, biogeography, and an uncertain future. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *371*(1703), 20150305. https://doi.org/10.1098/rstb.2015.0305

Ravanera, R. R., & Gorra, V. (2011). *Commercial pressures on land in Asia: An overview*. Philippines.

Rawal, R. S., Gairola, S., & Dhar, U. (2012). Effects of disturbance intensities on vegetation patterns in oak forests of Kumaun, west Himalaya. *Journal of Mountain Science*, *9*(2), 157–165. https://doi.org/10.1007/s11629-012-2029-y

Rawat, G. S., & Adhikari, B. S. (Eds.). (2015). *Ecology and Management of Grassland Habitats in India, ENVIS Bulletin*. *Wildlife and Protected Areas.* (Vol. 17). Dehradun-248001, India.

Reich, P. B., Tilman, D., Isbell, F., Mueller, K., Hobbie, S. E., Flynn, D. F. B., & Eisenhauer, N. (2012). Impacts of Biodiversity Loss Escalate Through Time as Redundancy Fades. *Science*, *336*(6081), 589–592. https://doi.org/10.1126/science.1217909

Renton, A. (2008, July). No net gain from empty seas. Retrieved from http://www.guardian.co.uk/books/2008/jul/13/scienceandnature.features

Reopanichkul, P., Schlacher, T. A., Carter, R. W., & Worachananant, S. (2009). Sewage impacts coral reefs at multiple levels of ecological organization. *Marine Pollution Bulletin*, *58*(9), 1356–1362. https://doi.org/10.1016/J.MARPOLBUL.2009.04.024

Republic of the Philippines. (2014). The Fifth National Report to the Convention on Biological Diversity - Republic of the Philippines.

Rerkasem, K., Lawrence, D., Padoch, C., Schmidt-Vogt, D., Ziegler, A. D., & Bruun, T. B. (2009). Consequences of swidden transitions for crop and fallow biodiversity in southeast asia. *Human Ecology*, *37*(3), 347–360. https://doi.org/10.1007/s10745-009-9250-5

Rex, M. A., & Etter, R. J. (1998). Bathymetric patterns of body size: Implications for deep-sea biodiversity. *Deep-Sea Research Part II: Topical Studies in Oceanography*, *45*(1–3), 103–127. https://doi.org/10.1016/S0967-0645(97)00082-9

Reyes, M., Engel, M., May, S. M., Brill, D., & Brueckner, H. (2015). Life and death after super typhoon Haiyan. *Coral Reefs*, *34*(2), 419–419. https://doi.org/10.1007/s00338-015-1259-1

Reynolds, J. F., Smith, D., Stafford, M., Lambin, E. F., Turner, B. L., Mortimore, M., Batterbury, S. P. J., Downing, T. E., Dowlatabadi, H., Fernández, R. J., Herrick, J. E., Huber-Sannwald, E., Jiang, H., Leemans, R., Lynam, T., Maestre, F. T., Ayarza, M., & Walker, B. (2007). Global desertification: building a science for dryland development. *Science (New York, N.Y.)*, *316*(5826), 847–851. https://doi.org/10.1126/science.1131634

Reynolds, T. W., Waddington, S. R., Anderson, C. L., Chew, A., True, Z., & Cullen, A. (2015). Environmental impacts and constraints associated with the production of major food crops in Sub-Saharan Africa and South Asia. *Food Security*, *7*(4), 795–822. https://doi.org/10.1007/s12571-015-0478-1

Ribera, I., & Vogler, A. P. (2000). Habitat type as a determinant of species range sizes: The example of lotic-lentic differences in aquatic Coleoptera. *Biological Journal of the Linnean Society*, *71*(1), 33–52. https://doi.org/10.1006/bijl.1999.0412

Richards, D. R., Friess, D. A., & Hansen, M. C. (2016). Rates and drivers of mangrove deforestation in Southeast Asia, 2000–2012. *PNAS*, *113*(2), 344–349. https://doi.org/10.1073/pnas.1510272113

Richardson, A. J., & Gibbons, M. J. (2008). Are jellyfish increasing in response to ocean acidification? *Limnology and Oceanography*, *53*(5), 2040–2045. https://doi.org/10.4319/lo.2008.53.5.2040

Richardson, D. M., & Rejmánek, M. (2011). Trees and shrubs as invasive alien species - a global review. *Diversity and Distributions*. https://doi.org/10.1111/j.1472-4642.2011.00782.x

Ricketts, T. H., Dinerstein, E., Boucher, T., Brooks, T. M., Butchart, S. H. M., Hoffmann, M., Lamoreux, J. F., Morrison, J., Parr, M., Pilgrim, J. D., Rodrigues, A. S. L., Sechrest, W., Wallace, G. E., Berlin, K., Bielby, J., Burgess, N. D., Church, D. R., Cox, N., Knox, D., Loucks, C., Luck, G. W., Master, L. L., Moore, R., Naidoo, R., Ridgely, R., Schatz, G. E., Shire, G., Strand, H., Wettengel, W., & Wikramanayake, E. (2005). Pinpointing and preventing imminent extinctions. *Proceedings of the National Academy of Sciences of the United States of America*, *102*(51), 18497–18501. https://doi.org/10.1073/pnas.0509060102

Roberts, C. (2007). *The Unnatural History of the Sea*. *Island Press*. Washington, DC: Island Press/Shearwater Books. Retrieved from http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:The+unnatural+history+of+the+sea#1

Rodda, G. H., & Fritts, T. H. (1993). The brown tree snake on Pacific islands. 1993 Status. *Pacific Science Association Information Bulletin*, *45*(3–4), 1–3. Retrieved from https://pubs.er.usgs.gov/publication/5223742

Rodrigues, A. S. L., Brooks, T. M., Butchart, S. H. M., Chanson, J., Cox, N., Hoffmann, M., & Stuart, S. N. (2014). Spatially Explicit Trends in the Global Conservation Status of Vertebrates. *PLoS ONE*, *9*(11), e113934. https://doi.org/10.1371/journal.pone.0113934

Rogers, D. I., Yang, H. Y., Hassell, C. J., Boyle, A. N., Rogers, K. G., Chen, B., Zhang, Z. W., & Piersma, T. (2010). Red Knots (Calidris canutus piersmai and C. c. rogersi) depend on a small threatened staging area in Bohai Bay, China. *Emu*, *110*(4), 307–315. https://doi.org/10.1071/MU10024

Rogers, H. S., Buhle, E. R., HilleRisLambers, J., Fricke, E. C., Miller, R. H., & Tewksbury, J. J. (2017). Effects of an invasive predator cascade to plants via mutualism disruption. *Nature Communications*. https://doi.org/10.1038/ncomms14557

Rose, M., Posa, C., Wijedasa, L. S., & Corlett, R. T. (2011). Biodiversity and Conservation of Tropical Peat Swamp Forests. *BioScience, 61*(49), 49–57. https://doi.org/10.1525/bio.2011.61.1.10

Rots, A. (2015). Sacred Forests, Sacred Nation. *Japanese Journal of Religious Studies*, *42*(2), 205–233.

Ruesink, J. L., Lenihan, H. S., Trimble, A. C., Heiman, K. W., Micheli, F., Byers, J. E., & Kay, M. C. (2005). INTRODUCTION OF NON-NATIVE OYSTERS: Ecosystem Effects and Restoration Implications. *Annual Review of Ecology, Evolution, and Systematics*, *36*(1), 643–689. https://doi.org/10.1146/annurev.ecolsys.36.102003.152638

Russ, G. R., & Alcala, A. C. (1998). Natural fishing experiments in marine reserves 1983-1993: Community and trophic responses. *Coral Reefs*, *17*(4), 383–397. https://doi.org/10.1007/s003380050144

Russell-Smith, J., Yates, C., Edwards, A., Allan, G. E., Cook, G. D., Cooke, P., Craig, R., Heath, B., Smith, R., Russell-Smith, J., Yates, C., Edwards, A., Allan, G. E., Cook, G. D., Cooke, P., Craig, R., Heath, B., & Smith, R. (2003). Contemporary fire regimes of northern Australia, 1997–2001:

change since Aboriginal occupancy, challenges for sustainable management. *International Journal of Wildland Fire*, *12*(4), 283. https://doi.org/10.1071/WF03015
Rydin, H., & Jeglum, J. (2013). *The Biology of Peatlands*. (O. U. Press., Ed.) (2nd ed.). Oxford.
Saalfeld, W. K., Edwards, G. P., Drucker, A. G., Edwards, G. P., Saalfeld, W. K., Edwards, G. P., Eldridge, S. R., Wurst, D., Berman, D. M., Garbin, V., Edwards, G. P., Saalfeld, K., Clifford, B., Edwards, G. P., Zeng, B., Saalfeld, W. K., Vaarzon-Morel, P., Grigg, G. C., Pople, A. R., Beard, L. A., Lamb, D. S., Saalfeld, W. K., McGregor, M. J., Edwards, G. P., Zeng, B., Vaarzon-Morel, P., Marsh, H., Sinclair, D. F., McLeod, S. R., Pople, A. R., Pople, A. R., McLeod, S. R., Short, J., Caughley, G., Grice, D., Brown, B., Zeng, B., & Edwards, G. P. (2010). Distribution and abundance of the feral camel (*Camelus dromedarius*) in Australia. *The Rangeland Journal*, *32*(1), 1. https://doi.org/10.1071/RJ09058
Sadovy de Mitcheson, Y., Craig, M. T., Bertoncini, A. A., Carpenter, K. E., Cheung, W. W. L., Choat, J. H., Cornish, A. S., Fennessy, S. T., Ferreira, B. P., Heemstra, P. C., Liu, M., Myers, R. F., Pollard, D. A., Rhodes, K. L., Rocha, L. A., Russell, B. C., Samoilys, M. A., & Sanciangco, J. (2013). Fishing groupers towards extinction: A global assessment of threats and extinction risks in a billion dollar fishery. *Fish and Fisheries*, *14*(2), 119–136. https://doi.org/10.1111/j.1467-2979.2011.00455.x
Sadovy, Y. (2005). Trouble on the reef: the imperative for managing vulnerable and valuable fisheries. *Fish and Fisheries*, *6*(3), 167–185. https://doi.org/10.1111/j.1467-2979.2005.00186.x
Sadovy, Y., Kulbicki, M., Labrosse, P., Letourneur, Y., Lokani, P., & Donaldson, T. J. (2003). The Humphead Wrasse, Cheilinus Undulatus: Synopsis of a Threatened and Poorly Known Giant Coral Reef Fish. *Reviews in Fish Biology and Fisheries*, *13*(3), 327–364. https://doi.org/10.1023/B:RFBF.0000033122.90679.97
Safaei-Mahroo, B., Ghaffari, H., Fahimi, H., Yazdanian, S. B. M., Majd, E. N., Rezazadeh, S. S. H. Y. E., Hosseinzadeh, M. S., Nasrabadi, R., Rajabizadeh, M., Mashayekhi, M., Motesharei, A., Nader, A., & Kazemi, S. M. (2015). The Herpetofauna of Iran: Checklist of Taxonomy, Distribution and Conservation Status. *Asian Herpetological Research*, *6*(4), 257–290. https://doi.org/10.16373/j.cnki.ahr.140062
Sahani, M., Zainon, N. A., Wan Mahiyuddin, W. R., Latif, M. T., Hod, R., Khan, M. F., Tahir, N. M., & Chan, C. C. (2014). A case-crossover analysis of forest fire haze events and mortality in Malaysia. *Atmospheric Environment*, *96*, 257–265. https://doi.org/10.1016/j.atmosenv.2014.07.043
Saito, T., Hirabayashi, Y., Suzuki, K., Watanabe, K., & Saito, H. (2016). Recent Decline of Pink Salmon (Oncorhynchus gorbuscha) Abundance in Japan. *North Pacific Anadromous Fish Commission Bulletin*, (6), 279–296. https://doi.org/10.23849/npafcb6/279.296
Sandhu, H., Porter, J., & Wratten, S. (2013). Experimental Assessment of Ecosystem Services in Agriculture. In S. Wratten, H. Sandhu, R. Cullen, & R. Costanza (Eds.), *Ecosystem Services in Agricultural and Urban Landscapes* (1st ed., pp. 122–135). Oxford: John Wiley & Sons, Ltd. https://doi.org/10.1002/9781118506271.ch8
Sandhu, H. S., Crossman, N. D., & Smith, F. P. (2012). Ecosystem services and Australian agricultural enterprises. *Ecological Economics*, *74*, 19–26. https://doi.org/10.1016/j.ecolecon.2011.12.001
Sasaki, T., Imanishi, J., Fukui, W., & Morimoto, Y. (2016). Fine-scale characterization of bird habitat using airborne LiDAR in an urban park in Japan. *Urban Forestry and Urban Greening*, *17*, 16–22. https://doi.org/10.1016/j.ufug.2016.03.007
Sax, D. F., & Gaines, S. D. (2008). Species invasions and extinction: The future of native biodiversity on islands. *Proceedings of the National Academy of Sciences*. https://doi.org/10.1073/pnas.0802290105
Scanlon, A. T., Petit, S., Tuiwawa, M., & Naikatini, A. (2014). High similarity between a bat-serviced plant assemblage and that used by humans. *Biological Conservation*, *174*, 111–119. https://doi.org/10.1016/j.biocon.2014.03.023
Schnell, S., Altrell, D., Ståhl, G., & Kleinn, C. (2015). The contribution of trees outside forests to national tree biomass and carbon stocks—a comparative study across three continents. *Environmental Monitoring and Assessment*, *187*(1), 4197. https://doi.org/10.1007/s10661-014-4197-4

Schnell, S., Kleinn, C., & Ståhl, G. (2015). Monitoring trees outside forests: a review. *Environmental Monitoring and Assessment*, *187*(9), 600. https://doi.org/10.1007/s10661-015-4817-7

Schulte, D. M., Burke, R. P., & Lipcius, R. N. (2009). Unprecedented restoration of a native oyster metapopulation. *Science*, *325*(5944), 1124–1128. https://doi.org/10.1126/science.1176516

Scott, P., & Williams, N. (2014). Phytophthora diseases in New Zealand forests. *New Zealand Journal of Forestry*, *59*(2), 15.

Scott, S. D. (2007). The Dawning of Deep Sea Mining of Metallic Sulfides: The Geologic Perspective. In *Proceedings of The Seventh (2007) ISOPE Ocean Mining Symposium, July 1-6, 2007*. Lisbon, Portugal: The International Society of Offshore and Polar Engineers (ISOPE). Retrieved from http://www.isope.org/publications/proceedings/ISOPE_OMS/OMS 2007/papers/M07OMS-22scott.pdf

Seddon, S., Connolly, R. M., & Edyvane, K. S. (2000). Large-scale seagrass dieback in northern Spencer Gulf, South Australia. *Aquatic Botany*, *66*(4), 297–310. https://doi.org/10.1016/S0304-3770(99)00080-7

Seebens, H., Blackburn, T. M., Dyer, E. E., Genovesi, P., Hulme, P. E., Jeschke, J. M., Pagad, S., Pyšek, P., Winter, M., Arianoutsou, M., Bacher, S., Blasius, B., Brundu, G., Capinha, C., Celesti-Grapow, L., Dawson, W., Dullinger, S., Fuentes, N., Jäger, H., Kartesz, J., Kenis, M., Kreft, H., Kühn, I., Lenzner, B., Liebhold, A., Mosena, A., Moser, D., Nishino, M., Pearman, D., Pergl, J., Rabitsch, W., Rojas-Sandoval, J., Roques, A., Rorke, S., Rossinelli, S., Roy, H. E., Scalera, R., Schindler, S., Štajerová, K., Tokarska-Guzik, B., Van Kleunen, M., Walker, K., Weigelt, P., Yamanaka, T., & Essl, F. (2017). No saturation in the accumulation of alien species worldwide. *Nature Communications*. https://doi.org/10.1038/ncomms14435

Settele, J., Spangenberg, J. H., Heong, K. L., Burkhard, B., Bustamante, J. V., Cabbigat, J., Van Chien, H., Escalada, M., Grescho, V., Hai, L. H., Harpke, A., Horgan, F. G., Hotes, S., Jahn, R., Kühn, I., Marquez, L., Schädler, M., Tekken, V., Vetterlein, D., Villareal, S. "Bong," Westphal, C., & Wiemers, M. (2015). Agricultural landscapes and ecosystem services in South-East Asia—the LEGATO-Project. *Basic and Applied Ecology*, *16*(8), 661–664. https://doi.org/10.1016/j.baae.2015.10.003

Sexton, J. O., Noojipady, P., Song, X.-P., Feng, M., Song, D.-X., Kim, D.-H., Anand, A., Huang, C., Channan, S., Pimm, S. L., & Townshend, J. R. (2015). Conservation policy and the measurement of forests. *Nature Climate Change*, *6*(October), 1–6. https://doi.org/10.1038/nclimate2816

Shabani, F., Kumar, L., Ahmadi, M., & Esmaeili, A. (2017). Are research efforts on Animalia in the South Pacific associated with the conservation status or population trends? *Journal for Nature Conservation*, *39*, 1–36. https://doi.org/10.1016/j.jnc.2017.06.004

Shaheen, H., & Mashwani, Z. (2015). Spatial patterns and diversity of alpine vegetation across Langer – Shandur Valley , Hindukush. *Current Science*, *108*(8), 1534–1539.

Shahid, S., & Behrawan, H. (2008). Drought risk assessment in the western part of Bangladesh. *Natural Hazards*, *46*(3), 391–413. https://doi.org/10.1007/s11069-007-9191-5

Shanker, K., & Pilcher, N. J. (2003). Marine turtles in south and southeast Asia: hopeless cause or cause for hope? *Marine Turtle Newsletter*, *100*, 43–51.

Sharrock, S., Oldfield, S., & Wilson, O. (2014). *Plant conservation report 2014: 81*. *Technical Series*.

Sharrow, S. H. (1999). Silvopastoralism: competition and facilitation between trees, livestock, and improved grass-clover pastures on temperate rainfed lands. In L. J. Buck LE (Ed.), *Agroforestry in sustainable agricultural systems* (pp. 111–130). Boca Raton: CRC Press.

Shen, X., Li, S., Wang, D., & Lu, Z. (2015). Viable contribution of Tibetan sacred mountains in southwestern China to forest conservation. *Conservation Biology*, *29*(6), 1518–1526. https://doi.org/10.1111/cobi.12587

Sheppard, C. R. C., Ateweberhan, M., Bowen, B. W., Carr, P., Chen, C. A., Clubbe, C., Craig, M. T., Ebinghaus, R., Eble, J., Fitzsimmons, N., Gaither, M. R., Gan, C.-H., Gollock, M., Guzman, N., Graham, N. A. J., Harris, A., Jones, R., Keshavmurthy, S., Koldewey, H., Lundin, C. G., Mortimer, J. A., Obura, D., Pfeiffer, M., Price, A. R. G., Purkis, S., Raines, P., Readman, J. W., Riegl, B., Rogers, A., Schleyer, M., Seaward, M. R. D., Sheppard, A. L. S., Tamelander, J., Turner, J. R., Visram, S., Vogler, C., Vogt, S., Wolschke, H., Yang, J. M.-C., Yang, S.-Y., & Yesson, C. (2012). Reefs and islands of the Chagos Archipelago, Indian Ocean: why it is the world's largest no-take marine protected area. *Aquatic Conservation: Marine and Freshwater Ecosystems*, *22*(2), 232–261. https://doi.org/10.1002/aqc.1248

Shirayama, Y. (1984). The abundance of deep sea meiobenthos in the Western Pacific in relatoin to environmentral factors. *Oceanologica Acta*, *7*, 113–121.

Shirayama, Y., & Kojima, S. (1994). Abundance of deep-sea meiobenthos off Sanriku, Northeastern Japan. *Journal of Oceanography*, *50*(1), 109–117. https://doi.org/10.1007/BF02233860

Shobrak, M. Y. (2015). Trapping of Saker Falcon Falco cherrug and Peregrine Falcon Falco peregrinus in Saudi Arabia: Implications for biodiversity conservation. *Saudi Journal of Biological Sciences*, *22*(4), 491–502. https://doi.org/10.1016/j.sjbs.2014.11.024

Short, F., Carruthers, T., Dennison, W., & Waycott, M. (2007). Global seagrass distribution and diversity: A bioregional model. *Journal of Experimental Marine Biology and Ecology*, *350*(1–2), 3–20. https://doi.org/10.1016/j.jembe.2007.06.012

Shrestha, A. B., & Aryal, R. (2011). Climate change in Nepal and its impact on Himalayan glaciers. *Regional Environmental Change*, *11*(SUPPL. 1), 65–77. https://doi.org/10.1007/s10113-010-0174-9

Silva, L. C. R. (2014). Natural history and evolution of the Kwongan – a global biodiversity hotspot. https://doi.org/10.1016/j.tplants.2014.08.002

Sing, K. W., Jusoh, W. F. A., Hashim, N. R., & Wilson, J. J. (2016). Urban parks: refuges for tropical butterflies in Southeast Asia? *Urban Ecosystems*, *19*(3), 1131–1147. https://doi.org/10.1007/s11252-016-0542-4

Singh, H. P., Sharma, K. D., Reddy, G. S., & Sharma, K. L. (2004). Dryland agriculture in India. In *Challenges and Strategies for Dryland Agriculture* (No. 32, p. 16). Madison, USA.: Special Publ.

Singh, R. P. B., & Rana, C. S. (2016). Indian Sacred Natural Sites: Ancient Traditions of Reverence and Conservation Explained from a Hindu Perspective. In N. Verschuuren, B. & Furuta (Ed.), *Asian Sacred Sites*. Routledge.

Singh, V. S., Pandey, D. N., & Chaudhry, P. (2010). *Urban forests and open green spaces: lessons for Jaipur, Rajasthan, India* (No. RSPCB Occasional Paper No. 1/2010). *RSPCB Occasional Paper*. Jaipur, Rajasthan (IN). Retrieved from http://dlc.dlib.indiana.edu/dlc/handle/10535/5458

Smith, B. D., & Braulik, G. T. (2012). Platanista gangetica. Retrieved from http://dx.doi.org/10.2305/IUCN.UK.2012.RLTS.T41758A17355810.en

Smith, B. D., Zhou, K., Wang, D., Reeves, R. R., Barlow, J., Taylor, B. L., & Pitman, R. (2008). Lipotes vexillifer. Retrieved from http://dx.doi.org/10.2305/IUCN.UK.2008.RLTS.T12119A3322533.en

Smith, C. R. (1992). Whale falls: Chemosynthesis on the deep seafloor. *Oceanus*, *35*(3), 74–79.

Smith, C. R., & Baco, A. R. (2003). Ecology of whale falls at the deep-sea floor. *Oceanography and Marine Biology: An Annual Review*, *41*, 311–354. Retrieved from https://www.soest.hawaii.edu/oceanography/faculty/csmith/Files/Smith and Baco 2003.pdf

Smith, J. B., Schellnhuber, H. J., & Mirza, M. M. Q. (2001). Vulnerability to Climate Change and Reasons for Concern: A Synthesis. In J. McCarthy, J, F. Canziani, O, A. Leary, N, J. Dokken, D, & S. White, K (Eds.), *Climate Change 2001: Impacts: Adaptation and Vulnerability* (pp. 913–970). Cambridge, U.K.: Cambridge University Press. Retrieved from http://www.ipcc.ch/ipccreports/tar/wg2/pdf/wg2TARchap19.pdf

Sodhi, N. S., & Brook, B. W. (2006). *Southeast Asian biodiversity in crisis*. Cambridge University Press. Retrieved from http://www.cambridge.org/us/academic/subjects/life-sciences/ecology-and-conservation/southeast-asian-biodiversity-crisis?format=HB&isbn=9780521839303#xYsRCvbmj67qKWz3.97

Sodhi, N. S., Lee, T. M., Koh, L. P., & Brook, B. W. (2009). A Meta-Analysis of the Impact of Anthropogenic Forest Disturbance on Southeast Asia's Biotas. *Biotropica*, *41*(1), 103–109. https://doi.org/10.1111/j.1744-7429.2008.00460.x

Soga, M., & Koike, S. (2013). Mapping the potential extinction debt of butterflies in a modern city: Implications for conservation priorities in urban landscapes. *Animal Conservation*, *16*(1), 1–11. https://doi.org/10.1111/j.1469-1795.2012.00572.x

Somveille, M., Manica, A., Butchart, S. H. M., & Rodrigues, A. S. L. (2013). Mapping Global Diversity Patterns for Migratory Birds. *PLoS ONE*, *8*(8). https://doi.org/10.1371/journal.pone.0070907

Son, J.-Y., Lane, K. J., Lee, J.-T., & Bell, M. L. (2016). Urban vegetation and heat-related mortality in Seoul, Korea. *Environmental Research*, *151*, 728–733. https://doi.org/10.1016/J.ENVRES.2016.09.001

Soora, N. K., Aggarwal, P. K., Saxena, R., Rani, S., Jain, S., & Chauhan, N. (2013). An assessment of regional vulnerability of rice to climate change in India. *Climatic Change*, *118*(3–4), 683–699. https://doi.org/10.1007/s10584-013-0698-3

Spalding, M. D., Blasco, E., & Field, C. D. (1997). *World Mangrove Atlas*. *The International Society for Mangrove Ecosystems*. Okinawa, Japan: International Society for Mangrove Ecosystems. https://doi.org/10.1017/S0266467498300528

Spalton, J. A., & Hikmani, H. M. Al. (2006). The Leopard in the Arabian Peninsula – Distribution and Subspecies Status. *CAT News*, (Special Issue 1 – Arabian Leopard), 4–8.

SRAP. (2007). *Integrated Natural Resource Management for Combating Desertification in West Asia*. *UNCCD/SRAP Pilot Projects in Jordan, Lebanon, Syria and Yemen 2003–2006, Final Report*.

Srinivasarao, C., Lal, R., Kundu, S., & Thakur, P. B. (2015). Conservation Agriculture and Soil Carbon Sequestration. In *Conservation Agriculture* (pp. 479–524). Cham: Springer International Publishing. https://doi.org/10.1007/978-3-319-11620-4_19

Sritongchuay, T., Kremen, C., & Bumrungsri, S. (2016). Effects of forest and cave proximity on fruit set of tree crops in tropical orchards in Southern Thailand. *Journal of Tropical Ecology*, *32*(04), 269–279. https://doi.org/10.1017/S0266467416000353

Srivastava, A., Dagbenonbakin, G. D., & Gaiser, T. (2010). Effect of fertilization on yam (Dioscorea rotundata) biomass production. *Journal of Plant Nutrition*, *33*(7), 1056–1065. https://doi.org/10.1080/01904161003729766

Stats NZ. (2017). *Lake water quality*. Retrieved from http://www.stats.govt.nz/browse_for_stats/environment/environmental-reporting-series/environmental-indicators/Home/Fresh water/lake-water-quality.aspx

Steffen, W. L. (2009). *Australia's biodiversity and climate change*. CSIRO Publishing.

Stieglitz, T. C. (2012). The yongala's "Halo of Holes"-Systematic Bioturbation Close to a Shipwreck. In P. T. Harris & E. K. Baker (Eds.), *Seafloor Geomorphology as Benthic Habitat* (pp. 277–287). Elsevier Inc. https://doi.org/10.1016/B978-0-12-385140-6.00016-5

Stobutzki, I. C., Silvestre, G. T., & Garces, L. R. (2006). Key issues in coastal fisheries in South and Southeast Asia, outcomes of a regional initiative. *Fisheries Research*, *78*(2–3), 109–118. https://doi.org/10.1016/j.fishres.2006.02.002

Stocks, K. I., Clark, M. R., Rowden, A. A., Consalvey, M., & Schlacher, T. A. (2012). CenSeam, an international program on seamounts within the census of marine life: Achievements and lessons learned. *PLoS ONE*, *7*(2). https://doi.org/10.1371/journal.pone.0032031

Stramma, L., Schmidtko, S., Levin, L. A., & Johnson, G. C. (2010). Ocean oxygen minima expansions and their biological impacts. *Deep-Sea Research Part I: Oceanographic Research Papers*, *57*(4), 587–595. https://doi.org/10.1016/j.dsr.2010.01.005

Strayer, D. L., & Dudgeon, D. (2010). Freshwater biodiversity conservation: recent progress and future challenges. *Journal of the North American Benthological Society*, *29*(1), 344–358. https://doi.org/10.1899/08-171.1

Strong, E. E., Gargominy, O., Ponder, W. F., & Bouchet, P. (2008). Global diversity of gastropods (Gastropoda; Mollusca) in freshwater. *Hydrobiologia*, *595*(1), 149–166. https://doi.org/10.1007/s10750-007-9012-6

Stuart, S. N., Chanson, J. S., Cox, N. A., Young, B. E., Rodrigues, A. S. L., Fischman, D. L., & Waller, R. W. (2004). Status and trends of amphibian declines and extinctions worldwide. *Science*, *306*(5702), 1783–1786. https://doi.org/10.1126/science.1103538

Suttie, J. M., Reynolds, S. G., & Batello, C. (2005). *Grasslands of the World*. *Plant Production and Protection Series 34*. Rome.

Swei, A., Rowley, J. J. L., Rödder, D., Diesmos, M. L. L., Diesmos, A. C., Briggs, C. J., Brown, R., Cao, T. T., Cheng, T. L., Chong, R. A., Han, B., Hero, J. M., Hoang, H. D., Kusrini, M. D., Le, D. T. T., McGuire, J. A., Meegaskumbura, M., Min, M. S., Mulcahy, D. G., Neang, T., Phimmachak, S., Rao, D. Q., Reeder, N. M., Schoville, S. D., Sivongxay, N., Srei, N., Stöck, M., Stuart, B. L., Torres, L. S., Tran, D. T. A., Tunstall, T. S., Vieites, D., & Vredenburg, V. T. (2011). Is chytridiomycosis an emerging infectious disease in Asia? *PLoS ONE*, *6*(8). https://doi.org/10.1371/journal.pone.0023179

Takamura, N. (2012). Status of biodiversity loss in lakes and ponds in Japan. In T. Y. and T. N. S.Nakano (Ed.), *The Biodiversity Observation Network in the Asia-Pacific region: Towards further development of monitoring* (pp. 133–148). Tokyo: Springer. https://doi.org/10.1007/978-4-431-54032-8

Takeuchi, K., Brown, R. D., Washitani, I., Tsunekawa, A., & Yokohari, M. (Eds.). (2003). *Satoyama* (1st ed.). Tokyo: Springer Japan. https://doi.org/10.1007/978-4-431-67861-8

Takeuchi, K., Ichikawa, K., & Elmqvist, T. (2016). Satoyama landscape as social-ecological system: Historical changes and future perspective. *Current Opinion in Environmental Sustainability*, *19*, 30–39. https://doi.org/10.1016/j.cosust.2015.11.001

Tam, K. C., & Bonebrake, T. C. (2016). Butterfly diversity, habitat and vegetation usage in Hong Kong urban parks. *Urban Ecosystems*, *19*(2), 721–733. https://doi.org/10.1007/s11252-015-0484-2

Tan, P. Y., & Abdul Hamid, A. R. bin. (2014). Urban ecological research in Singapore and its relevance to the advancement of urban ecology and sustainability. *Landscape and Urban Planning*, *125*, 271–289. https://doi.org/10.1016/j.landurbplan.2014.01.019

Tan, P. Y., Wang, J., & Sia, A. (2013). Perspectives on five decades of the urban greening of Singapore. *Cities*, *32*, 24–32. https://doi.org/10.1016/j.cities.2013.02.001

Tang, Z., Deng, L., An, H., Yan, W., & Shangguan, Z. (2017). The effect of nitrogen addition on community structure and productivity in grasslands: A meta-analysis. *Ecological Engineering*, *99*, 31–38. https://doi.org/10.1016/j.ecoleng.2016.11.039

Taylor, M. F. J. (2017). *Building Nature's Safety Net 2016: State of Australian terrestrial protected areas 2010-2016*. Sydney. Retrieved from http://apo.org.au/system/files/96836/apo-nid96836-349256.pdf

Taylor, M. F. J., Sattler, P. S., Curnow, C., Fitzsimons, J. A., Beaver, D., Gibson, L., & Llewellyn, G. (2011). *Building Nature's Safety Net 2011. The state of protected areas for Australia's ecosystems and wildlife.* Sydney. Retrieved from https://dro.deakin.edu.au/eserv/DU:30037002/fitzsimons-buildingnatures-2011.pdf

Tedesco, P. A., Cornu, J.-F., Hugueny, B., & Oberdorff, T. (2013). Freshwater Fish Extinction Rates due to Water Availability Loss from Climate Change. Retrieved from atlas.freshwaterbiodiversity.eu

Teh, L. S. L., & Sumaila, U. R. (2007). Malthusian overfishing in Pulau Banggi? *Marine Policy*, *31*(4), 451–457. https://doi.org/10.1016/J.MARPOL.2007.01.001

Teh, L. S. L., Witter, A., Cheung, W. W. L., Sumaila, U. R., & Yin, X. (2017). What is at stake? Status and threats to South China Sea marine fisheries. *Ambio*, *46*(1), 57–72. https://doi.org/10.1007/s13280-016-0819-0

Telwala, Y., Brook, B. W., Manish, K., & Pandit, M. K. (2013). Climate-Induced Elevational Range Shifts and Increase in Plant Species Richness in a Himalayan Biodiversity Epicentre. *PLoS ONE*, *8*(2). https://doi.org/10.1371/journal.pone.0057103

Thailand State of Pollution Report Group. (2011). *Thailand State of Pollution Report 2009*. Bangkok: BTS Press.

Thaiutsa, B., Puangchit, L., Kjelgren, R., & Arunpraparut, W. (2008). Urban green space, street tree and heritage large tree assessment in Bangkok, Thailand. *Urban Forestry and Urban Greening*, *7*(3), 219–229. https://doi.org/10.1016/j.ufug.2008.03.002

Thaman, R. R. (2005). Biodiversity is the key to food security. *Spore*, 1–3.

Thaman, R. R. (2008). Pacific Island agrobiodiversity and ethnobiodiversity: A foundation for sustainable Pacific Island life. *Biodiversity: Journal of Life on Earth (Special Issue: The Value of Biodiversity to Food & Agriculture)*, *9*(1&2), 102–110. https://doi.org/10.1080/14888386.2008.9712895

Thaman, R. R. (2011). The silent invasion of our islands. *Mai Life*, *55*(Dec.), 64–65.

Thaman, R. R. (2013). Islands on the frontline against the winds and waves of global change: emerging environmental issues and actions to build resilience in pacific small island developing states (PSIDS). In H. -M. Tsai (Ed.), *2013 Proceedings of the IGU Commission on Islands International Conference on Island Development: Local Economy, Culture, Innovation and Sustainability*. (p. 3-H-1-1 - 10). Makong, Penghu Archipelago Taiwan: National Penghu University.

Thaman, R. R., Balawa, A., & Fong, T. (2014). Putting ancient winds and life into new sails: Indigenous knowledge as a basis for education for sustainable development (ESD) – a case study of the return of marine biodiversity to Vanua Navakavu, Fiji. In M. ’Otunuku, U. Nabobo-Baba, & S. F. Johansson-Fua (Eds.), *Of waves, winds and wonderful things: a decade of rethinking Pacific education* (pp. 163–184). Suva: University of the South Pacific Press.

Thaman, R. R., & O’Brien, K. (2011). Caterpillar devastates kanava and undermines resilience to climate change in Tuvalu. *Mai Life*, *50*(July), 56–57.

Thangaradjou, T., Sivakumar, K., Nobi, E. P., & Dilipan, E. (2010). Distribution of seagrasses along the Andaman and Nicobar Islands: A post Tsunami Survey. *Recent Trends in Biodiversity of Andaman and Nicobar Islands*, 157–160.

Thapa, G., & Gaiha, R. (2011). Smallholder Farming in Asia and the Pacific: Challenges and Opportunities, 1–41.

The Millennium Ecosystem Assessment. (2005). *Ecosystems and Human Well-Being Ecosystems and Human Well-Being*. Washington, DC: Island Press. Retrieved from http://scholar.googleusercontent.com/scholar?q=cache:D6gF0ccyxM0J:scholar.google.com/+The+Millennium+Ecosystem+Assessment&hl=en&as_sdt=0,5

The Nature Conservancy. (2012). *Capacity building for Mongolian Ministry of Environment and Green Development (MEGDT) in relation to biodiversity and conservation in the southern Gobi Desert*. Retrieved from https://www.conservationgateway.org/ConservationByGeography/AsiaPacific/mongolia/Pages/southerngobi-ebrd.aspx

Threlfall, C. G., Williams, N. S. G., Hahs, A. K., & Livesley, S. J. (2016). Approaches to urban vegetation management and the impacts on urban bird and bat assemblages. *Landscape and Urban Planning*, *153*, 28–39. https://doi.org/10.1016/j.landurbplan.2016.04.011

Thrush, S. F., Townsend, M., Hewitt, J. E., Davies, K., Lohrer, A. M., Lundquist, C., & Cartner, K. (2013). The many uses and values of estuarine ecosystems. In J. R. Dymond (Ed.), *Ecosystem services in New Zealand – conditions and trends* (pp. 226–237). Lincoln, New Zealand: Manaaki Whenua Press. Retrieved from https://www.landcareresearch.co.nz/__data/assets/pdf_file/0004/77044/1_16_Thrush.pdf

Thu, P. M., & Populus, J. (2007). Status and changes of mangrove forest in Mekong Delta: Case study in Tra Vinh, Vietnam. *Estuarine, Coastal and Shelf Science*, *71*(1–2), 98–109. https://doi.org/10.1016/j.ecss.2006.08.007

Thuy, B., Gale, A. S., Kroh, A., Kucera, M., Numberger-Thuy, L. D., Reich, M., & Stöhr, S. (2012). Ancient Origin of the Modern Deep-Sea Fauna. *PLoS ONE*, *7*(10), 1–11. https://doi.org/10.1371/journal.pone.0046913

Tittensor, D. P., Mora, C., Jetz, W., & Lotze, H. K. (2010). Global patterns and predictors of marine biodiversity across taxa. *Nature*, *466*(7310), 1098–1101. https://doi.org/10.1038/nature09329

Toba, M., Kobayashi, Y., Kakino, J., Yamakaw, H., Ishii, R., & Okamoto, R. (2016). Stocks and fisheries of asari in Japan. *Bulletin of Japan Fisheries Research and Education Agency*, *42*, 9–21. Retrieved from http://www.fra.affrc.go.jp/bulletin/bull/bull42/42-05.pdf

Todd, P. A., Ong, X., & Chou, L. M. (2010). Impacts of pollution on marine life in Southeast Asia. *Biodiversity and Conservation*, *19*(4), 1063–1082. https://doi.org/10.1007/s10531-010-9778-0

Tokeshi, M. (2011). Spatial structures of hydrothermal vents and vent-associated megafauna in the back-arc basin system of the Okinawa Trough, western Pacific. *Journal of Oceanography*, *67*(5), 651–665. https://doi.org/10.1007/s10872-011-0065-9

Tsatsia, H., & Jackson, G. (2009). The Giant African Snail. Retrieved March 26, 2018, from http://www.pestnet.org/fact_sheets/giant_african_snail_050.htm

Tsatsia, H., & Jackson, G. (2017). Pacific Pests and Pathogens - Fact Sheets; Taro leaf blight (014). Retrieved from http://www.pestnet.org/fact_sheets/taro_leaf_blight_014.pdf

UNCCD. (2008). *The 10-year strategic plan and framework to enhance the implementation of the Convention (2008–2018). Decision 3/COP.8. Report of the Conference of the Parties on its* *eighth session, held in Madrid from 3 to 14 September 2007*. Retrieved from http://www.unccd.int/cop/officialdocs/cop8/pdf/16add1eng.pdf#page=8

UNEP-WCMC. (2016a). *The State of Biodiversity in West Asia: A mid-term review of progress towards the Aichi Biodiversity Targets.* Cambridge, U.K.: UNEP-WCMC. Retrieved from https://www.cbd.int/gbo/gbo4/outlook-westasia-en.pdf

UNEP-WCMC. (2016b). Vital Index of Traditional Environmental Knowledge. Retrieved from http://www.bipindicators.net/vitek

UNEP-WCMC, & IUCN. (2015). The World Database on Protected Areas [Online], November/2015. *World Wide Web Electronic Publication, Www.Protectedplanet.Com*, (January), 1–5. https://doi.org/www.protectedplanet.net

UNEP-WCMC, & IUCN. (2017). Protected Planet: The World Database on Protected Areas (WDPA) [On-line] [Oct 2017]. Retrieved from www.protectedplanet.net

UNEP-WCMC, & IUCN. (2018). Protected Planet: The World Database on Protected Areas (WDPA) [On-line], [March 2018]. Retrieved from www.protectedplanet.net

UNEP/GRID-Arendal. (2007). Water towers of Asia - glaciers, water and population in the greater Himalayas-Hindu Kush-Tien Shan-Tibet region. Retrieved December 8, 2010, from http://maps.grida.no/go/graphic/water-towers-of-asia-glaciers-water-and-populationin-the-greater-himalayas-hindu-kush-tien-shan-tib

UNEP/UNCTAD. (2014). *Emerging Issues for Small Island Developing States: Results of the UNEP Foresight Process*. Nairobi, Kenya. Retrieved from http://www.unep.org/pdf/Emerging_issues_for_small_island_developing_states.pdf

UNEP. (2008). *National Reports on Seagrass in the South China Sea (UNEP/GEF/SCS Technical Publication No. 12)* (UNEP/GEF/SCS Technical Publication No. 12). *Otro*. Bangkok, Thailand. Retrieved from http://www.unepscs.org/Publication/Booklets/Seagrass booklet combine version.pdf

UNEP. (2011). *Resource Efficiency: Economics and Outlook for Asia-Pacific (REEO)*. Bangkok, Thailand. Retrieved from http://www.unep.org/dewa/Portals/67/pdf/Resource_Efficiency_EOAP_web.pdf

UNEP. (2016). *Global Environment Outlook (GEO-6): Regional Assessment for Asia and the Pacific*. Nairobi, Kenya. Retrieved from http://www.unep.org/geo2000/english/0064.htm

UNESCAP. (2014). Statistical Yearbook for Asia and the Pacific 2014. Retrieved September 15, 2015, from http://www.unescap.org/resources/statistical-yearbook-asia-and-pacific-2014

UNISDR/UNDP. (2012). Review Paper – Status of Coastal and Marine Ecosystem Management in South Asia. In *Inputs of the South Asian Consultative Workshop on " Integration of Disaster Risk Reduction and Climate Change Adaptation into Biodiversity and Ecosystem Management of Coastal and Marine Areas in South Asia" held in New Delhi on 6 and 7 March 2012* (p. 173). New Delhi: UNDP. Retrieved from http://www.in.undp.org/content/india/en/home/library/environment_energy/review-paper-status-of-coastal-and-marine-ecosystem-management-in-south-asia.html

United Nations. (2015). *World Urbanization Prospects: The 2014 Revision. Report ST/ESA/SER.A/366. (ST/ESA/SER.A/366)*. New York. Retrieved from http://esa.un.org/unpd/wup/Publications/Files/WUP2014-Report.pdf

Urabe, T., Ishibashi, J. I., Sunamura, M., Okino, K., Takai, K., & Suzuki, K. (2015). Interdisciplinary studies: Introduction of TAIGA concept. In J. (Junichiro) Ishibashi, K. Okino, & M. Sunamura (Eds.), *Subseafloor Biosphere Linked to Hydrothermal Systems: TAIGA Concept* (pp. 1–10). Tokyo: Springer Japan. https://doi.org/10.1007/978-4-431-54865-2_1

Uye, S. I. (2014). The giant jellyfish nemopilema nomurai in east asian marginal seas. In K. A. Pitt & C. H. Lucas (Eds.), *Jellyfish Blooms* (Vol. 9789400770, pp. 185–205). Dordrecht: Springer Netherlands. https://doi.org/10.1007/978-94-007-7015-7_8

Valbo-Jørgensen, J., Coates, D., & Hortle, K. (2009). Chapter 8 - Fish Diversity in the Mekong River Basin. In *The Mekong* (pp. 161–196). https://doi.org/http://dx.doi.org/10.1016/B978-0-12-374026-7.00008-5

Valbuena, D., Erenstein, O., Homann-Kee Tui, S., Abdoulaye, T., Claessens, L., Duncan, A. J., Gérard, B., Rufino, M. C., Teufel, N., van Rooyen, A., & van Wijk, M. T. (2012). Conservation Agriculture in mixed crop–livestock systems: Scoping crop residue trade-offs in Sub-Saharan

Africa and South Asia. *Field Crops Research*, *132*, 175–184. https://doi.org/10.1016/J.FCR.2012.02.022
Van Damme, K. (2011). Insular biodiversity in a changing world. *Nature Middle East*. https://doi.org/10.1038/nmiddleeast.2011.61
van der Ent, A., & Lambers, H. (2016). Plant-soil interactions in global biodiversity hotspots. *Plant and Soil*, *403*(1–2), 1–5. https://doi.org/10.1007/s11104-016-2919-9
Van Kleunen, M., Dawson, W., Essl, F., Pergl, J., Winter, M., Weber, E., Kreft, H., Weigelt, P., Kartesz, J., Nishino, M., Antonova, L. A., Barcelona, J. F., Cabezas, F. J., Morozova, O., Moser, D., Nickrent, D. L., Patzelt, A., Pelser, P. B., Baptiste, M. P., Poopath, M., Schulze, M., Seebens, H., Shu, W.-S., Thomas, J., Velayos, M., & Wieringa, J. J. (2015). Global exchange and accumulation of non-native plants. *Nature*, *525*, 100–103. https://doi.org/10.1038/nature14910
Van Noordwijk, M., Barrios, E., Shepherd, K., Bayala, J., & Öborn, I. (2015). *The rooted pedon in a dynamic multifunctional landscape: Soil science at the World Agroforestry Centre* (Working Paper 200). Nairobi, Kenya. https://doi.org/10.5716/WP15023.PDF
van Noordwijk, M., Bayala, J., Hairiah, D. K., Lusiana, B., Muthuri, C. W., Khasanah, N. M., & Mulia, R. M. (2014). Agroforestry solutions for buffering climate variability and adapting to change. In J. F. and P. J. Gregory (Ed.), *Climate change Impact and Adaptation in Agricultural Systems* (pp. 216–232). Wallingford (UK): CAB-International.
van Vliet, N., Mertz, O., Heinimann, A., Langanke, T., Pascual, U., Schmook, B., Adams, C., Schmidt-Vogt, D., Messerli, P., Leisz, S., Castella, J.-C., Jørgensen, L., Birch-Thomsen, T., Hett, C., Bech-Bruun, T., Ickowitz, A., Vu, K. C., Yasuyuki, K., Fox, J., Padoch, C., Dressler, W., & Ziegler, A. D. (2012). Trends, drivers and impacts of changes in swidden cultivation in tropical forest-agriculture frontiers: A global assessment. *Global Environmental Change*, *22*(2), 418–429. https://doi.org/10.1016/J.GLOENVCHA.2011.10.009
van Weerd, M., C. Pomaro, C., de Leon, J., Antolin, R., & Mercado, V. (2016). Crocodylus mindorensis. https://doi.org/http://dx.doi.org/10.2305/IUCN.UK.2016-3.RLTS.T5672A3048281.en
Vaqalo, M., Lonalona, M., Panapa, S., & Khan, F. (2014). *Yellow crazy ants and fruit fly surveys in Tuvalu (25th October to 4th November 2014).* Funafuti. Retrieved from http://piat.org.nz/uploads/PIAT_content/pdfs/Vaqalo et al_2014.pdf
Varnosfaderany, M. N., Ebrahimi, E., Mirghaffary, N., & Safyanian, A. (2010). Biological assessment of the Zayandeh Rud River, Iran, using benthic macroinvertebrates. *Limnologica*, *40*(3), 226–232. https://doi.org/10.1016/j.limno.2009.10.002
Verburg, P., Hamill, K., Unwin, M., & Abell, J. (2010). Lake water quality in New Zealand 2010: Status and trends. *NIWA Client Report HAM2010*, (August). Retrieved from http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:Lake+water+quality+in+New+Zealand+2010+:+Status+and+trends#0
Verchot, L. V., Van Noordwijk, M., Kandji, S., Tomich, T., Ong, C., Albrecht, A., Mackensen, J., Bantilan, C., Anupama, K. V., & Palm, C. (2007). Climate change: Linking adaptation and mitigation through agroforestry. *Mitigation and Adaptation Strategies for Global Change*, *12*(5), 901–918. https://doi.org/10.1007/s11027-007-9105-6
Verhoeven, J. T. A., & Setter, T. L. (2010). Agricultural use of wetlands: Opportunities and limitations. *Annals of Botany*, *105*(1), 155–163. https://doi.org/10.1093/aob/mcp172
Verschuuren, B. (2016). Themes and perspectives on the conservation of Asian sacred natural sites. In N. Verschuuren, B. & Furuta (Ed.), *Asian Sacred Sites*. Routledge.
von Rintelen, T., von Rintelen, K., Glaubrecht, M., Schubart, C. D., & Herder, F. (2012). Aquatic biodiversity hotspots in Wallacea: the species flocks in the ancient lakes of Sulawesi, Indonesia. *Biotic Evolution and Environmental Change in Southeast Asia*, 290–315.
Vörösmarty, C. J., McIntyre, P. B., Gessner, M. O., Dudgeon, D., Prusevich, A., Green, P., Glidden, S., Bunn, S. E., Sullivan, C. A., Liermann, C. R., & Davies, P. M. (2010). Global threats to human water security and river biodiversity. *Nature*, *467*(7315), 555–561. https://doi.org/10.1038/nature09440
Wan, F., Jiang, M., & Zhan, A. (2017a). *Biological invasions and its management in China. Volume 1*.

Wan, F., Jiang, M., & Zhan, A. (2017b). *Biological invasions and its management in China. Volume 2*.
Wang, G., Jiang, G., Zhou, Y., Liu, Q., Ji, Y., Wang, S., Chen, S., & Liu, H. (2007). Biodiversity conservation in a fast-growing metropolitan area in China: A case study of plant diversity in Beijing. *Biodiversity and Conservation*, *16*(14), 4025–4038. https://doi.org/10.1007/s10531-007-9205-3
Wang, P., Lassoie, J. P., Morreale, S. J., & Dong, S. (2015). A critical review of socioeconomic and natural factors in ecological degradation on the Qinghai-Tibetan Plateau, China. *Rangeland Journal*, *37*(1), 1–9. https://doi.org/10.1071/RJ14094
Wang, S. J., Li, R. L., Sun, C. X., Zhang, D. F., Li, F. Q., Zhou, D. Q., Xiong, K. N., & Zhou, Z. F. (2004). How types of carbonate rock assemblages constrain the disribution of karst rocky desertified land in Guizhou Province, PR China: Phenomena and mechanisms. *Land Degradation and Development*, *15*(2), 123–131. https://doi.org/10.1002/ldr.591
Wang, S., & Xie, Y. (2009). *China species red list.* (Vol. 2). Beijing: High Education Press.
Wang, S., Zhang, B., Yang, Q., Chen, G., Yang, B., Lu, L., Shen, M., & Peng, Y. (2017). Responses of net primary productivity to phenological dynamics in the Tibetan Plateau, China. *Agricultural and Forest Meteorology*, *232*, 235–246. https://doi.org/10.1016/j.agrformet.2016.08.020
Wang, Y., Heberling, G., Görzen, E., Miehe, G., Seeber, E., & Wesche, K. (2017). Combined effects of livestock grazing and abiotic environment on vegetation and soils of grasslands across Tibet. *Applied Vegetation Science*, *20*(3), 327–339. https://doi.org/10.1111/avsc.12312
Wang, Y., Wang, J., Li, S., & Qin, D. (2014). Vulnerability of the Tibetan pastoral systems to climate and global change. *Ecology and Society*, *19*(4). https://doi.org/10.5751/ES-06803-190408
Wang, Y., & Wesche, K. (2016). Vegetation and soil responses to livestock grazing in Central Asian grasslands: a review of Chinese literature. *Biodiversity and Conservation*, *25*(12), 2401–2420. https://doi.org/10.1007/s10531-015-1034-1
Wanger, T. C., Darras, K., Bumrungsri, S., Tscharntke, T., & Klein, A.-M. (2014). Bat pest control contributes to food security in Thailand. *Biological Conservation*, *171*, 220–223. https://doi.org/10.1016/J.BIOCON.2014.01.030
Watson, R. A., Cheung, W. W. L., Anticamara, J. A., Sumaila, R. U., Zeller, D., & Pauly, D. (2013). Global marine yield halved as fishing intensity redoubles. *Fish and Fisheries*, *14*(4), 493–503. https://doi.org/10.1111/j.1467-2979.2012.00483.x
Watson, R., & Pauly, D. (2001). Systematic distortions in world fisheries catch trends. *Nature*, *414*(6863), 534–536. https://doi.org/10.1038/35107050
Waycott, M., Duarte, C. M., Carruthers, T. J. B., Orth, R. J., Dennison, W. C., Olyarnik, S., Calladine, A., Fourqurean, J. W., Heck, K. L., Hughes, A. R., Kendrick, G. A., Kenworthy, W. J., Short, F. T., & Williams, S. L. (2009). Accelerating loss of seagrasses across the globe threatens coastal ecosystems. *Proceedings of the National Academy of Sciences of the United States of America*, *106*(30), 12377–12381. https://doi.org/10.1073/pnas.0905620106
Webb, T. J., vanden Berghe, E., & O'Dor, R. (2010). Biodiversity's big wet secret: The global distribution of marine biological records reveals chronic under-exploration of the deep pelagic ocean. *PLoS ONE*, *5*(8), 1–6. https://doi.org/10.1371/journal.pone.0010223
Wen, L., Dong, S., Li, Y., Li, X., Shi, J., Wang, Y., Liu, D., & Ma, Y. (2013). Effect of Degradation Intensity on Grassland Ecosystem Services in the Alpine Region of Qinghai-Tibetan Plateau, China. *PLoS ONE*, *8*(3), 1–7. https://doi.org/10.1371/journal.pone.0058432
Wernberg, T., Russell, B. D., Moore, P. J., Ling, S. D., Smale, D. A., Campbell, A., Coleman, M. A., Steinberg, P. D., Kendrick, G. A., & Connell, S. D. (2011). Impacts of climate change in a global hotspot for temperate marine biodiversity and ocean warming. *Journal of Experimental Marine Biology and Ecology*, *400*(1–2), 7–16. https://doi.org/10.1016/j.jembe.2011.02.021
Wesche, K., Ambarlı, D., Kamp, J., Török, P., Treiber, J., & Dengler, J. (2016). The Palaearctic steppe biome: a new synthesis. *Biodiversity and Conservation*, *25*(12), 2197–2231. https://doi.org/10.1007/s10531-016-1214-7
Wetlands International. (2012). *Waterbird Population Estimates, Fifth Edition. Summary Report*. *Wetlands International*. Wageningen, The Netherlands. Retrieved from wpe.wetlands.org

Wetzel, F. T., Beissmann, H., Penn, D. J., & Jetz, W. (2013). Vulnerability of terrestrial island vertebrates to projected sea-level rise. *Global Change Biology*, *19*(7), 2058–2070. https://doi.org/10.1111/gcb.12185

White, R., Murray, S., & Rohweder, M. (2000). *Pilot Analysis of Global Ecosystems: Grassland Ecosystems. World Resources Institute*. Washington D.C. https://doi.org/10.1021/es0032881

Whittington, R., Hick, P., Evans, O., Rubio, A., Dhand, N., & Paul-Pont, I. (2016). Pacific oyster mortality syndrome: a marine herpesvirus active in Australia. *Microbiology Australia*, *37*(3), 126–128. https://doi.org/10.1071/MA16043

Wilcove, D. S., Giam, X., Edwards, D. P., Fisher, B., & Koh, L. P. (2013). Navjot ' s nightmare revisited : Logging , agriculture , and biodiversity in Southeast Asia Navjot ' s nightmare revisited : logging , agriculture , and biodiversity in Southeast Asia. *Trends in Ecology & Evolution*, *28*(JUNE), 531–540. https://doi.org/10.1016/j.tree.2013.04.005

Wilkinson, C. (2008). *Status of Coral Reefs of the World :* Townsville, Australia. Retrieved from http://www.reefcheck.org/PDFs/scr_2008full.pdf

Willer, H., & Lernoud, J. (Eds.). (2016). *The World of Organic Agriculture. Statistics and Emerging Trends 2016.* Research Institute of Organic Agriculture (FiBL), Frick, and IFOAM - Organics International, Bonn. Retrieved from http://www.organic-world.net/yearbook/yearbook-2016.html

Wilson, H. B., Kendall, B. E., Fuller, R. A., Milton, D. A., & Possingham, H. P. (2011). Analyzing Variability and the Rate of Decline of Migratory Shorebirds in Moreton Bay, Australia. *Conservation Biology*, *25*(4), 758–766. https://doi.org/10.1111/j.1523-1739.2011.01670.x

Wilting, A., Duckworth, J. W., Meijaard, E., Ross, J., Hearn, A., & Ario, A. (2015). Mydaus javanensis. *The IUCN Red List of Threatened Species 2015: E.T41628A45209955.*

Wiser, S. K., Bellingham, P. J., & Burrows., L. E. (2001). Managing biodiversity information: development of the National Vegetation Survey Databank. *New Zealand Journal of Ecology*, *20*(2), 1–17. Retrieved from http://www.jstor.org/stable/24055293

Wissinger, S. A., Oertli, B., & Rosset, V. (2016). Invertebrate communities of alpine ponds. In *Invertebrates in Freshwater Wetlands: An International Perspective on Their Ecology* (pp. 55–103). https://doi.org/10.1007/978-3-319-24978-0_3

Woinarski, J., Burbidge, A. A., & Harrison, P. (2014). *The action plan for Australian mammals 2012*. Collingwood, Victoria: CSIRO Publishing.

Woinarski, J. C. Z., Burbidge, A. A., & Harrison, P. L. (2015). Ongoing unraveling of a continental fauna: Decline and extinction of Australian mammals since European settlement. *Proceedings of the National Academy of Sciences of the United States of America*, *112*(15), 4531–4540. https://doi.org/10.1073/pnas.1417301112

Wong, K., Saw, L., & Kochummen, K. (1987). A survey of the forests of the Endau-Rompin area, Peninsular Malaysia: Principal forest types and floristic notes. *Malayan Nature Journal*, (June 1985), 125–144.

Wooldridge, S. A., & Brodie, J. E. (2015). Environmental triggers for primary outbreaks of crown-of-thorns starfish on the Great Barrier Reef, Australia. *Marine Pollution Bulletin*. https://doi.org/10.1016/j.marpolbul.2015.08.049

Wooster, M. J., Perry, G. L. W., & Zoumas, A. (2012). Fire, drought and El Niño relationships on Borneo (Southeast Asia) in the pre-MODIS era (1980-2000). *Biogeosciences*, *9*(1), 317–340. https://doi.org/10.5194/bg-9-317-2012

World Bank. (2006). *Room to Roam. The Threat to Khulan (Wild Ass) from Human Intrusion. Mongolia Discussion Papers. World Bank, Washington, D.C: World Bank. http://documents.worldbank.org/curated/en/559701468060257075/Mongolia-Room-to-roam-the-threat-to-Khulan-wild-ass-from-*.

Worm, B. (2016). Averting a global fisheries disaster. *Proceedings of the National Academy of Sciences*, *113*(18), 4895–4897. https://doi.org/10.1073/pnas.1604008113

Worm, B., Barbier, E. B., Beaumont, N., Duffy, J. E., Folke, C., Halpern, B. S., Jackson, J. B. C., Lotze, H. K., Micheli, F., Palumbi, S. R., Sala, E., Selkoe, K. A., Stachowicz, J. J., & Watson, R. (2006). Impacts of biodiversity loss on ocean ecosystem services. *Science*, *314*(5800), 787–790. https://doi.org/10.1126/science.1132294

Worm, B., & Branch, T. A. (2012). The future of fish. *Trends in Ecology and Evolution*, *27*(11), 594–599. https://doi.org/10.1016/j.tree.2012.07.005

Worm, B., Lotze, H. K., & Myers, R. A. (2003). Predator diversity hotspots in the blue ocean. *Proceedings of the National Academy of Sciences of the United States of America*, *100*(17), 9884–9888. https://doi.org/10.1073/pnas.1333941100

Wright, L., de Silva, P., Chan, B., & Reza Lubis, I. (2015). Aonyx cinereus. *The IUCN Red List of Threatened Species 2015: E.T44166A21939068.* . Retrieved from http://dx.doi.org/10.2305/IUCN.UK.2015-2.RLTS.T44166A21939068.en

Wu, R., Zhang, S., Yu, D. W., Zhao, P., Li, X., Wang, L., Yu, Q., Ma, J., Chen, A., & Long, Y. (2011). Effectiveness of China's nature reserves in representing ecological diversity. *Frontiers in Ecology and the Environment*, *9*(7), 383–389. https://doi.org/10.1890/100093

WWAP. (2015). *The United Nations World Water Development Report 2015: Water for a Sustainable World.* Paris, UNESCO. Retrieved from http://unesdoc.unesco.org/images/0023/002318/231823E.pdf

WWF. (2006). *Conservation of High Altitude Wetlands In the Himalayas – Report of the Fourth Regional Workshop*. New Dehli.

WWF, & ADB. (2012). *Ecological footprint and investment in natural capital in Asia and the Pacific*. UK: INWK. Retrieved from http://panda.org/downloads/footprint_and_investment_in_natural_capital_in_apac.pdf

Xie, S., Lu, F., Cao, L., Zhou, W., & Ouyang, Z. (2016). Multi-scale factors influencing the characteristics of avian communities in urban parks across Beijing during the breeding season. *Scientific Reports*, *6*(July), 1–9. https://doi.org/10.1038/srep29350

Xing, Y., Zhang, C., Fan, E., & Zhao, Y. (2016). Freshwater fishes of China: Species richness, endemism, threatened species and conservation. *Diversity and Distributions*, *22*(3), 358–370. https://doi.org/10.1111/ddi.12399

Xu, J., Grumbine, R. E., Shrestha, A., Eriksson, M., Yang, X., Wang, Y., & Wilkes, A. (2009). The melting Himalayas: Cascading effects of climate change on water, biodiversity, and livelihoods. *Conservation Biology*, *23*(3), 520–530. https://doi.org/10.1111/j.1523-1739.2009.01237.x

Xue, Z., Zhang, Z., Lu, X., Zou, Y., Lu, Y., Jiang, M., Tong, S., & Zhang, K. (2014). Predicted areas of potential distributions of alpine wetlands under different scenarios in the Qinghai-Tibetan Plateau, China. *Global and Planetary Change*, *123*, 77–85. https://doi.org/10.1016/J.GLOPLACHA.2014.10.012

Yamaguchi, T. (2004). Influence of urbanization on ant distribution in parks of Tokyo and Chiba City, Japan II. Analysis of species. *Entomological Science*, *8*(1), 17–25. https://doi.org/10.1111/j.1479-8298.2005.00096.x

Yamakita, T., Sudo, K., Jintsu-Uchifune, Y. Yamamoto, H., & Shirayama, Y. (2017). Identification of important marine areas using ecologically or biologically significant areas (EBSAs) criteria in the East to Southeast Asia region and comparison with existing registered areas for the purpose of conservation Marine Policy in press.

Yamakita, T., Watanabe, K., & Nakaoka, M. (2011). Asynchronous local dynamics contributes to stability of a seagrass bed in Tokyo Bay. *Ecography*, *34*(3), 519–528. https://doi.org/10.1111/j.1600-0587.2010.06490.x

Yamamoto, K. (2010). Evaluation of the Degree of the Sufficiency of Public Green Spaces as an Indicator of Urban Density in the Chubu Metropolitan Area in Japan. *International Journal of Advanced Computer Science*, *4*(7), 276–284.

Yamano, H., Sugihara, K., Goto, K., Kazama, T., Yokoyama, K., & Okuno, J. (2012). Ranges of obligate coral-dwelling crabs extend northward as their hosts move north. *Coral Reefs*, *31*(3), 663. https://doi.org/10.1007/s00338-012-0893-0

Yamano, H., Sugihara, K., & Nomura, K. (2011). Rapid poleward range expansion of tropical reef corals in response to rising sea surface temperatures. *Geophysical Research Letters*, *38*(4). https://doi.org/10.1029/2010GL046474

Yang, G., Xu, J., Wang, Y., Wang, X., Pei, E., Yuan, X., Li, H., Ding, Y., & Wang, Z. (2015). Evaluation of microhabitats for wild birds in a Shanghai urban area park. *Urban Forestry and Urban Greening*, *14*(2), 246–254. https://doi.org/10.1016/j.ufug.2015.02.005

Yang, J., Huang, C., Zhang, Z., & Wang, L. (2014). The temporal trend of urban green coverage in major Chinese cities between 1990 and 2010. *Urban Forestry and Urban Greening*, *13*(1), 19–27. https://doi.org/10.1016/j.ufug.2013.10.002

Yang, Y., Tian, K., Hao, J., Pei, S., & Yang, Y. (2004). Biodiversity and biodiversity conservation in Yunnan, China. *Biodiversity and Conservation*. https://doi.org/10.1023/B:BIOC.0000011728.46362.3c

Yara, Y., Vogt, M., Fujii, M., Yamano, H., Hauri, C., Steinacher, M., Gruber, N., & Yamanaka, Y. (2012). Ocean acidification limits temperature-induced poleward expansion of coral habitats around Japan. *Biogeosciences*, *9*(12), 4955–4968. https://doi.org/10.5194/bg-9-4955-2012

Yonezaki, S., Kiyota, M., & Okamura, H. (2015). Long-term ecosystem change in the western North Pacific inferred from commercial fisheries and top predator diet. *Deep Sea Research Part II: Topical Studies in Oceanography*, *113*, 91–101. https://doi.org/10.1016/J.DSR2.2014.10.027

Young, J. A. (2007). *People and Forests: Yunnan Swidden Agriculture in Human-Ecological Perspective*. *American Anthropologist* (Vol. 109). Kunming: Yunnan Education Publishing House. https://doi.org/10.1525/aa.2007.109.4.782.1

Yule, C. M., Boyero, L., & Marchant, R. (2010). Effects of sediment pollution on food webs in a tropical river (Borneo, Indonesia). *Marine and Freshwater Research*, *61*(2), 204–213. https://doi.org/10.1071/MF09065

Zaizhi, Z. (2000). Landscape changes in a rural area in China. *Landscape and Urban Planning*, *47*(1–2), 33–38. https://doi.org/10.1016/S0169-2046(99)00069-9

Zeller, D., Harper, S., Zylich, K., & Pauly, D. (2015). Synthesis of underreported small-scale fisheries catch in Pacific island waters. *Coral Reefs*, *34*(1), 25–39. https://doi.org/10.1007/s00338-014-1219-1

Zeng, L., & Reuse, G. (2016). Holy hills: sanctuaries of biodiversity in Xishuangbanna, southwest. In N. Verschuuren, B. & Furuta (Ed.), *Asian Sacred Sites* (pp. 194–205). Routledge.

Zeng, X. (1990). *Fishery resources of the Yangtze River basin*. Beijing, China: Marine Press.

Zhai, D., Xu, J., Dai, Z., & Schmidt-Vogt, D. (2017). Lost in transition: Forest transition and natural forest loss in tropical China. *Plant Diversity*, *39*(3), 149–153. https://doi.org/10.1016/J.PLD.2017.05.005

Zhang, H., & Jim, C. Y. (2013). Species adoption for sustainable forestry in Hong Kong's degraded countryside. *International Journal of Sustainable Development & World Ecology*, *20*(6), 484–503. https://doi.org/Doi 10.1080/13504509.2013.818590

Zhang, W., Ricketts, T. H., Kremen, C., Carney, K., & Swinton, S. M. (2007). Ecosystem services and dis-services to agriculture. *Ecological Economics*, *64*(2), 253–260. https://doi.org/10.1016/j.ecolecon.2007.02.024

Zhang, Z., He, J. S., Li, J., & Tang, Z. (2015). Distribution and conservation of threatened plants in China. *Biological Conservation*, *192*, 454–460. https://doi.org/10.1016/j.biocon.2015.10.019

Zhang, Z., Pech, R., Davis, S., Shi, D., Wan, X., & Zhong, W. (2003). Extrinsic and intrinsic factors determine the eruptive dynamics of Brandt's voles Microtus brandti in Inner Mongolia , China. *Oikos*, *2*(August 2002), 299–310.

Zhao, S., Da, L., Tang, Z., Fang, H., Song, K., & Fang, J. (2006). Ecological consequences of rapid urban expansion: Shanghai, China. *Frontiers in Ecology and the Environment*, *4*(7), 341–346. https://doi.org/10.1890/1540-9295(2006)004[0341:ECORUE]2.0.CO;2

Zheng, C., Jiang, Y., Chen, C., Sun, Y., Feng, J., Deng, A., Song, Z., & Zhang, W. (2014). The impacts of conservation agriculture on crop yield in China depend on specific practices, crops and cropping regions. *The Crop Journal*, *2*(5), 289–296. https://doi.org/10.1016/J.CJ.2014.06.006

Zhou, D., Zhao, S., Zhang, L., & Liu, S. (2016). Remotely sensed assessment of urbanization effects on vegetation phenology in China's 32 major cities. *Remote Sensing of Environment*, *176*, 272–281. https://doi.org/10.1016/J.RSE.2016.02.010

Zhou, X., & Wang, Y. C. (2011). Spatial-temporal dynamics of urban green space in response to rapid urbanization and greening policies. *Landscape and Urban Planning*, *100*(3), 268–277. https://doi.org/10.1016/j.landurbplan.2010.12.013

Zhu, H., Wang, D., Guo, Q., Liu, J., & Wang, L. (2015). Interactive effects of large herbivores and plant diversity on insect abundance in a meadow steppe in China. *Agriculture, Ecosystems and Environment*, *212*, 245–252. https://doi.org/10.1016/j.agee.2015.07.008

Ziv, G., Baran, E., Nam, S., Rodríguez-Iturbe, I., & Levin, S. A. (2011). Trading-off fish biodiversity, food security, and hydropower in the Mekong River Basin. *Proceedings of the National Academy of Sciences*, *109*(15), 5609–5614. https://doi.org/10.1073/pnas.1201423109

Zöckler, C., Syroechkovskiy, E. E., & Atkinson, P. W. (2010). Rapid and continued population decline in the Spoon-billed Sandpiper Eurynorhynchus pygmeus indicates imminent extinction unless conservation action is taken. *Bird Conservation International*, *20*(02), 95–111. https://doi.org/10.1017/S0959270910000316

Zomer, R. J., Trabucco, A., Coe, R., Place, F., van Noordwijk, M., & Xu, J. C. (2014). Trees on farms: an update and reanalysis of agroforestry's global extent and socio-ecological characteristics, 54. https://doi.org/10.5716/WP14064.PDF

Zong, C., Ma, J. Z., & He, L. (2007). Achievements of the nature reserve construction in the past fifty years in China. In *Forest Resources Management* (pp. 1–6).

Zou, Y., Sang, W., Warren-Thomas, E., & Axmacher, J. C. (2016). Geometrid moth assemblages reflect high conservation value of naturally regenerated secondary forests in temperate China. *Forest Ecology and Management*, *374*, 111–118. https://doi.org/10.1016/J.FORECO.2016.04.054

Chapter 4. Direct and indirect drivers of change in biodiversity and nature's contributions to people

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Table of Contents

Executive summary

Both direct and indirect drivers are causing the decline of biodiversity and nature's contribution to people in the Asia-Pacific region with the complex interaction among drivers synergistically undermining sustainable development and impacting on indigenous and local communities (*well established*). Biodiversity and nature's contributions to people in the Asia-Pacific region are impacted by a wide variety of strongly interwoven direct and indirect drivers (*well established*). Economic and demographic factors are key indirect drivers affecting the sustainability of nature's contributions to people through their interactions with socio-cultural and technological factors; this in turn influences direct drivers (land-use and land cover changes, overexploitation of nature's resources, climate change, invasions by alien species and pollution) (*well established*). Environmental governance and targeted policies are a powerful tool to alter these interlinked drivers and have significant effects on biodiversity and nature's contributions to people across the Asia-Pacific region (*well established*). More importantly, the interaction among drivers and the institutional change is causing both positive and negative impacts on biodiversity and nature's contribution to people pointing toward the need to improve the knowledge and capacity of policymakers to better understand and assess drivers impacting on biodiversity and ecosystems at the national, subregional and regional level {4.3; 4.6}.

Economic growth and globalization are modifying consumption and production patterns as well as profoundly impacting biodiversity and nature's contribution to people (*well established*). Integration of many rural societies in the Asia-Pacific region into regional and global markets over the last two decades and increasing urbanization and industrialization has seen many of these shifts from subsistence economies to market-based agricultural production increasing the extraction of ecosystem services and the loss of indigenous and local knowledge (*well established*) {4.1.1; 4.2.2; 4.2.3; 4.4.5}. This is leading to the conversion of traditionally managed farming lands and grazing lands to other uses or to land abandonment in marginal areas (*established but incomplete*) {4.4.1; 4.4.5; 4.5.2}. Rapidly economic growth in the Asia-Pacific region is also changing the cultures and quantity of traditional consumption including westernization of diets and increasing demand for animal protein, reducing the dependence on traditional crops or breeds and leading to a significant land-use change in North-East, South and South-East Asia (*established but incomplete*) {4.2.2; 4.2.3; 4.4.5}. Scientific advances, implementation of new technology and increased investment in research and development (R&D) in some emerging economies are providing sustainable solutions to food, water and energy issues in the Asia-Pacific region (*established but incomplete*) {4.2.4}. Improved connectivity through modernized transportation and communications is increasing the accessibility of remote rural areas and thus enhancing market opportunities to local communities (*established but incomplete*) {4.2.4; 4.5.2}. The application of appropriate technological innovation and promotion of local and indigenous knowledge systems enable conservation and utilization of biodiversity and nature's contribution to people and support sustainable development (*established but incomplete*).

Environmental degradation and habitat fragmentation due to unsustainable land use, overexploitation of natural resources, poorly planned infrastructure development and uncontrolled urbanization have adversely affected biodiversity and nature's contributions to people, thereby compromising human well-being and progress towards sustainable development goals in the Asia-Pacific region (*well established*). With growing human demands and economic opportunities through access to new global markets and application of new technology is now raising serious concerns about the sustainability of this utilization and the equitable sharing of associated benefits (*well established*) {4.1.2; 4.2.1; 4.2.2; 4.2.4}. Unsustainable land use, mining, deforestation, overfishing, livestock over-grazing and poor-planned booming tourism as well as other factors have led to the decline of biodiversity and degradation of ecosystems especially in agro-ecosystems, coastal ecosystems, inland freshwater and wetlands, urban and semi-urban areas, grasslands, and tropical forests (*well established*) {4.1.1; 4.1.2; 4.4.1-8; Figure 4.8}. Agricultural landscapes across the Asia-Pacific region have changed enormously due to declining traditional agriculture, agroforestry and multi-cropping approaches as well as, the establishment of large scale monoculture plantations and associated deforestation. This has been detriment to biodiversity and nature's contribution to people in many ways (*established but incomplete*) {4.1.1; 4.4.1; 4.4.5}, including water diversion and draining of some Asian wetlands of high conservation value to support intensive agriculture (*established but incomplete*) {4.4.5; 4.4.7}. Ongoing urbanization is creating many challenges for biodiversity such as the conversion of farmlands to urban areas but can also provide better access to social services such as improved health care and education (*established but incomplete*) {4.1.1; 4.4.6}. Despite a general increase in forest cover in the Asia-Pacific region, many South-East Asian forests, including mangroves, are rapidly vanishing due to timber extraction, large-scale bio-fuel plantations, and expansion of intensive agriculture and shrimp farms (*well established*) {4.4.1; 4.4.8}. Better planned land and resource use, community involvement in ecosystem management and equity in wealth sharing are imperative to increase biodiversity and nature's contribution to people including health and well-being.

Widespread pollution is an increasing, often trans-boundary driver of environmental degradation (*well established*). The Asia-Pacific region contains some of the world's most polluted cities and has had the most rapid increase in pollutant emission primarily from fuel wood and coal burning, motor vehicles and industry (*well established*) {4.1.3; 4.4.6}. Water is being polluted by domestic sewage, industrial effluents, and runoff from activities such as agriculture and mining (*well established*; 4.1.3; 4.4.7). Leaching of pollutants from excessive chemical fertilizer and pesticide use continues, increasing nutrient loads in ground and surface water and leading to eutrophication of freshwater and coastal water bodies (*well established*) {4.1.3; 4.4.5; 4.4.7; 4.4.8}. Decontamination of these sites is a major challenge as many developing regions lack suitable frameworks for characterizing, managing and restoring degraded sites (*established but incomplete*). Increased regional cooperation with enhanced investment, capacity and governance in association with the use of new technologies and best practices are necessary to better mitigate or eliminate the impacts of pollution (*well established*).

Invasive alien species (IAS) is one of key drivers for declining biodiversity and nature's contribution to people, particularly on island ecosystems (*well established*). The Asia-Pacific region is a major source of species becoming invasive elsewhere (*well established*) {4.1.4}. Some Asia-Pacific countries are experiencing local biodiversity losses and decreased ecosystem services following invasion by alien species although data regarding the current level of invasion in the some parts of the Asia-Pacific region remains poor (*established but incomplete*) {4.1.4}. Areas most impacted by invasive alien species include islands and coastlines as well as agricultural heartlands and large affluent cities (*established but incomplete*) {4.4.6; 4.4.7; 4.4.8; 4.5.1; 4.5.2}. Invasive alien species may bring about strong localized changes in ecosystem composition and structure, and contribute towards the local extinctions of less competitive native species (*well established*). There is evidence that invasive alien species are increasing in tandem with rapid economic and demographic development through increased global trade, development of transportation routes and cross-border migration (*established but incomplete*) {4.1.4; 4.2.1; 4.2.5; 4.4.6; 4.5.2}. Strengthening of trans-boundary collaborations across the entire Asia-Pacific region in biosecurity, early detection, eradication and monitoring of invasive alien species is seen as a crucial component in any efforts to address the detrimental effects of invasive alien species in the region.

Climate change and associated extreme events are impacting species distributions, population sizes, and the timing of reproduction or migration; increased frequencies of pest and disease outbreaks may have additional adverse effects on agricultural production and human well-being (*well established*). Observed changes in climate have already directly and indirectly affected both ecosystems and human well-being, and there is evidence that the climate of the Asia-Pacific region will continue to change over the coming decades (*well established*) {4.1.5}. Some Pacific islands are already threatened by sea-level rise (*established but incomplete*; 4.5.1). Climate induced floods due to the melting of inland ices/glacial dams pose a major threat to people and biodiversity in the Himalayan forelands (*well established*) {4.1.5; 4.4.3; 4.5.2}. Regional changes in precipitation are also anticipated as well as more climate-related extremes such as floods and drought (*well established*). The hydrological cycle is now demonstrably altered by climate change, impacting on food and water security in some Asia-Pacific countries (*established but incomplete*) {4.1.5; 4.4.7}. Associated changes in species distributions, population sizes, and the timing of reproduction or migration as well as an increase in the frequency of pest and disease outbreaks have been observed (*established but incomplete*) {4.1.5; 4.4.1; 4.4.3; 4.4.5; 4.4.7}. All of these impacts on biodiversity and nature's contribution to people are projected to worsen and will require close regional and global collaboration, improved policy, governance and institutional system (*established but incomplete*). At the same time, regional countries have the unprecedented opportunity to adopt eco-friendly technology (e.g. renewable energy) and best practice to mitigate and adapt to climate change, and break the greenhouse-gas-intensive development path by rapidly modifying the historical model of industrialization and urbanization (*well established*) {4.1.5; 4.2.4; 4.4.6}.

Strong, effective participatory governance can help alleviate the negative impacts of many drivers on biodiversity and nature's contributions to people (*well established*), facilitating progress towards the Aichi Biodiversity Targets and UN's Sustainable Development Goals (*established but incomplete*). Increasing global environmental awareness of publics and decision makers has signalled further impetus for resource governance reform in the Asia-Pacific region (*established but incomplete*). Unclear land tenure, weak governance, corruption, political unrest and even local conflicts are exacerbating the effects of illegal logging, mining, poaching, overgrazing, and overexploitation of natural resources due to a lack of enforcement by local authorities and government line agencies (*established but incomplete*) {4.1.2; 4.2.5; 4.4.1-8}. Influences from governance and institutional issues have in some cases proven stronger than more direct efforts to promote sustainable management of ecosystems and may prove more effective for conservation and sustainable development in the future.

The Asia-Pacific region is extremely biodiverse and contains many ecosystems of global significance (see Chapter 2 and Chapter 3). Despite being significant for sustaining our planet, biodiversity in almost all ecosystems across the Asia-Pacific region is declining, with species extinction rates being higher than the global average (A. C. Hughes, 2017; UNEP, 2016a, 2016b; WWF, 2014). This biodiversity decline is attributed to various direct and indirect drivers of change. During the last 300 years, 55 per cent of the planet's ice-free land had been transformed into rangelands, croplands, villages and densely populated settlements, with the most marked changes taking place over the last century (Ellis *et al.* 2010). More recently, climate change has emerged as the most widely discussed driver of global change and is embedded within the matrix of other drivers such as globalization, economic growth, demographic change and local land-use and land-cover change, all of which have significant ramifications. Crucially, these drivers are linked and interwoven with interactions often leading to changes in biodiversity and nature's contribution to people beyond what could be expected if any one driver acted in isolation. Thus, a better understanding of the drivers of change and associated interactions, inter-linkages between the temporal and spatial strength of drivers and of feedbacks to coupled socio-ecological systems at local and regional scales is now required. This chapter aims to explore direct and indirect drivers underpinning change in biodiversity and ecosystem services across the Asia-Pacific region, and then focuses on the impacts of drivers on major ecosystems (forests and woodlands, grasslands and savannahs, alpine ecosystems, deserts and semi-deserts, agro-ecosystems, urban and semi-urban, freshwater wetlands, coastal and marine) and two integrated ecosystem complex (island and mountain) distributed in the Asia-Pacific region.

4.1 Direct drivers

4.1.1 Land-use and land-cover changes

As a direct driver, land-use and land-cover change varies in space and time (Roy *et al.*, 2015). Simultaneously, it is also embedded in other factors such as climate change, biophysical conditions of the land, demographic change, technology implementation, political structures, economic growth, and even people's attitudes and values that operate on multiple interacting scales (Agarwal *et al.*, 2002). Growing evidence indicates that land-use and land-cover change brought about by rapid industrialization, urbanization and agricultural activities accelerate the degradation of land resources through pollution and soil erosion (Stavi & Lal, 2015; V. Tripathi *et al.*, 2015; Turner *et al.*, 2015). Generally, five major causes contribute to land-use and land-cover change through their interaction, including resource scarcity, market opportunities, policy intervention, increased vulnerability and institutional changes (Lambin *et al.*, 2003).

The Asia-Pacific region is one of the most populated places on earth, resulting in fragmented land cover and degraded ecosystems in many eco-regions. The scale of deforestation, for example, has dramatically expanded in the last few decades, especially in South-East Asia where the forest area sharply declined by 12.9 per cent from 242 million ha in 1990 to 210.8 million ha in 2015 (FAO, 2015b) (see section 4.1.2.1); this is the highest rate of habitat loss among the world's tropical regions (N.S. Sodhi *et al.*, 2010) (see section 3.2.1.1). Land-use and land-cover change due to developing large-scale intensive agriculture (e.g. oil palm, rubber and sugarcane), and logging activities have become key drivers of habitat fragmentation or loss in South-East Asia and threatened many endemic species (Fitzherbert *et al.*, 2008; Navjot S. Sodhi *et al.*, 2010; Wertz-Kanounnikoff & Kongphan-apirak, 2008) (section 4.1.2).

Land-use and land-cover change due to urbanization has also led to the massive loss of natural ecosystems and agricultural lands in developing Asia-Pacific countries (see 4.4.6). For example, urban lands in metropolitan Dhaka in Bangladesh increased from 11 per cent to 344 per cent from 1960 to 2005 (Dewan & Yamaguchi, 2009) while in Indonesia drastic reductions in forest cover have been attributed to rapidly increasing industrialization (APN, 2011). Urban expansion is also rapidly occurring in low-lying and biodiversity-rich areas such as coastal zones (Seto *et al.*, 2012) including coastal regions of Australia which are highly urbanized (Jackson, 2017) with >60 per cent of the population concentrated in capital cities (Gurran & Blakely, 2007). Urbanization and peri-urban areas of New Zealand including proliferation of small rural properties is constraining future land productivity by expanding onto high quality soils (Andrew & Dymond, 2013; Curran-Cournane *et al.*, 2014). Overall, the Asia-Pacific region is experiencing some of the fastest urbanization rates (section 1.1.3), with urban areas expanding faster than urban populations. By 2030, the total urban area is expected to triple whereas the urban populations are expected to nearly double (increasing from 2.84 to 4.9 billion) during the same period (Elmqvist *et al.*, 2013). Such urban expansion is threatening several key biodiversity hotspots and contributing to carbon emissions associated with deforestation and land-use and land-cover change (United Nations, 2014).

Vegetation clearing due to agriculture development has resulted in widespread land degradation via erosion and reduced soil fertility in some Asia-Pacific region as well as off-site impacts on water quality, aquatic biodiversity and aggradation of rivers that increase flood damage risk (H. Jones *et al.*, 2008; Wymann von Dach *et al.*, 2016). Land clearing for agriculture continues in Australia, most especially in Queensland (Jackson, 2017). Population growth and increasing demand on food in tropical and subtropical South Asia and South-East Asia have shortened fallow periods and intensified cultivation of farming lands resulting in traditional shifting cultivation being one of main causes of deforestation and soil erosion (Cairns, 2015).

In North-East and South-East Asia traditionally diverse farming systems have been replaced by intensified plantations, monocultures or large scale commercial cultivation to grow commodities such as food, timber, pulp, rubber, and palm oil, leading to the decline or loss of local crop varieties (FAO, 2010a, 2015b; Squires, 2014)(see also 4.4.5). Fragmentation and degradation of terrestrial ecosystems also impacts on pollination and dispersal services of native species (IPBES, 2016). For example, birds and bats are important pollinators and dispersers of several economically, ecologically and culturally important species such as *Ficus*, durian, Mahwa tree, *Terminalia catappa* and breadfruit (Kunz, de Torrez, & Bauer, 2011; Hughes, Satasook, & Bates *et al*., 2012). Replacing terrestrial ecosystems with orchards and plantations has changed pollinator species diversity and abundance (Sekercioglu, 2012) with several key bird pollinators having already disappeared in New Zealand and the south Pacific islands (Whelan, Wenny, & Marquis, 2008; IPBES, 2016).

The loss of South-East Asian peatlands over the last two decades associated with legal and illegal logging, extensive plantation development, drainage and land development projects, fires and strong El Nino effects has resulted in these ecosystems emitting large volumes of carbon into the atmosphere (Miettinen *et al.*, 2012). The past few decades has also seen the tranformation of the Sanjiang Plain located in North-East China from natural welands into croplands but the land conversion process almost stopped by 2005 (Mao,Wang, Luo, Ren, 2016; Wang *et al*., 2009), and a significant increase in human-made wetlands (e.g. reservoirs and ponds etc.) of 1141.9 km^2 hasbeen observed in the Songnen Plain of North-East China (Mao *et al.,* 2016; Z. M. Wang *et al.*, 2009).

Land-use and land-cover change processes also affects freshwater and marine biodiversity and associated ecosystem services (Secretariat of the Convention on Biological Diversity, 2012; see 4.4.7) with habitat fragmentation as well as other factors such as flow modification, pollution and alien species invasion impacting on freshwater fish (Dudgeon *et al.*, 2006). Along the Mekong Basin, for example, increasing demand for power and associated infrastructure disrupts fisheries and associated ecosystem services, impacts on river-dependent livelihoods and increases the risk of disease and change sediment flows (Grumbine *et al.*, 2012). Along many tropical coastal belts, fragmented mangroves and their surrounds are negatively impacting ecosystem services such as providing timber, fuel wood and charcoal as well as cultural services through recreation and aesthetic values (Brander *et al*., 2012; see 4.4.8).

4.1.2 Natural resource overexploitation

Among several regional and subregional drivers posing a threat to biodiversity and nature's contribution to people in the Asia-Pacific region overexploitation of natural resources is one of the key factors. The Asia-Pacific region was regarded as the single largest user of natural resources in the world (UNEP, 2016a). As the rapid urbanization and industrialization in the Asia-Pacific economies, the use of primary materials (metal ores and industrial minerals, fossil fuels and construction minerals) continues to grow (Fong-Sam *et al*., 2016; UNEP, 2016a; 2016b). Recently, Maxwell and his colleagues (2016) reported an analysis of threat information gathered for more than 8,000 species in IUCN Red List data, which also revealed the biggest drivers of biodiversity decline are overexploitation (the harvesting of species from the wild at rates that cannot be recovered) and agricultural activities (Maxwell *et al.*, 2016).

4.1.2.1 Overexploitation of forest products

Asia-Pacific region forests account for about one-fifth of the world's forests, cover around 18 per cent of the land area (around 723 million hectare) (FAO, 2015b) and provide significant ecosystem services within the region and beyond. Generally, 0.7 million hectare of Asia-Pacific region forests were lost annually from 1990 to 2000 but this trend has reversed since then with annual gains of 1.35 million hectare (FAO and RECOFTC, 2016) .

It should be emphasised that forest loss in South-East Asia is of greatest concern since annual loss here was about 1.3 million ha in comparison to the global annual loss of about 5 million ha during 1990-2010, thereby being 26 per cent of the total global loss (FAO, 2015b). Although deforestation is heavily driven by many complex interactions, increased demand for forest goods (e.g. industrial round-wood, fuelwood) and agricultural products in association with the expansion of agricultural and urban lands due to economic and population growth in the region have led to deforestation and forest degradation (FAO, 2015b; 2010b; FAO and RECOFTC, 2016); Figure 4.1).

Table 4.1 Forest area change in the Asia-Pacific region

Subregion	Area (million ha)					% change (1990-2015)
	1990	2000	2005	2010	2015	
North-East Asia	209.2	226.8	241.8	250.5	257.0	22.9%
South Asia	77.6	77.7	79.5	81.4	82.0	5.8%
South-East Asia	242.0	221.0	217.1	214.6	210.8	-12.9%
Oceania	176.8	177.6	176.5	172.0	173.5	-1.9%
Asia-Pacific	705.6	703.1	714.9	718.5	723.4	2.5%
World	4,128.3	4,055.6	4,032.7	4,015.7	3,999.1	-3.1%

Source: FAO (2015a); FAO and RECOFTC (2016)

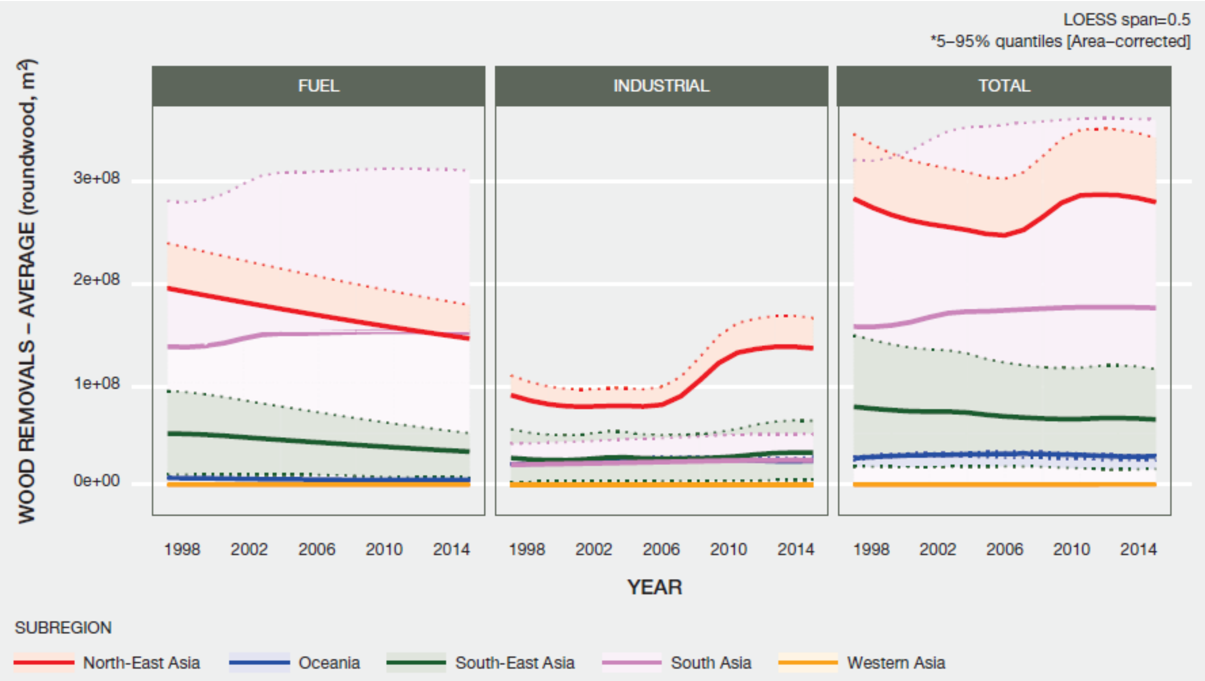


Figure 4.1 Change in fuel-wood production (left) and industrial round-wood production (right) in the five Asia-Pacific subregions, 1995-2015.
Figure prepared by the IPBES Task Group on Indicators and Knowledge and Data Technical Support Unit. Indicator data source: FAO

Non-timber forest products (NTFPs) such as fungi, medicinal plants, fuelwood, spices and forage are important forest products in developing the Asia-Pacific countries where most the rural population is completely dependent on forests for their basic needs (Agrawal *et al.*, 2013; Pandey *et al.*, 2016; Uprety *et al.*, 2016a). For example, in the Chittagong Hill Tracts of Bangladesh forest dependent households collect NTFPs to support their basic livelihood needs and derive a major part of their income through the sale of NTFPs (Kar & Jacobson, 2012; Mukul *et al.*, 2016) while almost 73 per cent of Jah Hut households collect NTFPs near the Krau Forest and Wildlife reserves in Pahang, Malaysia (Agrawal *et al.*, 2013). Within the Himalaya Kanchenjunga Landscape some 739 species of NTFPs used by the local people from India, Nepal and Bhutan for 24 different purposes, most frequently for medicinal and edible plants (Uprety, Poudel, Gurung, Chettri, & Chaudhary, 2016). In Vietnam forests are generally recognized as important for household livelihoods for both regular consumption needs and as an additional source of income in times of environmental or economic shock (Agrawal *et al.*, 2013).

Though NTFPs are known to be very important for large numbers of households in developing Asia-Pacific countries, these receive limited attention (Agrawal *et al.*, 2013). NTFP resources are under heavy pressure due to poor harvesting practices, overexploitation and increasing market demand for medicinal and ornamental plants, impacting on the livelihoods of forest-dependent communities (Mukul *et al.*, 2016; Pandey *et al.*, 2016), particularly for women and children who are the most common consumers of wild forest foods (Shackleton *et al.*, 2011). Additionally, overexploitation of forest products not only disturb wildlife habitats but also threaten their survival directly due to market-driven demand for wildlife products (IUCN, 2017; Squires, 2014; UNEP, 2016a). Increased demand for forest products has raised serious concerns among stakeholders regarding the sustainability of resources, equal distribution of benefits, and regional cooperation in controlling illegal trade (Uprety *et al.*, 2016a; Vedeld *et al.*, 2004).

4.1.2.2 Overgrazing

Livestock overgrazing is a major cause of rangeland degradation across the arid and semi-arid Asia-Pacific region. Overgrazing has several environmental impacts including soil erosion and soil degradation, endangering plants, salinization, and conflicts with wildlife (FAO, 2014; see 4.4.2). A shift from migratory pastoralism to sedentary animal husbandry has seen stocking rates in Inner Mongolia increased by at least 11-fold over the past 60 years which has variously degraded the majority of grasslands (about 78 million hectare; Briske *et al.*, 2015). Some of the highest livestock densities in the world are found in Western Asia, South Asia and Australia which has led to the loss of ‘desirable’ perennial grasses and herbs, decline in forage yield, changes in hydrological cycles and soil physical characteristics, reduced carbon storage, and even the loss of livelihoods due to overgrazing and desertification (Bouwman *et al.*, 2005; Menzi *et al.*, 2010). In the last two decades very rapid per capita income growth and associated diversification away from plant-based food staples towards animal products have driven the rapid growth in the production and consumption of major livestock commodities (P. Pingali & McCullough, 2010) , increasing pressures on rangelands. Climatic changes such as drought and reduced precipitation in pastoral areas can impact vegetation, aggravating the risk of overgrazing (see 4.1.5; 4.4.2). A negative feedback may also exist, grassland degradation due to overgrazing can decrease latent heat flux, increasing temperature and decreasing precipitation (Du *et al.*, 2012; Y. Li *et al.*, 2013; Y. Y. Liu *et al.*, 2013).

4.1.2.3 Overfishing

In the Asia-Pacific region, extensive inland water bodies and associated fisheries provide significant food and livelihoods to local communities. The Mekong River Basin (MRB), for instance, is home to about 65 million people (MRC (Mekong River Commission), 2010), with about 70 per cent of them relying on subsistence fisheries (Dugan *et al.*, 2010). At last assessment, the MRB produced around 2.5 million tonnes of fish annually (as of 2004) with more than two thirds of the value of inland fish production coming from capture fisheries, making it the most productive inland fishery in the world (Baran & Myschowoda, 2009). However, overfishing was identified as the second biggest threat to this fishery after hydrological alteration, especially due to dam construction for hydropower generation on rivers (see 4.4.7.2) (Baran & Myschowoda, 2009; Kang *et al.*, 2009). In the Cambodian and Vietnamese floodplains alone, there are about one million tons of freshwater fish caught every year (Baran & Myschowoda, 2009; Barlow *et al.*, 2008), which is impacting on the sustainability of floodplains fisheries in both nations (Dugan *et al.*, 2010).

Aquatic environments are home to numerous species of fish and invertebrates, many of which are consumed as food (Table 4.2). In 2014, 84 per cent of the global population engaged in the fisheries and aquaculture sector was found in Asia (FAO, 2016b). About 90 per cent of global aquaculture production, including the top ten producer countries, occurs in the Asia-Pacific region (Funge-Smith *et al.*, 2012; Lymer *et al.*, 2010) with aquaculture growing at approximately 6.7 per cent per annum (Funge-Smith *et al.*, 2012). By comparison, the contribution of marine capture fisheries to the total production continued to decline, particularly in South-East Asia where it changed from around 70 per cent of the region's total production in 2000 to only 40 per cent in 2014 (SEAFDEC, 2017), due to the sharp increase in aquaculture production for sustaining an increasing demand in fish. The major proportion of marine and brackish water aquaculture occurs in China, Indonesia, Philippines, Japan, Vietnam, Republic of Korea and Bangladesh where the production growth rate is at 3 per cent per annum (Funge-Smith *et al.*, 2012). Key biodiversity challenges associated with marine aquaculture across most of the Asia-Pacific countries include overfishing, introduction of invasive alien species, ineffective management of the fisheries sector, and inadequate management of biosecurity measures, diseases and water pollution (Funge-Smith *et al.*, 2012; Pauly & Zeller, 2017a; Todd *et al.*, 2010) (see 3.2.4.6; 4.4.5; 4.4.7; and 4.4.8).

Table 4.2 Major species under aquaculture production in the Asia-Pacific region

Type		% of total production
Fin fish	Fresh Water	60
	Marine	32
	Brackish water	8
Invertebrates	Molluscs	19
	Crustaceans	7
	Echinoderms	<1
Aquatic plants		22

Source: Funge-Smith *et al*. (2012)

Despite marine fishing being one of the most important provider of livelihoods for many Asia-Pacific countries, overfishing is a significant challenge. Over the last 50 years, increasing global demand for animal-based commodities has resulted in immense fishing pressure and led to reductions in the biomass of targeted species including those caught incidentally in marine ecosystems (World Bank, 2013). There are many reports published by regional fisheries management organizations (RFMOs) of FAO regarding fisheries stock, although they include information of not only exclusive economic zones (EEZ) but also open ocean. Globally, the proportion of fish stocks (based on coastal and offshore regions) within biologically sustainable levels has decreased rapidly in the last four decades (FAO, 2016b): approximately 29 per cent to 31 per cent of fish stocks are classified as overfished (FAO, 2016b; Pauly & Zeller, 2017a), with an estimated 17 per cent having collapsed stocks (catches < 10 per cent of peak and year is post-peak) in 2014[64]. Fishing efforts have shifted geographically with Asia rapidly dominating global fishing efforts since the 1970s and 1980s (Anticamara *et al.*, 2011; Swartz *et al.*, 2010). It is worth noting that marine capture fisheries statistics have been widely debated as they are possibly under-estimating catches, due to incomplete data on small-scale fisheries, subsistence and recreational fisheries, discarded bycatch; recently termedIllegal, Unregulated and Unreported (IUU) fishing (Pauly & Zeller, 2017b, 2017a; Ye *et al.*, 2017). Attempts to reconstruct catches have shown that global catches could be 50 per cent higher than data reported by FAO (2016b), with stronger declines since catches peaked in the 1990s (Pauly & Zeller, 2016), although these estimates are still highly researched and debated (Pauly & Zeller, 2017b; Ye *et al.*, 2017). Under-reporting is an issue as it can hide over-exploitation of fisheries (Johnson *et al.*, 2013; Watson *et al.*, 2013) and under-represent marine employment (L. C. L. Teh & Sumaila, 2013), with ongoing research in Asia-Pacific showing under-reported catches from some distant vessels (Pauly *et al.*, 2014).

In the Asia-Pacific region, from available and estimated information, marine capture fisheries have flattened with probable declining trends in the past 5 to 10 years (Funge-Smith *et al.*, 2012; Pauly &

[64] http://www.seaaroundus.org/data/#/global/stock-status

Zeller, 2016), and signs of overfishing for instance in the Western Central Pacific zone (zone 71 from the FAO fishing area[65]) (Costello *et al.*, 2016).

In South-East Asia, small-scale fisheries that are vital for providing food to local communities, employment and income have been estimated to have declined possibly due to a rise in industrial fishing for human and non-human consumption (L. C. L. Teh & Pauly, 2018). Some small scale and large scale fisheries of species such as tuna are also continuing to show declines in catch in countries like Japan, in spite of reduction in fishing effort and implementation of management (Saito *et al.*, 2016; Toba *et al.*, 2016; Yonezaki *et al.*, 2015). It is not clear whether the situation is the same in other subregions of the APR, as there may be other factors such as demographics (e.g. migration, aging population) and societal changes (e.g. changing dietary preferences) that may also explain this trend (Bulian & Nakano, 2018) . Literature shows that the main drivers for overfishing in the South-East Asia region are a weak governance, growing demand in food and an overcapitalisation that doesn't limit fishing capacity (Pomeroy, 2012; Pomeroy *et al.*, 2007; L. S. L. Teh *et al.*, 2017), leading to a high proportion of fishing vessels (over 75 per cent of the world reported fishing vessels are from Asia) (SEAFDEC, 2017). Pacific Islands suffer the same issue of weak management, with increased pressure on coastal fisheries due to population growth, urbanization, poor economic development, climate change and increased demand from offshore countries as over-exploitation continues in Asia, with bigeye tuna, in particular, considered as being overfished (UNESCAP, 2014).

In spite of the challenges facing the marine capture fisheries in the Asia-Pacific region, some progress is being made in reducing fishing rates and restoring overfished stocks and marine ecosystems through effective management actions in some areas and improvement in data collection, although only for a few developed countries in the region such as Australia and New Zealand. The FAO has several initiatives that aim to improve data collection, reduce overfishing and IUU fishing. In particular, FAO is making efforts to build capacity of less developed States to assess their stock status and then include those additional stocks in each biannual report (FAO, 2016). The FAO noted in particular that data in key marine capture production areas are still uncertain (e.g. Indonesia, Myanmar) which may affect conclusions on assessed stocks and trends. The voluntary guidelines for securing small-scale fisheries in the context of food security and poverty eradication were designed to promote more sustainable small-scale fisheries, and also elevate policy priorities for such fisheries (FAO, 2015c). Progress in combating IUU fishing has been impeded by weak governance, but the FAO is developing international guidelines and tools such as the Global Record of Fishing Vessels to improve certification (FAO, 2016). Note that apart from FAO reports, national level or even smaller scale reports exist, based on EEZ only data, however they are not peer reviewed papers and many of them are written in local languages that couldn't be used in this assessment. Consequently, management practices discussed here are restricted to Oceania countries. In the region, Australia and New Zealand are generally considered as among the best countries to sustainably manage their marine fisheries (Pascoe *et al.*, 2016). Efforts are being made to reduce overfishing on specific stocks, e.g. Government of the Commonwealth of Australia in 2014 (FAO, 2016b), Commission for the Conservation of Southern Bluefin Tuna (CCSBT) and the Western and Central Pacific Fisheries Commission (WCPFC) for the Pacific bluefin tuna. New Zealand, with its single jurisdiction and single over-arching approach to fisheries management has achieved remarkable results, with 83.6 per cent of assessed stocks not considered overfished (New Zealand Ministry for the Environment, 2017; Pascoe *et al.*, 2016). Overfishing is actively managed through targeted closure of fisheries or reduction in total allowable commercial catch, however transnational management remains a challenge and demands active participation (Chu & Kompas, 2014; New Zealand Ministry for the Environment, 2017). The success in Australia and New Zealand in assessing and managing some of the key target fish stocks within their jurisdiction may provide opportunities and best practice examples for rebuilding and managing depleted and overfished stocks in other parts of Asia-Pacific region.

[65] http://www.fao.org/fishery/area/search/en

Considering the complexity and often synergistically combined effects of multiple drivers impacting fisheries, the management of marine and coastal ecosystems and inland water bodies is imperative to prevent further declines and ensure sustainability of fisheries and aquaculture in Asia-Pacific (see 4.4.7; 4.4.8).

4.1.2.4 Energy utilization

Asia-Pacific region is the region with the greatest use of wood-based fuels globally (FAO, 2015a; Union of Concerned Scientists, 2011) (Figure 4.1) with most rural people in Asia relying on fuelwood as their primary source of household energy. Although charcoal production was considered as a driver of deforestation and forest degradation (Hughes, 2017), charcoal is not as heavily used in Asia as in Africa and South America (Union of Concerned Scientists, 2011). India and China are among the top 10 wood charcoal-producing countries with each contributing to 4 per cent of global charcoal production (Oberheu, 2017).

In term of fossil fuels, Asia is the biggest market for coal, currently consuming 66 per cent of global coal production (World Energy Council, 2016). At the same time, the Asia-Pacific region is the biggest coal producer with the total production in 2015 being 5,440 million tonnes and accounting for 69 per cent of the global production (World Energy Council, 2016). Australia, China, India and Indonesia are among the top 10 coal-producing countries globally (World Energy Council, 2016). Also, Australia is projected to be the world's top coal exporter followed by Indonesia through to 2040 (EIA, 2017).

For most of Asia-Pacific economies, oil remains the major fuel of choice. Population growth and an increasing consumer class in the Asia-Pacific region has supported increasing oil demand which will likely continue in the future (World Energy Council, 2016). The largest consumer of refined petroleum is transportation sector which supports increasing travel and freight services in the Asia-Pacific region (EIA, 2017) but is likely to exacerbate air pollution in rapidly growing urban areas (see 4.1.3; 4.4.6). However, technological advancements in the oil industry including trends to improve energy efficiencies, the diminishing role of high-sulphur oil in the marine fuel industry, and the emergence of shale oil may reduce environmental pressures (World Energy Council, 2016). The growth of renewable energy industries, popularization of electric vehicles and rural electrification in Asia-Pacific countries is expected to reduce environmental pressures although the scales of these technologies is limited at present (UNDP, 2013) (see 4.2.4).

In recent years there has been a major upsurge in hydropower in the Asia-Pacific region which is considered to be an underutilised potential, capable of delivering an estimated at 7,195 TWh per annum (World Energy Council, 2016). However, there are concerns over environmental impacts associated with the large number of dams in Asia (A. C. Hughes, 2017) including affecting stream continuity, flow regimes and freshwater biodiversity (section 3.2.2.2). However, hydropower does offer clean energy as well as other services such as flood control. Among non-hydroelectric renewable energy sources, wind and solar increased most quickly in last decade and will continue, as these technologies become more cost competitive (EIA, 2017).

4.1.2.5 Mining

Many countries in the Asia-Pacific region heavily depend on mineral production as the backbone of national economy (U.S. Geological Survey, 2017) . Australia and China are among the world's leading mineral producers with China and Japan being the two major regional markets for crude and processed minerals (Fong-Sam *et al.*, 2016; U.S. Geological Survey, 2017). In Mongolia economic growth was attributable mainly to growth in the mining sector which accounted for over 80 per cent of export revenue (Fong-Sam *et al.*, 2016). Rapid economic growth and expansion of transportation and utility infrastructure has seen the demand for cement in Asia-Pacific countries increased simultaneously. Currently, India, Vietnam, and Malaysia are among the top five exporters of limestone in the world and export near 20 per cent of global cement collectively (A. C. Hughes, 2017).

In the Asia-Pacific region high dependence on mineral extraction resulted in vegetation clearance and ecosystem degradation through access expanding, exploration drilling, overburden stripping, ground-water pollution, and quarry collapse. Indirect effects include fragmentation of landscape through road and settlement construction or threats to human health due to air pollution such as dusts or smelter emissions (International Council on Mining and Metals (ICMM), 2006; Y. Y. Yang *et al.*, 2014). The extensive exploitation of limestone for cement production has had devastating consequences on ecosystems in karst areas which represent a few global endemicity hotspots (A. C. Hughes, 2017). The depletion of mineral resources is increasingly being proposed in remote and biodiversity-rich areas that were previously unexplored (International Council on Mining and Metals (ICMM), 2006) or even protected (Durán *et al.*, 2013).

4.1.3 Pollution

4.1.3.1 Air Pollution

Air pollution is a serious threat to human health and the well-being of people in the Asia-Pacific region where it has become an inescapable reality of urban life in many cities. According to the WHO (Osseiran & Chriscaden, 2016b), an estimated 6.5 million deaths (11.6 per cent of all global deaths) were associated with air pollution, with most of deaths occurring in low and middle income countries of South-East Asia and Western Pacific (Osseiran & Chriscaden, 2016b; UNEP, 2016a). Motor vehicle and industrial emissions and household fuel combustion are major sources of air pollution in the Asia-Pacific region. Air pollution, caused by particulate matters (PM) primarily PM10 and PM2.5, sulphur oxides (SOx), nitrogen oxides (NOx), and tropospheric ozone (O_3) is a common concern and challenge among regional countries, particularly in developing countries (UNEP, n.d.).

A World Health Organization (WHO) (2016) comparison of 795 cities in 67 countries for levels of small and fine particulate matters (PM10 and PM2.5) between 2008 and 2013 found that the highest urban air pollution levels occurred in South-East Asia, with annual mean levels often 5-10 times higher than WHO's limits; low-income cities in the Western Pacific Region were next highest. In South-East Asia and Western Pacific, levels of urban air pollution have increased by more than 5 per cent in over two-thirds of the cities (Osseiran & Chriscaden, 2016a). In India, air pollution reduces life expectancy by 3.2 years for the 660 million people living in cities including Delhi (Chauhan, 2015). In China, air pollution sources are particularly intense in eastern and north-eastern regions but there has been obvious improvement in air quality recently in most of the Chinese cities (Fu *et al.*, 2016).

Air pollutants may impact ecosystems and human health as both wet and dry deposits. In the Asia-Pacific region many air pollution problems are attributable to energy use, including the combustion of fossil fuels in urban and industrial areas and the burning of coal and biomass in rural and some urban areas (UNEP, 2016a). Air pollutants involved in forest damage mainly include sulphur and nitrogen compounds, ozone, and heavy metals (Lorenz *et al.*, 2010). Nitrogen oxides (NOx) released into the atmosphere in the course of various combustion processes are also biologically produced by soil bacteria or emissions from transportation. Using satellite-based NO_2 observations to constrain the global deposition of reactive nitrogen oxides (NOy), Geddes and Martin (Geddes & Martin, 2017) found that from 1996 to 2014, NOy deposition has increased substantially in some parts of North-East Asia and in the north-western Pacific Ocean. Zhao *et al*. (2015) also reported that rapid Asian industrialization has led to increased atmospheric nitrogen deposition which threatens marine environments in the north-western Pacific. These trends are also likely to continue increasing in South Asia in particular (Lamarque *et al.*, 2013). In Japan the wet deposition of nitrogen was 1.5 times larger than in Europe and two times larger than in the United States on the median (7.86 kg N/ha/year in Japan, 5.19 kg N/ha/year in Europe, and 3.61 kg N/ha/year in USA) (Matsubara *et al.*, 2009).

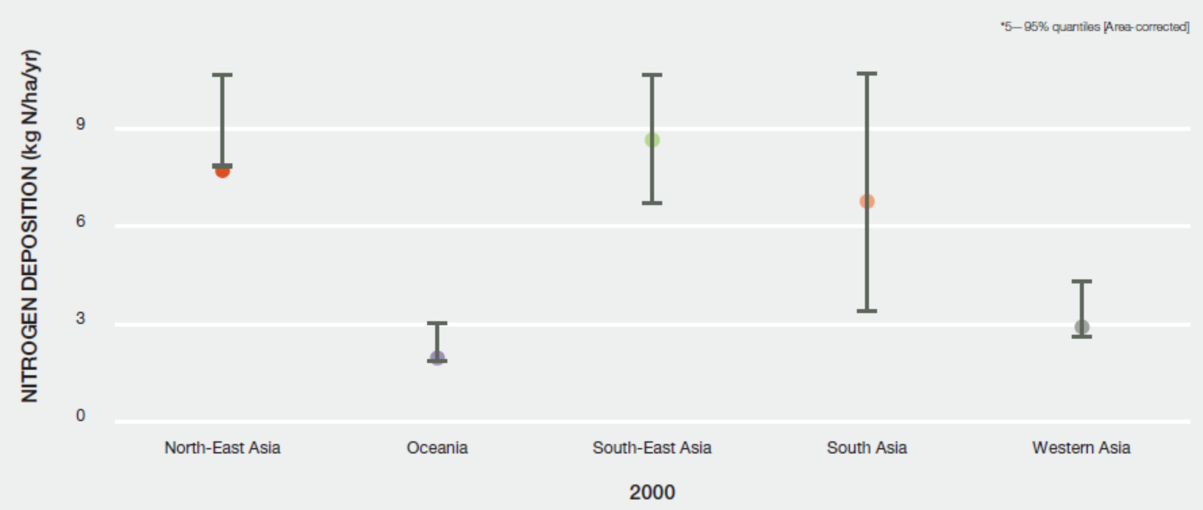


Figure 4.2 Nitrogen deposition (kg N/ha/yr) in the Asia-Pacific region.
Figure prepared by the IPBES Task Group on Indicators and Knowledge and Data Technical Support Unit. Indicator data source: International Nitrogen Initiative.

Besides health impacts, air pollution also poses a threat to the Asia-Pacific region's biodiversity, food and water security and climate systems, thereby undermining poverty alleviation and sustainable development (UNEP, 2016a). Air pollutants may damage forests directly via damage to foliage and indirectly via the soil (Lorenz *et al*. 2010). In addition to the visible direct effects of O_3, SO_2, NO_2, and NH_3 on plants, indirect effects include soil acidification (Lorenz *et al*., 2010). Increased nitrate leaching also enhances the risk of eutrophication of coastal marine areas and groundwater (UNEP, 2016a). Ozone has strong ecological effects, including species- and individual-specific effects on resource acquisition and root/crown architecture (Matyssek & Sandermann, 2003). In addition, some of the biodiversity hotspots at high risk from O_3 effects coincide with those at high risk from N-deposition including forests in South-East Asia (Phoenix *et al.*, 2006). Black carbon, a component of particulate matters, has been identified as a major contributing factor to accelerated melting of snowpack and glaciers (Centre for Climate and Energy Solutions, 2010) . In addition, particulate matter disturbs rainfall patterns including the Asian monsoon leading to the increasing floods disasters in the region (UNEP, 2016a).

4.1.3.2 Soil Pollution

Rapid population growth, economic development, urbanization, industrialization, and intensive agriculture are leading to soil pollution. Soil in many areas of the Asia-Pacific region is contaminated by municipal, hospital, radionuclides and industrial wastes; solid waste landfills and sewage sludge; agrochemicals, insecticides, herbicides, fungicides and other pesticides, mine tailings, organic pollutants, and heavy metals (P. Li *et al.*, 2009; Osman, 2014; Vijgen *et al.*, 2011)(Osman, 2014). Arsenic (As) pollution of rice-field soils in South, South-East and North-East Asia is associated with irrigation using contaminated groundwater; rice-paddy As concentrations include 11-32 mg/kg in Bangladesh, 8.9-13.12 mg/kg in India, 0.07-33 mg/kg in Cambodia, 3.3-9.9 mg/kg in Korea and 7.4-22.8 mg/kg in China (Gillispie *et al.*, 2015) . Heavy metals and metalloids accumulation (Cd, Zn, Cu, Pb, Cr, Ni, Fe, Zn, Co, Hg and As) in rice from other Asian countries has also been reported (Arunakumara *et al.*, 2013; Guo *et al.*, 2017).

Increasing waste volumes and growing complexity of waste streams which contain large volumes of hazardous substances will further impact the soils in the Asia-Pacific region. Osman (Osman, 2014) confirmed that the most important categories of soil pollutants were persistent organic pollutants such as Polycyclic Aromatic Hydrocarbons (PAHs) and Polychlorinated Biphenyl (PCBs), and heavy metals such as Plumbum (Pb), Cadmium (Cd), Arsenic (As), Mercury (Hg), Zinc (Zn), and Copper

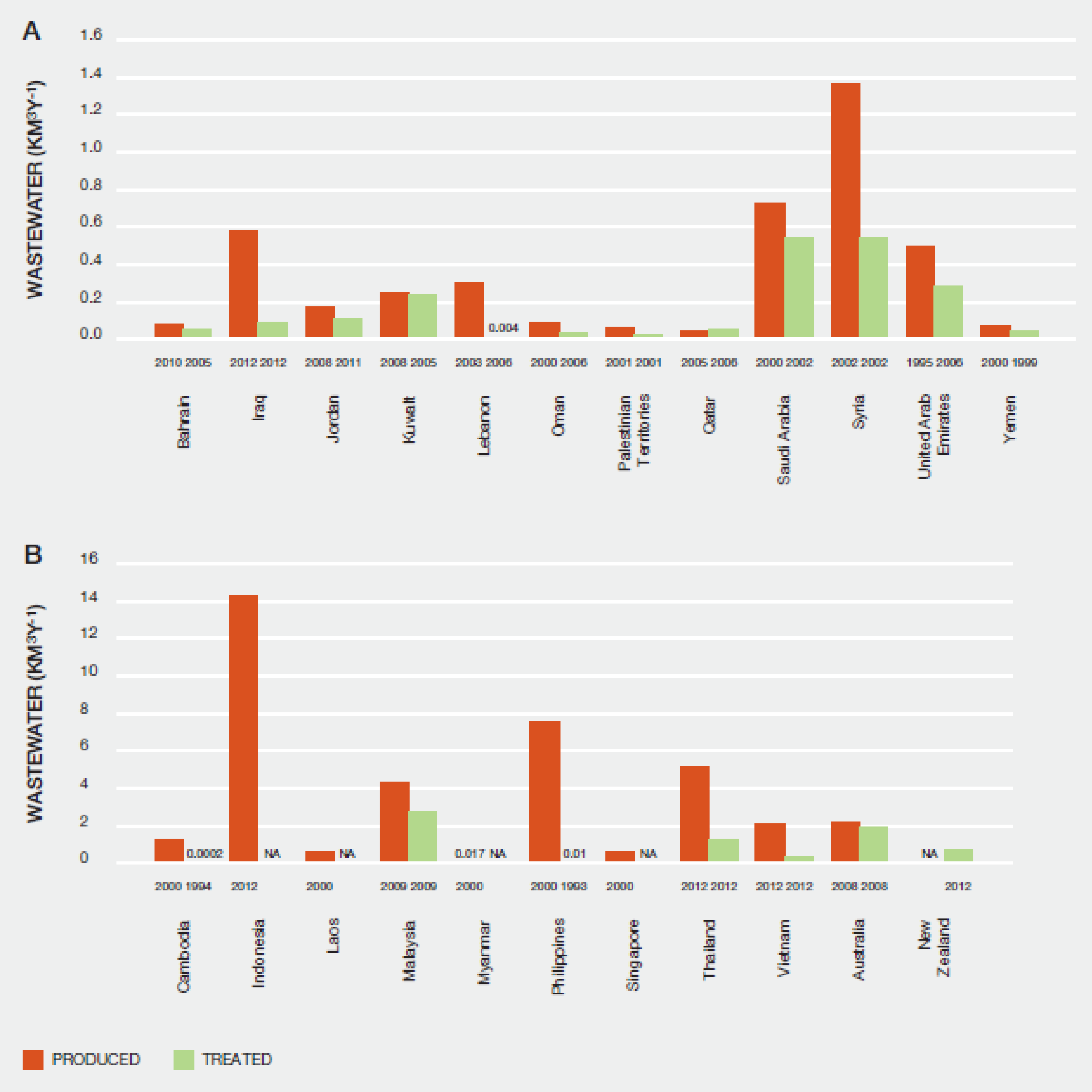
(Cu), all of which are toxic to biodiversity including plants and animals as humans when found above critical levels (Osman, 2014). Remediation of contaminated sites is a major challenge as some the Asia-Pacific countries still lack of suitable framework for characterizing and managing degraded and contaminated sites (V. Tripathi *et al.*, 2014, 2015).

4.1.3.3 Water Pollution

The annual volume of wastewater generated in Asia, excluding agricultural drainage, is some 142 km^3 (Evans *et al.*, 2012) although wastewater generation and treatment varies greatly among Asia-Pacific countries (Figure 4.3) (Mateo-Sagasta *et al.*, 2015; Sato *et al.*, 2013). Water pollution caused mainly by domestic sewage, industrial effluents, and runoff from agricultural and mining activities, affects both water security and aquatic biodiversity (Vörösmarty, 2010). For instance, mussels from Cambodia, China, India, Indonesia, Japan, Korea, Malaysia, Philippines, and Vietnam were reportedly contaminated with Polychlorinated biphenyl (PCBs), Dichlorodiphenyl-trichloroethane (DDTs), Polybrominated diphenyl ethers (PBDEs), synthetic musk and benzotriazole UV stabilizers (Nakata *et al.*, 2012). In Japanese agricultural ponds, eutrophication was the most influential driver of aquatic biodiversity loss along with invasive fish (bluegill) and concrete bank construction (Kadoya *et al.*, 2011).

The overapplication of agricultural fertilizers that are primarily lost through runoff or waste water is leading to eutrophication and acidification of water bodies and biodiversity loss in South Asia, South-East Asia and even North-East Asia (Bassi *et al.*, 2014; Erisman *et al.*, 2015; S. Zhao *et al.*, 2006). Water pollution associated with agriculture causes environmental damage and ecosystem degradation (see 4.4.7.4), lost aquaculture and fisheries income, and increased treatment costs for drinking water (Smith & Siciliano, 2015). In New Zealand, agricultural leachates mainly from livestock farming increased total nitrogen levels in rivers by 12 per cent over the last 20 years (Ministry for the Environment & Statistics New Zealand, 2015). Under conditions with high inputs of nitrogen fertilizers, faster-growing species assimilate nitrogen but acid-tolerant species may adapt. Loss of plant species or habitat can further impact insects or other animals in the ecosystem which are dependent on these plants and habitats (Erisman *et al.*, 2015). Increasing nitrogen deposition in surface and ground water has led to ‘Alga blooms’ in some lakes, ‘red tides’ in estuaries and N_2O and NH_3 emissions from farmlands (Erisman *et al.*, 2015; Y. Zhao *et al.*, 2015).

Pesticide use is growing across the Asia-Pacific region. For example, pesticide use in India grew by 750 per cent from the mid-1900s to the present day (Evans *et al.*, 2012) with some prohibited pesticides still being detected in excess of international recommendations in the Ganga River (Evans *et al.*, 2012). In Sri Lanka it was reported that the disposal of unused pesticides, equipment washing, and poor storage are the main factors contributing to surface water pollution (UNESCAP, 2006). Since the shift from the traditional agriculture-based economies to industrial economies in most of Asia-Pacific countries, the major sources of pollution are from industry production producing metals, paper and pulp, textiles, food and beverages as well as mining (Evans *et al.*, 2012).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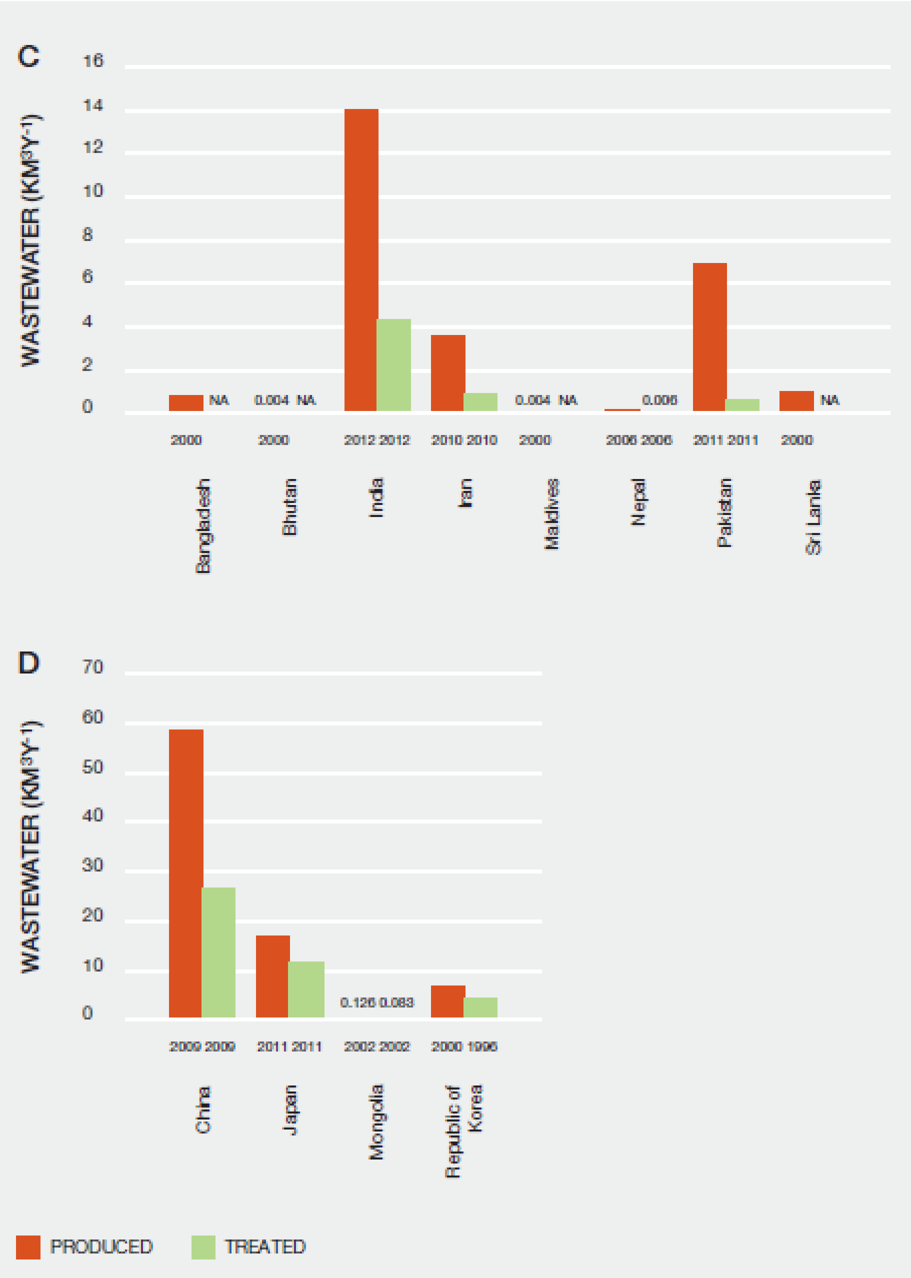

Figure 4.3 Annual production and treatment of wastewater in the Asia-Pacific region
A: Western Asia; B: South-East Asia and Oceania; C: South Asia; D: North-East Asia
Source: Mateo-Sagasta *et al*. (2015) is cited for Iraq, Indonesia, Malaysia, Thailand and Vietnam; Sato *et al*. (2013) for other countries in the figure.

Across the Asia-Pacific region many countries have made efforts to improve policies and regulations but enforcement is still difficult due to the lack of effective governance. Institutional capacities are unable to keep pace with rapid economic development especially in developing countries (Evans *et al*., 2012). Several countries, including China, India, Thailand, the Philippines, Bangladesh, and Indonesia, are implementing ambitious programmes to build wastewater treatment plants and rehabilitate degraded water environment (ESCAP, 2015; UNEP, 2016a; 2011a). Many Asia-Pacific countries have also passed water quality acts or laws to prevent pollution and protect receiving water. Due mainly to limit financial resources and the shortage of trained personnel, there are significant differences among Asia-Pacific countries in waste treatment (UNEP, 2011a, 2012b, 2016a, 2016b).

4.1.4 Invasive alien species

Prior to assessing invasive alien species (IAS) and their impacts on the Asia-Pacific region, it should be noted that this region is a major source of species becoming invasive elsewhere (Hui *et al*., 2014; Wilson *et al*., 2011; Rejmanek, 2014; Box 4.1). With Asia's key role in the global economy and the well-established close links between the spread of invasive species and economic trade-routes (Axmacher and Sang, 2013; Gotzek *et al*., 2015), governments in this region have a key global responsibility to prevent the spread of potential invasive species via strict bio-security measures for both imported and exported goods and products from this region. s

Box 4.1 What is invasive alien species (IAS) in this context?

Invasive alien species (IAS) in the context of this assessment includes all organisms introduced directly or indirectly by people into places out of their natural range, where they have become established and dispersed, impacting on local ecosystems, species, or human well-being. IAS include species from all major taxonomic groups, but we currently have a substantially better understanding of the status and implications of vertebrate and plant IAS in the Asia-Pacific region in comparison with invertebrates and microbes. Species that can directly affect human health, such as coronaviruses (Al-Tawfiq *et al.*, 2014), some aggressive ant species (Foucaud *et al.*, 2010; Lach & Thomas, 2008; D. F. Ward, 2007), and species causing substantial economic losses such as major agricultural and forest pest species (e.g. Choi *et al.*, 2012; Lee & Lin, 2013; Sekar, 2012; Paini *et al*., 2016) as well as species threatening the health of livestock (Olsen *et al.*, 2006), are notable exceptions to this pattern.

4.1.4.1 Current knowledge base

A recent global assessment of invasive species distributions indicates a number of general invasion hotspots for the investigated taxa in the region, particularly on its islands and in parts of Australia (T. P. Dawson *et al.*, 2011). Looking at the regional context, the IAS knowledge base is extremely variable across continental Asia, primarily due to regionally different concepts and definitions of IAS, differing levels of understanding of IAS impacts, and a lack of detailed large-scale surveys or a well-established central depository for IAS information. The information that is available mostly from China, India or Japan suggests that the level of IAS invasions are less severe than in Europe, and currently strongly concentrated on islands and along coastlines where global transportation hubs act as entry points, in agricultural heartlands and in large, affluent cities (Axmacher & Sang, 2013). Knowledge and research in many parts of Asia is centred on plant and insect species and exotic pathogens with serious economic or environmental impacts or that have direct implications for human health (Turbelin *et al.*, 2017).

In Australia and New Zealand, the largely endemic native fauna and flora has been supplemented and in some instances replaced by IAS following the arrival of Europeans (Fenner, 2010; Fox, 1998; Jay & Morad, 2006). In New Zealand, possums, rats and stoats are now present in about 94 per cent of the country (Ministry for the Environment & Statistics New Zealand, 2015). Overall, a good knowledge base exists both for plant (Dawson, M., Navie, S., James, T., Heenan, P., Champion ., 2010) and vertebrate IAS. Australia established a cooperative research centre focused on vertebrate pests in 1992, with studies focusing on the management of vertebrate invasive alien species (B. L. Allen *et al.*, 2015; Bengsen *et al.*, 2014; Fleming *et al.*, 2006; Hall *et al.*, 2015) (see also www.invasives.com.au). Research on invasive plants has been aimed at tackling the hundreds of invasive species, 70 per cent of which are believed to have been deliberately introduced for ornamental or agricultural reasons[66].

[66] https://soe.environment.gov.au/

Similarly, the endemic biota of Pacific Island states is strongly threatened by invasive species not least due to the high establishment and impact rates of invasive alien species on islands (Glen *et al.*, 2013; Hequet *et al.*, 2009; Theuerkauf *et al.*, 2010). In comparison to other parts of the Asia-Pacific region, there is a high level of cooperation across the Pacific Islands, and between these islands, New Zealand and Australia, to identify, manage and control invasive alien species as illustrated by common databases and reports for the Pacific islands (Pacific Invasives Initiative, 2010; SREP, 2009; and the "Biology and Impacts of Pacific Island Invasive Species" series published in 'Pacific Science'). There are also initiatives such as the 'Pacific Invasive Learning Network' that aim to strengthen collaborations and knowledge exchange across this area. This cooperation can be linked to the Pacific Islands being heavily impacted by invasive alien species, with one alien invader, the brown tree snake, for example being held responsible for the extinction of 10 bird species, several lizard species and one bat species on Guam alone (Pelley, 2008).

The coastal and marine environments across the Asia-Pacific region are also heavily impacted by invasive alien species, but the knowledge base for most marine invasive alien species, including current distributions and influence on marine ecosystems, fisheries and human well-being, remains patchy and geographically biased. A first assessment is available for Republic of Korea and China (Seo & Lee, 2009), while our understanding on the state of marine invasions on Australian (Campbell *et al.*, 2007; Hewitt, 2002; Hewitt *et al.*, 2004; Sliwa *et al*., 2009) and New Zealand coasts (Cranfield *et al*., 1998; Hayden *et al*., 2009; Hewitt, Willing, Bauckham *et al*., 2004; MacDiarmid *et al*., 2012) is more comprehensive, with Australian marine pest species being well documented[67] and also ranked (Hayes *et al*., 2005). Little data are available for the Pacific islands, with some information compiled in Eldredge (1994), Lambert (2002), Paulay (2003), Paulay *et al*. (2002) and from Coles *et al*. (2003). A focus on marine invasions has been on the transport of non-indigenous species through exploration and commercial shipping (Davidson, Campbell, Hewitt *et al*., 2015; Frey *et al*., 2014), with major ports suffering significant invasions (Hewitt *et al.*, 2004). This has already led to revisions to international policies and agreements on biofouling and ballast water management (International Maritime Organization, n.d.).

4.1.4.2 Impacts

Invasive alien species impact on native species through predation, competition and displacement through both direct and indirect disruption of ecosystem services such as soil stabilisation, pollination and seed dispersal (*https://soe.environment.gov.au*). In raw economic terms, it is estimated that South-East Asia alone incurs losses of about $33.5 billion annually due to invasive alien species in terms of damage to environment, human health, and agricultural production (Nghiem *et al*., 2013). Similar analyses for Australia, when combined, estimate combined annual direct costs of at least $9 billion, an estimate that has doubled in the last 10 years (Australian Biosecurity Group, 2005; W. Gong *et al.*, 2009; Llewellyn *et al.*, 2016; Sinden *et al.*, 2004), although not all agro-industries have been included in this analysis (e.g. forestry and horticulture). Furthermore, un-monetarised social and environmental impacts, such as on ecosystem function, fire regimes, sacred site access effects on indigenous communities and loss of traditionally used food resources, or allergy effects on the general population, are generally unquantifiable in monetary terms. The scales and depths of these impacts will be highly significant, and they are clearly increasing for biodiversity and non-agricultural ecosystem services (*https://soe.environment.gov.au*).

In relation to different taxonomic groups, **invasive plants** are known to impact on agriculture and silviculture and can force changes on traditional practices and methods (see e.g. Kent & Dorward, 2014). Based on a comprehensive meta-analysis, Schirmel *et al*. (2016) have concluded that 56 per cent of invasive plants studied significantly reduced animal abundance, diversity, fitness, and ecosystem functions. These authors have underlined, however, huge knowledge gaps in this field and recommended coordinated studies on impacts of invasive species on key faunal species and ecosystems. Plant invasive species may also cause strong localized alterations to native vegetation

[67] http://www.marinepests.gov.au

cover and local extinctions of weak native plant competitors, as well as affecting the biogeochemical cycles of invaded ecosystems.

Changes to native vegetation due to invasive alien species were limited in Singaporean forests (Nghiem *et al*., 2015), although the authors highlight that at disturbed sites, invasive pioneer plant species might suppress the regeneration of native species. In contrast, both agroforestry and natural forest regeneration in Fiji have been heavily impacted by the African tulip tree (*Spathodea campanulata*) (Thaman, 2011), while *Lantana camara* appeared to alter and hinder recruitment of native plants in a South-East Australian forest (Gooden, French, & Turner, 2009). Furthermore, it should be noted that a wide range of alien tree species are currently used and promoted in forestry across the region and are actively planted across large areas such as in southern and eastern China (Axmacher and Sang, 2013). Many of these tree species are known for their invasive potential elsewhere, but studies on their current and future potential impact are currently lacking.

The impacts of **invasive insect** species is highly species-specific, and the respective literature is primarily composed of individual case studies of pest species relevant to forestry and agriculture, and on species that act as vectors of humans or vertebrate pathogens or of diseases affecting agricultural crops and economically important tree species. Peltzer (2013) provides an insight into the effects of pest herbivores on soil and vegetation in New Zealand's native forests. When considering the numbers of exotic agroforestry pests that are increasingly being spread around the globe, the general impacts of invasive alien species on agricultural services across the Asia-Pacific region is very anxious. For example, the taro beetle (*Papuana* spp.) and taro leaf blight (*Phytophthora colocasiae*) in combination have caused losses of taro cultivars and cessation of taro production as key staple food across parts of the pacific islands and Papua New Guinea (Aloalii *et al*., 1993; Daigneault and Brown, 2013; Hunter *et al*., 1998; Thaman, 2011; Thaman, 2014). Often, the collective impact of several invasive alien species has severe consequences for agro-biodiversity and local economies.

Available data on **invasive alien fish** species in the Asia-Pacific region primarily covers localized case studies on the effects on local fisheries (e.g. Gu *et al*., 2015; Matsuzaki & Kadoya, 2015) or on the assemblage structure of fish communities or freshwater ecosystems (Khan & Panikkar, 2009). Invasive **alien amphibians** such as the cane toad invasion in Australia are well studied (Jolly *et al.*, 2015). Carnivorous invasive **alien mammals** like foxes and cats in Australia and stoats, rats and possums in New Zealand[68] are primarily known for their impacts on native fauna while herbivores change the composition and structure of native flora.

The spread of invasive **alien pathogens** receives attention due to their direct impact on human health, or due to economic losses associated with agriculture, while the spread of *Chytridiomycosis* has been linked to six documented frog species extinctions in Australia alone, and seven more species now highly threatened[69]. A range of plant pathogens like *Eucalyptus*/myrtle rust that affects many Myrtaceae and threatens the extinction of at least four native trees in Australia[70] and other dieback diseases of the flora in New Zealand and Hawaii indicate that pathogens are environmentally highly detrimental in many parts of the Asia-Pacific region. As an example, the giant kauri tree (*Agathis australis*) named 'Tāne Mahuta' that is sacred to the New Zealand *Māori* is at great risk of dying from the exotic pathogen *Phytophthora katsurae* in the near future.

Impacts of invasive alien species on **marine environments** are again taxon-specific, often leading to substantial changes to marine ecosystems and in the composition of local species assemblages. Most respective reviews are global in scale, although commonly also including case studies or literature from the Asia-Pacific region (A. D. Davidson *et al.*, 2015; Alisha Dahlstrom Davidson & Hewitt,

[68] www.predatorfreenz.org

[69] https://soe.environment.gov.au

[70] https://soe.environment.gov.au

2014; Ojaveer *et al.*, 2015; Schaffelke & Hewitt, 2007; Thomsen *et al.*, 2014; S. L. Williams & Smith, 2007)

In future, it can be expected that climate change will exacerbate the impact of invasive alien species, allowing these commonly highly competitive species to increase their distribution range, or to hybridize with an increasingly large set of native species (Muhlfeld *et al.*, 2014). In Australia, where invasive alien species is considered the biggest threat to listed species, and the third ranked threat affecting biodiversity more generally (*https://soe.environment.gov.au*), impacts of invasive species on biodiversity and ecosystem services are second only to anthropogenic habitat degradation, with invasive alien species directly implicated in the extinction of over 25 native marsupials and 6 native amphibians.

4.1.4.3 Control measures

Early detection and response to the occurrence and spread of invasive alien species is seen as crucial to limit or even prevent the permanent establishment of alien species (Westbrooks *et al.*, 2014). A large number of Asia-Pacific countries have developed highly advanced legal frameworks regarding the control of invasive species with a strong emphasis on the control of imports (Bewsell *et al.*, 2012; Goka, 2010; Goldson, 2011; A. Gray, 2015; Nelson *et al.*, 2014). Many authors highlight the importance of international cooperation and the challenges posed by emerging global free trade agreements. Biological control is often seen as a key measure to manage invasive alien species in the Asia-Pacific region (Hosking, Sullivan, & Welsby, 1994; Yang, Wang, & Zhang, 2014). In Australia, the benefits from weed biological control have been estimated at over 95 million Australian dollars a year since 1903, with a benefit cost ratio of 26:1 (De Clercq *et al.*, 2011; Page & Lacey, 2006), while rabbit biological control is estimated to have saved Australia 70 billion Australian dollars over the last 60 years (Cooke, 2012; Yang, Wang, & Zhang, 2014). Biological control is only applicable where a natural enemy can be identified that is highly specific to the target invasive alien species, and so has not yet proved useful for some of the most problematic invasive alien species.

Biological control has recently been acknowledged by the Convention of Biological Diversity (CBD) as a useful tool for invasive alien species management (http://cop13.mx/en/cop-13/). For vertebrates, trapping and/or poisoning have also proven successful approaches (see e.g. Ruscoe, Sweetapple, Perry, & Duncan, 2013). While bio-control is commonly focused on areas where invasive aliens have a direct economic impact, Kannan, Shackleton, & Shaanker (2013) and Julien *et al.* (2012) highlighted the importance of also managing invasive alien species in protected areas. Finally, it should be mentioned that many ecosystems adapt to the presence of IAS over time, and the eradication or strict control of these invasive alien species can lead to unexpected, potentially short-term detrimental outcomes (Dexter *et al.*, 2013). This is exemplified by the suppression of the regeneration in numerous forest plants by wallaby browsing following the successful control of invasive alien fox populations in an Australian forest ecosystem at Booderee National Park (Banks *et al.*, 2000; Dexter *et al.*, 2013; Kinnear J. E., Sumner N. R., 2002).

4.1.5 Climate change and variability

Regardless of future cuts in emissions of greenhouse gases, the Asia-Pacific region is likely to experience substantial near and long-term effects associated with climate change (Collins *et al.*, 2013; Hijioka *et al.*, 2014; Kirtman *et al.*, 2013; Larsen *et al.*, n.d.; Nurse *et al.*, n.d.; Reisinger *et al.*, 2014). Projected changes are considered to be significant stressors on biodiversity (from the individual organism to biome level), ecosystem services and human health, both today and in the future (Celine Bellard *et al.*, 2012; Hashim J.H. and Hashim Z, 2016; Scholes, 2016; Settele *et al.*, 2014), rivalling human land use (Leadley *et al.*, 2010). Determining the impact of future climate on biodiversity (including ecosystem services) and socio-economic systems, however, remains extremely challenging given the uncertainty around the magnitude and rate of projected changes for the large range of climate parameters (Runting *et al*., 2017), and the diversity of species responses to different climate variables, including their vulnerability, sensitivity and adaptive capacity (Dawson *et al*., 2011).

Understanding these complex interactions will be critical if proactive conservation planning measures are to be developed to future proof against projected climate changes (Sofaer *et al*,. 2017; Thuiller *et al*., 2008).

The Asia-Pacific region has experienced substantial climate changes and extremes in the recent (historic) past. Increasing terrestrial and ocean temperatures have been observed during the twentieth century (H. Deng *et al.*, 2015; Durack *et al.*, 2014; D. A. Jones *et al.*, 2013; Mondal *et al.*, 2015; P. Zhao *et al.*, 2014). In contrast, precipitation trends are spatially heterogeneous (Chang *et al.*, 2012; E. R. Cook *et al.*, 2010; Donat *et al.*, 2016; Duan *et al.*, 2015; Mcgree *et al.*, 2014; O'Donnell *et al.*, 2015; Palmer *et al.*, 2015; Verdon-Kidd & Kiem, 2009; H. Wang *et al.*, 2013) with recent weather extremes considered unprecedented in the observational record (Orlowsky & Seneviratne, 2012; (Herring *et al.*, 2016). Twenty-first century projections of climate variables across the Asia-Pacific region are spatially variable (Collins *et al.*, 2013; Kirtman *et al.*, 2013) but model simulations indicate increased likelihood of warmer conditions, with likely shifts in storm tracks and greater likelihood of multi-year droughts (Collins *et al.*, 2013; B. I. Cook *et al.*, 2016; Kilroy, 2015; Kirtman *et al.*, 2013; Murakami *et al.*, 2016; Ren & Leslie, 2015; Schlaepfer *et al.*, 2017) (see Figure 4.4). It is important to note that different climate model simulations are required to derive robust estimates of future species distributions (Beaumont *et al*., 2016; 2007). Arguably, the Asia-Pacific region may have experienced some of the earliest signs of anthropogenic climate change (Abram *et al.*, 2016; Tett *et al.*, 2007) providing an opportunity to better understand past and future climate-human-ecosystem interactions.

In recent years there have been major advances in our understanding of how climate interacts with biological systems, from the species level to full ecosystems/biomes through paleoecology, recent phenological and micro-evolutionary responses, experiments, and computational models (Dawson *et al*., 2011). At a basic level, species can successfully adapt to a change in climate through evolutionary pressures (e.g. genetic mutation or genotype selection) or short-term (in an individual's lifetime) responses (plasticity) (Bellard *et al*., 2012) with evidence that the latter may be the more significant of the two (Hoffmann and Sgro, 2011). Alternatively, individuals can track their climate niche either by changing their behaviour with time (on daily to seasonal timescales) or through migration at the micro-habitat, local or regional level to search out their climatic niche. The impact of recent climate change has been detected across a number of species and ecosystems (D. Bickford *et al.*, 2010; Camille Parmesan & Yohe, 2003; Rawal *et al.*, 2015; Root *et al.*, 2003; C. F. Tsai *et al.*, 2015)

Climate (temperature and moisture) anomalies have therefore been used to infer past biota responses to climate and have been used to infer likely future responses to change. These include changes in geographical distributions (Araújo *et al.*, 2008; Gouveia *et al.*, 2013), climatic refuges (Hortal *et al*., 2011) and rates of migration and extinctions (Ashcroft *et al.*, 2012; Burrows *et al.*, 2011; Cooper *et al*., 2015; Sandel *et al.*, 2011), although the attribution of extinction is contentious (Settele *et al*., 2014). Few responses are linear, however. For instance, whilst numerous studies have demonstrated a pole-ward shift of many species across a wide range of taxonomic groups and geographic locations (Luo, Z., Jiang, Z., Tang, 2015; Camille Parmesan & Yohe, 2003; X. Wang *et al.*, 2016), recent work in the Asia-Pacific region (including the oceans) has highlighted projected uni-directional distribution shifts may underestimate the rate of migration and emphasized species distributions because of multi-directional climate trends, particularly in the tropics (Barbet-Massin & Jetz, 2015; Burrows *et al.*, 2011; VanDerWal *et al.*, 2013; T. Wang *et al.*, 2016). Crucially, many of these studies suggest an alarming trend, with projected mean changes potentially leading towards a geological-scale mass extinction (Bellard *et al*., 2012). However, there are a host of other climate parameters that may provide valuable insights in our ability to plan for and mitigate the impacts of projected changes on the local and regional scale, including changes in extremes, seasonality, changes in area and distance to analogous climate and the creation of novel climates (Garcia *et al*., 2014). These changes are likely to have significant implications for the terrestrial and ocean biodiversity, with the creation of novel community compositions (Nagelkerken & Connell, 2015; Stachowicz *et al.*, 2002; J. W. Williams & Jackson, 2007) that lead to disruptions in ecological systems, including predator-prey and insect-plant systems (P. W. Boyd *et al.*, 2014; Camilla Parmesan, 2006).

Whilst numerous studies have investigated the impact of climate change on ecosystem services (Mason-D'Croz *et al.*, 2016; Porter *et al.*, 2014; Rosenzweig *et al.*, 2014; Shirsath *et al.*, 2017), few have considered decision-making and the uncertainties surrounding future projections into their analyses (Runting *et al.*, 2017; Scholes, 2016). Food and water provision are likely to be among the ecosystem services most at risk to climate change in the Asia-Pacific region. Projected lower crop production, especially rice, could aggravate the food security issue across Asia (Hijioka *et al.*, 2014) with optimal regions for fruit production and cropping shifting in some regions. For example, New Zealand may see a shift in maize and kiwifruit optimal climate range towards southern regions (Rutledge *et al.*, 2017), with socio-economic implications such as relocations, shifts in land uses or adaptation through management practices (Teixeira *et al.*, 2017) or adoption of new cultivars (Clothier *et al.*, 2012). Extreme events may however increase risks such as heat stress, especially around South and North-East Asia for rice, maize and soy production (Teixeira *et al.*, 2013). Water provisioning will also likely be at higher risk although confidence on projected precipitation is low (Hijioka *et al.*, 2014; Reisinger *et al.*, 2014). As such, options to deal with water scarcity issues should focus on adapting to the growing water demand and population growth and getting prepared for water shortage through more efficient water use technologies. Ecosystems most at risk are freshwater, coastal and urban due to increasing risk of sea level rise, heat stress, flooding, and high population density exposure along the coastline.

Changes and their impact on biodiversity systems can have a substantial influence on the effectiveness of delivering ecosystem services (Poiani *et al.*, 2011), particularly those affected by abrupt and extreme events (e.g. Gong, 2016). With the increasing recognition that decision makers (for example, farmers, business and policymakers) have different priorities (R. Q. Grafton *et al.*, 2016), there is an urgent need for more integrated studies across the wider Asia-Pacific region that incorporate different drivers of change and their uncertainty into decision-making by these groups (Gregr & Chan, 2015).

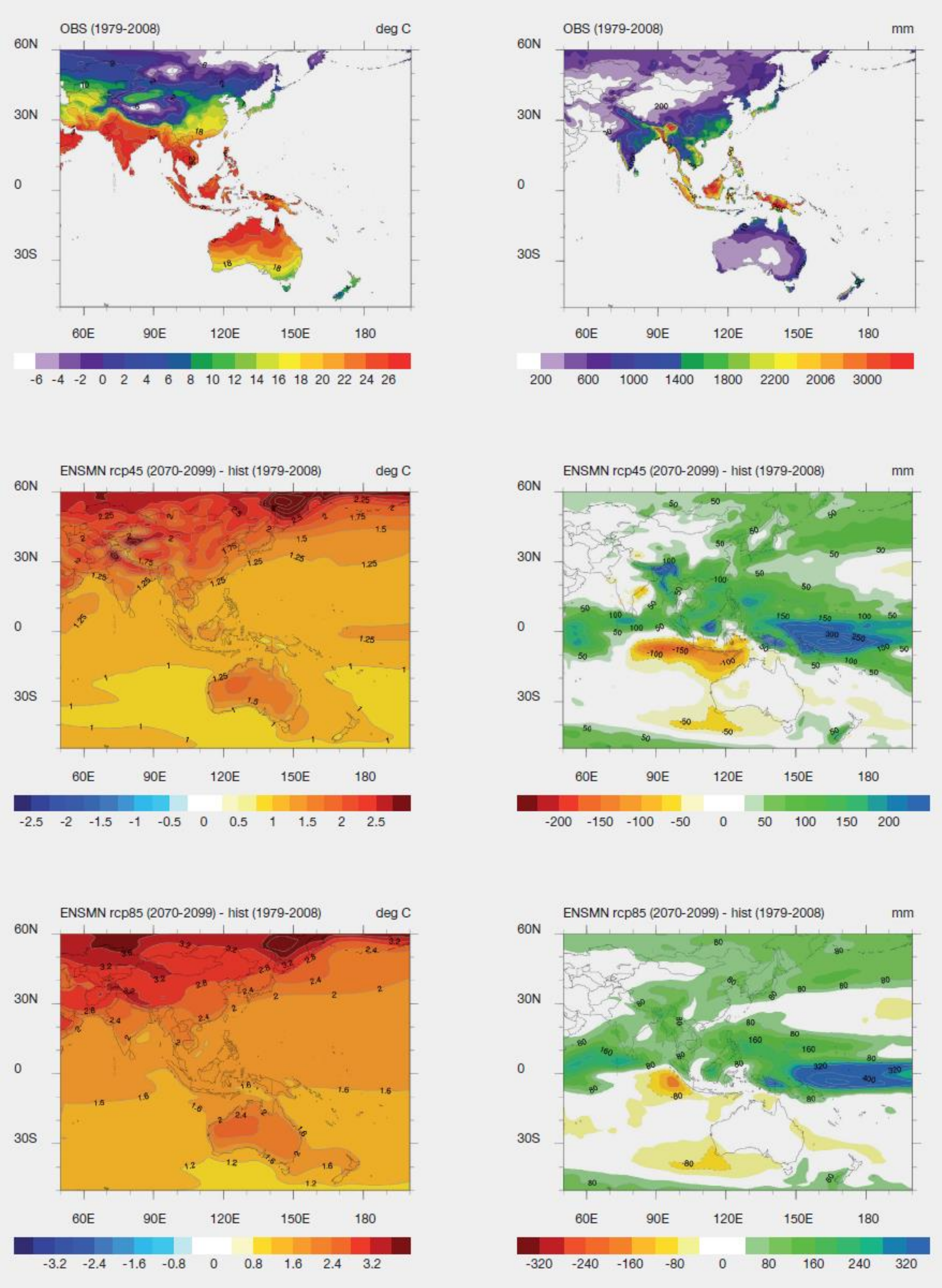

Figure 4.4 Mean observations for 1979-2008, RCP4.5 and RCP8.5 surface temperature (left column) and precipitation (right column) 2070-2099 minus 1979-2008 (January-December) AR5 CMIP5 ensemble mean

Source: Image courtesy of the NOAA mapping tool (https://www.esrl.noaa.gov/psd/ipcc/cmip5/) and Taylor *et al.* (2011)

4.2 Indirect drivers

There are six indirect drivers of change in ecosystems and their services. Collectively these factors influence the production and consumption of ecosystem services through the complicated interaction with direct drivers discussed above.

4.2.1 Demographic Drivers

Population growth rates and distribution are not always good proxies of the pressures that humans are placing on the Earth (de Sherbinin, Carr, Cassels, & Jiang, 2007; Hummel *et al*., 2013). The impact of population growth on biodiversity and ecosystem services is mediated by governance, technology, socio-economic conditions and cultural traditions such as consumption patterns (Keyfitz, 1991; Lambin *et al.*, 2001). These impacts can also be complex. For example, rapid population growth and poverty are often blamed as the main cause of deforestation whereas recent large-scale deforestation in South-East Asia is primarily driven by agricultural enterprises, accompanying road construction and migration enhancement (DeFries *et al.*, 2010; Rudel *et al.*, 2009). In addition, rising consumption and dietary changes are contributing to increased pressures on many ecosystems which could lead to changes in resilience and adaptation (de Sherbinin, Carr, *et al.*, 2007; Dietz *et al.*, 2007; Romanelli *et al.*, 2015; Tilman & Clark, 2014).

4.2.1.1 Total population change

The total population of the Asia-Pacific region in 2015 was approximately 4.4 billion (UNDESA, 2015c). From 1990 to 2015, the population increased by approximately 1.2 billion, although the annual growth rate has declined from 1.8 per cent in 1990-1991 to 1.0 per cent in 2014-2015 (UNDESA, 2015b). The South Asia population surpassed that of North-East Asia in the early 2000s following a drastic decline in growth in North-East Asian countries except Mongolia (<1 per cent in mean annual growth rate in 2010-2015) (UNDESA, 2015b). The mean annual growth rate of most countries in South-East and South Asia in 2010-2015 ranged from 1-2 per cent but was higher (>2 per cent) in Afghanistan, Pakistan and Timor-Leste and <1 per cent in Sri Lanka, Myanmar and Thailand (UNDESA, 2015b). Western Asia had the highest population growth rate in 2014-2015 in the Asia-Pacific region, but some countries such as Bahrain, United Arab Emirates and Syrian Arab Republic had lower rates (<2 per cent) (UNDESA, 2015b). Melanesian countries/territories also had high growth rates (>2 per cent) (UNDESA, 2015b) while Japan was the only country to experience a population decline (UNDESA, 2015c).

4.2.1.2 Fertility change

Almost all developing countries/territories in the Asia-Pacific region have experienced rapid fertility decline in recent decades, resulting in lower population growth (UNDESA, 2015c). In 2010-2015, 16 out of 53 countries/territories in the region had fertility rates of less than 2.1 children per woman over her lifetime, the threshold of replacement fertility to sustain population levels (UNDESA, 2015b). This includes all countries in North-East Asia except Mongolia, Brunei Darussalam, Malaysia, Singapore, Thailand and Vietnam in South-East Asia, Iran, United Arab Emirates, Australia, New Zealand and French Polynesia (UNDESA, 2015b). Conversely, Afghanistan, Timor-Leste, Iraq, State of Palestine, Yemen, Solomon Islands and Samoa have high total fertility larger than 4.0 children (UNDESA, 2015b; see Figure 4.5).

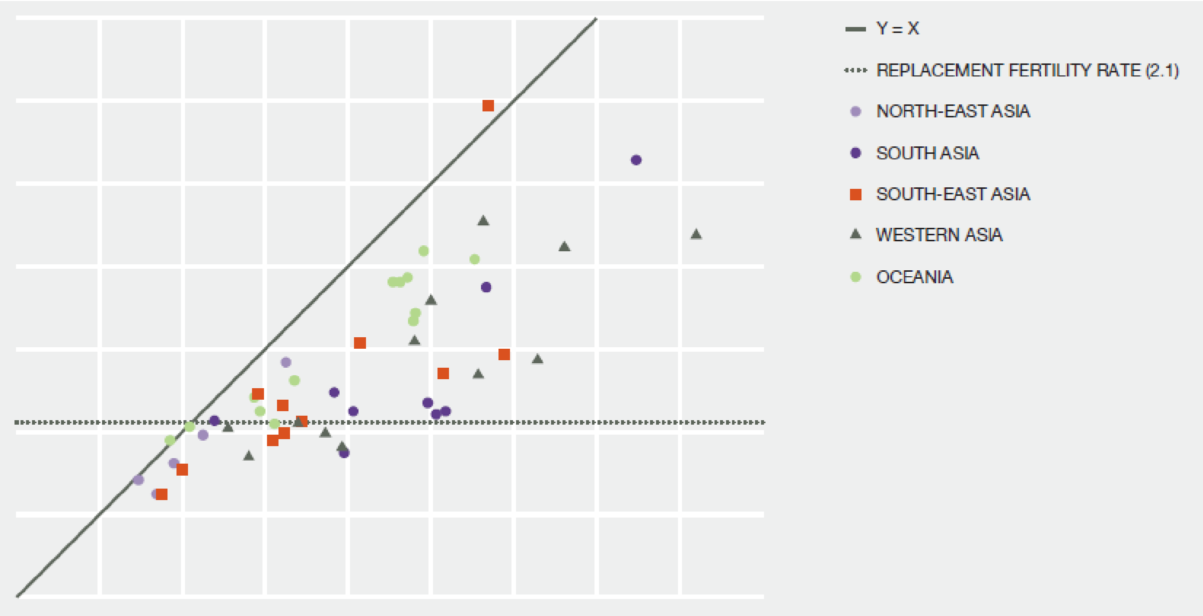

Figure 4.5 Total fertility rate (births per woman) for each Asia-Pacific country in 1990-1995 and 2010-2015.
Note: Countries below the solid line indicate fertility decline in recent two decades. Source: UNDESA (2015c).

Conscious efforts to limit fertility including knowledge and access to contraception and reduced infant mortality are important factors for managing high fertility rates (Hirschman, 1994). In societies where fertility control is the default option, fertility decline is probably attributable to the postponement of childbearing or higher ages at first birth through complex interactions among several socio-economic, cultural and institutional determinants (Balbo *et al.*, 2013).

4.2.1.3 Changes in mortality, life expectancy and epidemiologic transition

To meet the Millennium Development Goals (MDGs) 4 (reducing child mortality) and 5 (improving maternal health), most countries have rapidly reduced child and maternal mortality rates (Lozano *et al.*, 2011). Although under-five child mortality has declined tremendously in many Asia-Pacific countries/territories, further efforts are required to achieve the Target 3.2 of the Sustainable Development Goals (SDGs) especially for Oceania and South Asia where the rate in 2015 was higher than global rates (UNDESA, 2015a; UNESCAP *et al.*, 2015). Major causes of child mortality are pneumonia, measles and diarrhea (Liu *et al.*, 2012). Such causes are preventable, and high incidence of measles deaths in South Asia as well as sub-Saharan Africa needs to be eliminated through further vaccination program (UNDESA, 2015a).

There is also great progress in reducing maternal mortality related to the MDG 5 in the region. Most countries with high mortality in 1990 show drastic declines and have achieved Target 5.A by reducing mortality rates by three quarters between 1990-2015, although all subregions fell short of the Target (UNESCAP *et al.*, 2015). To achieve SGD Target 3.1, further efforts are required to ensure births delivered with skilled attendants particularly in South Asia, and reduce urban-rural disparities in access to and use of reproductive health services throughout most subregions (UNDESA, 2015a).

Globally, life expectancy at birth has risen remarkably in recent decades, and has exceeded or is reaching 70 years in almost all Asia-Pacific countries (UNDESA, 2015b). A marked decline in old age mortality has also been observed in North-East and South-East Asia during recent decades (D. Gu *et al.*, 2013) with life expectancy at birth being over 80 years in four countries in 2010-2015 compared with none in 1990-1995 (UNDESA, 2015b). Developing countries/territories of Oceania have shorter life expectancies than the global average (UNDESA, 2012).

Proportional changes to the causes of mortality have also changed in many countries with the burden of infectious or communicable diseases being surpassed by chronic non-communicable diseases (McKeown, 2009; UNDESA, 2012). In developing countries/territories of Oceania, the impact of communicable diseases on life expectancy remains high while it is very low in North-East Asia (UNDESA, 2012). Concurrently, non-communicable diseases such as heart diseases, stroke, and chronic obstructive pulmonary disease are among the leading causes of redcued life expectancy in the Asia-Pacific region (UNDESA, 2012).

4.2.1.4 Demographic urbanization and rural depopulation

The Asia-Pacific region, particularly Asia, has experienced rapid demographic urbanization with the average annual rate of the urban population change of 2.5 per cent in 2010-2015 (UNDESA, 2015d). In 2014, urban populations accounted for more than half of the world, although the region is still in low a level of demographic urbanization (48 per cent) when compared to other regions of the wrold; Asia-Pacific demographic urbanization is projected to continue (UNDESA, 2015d; Figure 4.6).

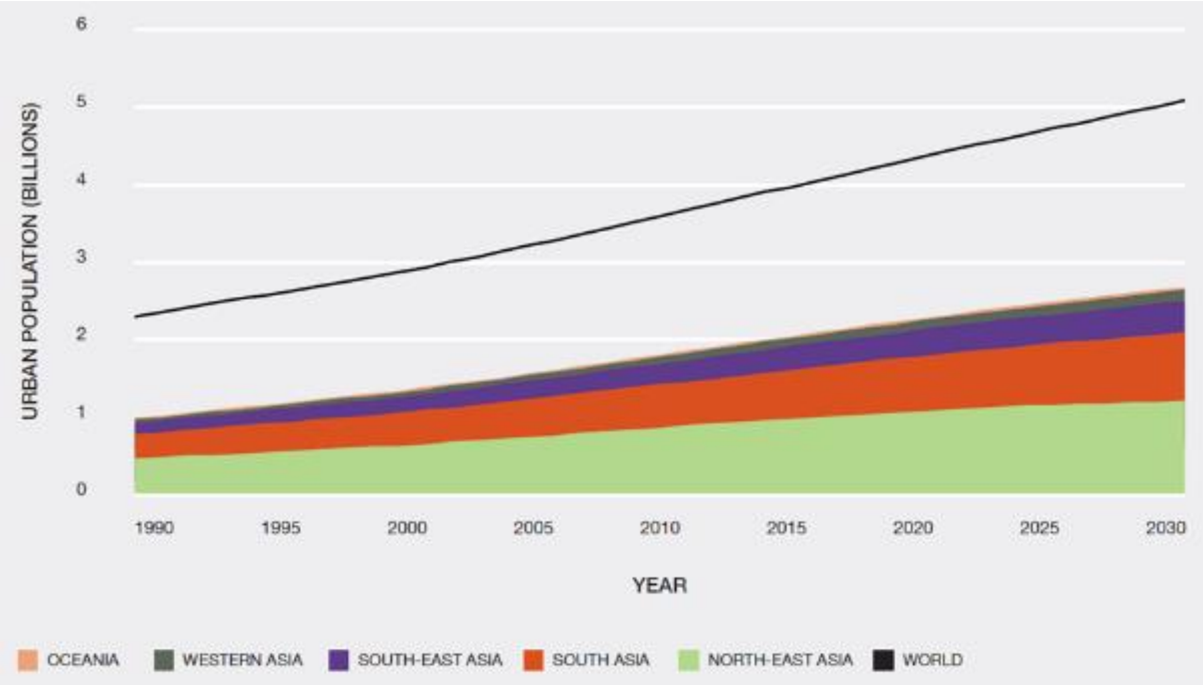

Figure 4.6 Urban population change by subregions.
Note: Asia will continue to host nearly one half of the world's urban population. Source: UNDESA (2015d)

There are large differences in levels of urbanization and population distribution across the region. In 2014, the urban population of South Asia was low (34 per cent of the total population) but the growing rate was at 2.5 per cent per year during 2010-2015 (UNDESA, 2015d). Oceania is highly urbanized owing to high levels in Australia and New Zealand, but Melanesia had low urban population (19 per cent) in 2014. Demographic urbanization rate is relatively stable in Oceania except Melanesia (UNDESA, 2015d).

The rapid urban growth in the Asia-Pacific region is due to natural increase and migration from rural to urban areas (Tacoli *et al.*, 2015; UNDESA, 2015d) with rural populations declining since 2000 except in South Asia, Western Asia and parts of Oceania (UNDESA, 2015d). In line with global trends, the proportion of urban population has increased in every country/territory in the Asia-Pacific region (UNDESA, 2015d). The unprecedented rate of urban population growth is causing environmental degradation and biodiversity loss (see the Section 4.4.6). Rapid demographic urbanization and loss of rural farmers is challenging food supplies for the growing urban population as is meeting increased demand associated with dietary changes (Tilman & Clark, 2014). This may drive agricultural intensification with agrochemicals to improve land and labour productivity, exacerbating biodiversity loss within agro-ecosystems and in the surrounding landscapes as has occurred in Japanese rice paddies (Katayama *et al.*, 2015). Demographic losses from rural areas may also negatively affect agro-bio- and bio-cultural diversity that has been developed through long-term human-nature interactions such as in Satoyama-Satoumi ecosystems in Japan (Duraiappah *et al.*, 2012) and other socio-ecological production landscapes and seascapes in the Asia-Pacific region.

4.2.1.5 Demographic dividend

Many Asia-Pacific developing countries/territories are in intermediate stage of the demographic transition from high fertility and mortality rates to low fertility and mortality rates as described above. As fertility declines, the proportion of the young population decreases relative to the working-age population (15 to 64 years old), and continues to drop until fertility decline ceases (Lee, 2011). With a decreasing dependency ratio (non-working-age populations, 14 and younger, and 65 and older, over the working-age population), a country has a window of the rapid economic growth potential by rising levels of per capita output (UNFPA, 2014). The phenomenon known as the demographic dividend has been realized in North-East Asia, accounting for up to one third of per capita output growth (Chomik & Piggott, 2015; Kelley & Schmidt, 2005).

Most South-East Asian countries have recently experienced a decline in the dependency ratio. However, the derived demographic dividend has varied among each country (Bloom, Canning, & Sevilla, 2003) although the window of opportunity is likely to close over the next decade as current working-age population reaches retirement age and dependency ratio increases again (Bloom *et al.*, 2003; Chomik & Piggott, 2015). By contrast, South Asia is projected to economically gain from the demographic transition for several more decades (Chomik & Piggott, 2015; Golley & Tyers, 2012). Demographic dividends associated with changing demographic structure are not automatic or guaranteed but can be realized through investment in human capital through health and education programs, and implementing appropriate economic and governance policies as demonstrated in North-East Asia (Bloom, Canning, & Sevilla, 2003; Gribble & Bremner, 2012; UNFPA, 2014). It is also crucial to create job opportunity for young people in various economic sectors including social services such as tourism (Bloom *et al.*, 2003), which is achievable in a transition to a green economy (UNEP, 2011b) and in line with the SDGs' Target 8 (https://sustainabledevelopment.un.org/sdgs).

4.2.1.6 Migration and environmental changes

There is a growing concern about accelerating environmental-change-induced human migration within and between nations, although the effect of this will be mediated by social, political, economic and demographic factors (Black *et al.*, 2011; Obokata *et al.*, 2014). Several reports estimate and predict the number of migrants displaced by environmental changes including climate changes (e.g. Myers, 2002; Tiwari and Joshi, 2015), but no consensus exists for the whole Asia-Pacific region due to limited empirical data (Gemenne, 2011; ADB, 2017). Seasonal, temporary and permanent migration has been already among the strategies that households utilize when faced with food and livelihood insecurity associated with climate variability (UNFPA, 2014), and climate-related migration could become more prevalent in the future with the anticipated increase in frequency and intensity of adverse climate events (Raleigh *et al.*, 2008). Moreover, migration due to environmental changes was reported in the Asia-Pacific region such as massive displacement in Sumatra after the 2004 Indian Ocean Tsunami (Gray *et al.*, 2014), short-distance outmigration caused by deforestation and subsequent land degradation in Nepal (Massey *et al.*, 2010), permanent migration from one province to another influenced by an increase in local temperature (Bohra-Mishra *et al.*, 2014), and long-term migration influenced by heat stress in Pakistan (Mueller *et al.*, 2014). Simplistic speculation and exaggeration on environmental migration should be avoided as is the case for popular awareness about climate refugees from the Pacific Islands and Tuvalu in particular (Mortreux & Barnett, 2009), but continuing evidence-based research on the connections between environmental changes and migration is critical especially for climate change adaptation (Bremner & Hunter, 2014; ADB, 2017). International migration induced by local conflicts and wars in South and Western Asia have led to the refugees fleeing away from their countries such as Afghanistan and Syria in last few years. The (UNHCR, 2015) identified over 3.9 million Syrian refugees and 2.6 million Afghan refugees in 2014, making up 33 per cent of the global total (19.5 million), but it lacks of empirical data to assess its socio-ecological effects.

4.2.2 Economic Drivers

4.2.2.1 Economic growth

Economic growth is expressed by the increase of Gross Domestic Product (GDP) and by GDP per capita. GDP growth in developing Asian countries was 6.2 per cent in 2014, much higher than in major industrial economies with 1.4 per cent (UNESCAP, 2015a; UNESCAP *et al.*, 2015). Economic growth changes consumption volumes and patterns and levels of investment in infrastructure. In last two decades rapid economic growth in the Asia-Pacific region has brought about many regional or global benefits but has also resulted in some negative environmental effects including threats to regional biodiversity and ecosystem services (Rands *et al.*, 2010; Squires, 2014). Agricultural expansion and road construction, for example, have led to deforestation and habitat fragmentation in some previously remote areas (see 4.1.1); demands for vegetable oils for food, cosmetics and biofuels are expanding cash crops plantation in tropic Asia (e.g. oil palm; see 4.4.1); and global demand for milk has increased dairy production in New Zealand resulting in intensified grazing (see 4.1.2; 4.4.2). Increasing consumption of marine proteins has brought about overexploitation of marine resources (see 4.4.8). Large scale construction of hydroelectric development impacts on biodiversity in river basins such as South and South-East Asia (see 4.1.1; 4.4.7).

Continued economic growth and increasing international trade in the Asia-Pacific region, however, also create conservation opportunities since the growing economic surplus is available for investment. With wealth and Research and Development (R&D) investment increase in some emerging economics, the implementation of new technologies (such as Information and Communication Technology and Geo-spatial Technology; see 4.2.4), and the fast popularization of internet social medias in the Asia-Pacific region, awareness on harnessing this growth towards conservation and sustainable development has been raised (IUCN, 2017; Squires, 2014). Economic development at some point raises people's awareness on biodiversity conservation and their appreciation of nature, all of which are beneficial to enforce the legislation, increase the investment, and finally effective implementation of ecological protection and restoration (UNEP, 2016a, 2016b).

4.2.2.2 Poverty and poverty reduction

Among indexes of poverty, ratio of population or total population below extreme US$1.25 per day (extreme poverty) is frequently used. According to the World Bank, the ratio of population below extreme poverty line is decreasing in most Asian developing countries (World Bank, 2017a). The percentage of undernourishment has also decline by 15 per cent in North-East Asia and the Pacific between 1990 and 2015, apart from the Democratic People's Republic of Korea (FAO, n.d.-b). ESCAP (United Nations Economic and Social Commission for Asia and the Pacific) estimates that the number of people in the Asia-Pacific region living on less than $1.25 a day fell from 52 per cent in 1990 to 18 per cent in 2011 – a reduction from 1.7 billion to 772 million people (D'Almeida, 2015). Up to 2015 real incomes per capita in developing economies of the region had doubled on average since the early 1990s (UNESCAP, 2015b). The dramatic progress in poverty reduction over the past three decades in China is well acknowledged, where more than 500 million people were lifted out of poverty and the poverty rate fell from 88 per cent in 1981 to 6.5 per cent in 2012 (World Bank, 2017b). There has also been a triple increase in real income per capita in Bhutan, Cambodia and

Vietnam over the same period (World Bank, 2017b). In conjucntion with other policies, this economic growth in the Asia-Pacific region has helped lift millions of people out of extreme poverty and reduced by half the proportion of people whose income is less than $1 a day (UNESCAP, 2015b)., which bodes well for achieving Sustainable Development Goals (SDGs) (especially Goal 1 and Goal 2) in the region.

In the Asia-Pacific region, ecological degradation has impacted mainly on the poor people especially in rural areas where poverty is intrinsically linked to the loss of biological resources (Squires, 2014). Poor people depend more on ecosystem services such as fuel woods, non-timber forest products, bush meats, and fish for their subsistence. They are less able to access or afford alternative sources for their livelihoods (Roe, 2008). In some developing Asia-Pacific countries (e.g. Vietnam, Indonesia and India), poor households depend on non-timber forest products (NTFPs) for more than 20 per cent of their income (Vedeld, Anglsen & Poor, 2004; see 4.1.2). The Convention of Biological Diversity (CBD) summarised four points for why poor people are especially reliant on certain ecosystem services, i.e. providing food, regulating water quality, supplying natural medicines and spiritual services etc (CBD Secretariat, n.d.-a).

Biodiversity can shape the path of economic development in a country or region, which, in other words, influence the type of livelihoods and the pattern of industries locally or regionally. For poor people, it is important to note that biodiversity is available locally making *in-situ* conservation significant for local development. Biodiversity can affect economic development, and *vice versa* since there may be a case for poverty reduction keading to reduced biodiversity exploitation (Secretariat of the Convention on Biological Diversity, 2010). In North-East Asia and the Pacific, the shortfall of Human Development Index (HDI) was 0.484 in 1990 and 0.290 in 2014, a narrowing of 0.194 (40 percent), which implies a beneficial effect on biodiversity conservation due to less use of biodiversity for subsistence (UNDP, 2015).

4.2.2.3 Trade liberalization

Trade liberalization and globalization lead to changes in the industrial structure of a country, concentrating industry more on abundant local natural resources which provide the country's economy with a comparative advantage (Hummel *et al.*, 2013; UNEP, 2016a; UNESCAP, 2015a). Abundant natural resources can therefore be intensively and unsustainably harvested. This can lead to overexploitation of natural resources and agricultural intensification to meet temporarily profitable domestic and overseas markets. It was estimated that agriculture with the supply chain is the direct driver of up to 80 per cent of deforestation worldwide and in tropical Asia commercial agriculture accounts for around one third of deforestation (Kissinger *et al.*, 2012). On the contrary, countries with fewer natural resources tend to specialize in industries that do not intensively exploit nature. In Japan, the timber industry is in decline due to trade liberalization that encourages cheaper timber imports, leading to native forest underuse (FAO, 2015b).

International trade unregulated for its environmental impacts can lead to an increase in the number of threatened and endangered species. With accelerating globalization, importing and exporting countries should take joint responsibility for environmental protection as part of managing the demand for the commodities produced in the developing countries (Lenzen *et al.*, 2012). Significant spread pathways for invasive alien species and associated with expanding international trade, which also further threatens native biodiversity (see 4.1.4). A regional strategy for transboundary cooperation in controlling illegal wildlife trade along the trade pipeline is very important and emergent across the Asia-Pacific region (Damania *et al.*, 2008; Walston *et al.*, 2010).

4.2.2.4 Globalization

Globalization is defined as the intensified flows between countries of goods, services, capital, ideas, information and people. Globalization provides income opportunities for developing economies such as in remote mountains where local people can sell niche products through a more networked global market. Global flows of services and technologies can enhance the level of traditional production so that reduce the dependence of local communities on the biological resources. Creating and strengthening social norms through improved connectiveness and on-line public education with the support of globalized Information and Communication Technology (ICT) is a slow but effective means of raising conservation awareness and a complement to economic incentive-based policies (IUCN, 2017, see 4.2.4.1.). Globalization, however, is also strong driver of invasive species spread and establishment as both contamnints and hitchhikers (Hulme, 2009; Perrings *et al.*, 2005). In New Zealand, for example, hull fouling has been the cause of most alien marine species (Bax *et al.,* 2003).

4.2.2.5 Economic incentives

Economic incentives are designed to influence government bodies, business, non government organization or local people to conserve biodiversity and ecosystem services in a sustainbe manner (Emerton, 2000). They include taxes, subsidies, tradable quotas, biodiversity offset, mitigation banking, and inverse auction. Generally, setting new or rationalising existing charges in considering the value of ecosystem services can be beneficial to finance biodiversity protection and regulate human's behaviour in the utilization of biological resources (J. Boyd & Banzhaf, 2007; Fisher *et al.*, 2011; Pascual *et al.*, 2017). However, in some Asia-Pacific countries weak governance or distorted economic policies have led to unsustainable exploitation and even biodiversity-depleting activities (UNEP, 2012a).

In the Asia-Pacific region Payments for Ecosystem Services (PES) is becoming an increasingly important direct incentive approach.. Through the Reef Trust, the Australian Government is using incentives, including grants and reverse tenders, to assist agricultural land managers in the Great Barrier Reef Catchment to implement improved land management practices for water quality and productivity outcomes. These incentives include support to develop innovative land management practices. Additional support is also provided to land managers for training and extension. A cutting edge monitoring, modelling and reporting program is used to estimate the reductions in loads of sediment, nutrients and pesticides entering the Great Barrier Reef as a result of the adoption of the improved land management practices. Some other subnational jurisdiction examples include the New South Wales Land Management and Biodiversity Conservation Reforms[71], Victoria's biodiversity offset mechanism managed by Bushbroker and Tasmania's inverse auction approach, which has been found to tremendously reduce the cost of conservation (OECD, 2010). Two of the largest PES programs in the world were initiated in China, including the Sloping Land Conversion Program (Grain for Green) and the Natural Forest Conservation Program, which have contributed a lot to the rapidly increase of forest area at the national level (Ministry of Environmental Protection of China, 2006; Sun X. Z. and Zhou H. L., 2008; Task Force for Eco-Compensation Mechanisms and Policies in China, 2007). With the implementation of Cooperative Afforestation CDM (Clean Development Mechanism) Pilot Project on Private Lands Affected by Shifting Sand Dunes in India, local communities have actively engaged in reforestation due to the accrued benefits (Kissinger *et al.*, 2013). PES mechanism is also introduced in Lam Dong in Vietnam, where communities who manage upland forests receive payments made by power companies (N. Q. Tan, 2011). In Indonesia, the PES project has been beneficial to control soil erosion and increase biodiversity in coffee farm and rubber forest through rewarding local people (Squires, 2014).

4.2.2.6 Tourism

The rapid expansion of the tourism industry is increasingly impacting on biodiversity and ecosystem services. However, ecotourism, combined with community conservation and protected areas, can be beneficial to conservation. In New Zealand where the main attraction is in the landscape and natural scenery (Tourism New Zealand, 2017), tourism contributes 4 per cent of national GDP and is the second largest export sector. A large number of international visitors also travel to Australia with numbers increasing by 7 per cent in 2015 compared with the previous year to some 6.6 million people

[71] https://www.landmanagement.nsw.gov.au/

(Tourism Research Australia, 2015). Progress has been made to ensure sustainable tourism via local policies although there are still pressures such as increased demands on local services (Connell *et al.*, 2009).

In the Hindu Kush Himalayan region the substantial growth of tourism activities clearly makes tourism one of the most remarkable economic and social phenomena of the past decades, which in some remote and inaccessible mountain areas may be only viable option for development (Balodi *et al.*, 2014; Kruk, 2011). In many developing Asian countries community-based ecotourism has developed rapidly in the last two decades and become the backbone of rural industries (Damania *et al.*, 2008). In Thailand, for instance, ecotourism in and around protected areas has contributed to poverty alleviation especially for rural societies (Sims, 2010; Ferraro and Hanauer, 2014). In Nepal, a community-based tiger tourism model has been developed sucessfully that strongly emphasises benefit sharing among stakeholders and encourages ecological restoration of degraded landscape (Damania *et al.*, 2008).

Despite the remarkable contribution to local economy, the rapidly expanding and ill-planned tourism also brought about pressures on ecosystems which should not be ignored. Large-scale and rapid infrastructure development including road network, residential building, restaurants and recreational facilities for tourists has led to negative impacts on previously silient natural scenery, such as coastal and alpine landscapes (see 4.4.3; 4.4.8; 4.5.2). The flow of tourists from urban to remote protected areas also has the potentital to disseminate unintentionally invasive alien species (see 4.1.4).

4.2.3 Socio-cultural Drivers

Societies across the Asia-Pacific region differ markedly from each other in terms of their structure and functioning, creating abundant cultural diversity. It has been estimated that about 70-80 per cent of the 370 million people in the world categorized as “indigenous” live in the Asia-Pacific region (Dhir, 2015). The amazing range of traditional and local cultures in the Asia-Pacific region has sprung from the contrasting landforms and climates of the region. The conservation of traditional and local knowledge and practice is important to not only the long-term survival of human kind but also the conservation of biodiversity in general (Pretty *et al.*, 2009; Bas Verschuuren *et al.*, 2010)(see also 3.2.5).

Many of the “indigenous” communities in the Asia-Pacific region have traditionally coexisted in a sustainable way with their natural environments (IUCN, 2017). Sacred natural sites often preserved important biological resources as ‘areas of land or water having special spiritual significance to peoples and communities’ (Oviedo & Jeanrenaud, 2007). These sacred sites with rich biodiversity and strong interlinkage with cultural services have been well protected by local communities over long time periods and have experienced low disturbance throughout that time (Negi, 2012; Pei, 2010). However, increased demands on biological resources and changing social norms are undermining many sacred sites (Dudley *et al.*, 2010). Traditional and local knowledge related to these scared sites are also losing in many Asia-Pacific countries.

Modern technology, information and capital are transcending administrative boundaries and reshaping relationships between the marketplace and societies. In particular, growth of the mass-media industry and improvements in connectivity and communication technology have impacted on individuals and societies across the Asia-Pacific countries (Baller *et al.*, 2016; Dutta & Bibao-Osorio, 2012; IUCN, 2017) . Modern technology has allowed people access to more information than ever before, but modern urban life-style also separates people from nature (Bas Verschuuren *et al.*, 2010). Young generations have less understanding on the dependence of human societies on ecosystem services. The interest in traditional wisdom and lifestyles among young generations is declining with the expansion of the increasingly globalized market economies and greater exposure to mass media, all of which inevitably lead to a general erosion of traditional culture (Parrotta *et al.*, 2009).

With the onset of globalization, traditional nation-states in the Asia-Pacific region and their socio-ecological production landscapes have been placed under enormous pressures. The World Trade Organization Agreement on Agriculture, which promotes export competition and import liberalization, has allowed the entry of cheap agricultural products into previously remote rural communities, thereby compromising their traditionally agricultural practices, food consumption, and cultures (United Nations, 2009). Small-scale farm production has given way to commercial cash-crop plantations, which further caused the uprooting of many community members from rural to urban areas (United Nations, 2009). Pastoralists across the drylands in the Asia-Pacific region and their livelihoods are also under constant and persistent threats from economic modernization (UNEP, 2012a). Traditional ways of pastoral life are changing from migratory to sedentary patterns due to development interventions, and are additionally threatened by climate change (ADB, 2017; United Nations, 2009), making it highly likely that a significant number of pastoralists will have to deal with increasingly dry and less fertile lands in the near future (UNEP, 2016b).

Overall, the region's economic growth and social development has markedly changed the lifestyle and culture of most people (Dutta & Bibao-Osorio, 2012). Westernization of foods has reduced rice consumption, once essential in many Asian traditional diets, leading to significant decreases in paddy fields. Globalization and the consequent global interconnectedness of the urban middle class is a driving force behind the convergence of diets (Prabhu Pingali, 2007) . International and intra-national migration, with remittances sent to home countries, can have an obvious impact on land-use and the environment through increased meat, dairy and material consumption (ADB, 2013; FAO, 2016a; UNEP, 2016a). Since the growing demand for diet diversity cannot be met by the traditional food supply chain, Asian agriculture is changing from a traditional dominance of cereal crop production towards an increasingly commercialized and diversified production system (Prabhu Pingali, 2007). The consumption of meat and dairy products has increased rapidly in most of Asia-Pacific countries, which is changing the traditional rural industries and even socio-cultural values (Thornton, 2010).

Similarly, oil and natural gas replaced wood and charcoal to support the rapid industrialization and modernization in many Asia-Pacific urban areas after World War II (WEF, 2013). In addition, demand for raw building material such as straw and bamboo decreased over this period. This has led to a decrease in the amount of land under traditional management practices. In addition to changing food habits and increasing demand for modern westernized housing, changes in leisure also influenced traditional landscapes. The introduction of golf and its popularity, for instance, has led to golf course developments in many landscapes, and those of marine sports and leisure led to many coastal developments (Honey & Krantz, 2007; Wheeler & Nauright, 2006). Generally, cultural changes in the form of changing food habits, housing styles and leisure interests have had a profound effect on traditional socio-ecological production landscapes in the Asia-Pacific region and the ecosystem services these supply (Blasiak & Ichikawa, 2012).

It also needs to be stressed that society's response to every dimension of climate change is mediated by culture (Adger *et al.*, 2012; IPCC, 2014a, 2014b). Culture is important for understanding both mitigation of and adaptation to climate change, and plays its role in the locally specific framing and perception of climate change. Different people in different regions exposed to the same sets of changes display vastly different responses (IPCC, 2014b). Recent research also illustrated that information about climate change does not connect with all cultures and worldviews in the same way (Hulme M., 2009; O'Brien and Wolf, 2010). Across the Asia-Pacific region climate change is threatening cultural dimensions of lives and livelihoods that include the material and lived aspects of culture, identity, community cohesion and sense of place (IPCC, 2014b; ADB, 2017).

4.2.4 Science and Technology

As the world is entering the Fourth Industrial Revolution, knowledge is becoming accessible to more people than ever before in human history (Baller *et al.*, 2016). The globalization of trade and commerce, rapid technological changes, emergence of new technologies, and the resulting emergence of a knowledge economy are bringing new challenges around the world, including in the Asia-Pacific region (QBE Asia Pacific, 2017). Today's integrated and interlinked technological areas, namely information and communication technology (ICT), biotechnology (BT), renewable energy (RE) technology, nano-technology, and space technology, are characterized as interdisciplinary, oriented to Research and Development (R&D), information-intensive, short life cycle and strongly globalized (Baller *et al.*, 2016; WEF, 2017). The application of new technologies has contributed significantly to encouraging borderless movement of products, services and labour, expanding economic activities in environmentally friendly ways, and increasing the supply of food, energy, clean water, as well as connectivity of human society (QBE Asia Pacific, 2017; UNESCAP, 2015a). All of these inevitably result in significant changes in regional or even global socio-economic and ecological systems (Gellert A., 2017).

4.2.4.1 Information and communication technology (ICT)

The Information and Communication Technology (ICT) is becoming one of the fastest-growing industries in the global economy in the twenty-first century (Baller *et al.*, 2016), and it is in particular booming in the Asia-Pacific region (QBE Asia Pacific, 2017). In this region, access to global services, software, storage and cloud computing are improving greatly. As of 2014, there were 88 mobile phone subscriptions per 100 inhabitants in Asia, with only two countries having mobile phone networks that cover less than 85 per cent of the population (ESCAP, 2015a). By 2020, the number of mobile internet subscribers in Asia is expected to increase to 2 billion. This is projected to account for 80 per cent of the population in the Asia-Pacific region and for over 50 per cent of global mobile internet subscribers in 2020 (Rood & Cole, 2015).

Further advances, and the diffusion of information technologies, are expected to have the potential to drastically change socio-economic systems and the environment of today by reducing the amounts of material and energy used by industries, shifting from the transportation of goods to transfer of information by telecommunications, increasing the volume of electronic commerce, and triggering numerous further changes in societies (Baller *et al*., 2016). ICT is already becoming instrumental in reshaping and transforming global and regional economies, social structures and environmental awareness. The increased availability of information and knowledge-sharing platforms associated with ICT are key to fostering the ongoing socio-economic development (Dutta and Bilbao-Osorio, 2012), as well as enhancing environmental governance associated with legislation and the development of clean technologies (IUCN, 2017).

Using ICT for agro-advisory services, e-business development, food security forecasting, and early disaster warning is emerging as an effective contributor to adaptation measures aimed at dealing with the impacts of climate change, irregularity in weather patterns and in geo- or bio-disaster planning, as well as in the liberation of regional trade (Baller *et al*., 2016; QBE Asia Pacific, 2017). Combining with 3S technologies (remote sensing, GIS and GPS), cloud computing and wireless transmission are expected to be particularly useful for the environmental monitoring of remote protected areas and for assessing the productivity of agriculture and aquaculture (Baller *et al*., 2016; WEF, 2017). In the Asia-Pacific region where natural disasters have become more frequent in recent decades, monitoring and forecasting systems for Disaster Risk Reduction are developing rapidly due to the application of ICT in connection with chiefly nature-based solutions (ESCAP, 2015b). In this region, floods and storms showed particularly steep increases in number and represented the most frequent events (ESCAP, 2015b). While Early Warning Systems on flash floods have been installed in a few countries, many more would benefit with an improvement in the integration of regional communication systems.

Supported by space technology and geo-spatial data, implementation of ICT brings about broader influence on human well-being in the Asia-Pacific region. ICT in combination with big data and cloud computing is driving the emergence of the new urban services-paradigm (WEF, 2016). Intelligent transportation systems in Australia, for example, enable users to be better informed and make safer, more coordinated and "smarter" use of transport networks (WEF, 2016). ICT is also simplifying technical information and knowledge-sharing including in vernacular languages which is changing the traditional socio-cultural linkages and social services in both rural and urban areas through newly emerging social media, messaging apps and mobile commerce (Satish Jha & Strous, 2007; RVC, 2016).

Although ICT has boosted many positive aspects of human development, some challenges and risks also need to be addressed. ICT evolves rapidly and requires frequent revisions and adjustments to product classifications which make it hard to quantify individual effects, and particularly the social impacts (ESCAP, 2015a). If not handled appropriately, challenges such as the rising threat of cyberattacks that expand into the physical world, privacy issues, and the polarizing effects of technologies on labour markets could counteract the aforementioned benefits (Baller *et al*., 2016). Moreover, construction of an information technology infrastructure is energy- and resource-intensive and the environmental impacts of the production, use, and disposal of information technologies is not a trivial matter (Kwazo *et al.*, 2014).

4.2.4.2 Biotechnology (BT)

The potential of biotechnology (BT) to contribute greatly to the world's fight against hunger and malnutrition, poverty, and environmental degradation, has been widely acknowledged. In the Asia-Pacific region, agricultural BT has rapidly evolved and helped to increase crop and animal productivity, improve nutritional quality of food, broaden tolerance of crops to drought, salinity, and other abiotic stresses, and increase resistance of crops to pests and diseases (Chaturvedi & Srinivas, 2010). In the last two decades, BT in countries across the region has become a powerful tool also in the modification of plant and animal genetic information (Genetically Modified Organisms) that could promise improved productivity, profitability and sustainability of farm production systems, including those existing in small and poor farming situations (Cohen, 2005; Delmer, 2005).

Rice is the dominant crop and staple food in many parts of Asia where it often dominates the arable land under agricultural use (Cantrell & Hettel, 2004). Thus, improvement of rice productivity and quality has been the priority for many Asian countries in agricultural development since the Green Revolution (FAO, 2013a; Redoña, 2004). In Asia, rice varieties that are semi-dwarf, early maturing, non-photoperiod sensitive, and responsive to nitrogen (N) fertilizer have been improved with intensive R&D inputs that are overall held accountable for about 84 per cent of the increase in rice-production (Maclean JL, Dawe DC, Hardy B, 2002; Redoña, 2004). Gradually, resistances and tolerances to biotic and abiotic stresses were incorporated into many rice varieties, thereby extending their cultivation and productivity potential in Asia and beyond (FAO, 2013).

Recently genetically modified (GM) cotton has been adopted in Australia, China and India, and GM maize in the Philippines. These GM crops have a higher productivity and pest resistance or drought resistance, and hence generate higher incomes for farmers (K. Gupta *et al.*, 2008). The area of cultivating GM crops also increased substantially in some Asia-Pacific countries over the last decades, but the number of GM crops is still limited. At the same time, there have been concerns about the likely risks of GM crops to the environment and human health associated with their cultivation and use (Philippe, 2007). Possible adverse effects on non-target species and other components of biodiversity are of particular concern among societies. It is also a question for these crops about their evolution of resistant pests and pathogens. Thus, many countries where GM crops are adopted have paid special attentions to biosafety-related issues, and taken specific measures to manage the potential risks associated with cultivating GM crops (K. Gupta *et al*., 2008).

Biological Technologies are being used in not only crop cultivation, but also forestry, livestock raising, fisheries, and agro-and pharma-industries (Chaturvedi & Srinivas, 2010; FAO, 2013b). Since the mid-2000s, biological molecular technologies have also been applied at many border and customs sites in detecting endangered species which are illegally traded (Johnson R. N., Wilson-Wilde L., 2014) and even the species traces mixed within complex traditional medicines (Luo *et al.*, 2013; L. Wang *et al.*, 2015), thus provide a faster and efficient detection tool.

4.2.4.3 Renewable energy (RE)

The global renewable energy (RE) sector is continuing a rapid development, and the Asia-Pacific region arguably is at the heart of this boom (Shah, 2016). In 2016 the Asia-Pacific region secured almost $180 million in clean energy investments – over 50 per cent of the global total (EY, 2016). Within the newest Renewable Energy Country Attractiveness Index (recai) (EY, 2017), China topped the global index in term of investment in RE, followed by India, the United States, Germany and Australia, with three of the five countries with biggest investments being located within the Asia-Pacific region. Globally, renewable energy provided an estimated 19.2 per cent of global electricity consumption while new investments in renewable energy having increased 18 per cent in the last decade (KPMG, 2016). For many developing countries in the Asia-Pacific region where renewable energy resources often exist in abundance (Syed *et al.*, 2014), the benefits of using renewable energy are obvious. Renewable energy sources including wind, solar and biomass are able to provide highly decentralized, mini-grid and off-grid solutions to developing countries especially those remote rural areas (IPCC, 2012; KPMG, 2016).

Overall, the appropriateness of applying different renewable energy technologies is highly case-specific, depending on the particular circumstances of a country or locality, so that governments have to establish their own specific targets to increase the proportion of renewable energy generation (Syed *et al*., 2014). Of all the renewable energy resources, solar energy is relatively abundant in most Asia-Pacific countries. Although hydropower is still the main source of renewable energy in the Asia-Pacific region, solar photovoltaic technology has developed rapidly and become the largest market for new investment (KPMG, 2016). Between 2005 and 2012, China increased its wind energy capacity about 50 fold (DLA Piper, 2014), while Japan has become the world’s largest solar market and one of the first countries to see the development of offshore wind generation (Syed *et al*., 2014; DLA Piper, 2014).

Biogas digesters are seen as a solution to deal with organic waste in rural and urban waterways. In 2014, there have been more than 1,600 large-scale digesters and more than 30 million household biogas digesters constructed in China alone (DLA Piper, 2014). Fuelled by its agriculture base, India has great potential in generating biomass energy. However, the scale of biomass energy generation is still limited (DLA Piper, 2014) although both China and India have an established natural gas infrastructure into which biogas could be incorporated (REN 21, 2017). In New Zealand, the biomass industry is applied in dealing with wood-processing wastes and producing a lot of biomass energy (KPMG, 2016). The combination of bioenergy with carbon capture and storage used for example at landfill sites may provide for optimized reductions in greenhouse gas (GHG) emissions (IPCC, 2012).

Replacing fossil fuels with renewable energy and innovative low-carbon technologies can significantly reduce greenhouse gas emissions, and drive improvements in local and regional air quality. However, there debate on the environmental impacts of renewable energy development such as site-specific impacts of hydropower development on flora and fauna due to dam construction continues (see 4.1.1; 4.4.7). Biofuel production is also feared to potentially enhance deforestation especially in tropical forests, with land-use being shifted to the large-scale plantation of bioenergy crops (see 4.1.2; 4.4.1). However, the 2012 IPCC reports: “Accident risks of renewable energy technologies are not negligible, but their often decentralized structure strongly limits the potential for disastrous consequences in terms of fatalities” (IPCC, 2012).

4.2.4.4 Electric vehicles (EV)

Electric vehicle (EV) technology has evolved rapidly over the past five years across the world, and in particular in the Asia-Pacific region (IBT STAFF REPORTER, 2010). As a result, the global number of electric vehicles (EVs) on the road exceeded one million in 2015. Led by a strong demand in China where electric vehicles are commonly excluded from driving bans associated with air quality improvement measures, but also in Japan, Korea and other Asian countries. It has been estimated that the various national-level initiatives and programs to promote the awareness of electric vehicles will see over 1.4 million electric vehicles on the roads across the Asia-Pacific region in the next five years. Growing awareness of the potential of reducing carbon emissions by electrifying transportation vehicles, along with an increase in government initiatives to encourage the use of these vehicles, is helping to drive the growth of high-performance electric vehicles in Asia-Pacific countries (Mordor Intelligence, 2017). The Chinese government for example, has increasingly emphasized the adoption of electric vehicles in its plans with the country witnessing a sharp increase in the adoption of battery electric vehicles. The growth rate of high performance electric vehicles in Japan is fuelled by the increased government initiatives to invest in improving electric vehicle charging infrastructure. Korea has been a critical market in the production of electric vehicles and extensive R&D in high performance electric vehicles was made. With the improvement of electric vehicles' quality, lower operating and maintenance costs, and direct subsidies from governments in the form of tax credits, electrifying transportation is expected to contribute significantly to the reduction of fossil-fuel use, carbon emission and air pollution in the Asia-Pacific region especially in the booming urban areas.

4.2.4.5 Desalination technology

Desalination is an unconventional method to produce freshwater that has shown promise in responding to demand from water stressed areas especially in coastal cities (WEF, 2009). In the Asia-Pacific region, Western Asian countries and Australia historically have been the most important desalination markets in the world (WEF, 2009). The increase of desalination capacity recently is caused primarily by increases in water demand, but also by the significant reduction in desalination cost as a result of technological advances (Al-Jamal K. & M., 2009). Experience in the Gulf States demonstrates that modern desalination technology can provide a reliable source of water at a price comparable to water from conventional sources (Nair & Kumar, 2012).

Six of the top ten countries employing seawater desalination across the globe are located in the Asia-Pacific region, with a total global market share of 55.7 per cent (Nair & Kumar, 2012). Saudi Arabia and United Arab Emirates already make up over 40 per cent of the total (see Table 4.3). Qatar and Kuwait have relied 100 per cent on desalinated water for domestic and industrial supplies for many years (Ghaffour, 2009). However, the prospects for desalination vary greatly depending on a countries wealth and levels of water scarcity, and whether major cities are located close to the coast (Al-Jamal K. & M., 2009).

Table 4.3 Asia-Pacific countries listed in top ten employing seawater desalination. Source: Nair and Kumar (2012)

World rank	Country	Capacity (Million m^3/d)	Global market share (%)
1	Saudi Arabia	7.4	20.6
2	United Arab Emirates	7.3	20.3
4	Kuwait	2.1	5.8
5	Qatar	1.4	3.9
7	China	1.1	2.9
10	Oman	0.8	2.2

Despite the many benefits this technology has to offer, concerns rise over potential negative impacts on social and ecological systems caused by desalination plants and the indirect impacts through their high use of energy (Elimelech & Phillip, 2011). On the one hand, desalination enhances the security of water resources, protects aquatic ecosystems and prevents groundwater depletion and saline intrusion.Desalination is nonetheless associated with environmental impacts such as greenhouse gas emissions. Brine discharge including chemicals from pre-treatment processes can damage coastal habitats and threaten marine ecosystem (Al-Jamal K. & M., 2009; Peluffo & Neger, 2014).

In the last decade, the significant improvement in water treatment industry, including membrane technology and equipment manufacture has reduced greatly the cost of freshwater production. For example, desalination by reverse osmosis technology is the most recent advance and improve energy efficiency by around 25 per cent (WEF, 2009). Since conventional desalination methods always require a high energy input, the depletion of fossil fuels makes it imperative to consider alternate energy sources like photovoltaic (PV), wind and nuclear energy (Shannon *et al*,. 2008; Nair & Kumar, 2012). Biological approaches to desalination without energy input are also starting to be developed, but require more applied research to be used at a very wide scale (Peluffo & Neger, 2014). In the Asia-Pacific region, the first large desalination plant powered almost entirely by renewable energy (an 80MW wind park) was commissioned in Perth, Australia, in 2008 (Al-Jamal & Schiffler, 2009).

4.2.4.6 Nanotechnology

In the Asia-Pacific region, nanotechnology is being promoted as a technological revolution, which is providing various engineered nanomaterials (i.e. nanoproducts) in countries such as Thailand, China, India, Korea, Japan and Australia (Senjen *et al.*, 2013). In several Asia-Pacific countries, nanotechnology has been declared a strategic sector of scientific and technological development, with an extensive associated R&D input. It was hoped that this technology could provide new ways of solving some of the chronic challenges faced by human society, such as health care, and water, food, and energy provisions (Senjen *et al.*, 2013). However, the potential risks and social implications of this new technology are also increasingly addressed (Gyory, 2007; Kwazo *et al.*, 2014).

Currently it is widely accepted that industrial-scale manufacturing and use of nanomaterials carries a significant risk to human and environment health (CDC-NIOSH, 2014; Kwazo *et al.*, 2014). Some nanoparticle products are known to have unintended consequences, although their effects are often not fully understood. Ecotoxicological impacts of nanoparticles and the potential for bioaccumulation in plants and microorganisms and further accumulation through the food chain is a subject of current research, as nanoparticles are considered to present novel environmental impacts (Gyory, 2007). Carbon nanotubes and other manufactured nanomaterials are increasingly used in many different industries, often being incorporated into products where the processes can present possibilities for workers to inhale those particles (Kwazo *et al.*, 2014). Nanomaterials contained in waste may also become hazardous through emissions since they may catalyse the formation, but could also aid the destruction, of other pollutants (e.g., dioxins) (Holder *et al.*, 2013). However, due to a lack of suitable monitoring equipment and extensive knowledge gaps, ascertaining the ecotoxicity, or more generally the environmental impacts, of nanomaterials and their distribution in are still remain as an urgent and highly significant challenge to researchers and policymakers alike (Senjen *et al.*, 2013).

4.2.4.7 Research and Development (R&D) investment and human resources

According to the 2016 report of the Industrial Research Institute, Asian economies continue to grow faster than many other parts of the world. A small set of Asian countries including China, Japan, South Korea and India account for more than 40 per cent of all global R&D investments (Industrial Research Institute, 2016). The rapid increase of R&D in the Asia-Pacific region will undoubtedly propel the development of new technologies, accerlate economic growth and provide more job opportunities in knowledge-based industries for future generations.

Over the past 30 years, the economic and technological advancement of Asia-Pacific countries already has shown the great potential to use science, technology and innovation as the engines of economic growth. Meanwhile, globalization has created an enormous demand for technicians and skilled workers who can meet emerging market needs (Majumdar, 2017). The Asia-Pacific region’s favourable demographics, with a relatively young labour force (see 4.2.1), has often been cited as a key factor contributing to its accelerating growth and as a major strength of the region also in the coming years. However, the development of human resources is unbalance in the Asia-Pacific region. In South-East and South Asia, the skills shortage manifests itself as a problem of retention and attrition in fast-growing knowledge-based industries as well as in social sector services (Majumdar, 2017). Thus, the scientific and technological development across the Asia-Pacific region faces two main challenges, driving the sustainable economic growth on the one hand, and generating high-quality employment opportunities through enhancing the capacity of human resources across the region on the other.

4.2.5 Policies, Governance systems and Institutions

The core issue of environmental governance is the way societies deal with environmental problems through interactions among formal and informal institutions (Harashima, 2000). In the Asia-Pacific region, many positive trends have occurred in governance systems with the progressively strengthened environmental laws. In most of developing Asia-Pacific countries, environmental policy formation and policy implementation are still following a top-down approach, but participatory approach with the involvement of local governments and civil society has gradually been adopted by more and more countries such as China, India and Thailand (Harashima, 2000). Within the newly emergent economics, industry has become a growing role in environmental governance. Considering the contribution to environmental pollution by industry, bringing industrial entities into full compliance with environmental legislation should be a governance priority.

A common problem faced by developing Asia-Pacific countries is the ineffectiveness of implementing environmental policy. The reasons behind include financial shortages, overlap of administrative authorities, poor communication and lack of economic incentives to control pollution and restore degradation. A lack of enforcement by government agencies also exacerbate illegal logging, mining and overexploitation (Scheyvens & Lopez-Casero, 2013). Some transboundary issues such as pollution of a shared river basin or loss of habitat across the migration range of a species are challenging the conventional governance and institutional systems. A regional system of environmental management with landscape approach is thus essential to securing cooperative implementation of specific action programs within an effective institutional framework.

In relation to the environmental protection legislation, substantial progress has been made in recent decades in many countries of the Asia-Pacific region (Hildebrand, Liu, & Chuang, 2013; Kelley & Slaney, 2006; Liu, 2015; Taylor, 2006; Yoo, 2014). Issues that could still be improved relate to the actual implementation of these laws, with some protected areas for example lacking strong enforcement and effective management (Qiu *et al.*, 2009; Sang *et al.*, 2011). Another common problem is the fragmentation of responsibilities for protected areas between different administrations or even ministries that currently hampers a coherent approach towards biodiversity conservation even within individual countries.

Habitat protection is essential to biodiversity conservation, which in turn is closely dependent upon land use and land ownership (Norton-Griffiths, 2007). Weak or ill-defined property rights for local communities can erode conservation incentives and result in abandoning sustainable land use approaches by forest dwellers (Grafton, 2000; Norton-Griffiths, 2007). The Forest Rights Act (FRA) that came into force in India in 2008 (see also Chapter 2) acknowledges the rights of indigenous and local communities on forest lands that they have been living on and in turn also historically conserved their ecological integrity (Scheyvens, H., Hyakumura, K., & Seki, 2007; Kashwan, 2013). In South-East Asia, many regions face issues of "land-grabbing" from large companies to develop large-scale plantations (e.g. oil palms and pulp production). Large corporations obtain land-ownership from local farmers through deals of often questionable legal basis, which has resulted in deforestation and degradation of surrounding areas (Global Witness, 2013; Michinaka *et al.*, 2013). These governance and institutional issues have in some cases over-ridden direct efforts to promote sustainable management of ecosystems (See more details in 4.4.2; 4.4.6; 4.4.7).

While environmental problems are a newly emerging issue within the conscience of many Asian societies, traditional actors have long been involved in environmental governance. In the context of India, the India Forest Conservation Act, 1980, is regarded as one of the most effective legislations that contributed to the reduction in deforestation (Ravindranath *et al.*, 2008). Traditional rural communities in India have used the village panchayat system which represents people from various sectors of society and decision-making reflects the consensus of the community (Harashima, 2000). In

Thailand, the monarchy has become a unique force in promoting Thailand's commitment to biodiversity conservation. Although governmental structures are diverse, environmental governance has often not fully adapted to the new pressures from globalization and economic development due to the lack of enough flexibility of centralized governments or these governments prioritizing economic development over environmental issues. However, in Asian countries, new types of environmental programs that involve various stakeholders are being initiated and contributing to stronger governance systems (Harashima, 2000). At the same time, global increases in environmental awareness have also signalled further modification in the stimulus for environmental governance reform in the Asia-Pacific region. Mediating current changes, institutional developments and changes in environmental policy are taking place as a result of these influences.

4.3 Interaction among direct and indirect drivers

The many drivers that impact biodiversity and nature's contribution to people (NCP) often interact to produce complex, and unintended consequences. In developing and implementing environmental policies and governance structures, it is and will be essential to consider potential implications and feedbacks for driver interactions that may affect biodiversity, ecosystem services, livelihoods and economic development at local or even regional scales. Drivers can affect nature's contributions to people and human well-being at different spatial and temporal scales, which makes both their assessment and their management complex (Millennium Ecosystem Assessment, 2005).

Interconnections among drivers are always multiple and interactive, so that there is no one-to-one relationship between a particular driver and changes in ecosystems. Drivers may act in a chain of events such as when an indirect driver (e.g. human population growth) modifies the effect of a direct driver (e.g. land-use and land cover change, overexploitation of natural resources) leading to changes in a landscape, and potentially resulting in feedbacks on both internal and external economic drivers (e.g. marketing or trading changes in agricultural products). The causal linkage between drivers is often influenced by other factors, thereby complicating their relationships.

The interaction of drivers could be observed for some cases in the Asia-Pacific region. Climate change, emerging as the most widely discussed driver of global change, is in fact embedded in a matrix of indirect drivers such as economic drivers, demographic drivers (population growth), and direct drivers such as local land-use and land-cover change, all of which can have significant ramifications (ADB, 2017). Observed changes in climate, for example, especially warmer regional temperatures, have already affected ecosystems directly like glacier meltdowns and boundary shift of ecosystems (Section 4.4.7) or are coupled with other anthropogenic drivers. Hydrological processes for instance are altered by climate change, which lead to changes in pollution levels (nitrogen deposition), exacerbates changes in climate regulation (changes of carbon sequestration), as well as socio-economic changes (livelihood and consumption) (Singh *et al.*, 2011). Biological diversity is adversely impacted by these changes, which eventually affect the system ability to provide services through various economic, cultural or socio-political factors.

Some drivers are of regional or even transboundary significance (e.g. climate change, invasive alien species, pollution) but others are more local (e.g. land-use and land-cover change, natural resource overexploitation). However, even for a local driver (e.g. local conflict or war), its effect could also be regional or global (e.g. through migration of population). Thus, the so-called 'regional' or 'local' might be a relative concept in temporal scale. For instance, direct impact such as road network development is widening accessibility and international investment in local agriculture and forestry in remote areas, which further drives new trends in rural economic activity and creates new marketing opportunities regionally. Forest transition in the Asia-Pacific region (e.g. land-use and land-cover change) has been shown to result from a complex interaction of several regional factors including urbanization, economic growth, and demographic changes (Ashraf *et al.*, 2017). The shift of economic structure from rural to urban sectors may even reduce demand for ecosystem services away from extractive uses of forests.

Furthermore, a combination of drivers can work over time (such as population and income growth interacting with overexploitation of nature resources lead to climate change or international trading change), at different level of organization (such as local zoning laws versus international climate change treaties), and can happen intermittently (such as droughts, floods, and economic crises). Changes in one category (e.g. direct driver) can feed back to another (e.g. indirect drivers) or *vice versa*. Land-use and land-cover changes, for instance, create new opportunities and constraints at the same time, induce institutional changes in response to perceived and anticipated natural resource decline, and give rise to socio-economic effects such as changes in income inequality. Reviews of case studies of deforestation and desertification (Geist & Lambin, 2004) also revealed that the most common type of interaction is a combination of synergetic factors – combined effects of multiple factors that are amplified by reciprocal action and feedbacks. What is needed is a better understanding of relations and interactions among different drivers, inter-linkages among specific ecosystems, as well as feedbacks to coupled socio-economic systems. At present, however, there are still significant challenges in disaggregating the impacts of drivers and in unravelling the complexity of dealing with them (Singh *et al.*, 2011; see Figure 4.7).

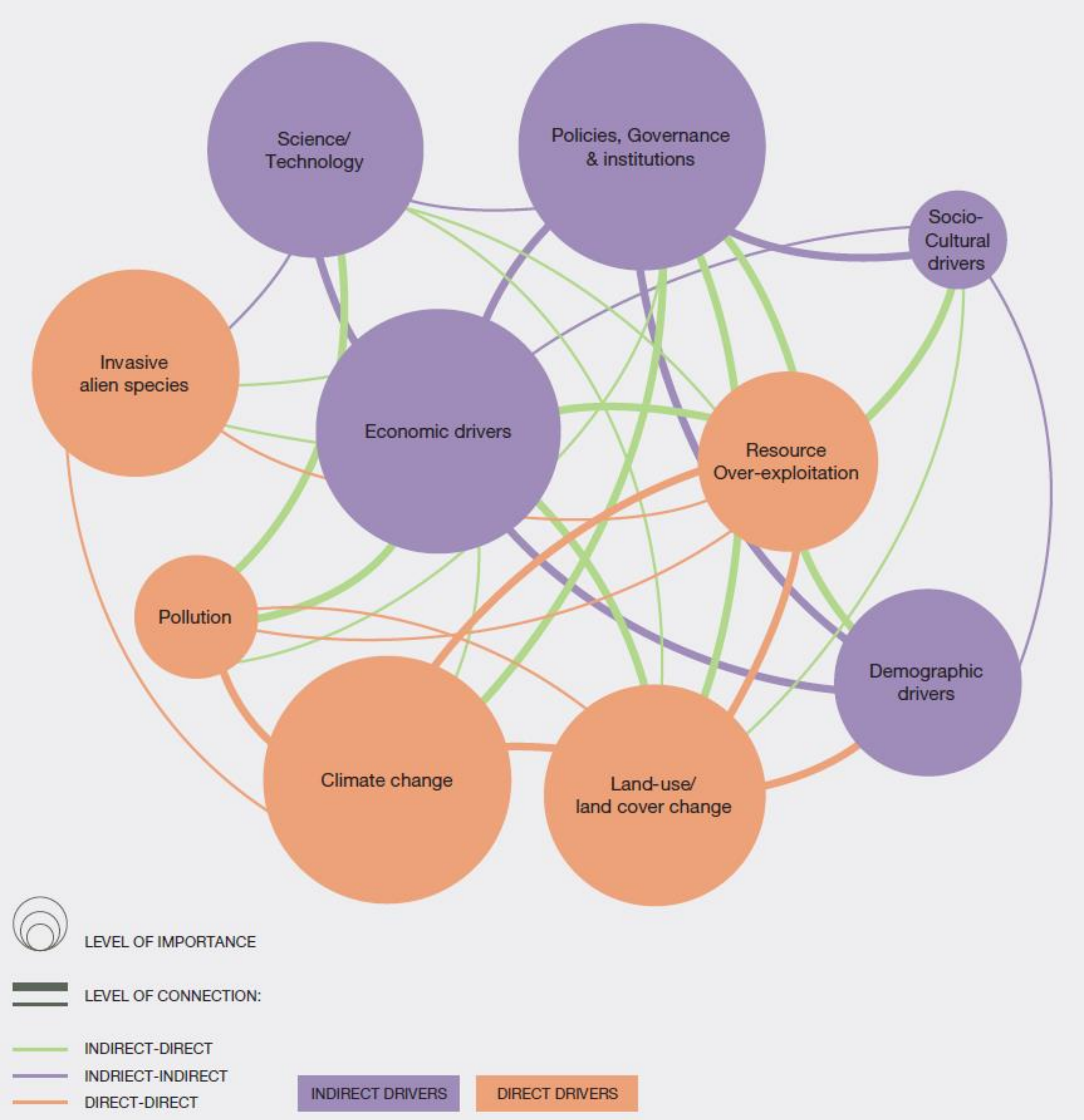

Figure 4.7 Interactions and relative importance among direct and indirect drivers

Most of the trends in direct drivers is estimated to remain constant or growing in intensity with some rapid increases in the Asia-Pacific region (Figure 4.8) and this is consistently observed through subregions (Figure 4.9; 4.10; 4.11; 4.12 and 4.13). Climate change, land-use and land-cover changes and invasive alien species are estimated to be the main direct drivers (Figure 4.7) showing both a rapid increase and strong impacts across ecosystems (especially agro-ecosystems, islands, coastal, marine, freshwater inland and wetlands and grasslands) and across the Asia-Pacific region. Changes in climate will affect the viability, distribution and presence of invasive alien species in different ways. In the presence of large pools of naturalised species changing climate creates opportunities for invasive alien species to move into new habitats (Roger *et al.*, 2015). Another complexity to consider is the multi-scale issue, as changes in a local ecosystem (e.g. small Pacific Islands) could be driven by global drivers such as the influence of global economic crisis and international trade. Natural resource overexploitation is also a big issue as agro-ecosystems are exploited to their limit of sustainability thus and starting to show levels of environmental degradation (Section 4.4.5).

Indirect drivers such as governance and policies are essential levers to bring positive changes in the region. In the Asia-Pacific region, a global increase in environmental awareness has initiated some slow but nevertheless noteworthy increased engagement in new actors other than governments, and innovative solutions that could lead to resource governance reforms (section 4.2.6). Socio-cultural drivers such as education and innovative technology such as the implementation of information and communication technology are also helping to pave the way for changes in both rural and urban development especially in previously remote areas. With the rapid economic growth in most of Asia-Pacific countries recently, more investment into biodiversity conservation, reforestation and low-carbon industries such as in North-East Asia subregion is available.

The following sections will elaborate on the integrated effects of drivers, their interactions and 'local' specific drivers upon major ecosystems in the Asia-Pacific region. Generally, inland freshwater and wetlands in the Asia-Pacific region are experiencing an increased pressure on water demand (Section 4.4.7) and native grasslands are unsustainably managed with over-stocking and over-harvesting for livestock farming, with an inter-related increased vulnerability to fire due to climate change (Section 4.4.2). Mountains are mainly impacted by land-use and land-cover changes and overexploitation of natural resources in South and South-East Asia, due to growth in an already dense population, leading to an increased urbanization and agricultural intensification. Coastal ecosystems are most vulnerable in South Asia, South-East Asia, North-East Asia and Pacific Islands due to climate change and sea level rise (UNEP, 2016a), increasing the risk of migration on high population areas and small Pacific atolls. Marine pollution is a continuing threat to biodiversity (section 4.4.8) with increased hypoxic zones and the top five plastic waste polluters in North-East, South and South-East Asia (UNEP, 2016a; 2016b). Ocean acidification, overfishing, coral bleaching have resulted in more than 80 per cent of coral reefs in the Asia-Pacific region being classified at risk, with direct consequences for coastal tourism and local economies (UNEP, 2016a). Although some impacts are shown to be low, their increases in some ecosystems require careful consideration, for instance the 'black carbon' increase from the Himalayan region (Section 4.5.2). Alpine and deserts ecosystems are also relatively less impacted, although increased vulnerability to climate change and invasive alien species will exacerbate this challenge, especially in the Hindu Kush Himalayan region, Australia and Western Asia.

Figure 4.8 Level of influence of direct and indirect drivers on ecosystem services supply in the Asia-Pacific region

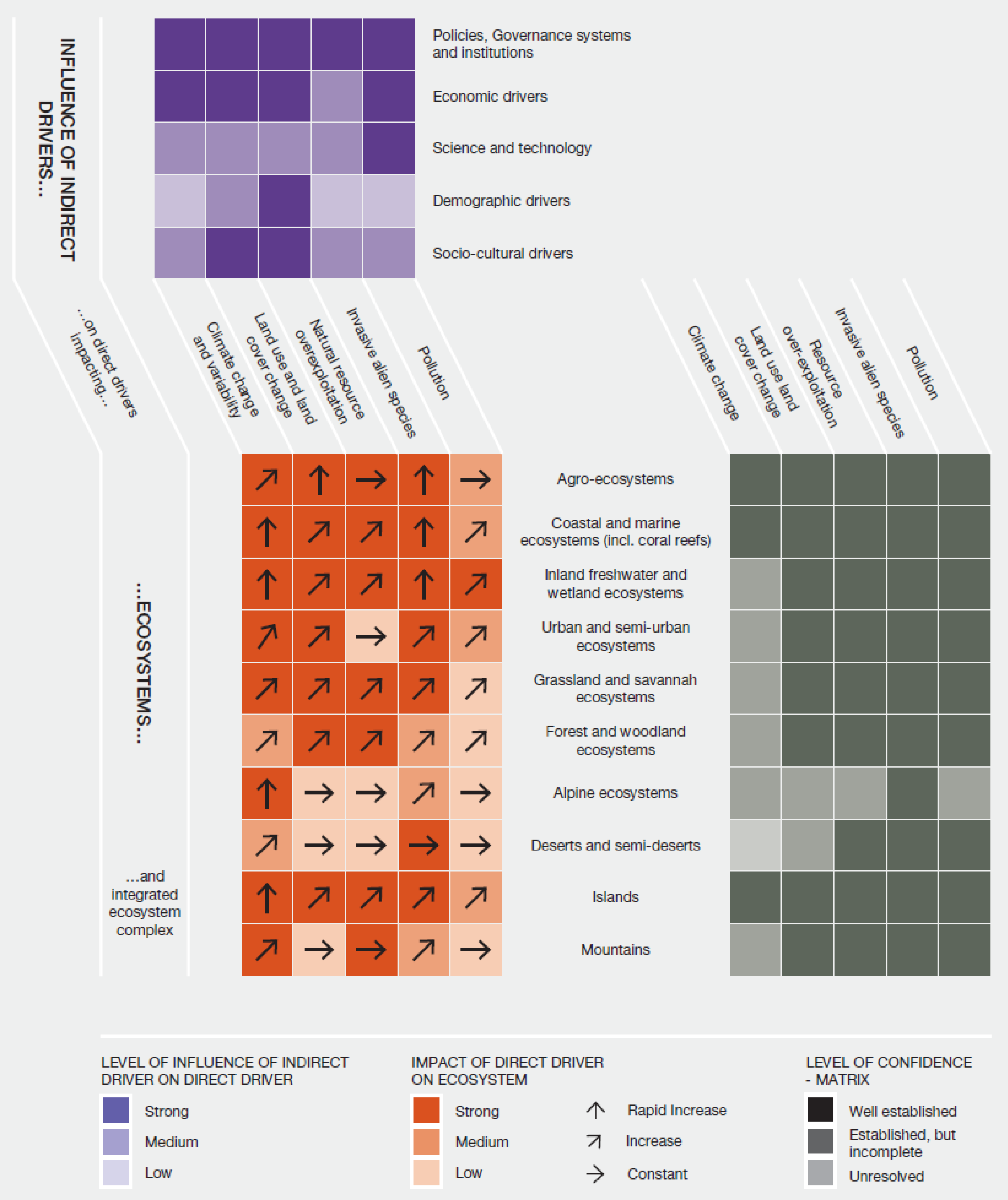

Figure 4.9 Level of influence of direct and indirect drivers on ecosystem services supply in the Oceania subregion

Figure 4.10 Level of influence of direct and indirect drivers on ecosystem services supply in the South-East Asia subregion

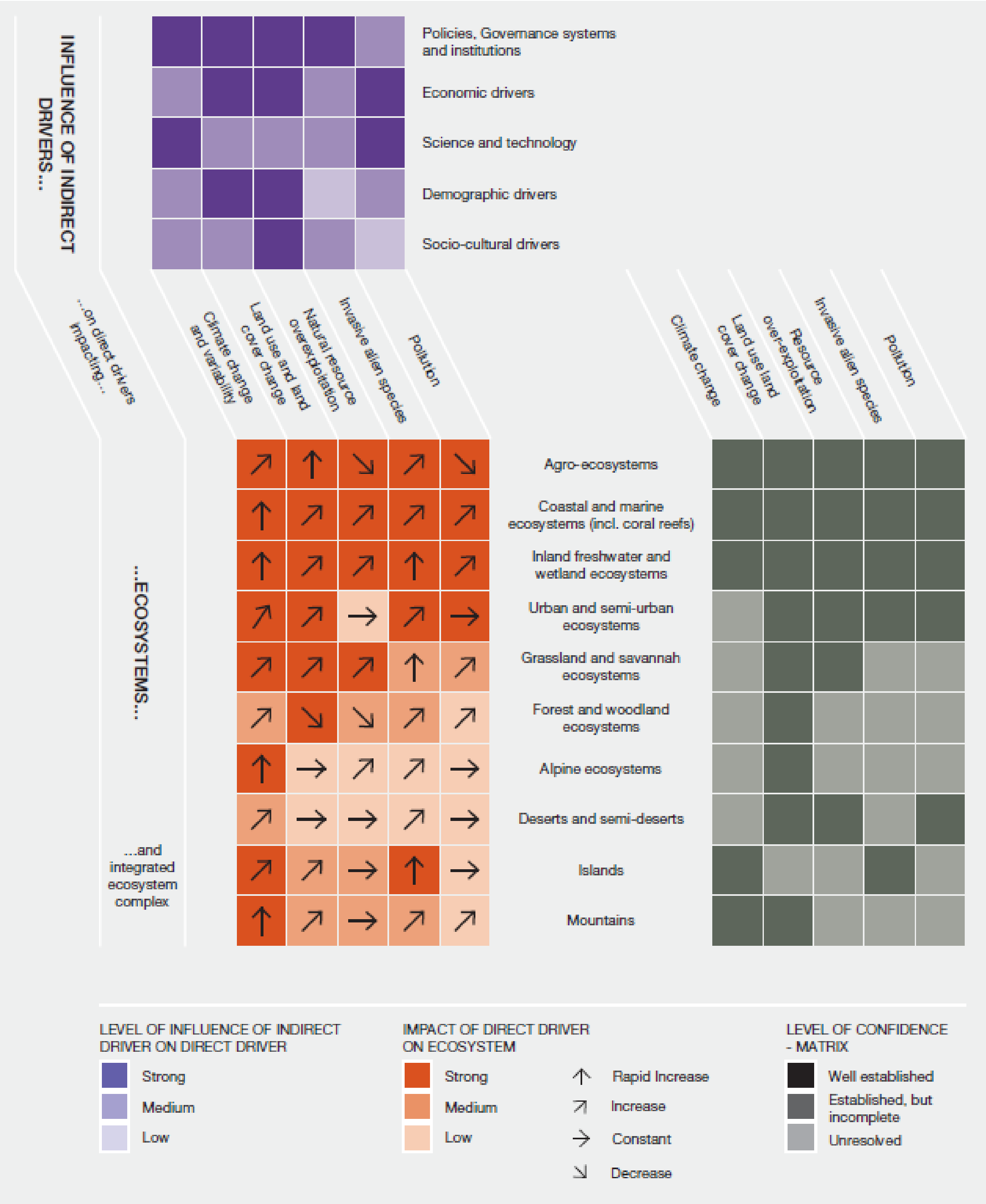

Figure 4.11 Level of influence of direct and indirect drivers on ecosystem services supply in the North-East Asia subregion

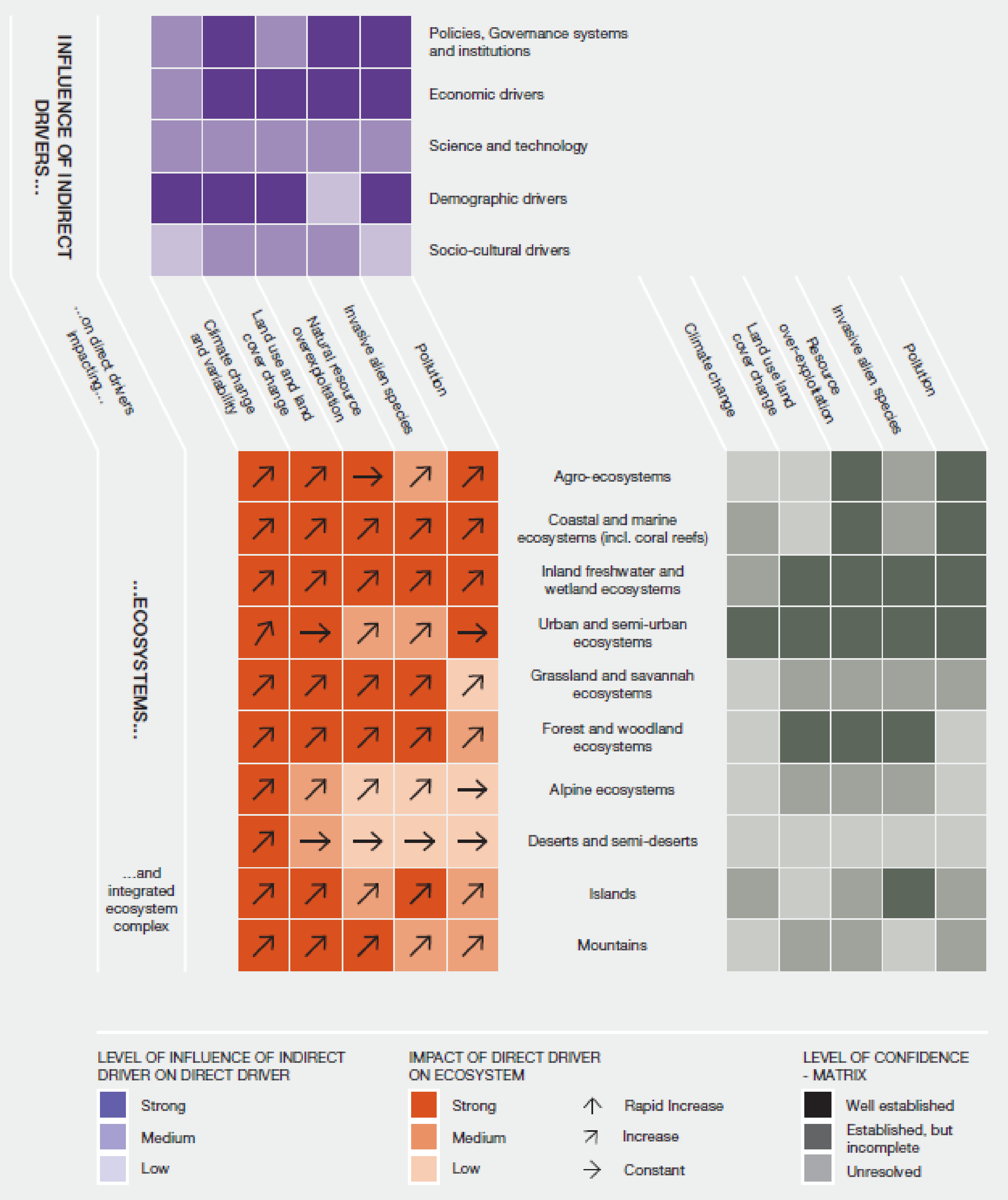

Figure 4.12 Level of influence of direct and indirect drivers on ecosystem services supply in the South Asia subregion

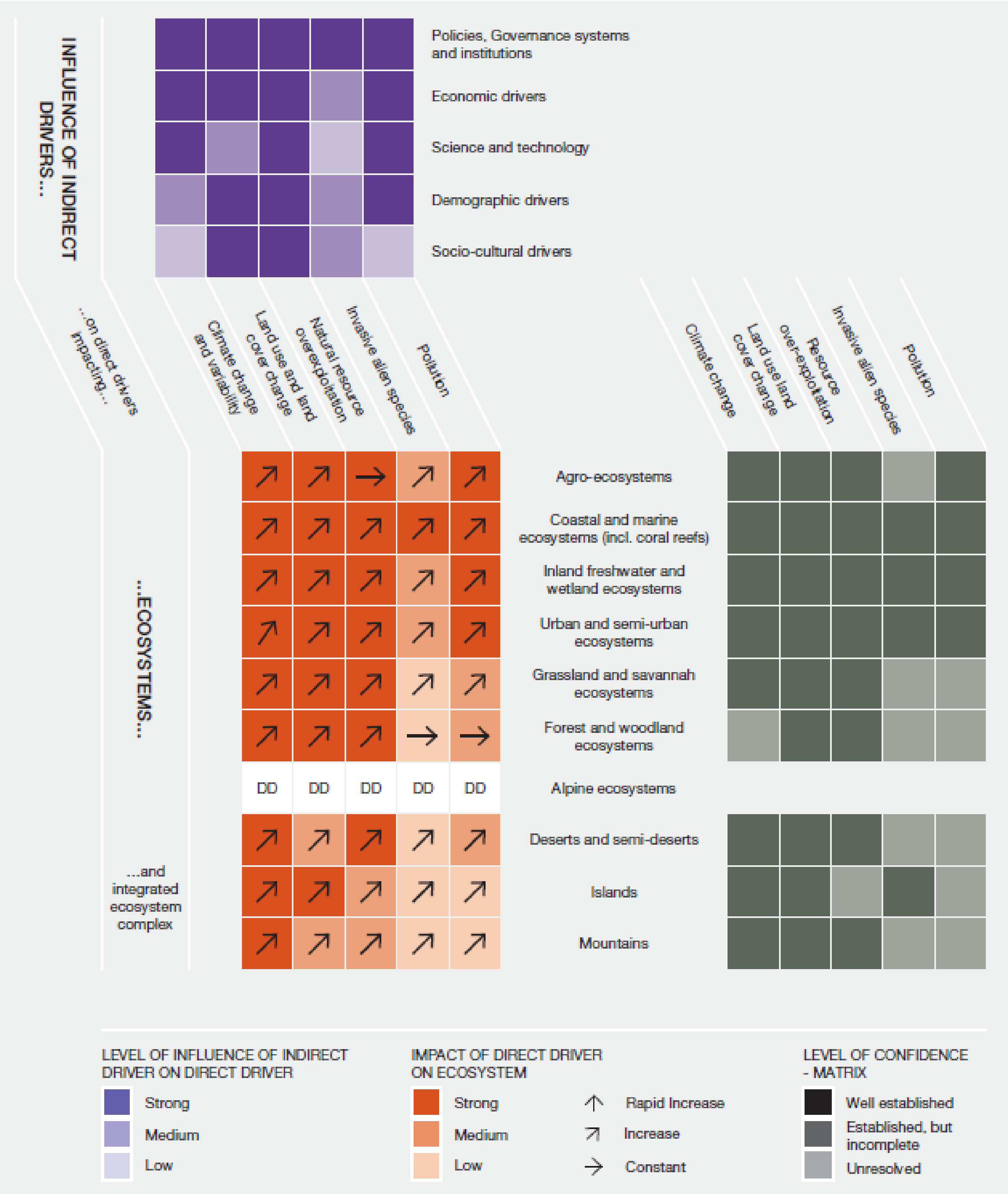

Figure 4.13 Level of influence of direct and indirect drivers on ecosystem services supply in the Western Asia subregion

4.4 Effects of drivers on major ecosystems

4.4.1 Forests and Woodlands (tropical & temperate)

Forests are one of the most important terrestrial ecosystems, providing many ecosystem services. However, for decades, forests have been under pressure from the increasing global demand for forest products and services, local harvest of non-timber forest products (NTFP) as well as agricultural expansion, rapid urbanization, infrastructure development and booming tourism (FAO, 2015a; UNEP, 2016a; see also 4.1.1; 4.1.2). Across the Asia-Pacific region, anthropogenic activities and environmental change are two of the main causes of biodiversity loss, habitat fragmentation, soil erosion, and the destabilization of forest ecosystems (FAO, 2015a; FAO and RECOFTC, 2016; Hughes, 2017; IUCN, 2017).

The conversion of primary forest for agricultural use including large-scale plantation such as bio-fuel and rubber production is detrimental to biodiversity through habitat loss and fragmentation and the subsequent depletion of nutrients from the forest soils (Squires, 2014; Edwards *et al*., 2014). Of the world's three major tropical regions, South-East Asian forests are vanishing more rapidly in comparative terms (FAO and RECOFTC, 2016; see 4.1.3). Profits from alternative land uses such as crops often determine whether forests are conserved or converted. External factors such as the price of agricultural products and agricultural policies also play a decisive role in shaping how forests are used. Palm oil has traditionally been used for cooking but much of the recent expansion has been driven by the demand for palm oil as a biofuel (Edwards *et al.*, 2014). Thus, market demand in tropical South-East Asia is becoming one of the key drivers behind this large-scale forest conversion. For instance, Indonesia and Malaysia are the largest producers of palm oil in the world, together contributing to around 85-90 per cent of total palm oil production globally (Indonesia Investments, 2017). Currently both pulp and paper industry are growing up quickly in the Asian Pacific region with the replacement of native forests by monoculture plantations (mainly *Eucalyptus* and *Acacia* plantations) (A. C. Hughes, 2017; Squires, 2014). In 2015, the paper and paperboard production in the Asia-Pacific region was 195 million tonnes, accounting to 48 per cent of the global total (FAO, 2015b).

Protected forest areas in the Asia-Pacific region are the important lands for biodiversity protection. However, due to habitat loss and environmental degradation many endemic species living in forest ecosystems are still at risk (IUCN, 2017). The efforts to expand protected areas in some countries do not match the extent of biodiversity loss in the whole region (UNEP, 2016a). In the Hindu Kush Himalayan region despite 39 per cent of the land being set aside as protected areas, major forested areas are outside the protected area regime and remain unprotected (Chettri, Shakya, and Thapa, 2008). Of five biodiversity hotspots found in Asia, the Indo-Burma hotspot is facing the greatest threat due to the most densely populated, with only 5 per cent of its natural habitat remaining (IUCN, 2017). Transboundary conservation and weak environmental governance in these protected areas remain major issues challenging many Asia-Pacific countries (see 4.2.5).

Since the early 1980s, restoration and regeneration of degraded forestlands has been found to be a crucial issue in South Asia and South-East Asia. India launched the Social Forestry Programme in 1980, followed by the more participatory Joint Forest Management (JFM) Programme, to recover degraded forests and meet biomass demands for village communities (Bhat *et al.*, 2001). Similarly, in Nepal, large areas of degraded forest land were handed over to community forest user groups for reforestation and supply of basic forest products to local communities (Kanel & Shrestha, 2001; Scheyvens *et al*., 2007). In the 1990s, Vietnam began two large restoration programmes (Greening the Barren Hills Program and the 5 Million Hectares Reforestation Programme) which resulted in the increase of forest cover from 35.6 per cent in 2000 to 47.6 per cent in 2015 (FAO and RECOFTC, 2016). In China the Natural Forest Conservation and Grain for Green Programs were initiated at the end of 1990s and are the largest payment for ecosystem services schemes globally. Over $15 billion has been spent on the conversion of 9 million hectare of farming land to forested lands since the year of 2000 (UNEP, 2012a; Ministry of Environmental Protection of China, 2013; FAO, 2010a; 2011; 2015a). Due to these efforts and increasing investment in ecological restoration with the rapidly economic growth, the forest area in North-East Asia and South Asia increased 22.9 per cent and 5.8 per cent respectively during the period between 1990 and 2015 (FAO and RECOFTC, 2016; see Table 4.1).

In the Asia-Pacific region, industrial wood production and gathering of fuel wood for household use are still major drivers of deforestation in some countries (Union of Concerned Scientists, 2011; FAO, 2015a; 2015b; see Figure 4.1), although timber production has generally declined across much of the region. Of the roughly 8 million hectares of wood fuel plantations globally, 6.7 million are located in Asia (FAO, 2010b). Due to the demand for timber in some countries, it has been noted that trading of unsustainably harvested native species from other countries is impacting the regional forest resource as a whole (Zhai *et al*., 2014; Hughes, 2017).

In some forested areas, mineral extraction is destructive to land cover and resulting in habitat fragmentation and some devastative impacts on forests (see 4.1.2.5). Shifting cultivation, considered as an important driver in tropical forest areas, is an age-old way of life or agricultural practice across the tropical or subtropical Asia-Pacific region (Karki *et al.*, 2017). A high level of biodiversity is maintained by this agricultural system which provides significant benefits to wildlife populations (Cairns, 2015) as well as potential sources of genetic material for modern crop breeding (Erni, 2015; Karki *et al*., 2017). In addition, there are a range of underlying causes for forest change that vary among countries, such as market failure, institutional failures and inappropriate policies (see FAO and RECOFTC, 2016).

4.4.2 Grasslands and Savannahs

Grasslands (including rangelands, shrublands, pastureland and cropland sown with pasture and fodder crops) cover some 3.5 billion hectare in 2000, i.e. 26 per cent of the global land mass (FAO, 2010c). Grassland ecosystems support a wide range of biodiversity and are important for animal husbandry, water regulation and carbon sequestration (White *et al*., 2000). Approximately 35 per cent (1,225 million hectare) of the Asia-Pacific region is covered by grasslands which are mostly found in China, Mongolia and Australia, including arid and semi-arid zones, as well as humid lowlands and high altitude cold zones (FAO, 2014; White *et al*., 2000). Dry grasslands in Asia support some of the highest human populations as well as some of the lowest in Oceania (White *et al.*, 2000). Temperate grasslands are some of the most altered ecosystems globally with 41 per cent replaced by intensive agriculture and another 13.5 per cent converted to urban, industrial and other uses; much of the remainder is degraded and vulnerable to desertification (Heidenreich, 2009). Historical drivers of change in arid and semi-arid the Asia-Pacific region have been climate and pastoral herding systems (Chuluun & Ojima, 2002).

4.4.2.1 Land-use and land-cover change

Arid and semi-arid grasslands in the Asia-Pacific region have been substantially modified or cleared due to agriculture expansion, unsustainable mining, groundwater decrease, urbanization and infrastructure development. Broad-scale agricultural expansion has modified or cleared grassland communities on a worldwide basis including the Asia-Pacific region (Suttie, 2005). In central Mongolia conversion to cultivation since the 1950s has included some of the best available pastures (Suttie, 2005; Suttie *et al*., 2005b). Recent land-use intensification in New Zealand has converted natural grasslands to support dairy production (Weeks, Walker, & Dymond *et al*., 2013). Agricultural expansion in Australia has also resulted in the loss or conversion of grasslands ecosystems with many now being legislatively protected (Australian Government, 2017). Other damage to grasslands includes through random track making, such as in Mongolia (Suttie, 2005), and road making associated with logging in Papua New Guinea (Lamb, 2011). Recently Chinese policymakers have implanted a range of policies and programs (e.g. “Control grazing for grassland recovery” and

"Grassland ecological compensation incentive mechanism") aiming to restore grasslands in west China (P. Zhang *et al.*, 2015) .

While the range of drivers impacting on grasslands are interwoven, grazing practices, grassland management schemes and land-use patterns play important roles in grassland health (Ning *et al.*, 2014; Suttie *et al.*, 2005a). Overstocking is problematic in some regions of Mongolia, West China, North Pakistan, Northwest India, and other high altitude grasslands in the Hindu Kush Himalayas, especially near permanent settlements, winter houses and along main roads while repeated grazing and hay cutting can also lead to a decline in grassland productivity (Suttie *et al*., 2005; Wu *et al*., 2016; see also 4.1.2). Grassland degradation due to over-harvesting of medicinal plants or large-scale mining has been reported in the Karakoram Pamir landscape, where the almost depredatory manner of collecting radix Glycyrrhiza (*Glycyrrhiza korshinskyi, G. inflate*) and gem stones have disturbed the fragile high-altitude vegetation cover (Ning *et al.*, 2014; N. Wu *et al.*, 2012; Zhaoli *et al.*, 2005). In Southern Australia temperate grasslands have been largely lost or modified, sown with exotic species and fertilized (Mcivor, 2005). Tree clearing, increased fertilizer and herbicide use and irrigation has reduced the biodiversity of many Australian grasslands while removal and conversion had led to some soil erosion as well as increased soil acidity and salinity (Mcivor, 2005).

4.4.2.2 Invasive species

Many invasive species occur in grasslands across the Asia-Pacific region (Pallewatta, Reaser & Gutierrez, 2003) including lantana replacing native grasslands in Indonesia (Peh, 2010) and crofton weed (*Ageratina adenophora*) and odor Eupatorium (*Chromolaena odorata*) in China with the cost of losses to grassland ecosystems (Xu *et al*., 2006). In Australia, some introduced pasture species have now become weeds (Mcivor, 2005; Cook & Dias 2006). Tree encroachment and weed invasion (hawkweed, sweet briar, scotch heather) of grasslands can also be problematic in New Zealand tussock grasslands, where the impact of wilding conifers (*Pinus*, *Pseudotsuga* and *Larix* spp.) is one of the greatest threats as it may reduce water yield, impact on indigenous diversity and impair recreation values (Mark *et al.*, 2013). Invasive vertebrates in Australia such as rabbits have led to the loss of native pastures, promoted invasive plant and limit regeneration of native species (Cooke, 2012).

Many invasive species occur in grasslands across the Asia-Pacific region (Pallewatta, Reaser & Gutierrez, 2003) including lantana replacing native grasslands in Indonesia (Peh, 2010) and Crofton weed (*Ageratina adenophora*) and Chromolaena (*Chromolaena odorata*) in China with the cost of losses to these grassland ecosystems estimated to be $317.11 million in 2000 (H. Xu *et al.*, 2006). Exotic grasses in combination with increased drought are increasing fire frequency and intensity across the Australian grasslands (Douglas *et al.*, 2008). Similarly the forest and grassland ecosystems in the Asian tropics, including protected areas, are like elsewhere in the tropics, increasingly threatened by globally impactful invasive alien plants such as *Lantana camara, Mikania micrantha, Chromolaena odorata,* and *Parthenium hysterophorus* (Weber, 2017).

4.4.2.3 Fire

Fire is a major factor in determining grassland composition and important for grassland management; it also removes unpalatable species but can be destructive and harmful to biodiversity (FAO, 2014; Mark, Barratt, & Weeks *et al*., 2013; Suttie *et al*., 2005). In tropical systems repeated short-spaced fire can transform forests to grasslands (Lamb, 2011).

4.4.2.4 Climate change

For cold areas such as Mongolia, the Hindu Kush and Himalayan region, lower temperatures are likely to shorten the growing season (Suttie, 2005). Drought has seen loss of livestock and conversion of rangelands to crops in some parts of the Asia-Pacific region (Suttie *et al.*, 2005b). Climate change is also likely to affect grassland biodiversity by placing native plant species at risk (Halloy & Mark, 2003). Weather extreme events such as snow storms across high altitude pastoral areas have led to serious animal loss and pastoralists' poverty placing enormous strain on the region's socio-economic development (Wu, N & Yan, 2002). In North Pakistan scientific observation and herders' perception illustrate that summer precipitation has reduced and heavy winter snowfall is more frequent over the past few decades. Longer summers and shorter winters were also noted by local people in the Karakoram, which resulted in longer and more intensive heat waves in recent years, and further the change of species composition and degradation of grasslands (Joshi *et al.*, 2013).

4.4.2.5 Governance and policies

Grassland conversion to croplands and grassland degradation are largely due to increasing population growth and political reform of pastoral systems (Chuluun & Ojima, 2002). Grazing lands in Mongolia and China have changed from a feudal system to collective management in last 150 years (Suttie *et al.*, 2005b) but many pastures have more recently been privatized or individualized (Yan *et al.*, 2005; Wu *et al*, 2012), which inevitably brought about the change of governance system. Loss and degradation of grasslands in the Asia-Pacific region have already impacted on many local livelihoods including the mobile herders in Mongolia, Western Asia, the Hindu Kush and Himalayan region (J. F. Reynolds *et al.*, 2007; S. G. Reynolds, 2005; Suttie *et al.*, 2005b) who previously adapted well to the harsh and unstable environment conditions in grasslands. The change of governance and land tenure led them to adjust their grazing practices and adapt to new surroundings. Loss of traditional knowledge and practices for mobile livestock grazing among pastoralists due to outmigration of young generation, livelihood diversification, conflict with wild life and restriction on long-distance migration has impacted the conservation of local genetic diversity of domesticated animals like yak in the Hindu Kush and Himalayan region (Ning Wu *et al.*, 2016) . Establishment of a new governance system adapting to emerging changes is imperative in these areas.

4.4.3 Alpine Ecosystems

The high-mountain ranges within the Asia-Pacific region are home to the highest concentration of glaciers globally (Pritchard, 2017) and a diverse range of globally-important ecosystems above tree line, including alpine meadows, shrub lands, sub-nival, and alpine tundra (Körner, 2003; Körner, 2012). These alpine ecosystems are particularly vulnerable to a range of natural and anthropogenic drivers including climate change, overgrazing, tourism, natural resource extraction, and invasion by alien species (Gottfried *et al.*, 2012; Kudo *et al.*, 2011; Wookey *et al.*, 2009)). These drivers impact on the ecosystem services provided by alpine ecosystems and the associated livelihoods of populations in high-mountain areas (Singh *et al.*, 2011).

Although the magnitude of warming across the Asia-Pacific region is less extreme than that observed in the Arctic (Settele *et al.*, 2014), sustained changes and impacts have been observed across a range of elevations and altitudes (Mohandass *et al.*, 2015; Shrestha *et al.*, 2014). For instance, recent studies in the Hindu Kush-Himalayan (HKH) region – a region which stores the largest amount of snow and ice outside the polar regions and is informally referred to as 'the Third Pole' – have highlighted significant ice mass loss since at least the late twentieth century as a result of long-term warming (Singh *et al.*, 2011), 2011; Bolch *et al*., 2012; Zhao *et al.*, 2016). Similarly, in the Tien Shan, long-term and pervasive glacier loss since the 1960s has taken place as a result of increasing summer melt (Farinotti *et al.*, 2015).

Projected climate changes across the Asia-Pacific region are expected to have substantial impacts on biodiversity and ecosystems. In some parts of the Asia-Pacific region, increases in summer temperatures and/or precipitation has been linked to increasing shrub dominance, with a shift to species less palatable to herbivores (Brandt *et al.*, 2013; Frost *et al.*, 2013; Frost & Epstein, 2014; Myers-Smith *et al.*, 2015; Nautiyal *et al.*, 2004). Decreasing snow cover and increased summer rainfall is likely to lead to changing alpine plant community composition, especially in snow-bed and cushion fields communities, resulting in increasing rates of soil erosion (Halloy & Mark, 2003; Telwala *et al.*, 2013). Permafrost thawing in alpine zones and loss of grasslands and wetlands may lead to decreasing reflectance (albedo) and increasing greenhouse gas emissions (Chen *et al*., 2013; Myers-Smith *et al*., 2015), amplifying future change (Bosch *et al.*, 2017) although a recent study has suggested that increased vegetation growth may result in an increase in the soil carbon stock (Ding *et al.*, 2017).

Some areas in the Asia-Pacific region, such as northern parts of Tibetan Plateau are likely to face increased temperature and decreased precipitation resulting in increasing abundance of communities adapted to warmer and drier conditions (Y. Q. Zhang & Welker, 2014). In the Himalayan region, warming alone is projected to cause a marked reduction in the distribution of Himalayan brown oak (*Quercus semicarpifolia*) (Singh *et al.*, 2011) and a 30 per cent decline of snow leopard habitats in the Himalayas (Forrest *et al.*, 2012). In Australian alpine areas, warming and hydro-climatic extremes have been experienced over the past few decades and are projected to become more common (B. I. Cook *et al.*, 2016; Palmer *et al.*, 2015). Biotic and abiotic responses to global warming have been observed in Australian, such as eucalypt recruitment in alpine belt, altitudinal expansion of rabbits' distribution and the timing change of migratory species (Australian government, 2009). Whilst upward shifts of alpine plants have already been recognised in the Himalayan region (Telwala *et al*., 2013), mountain regions with more isolated, fragmented and small-scale alpine landscapes and home to a large proportion of endemic species are expected to be highly sensitive to climate change-driven biodiversity losses, such as the mountains of Iran (Noroozi *et al.*, 2011), New Guinea (Hope, 2014) and Australia (J. Williams *et al*., 2015; Venn, Pickering, & Green, 2014) .

Anthropogenic pressures, including livestock grazing and natural resource exploitation such as the collection of lichens, fodder, fuelwood and herb medicine (e.g. intensive extraction of *Cordiceps sinensis*), prevent timberline trees from regenerating across large areas of their distributional range in the Himalayan region (Sharma & Singh, 2004; Singh, Rawat, & Garkoti, 1997; Wu & Liu, 1998). Warming may add further pressure to species at tree-line. The synergistic effects of anthropogenic activity and climate change may amplify future impacts. For instance, the major cause of widespread degradation of high altitude grasslands on the Tibetan Plateau is thought to be a consequence of global climate change compounded by overstocking, poor livestock management, excessive numbers of herbivores and disturbance from small mammals (Harris, 2010). Increasing human populations in alpine areas may further exacerbate these trends through the development of residential, commercial and tourist buildings (Mandal & Sengupta, 2015).

4.4.4 Deserts & Semi-deserts

Several significant deserts stretch across the Asia-Pacific region from the Arabian Desert in the west, through Gobi Desert, Takla Makan Desert and Thar Desert in the middle, to several Australian deserts in the east with the total area about 6.3 million km², making up 22.4 per cent of the total Asia-Pacific's land surface or 18.6 per cent of the global desert area (see Figure 3.1). Almost two-thirds of the Australian continent is considered as arid or desert making one of the driest places on the Earth after Antarctica. In Western Asia deserts and semi-deserts occupy around two thirds of the regional land, including rangeland (UNEP, 2016b).

Deserts and semi-deserts are characterized by a highly variable low rainfall, therefore, the air in deserts is very dry, and solar and terrestrial radiation are intense. Most deserts are thus characterized by specialized flora and fauna with a higher spatial and temporal variability influenced by the availability of water. Due to the extremely slow rate of biological activity in deserts, ecosystems in these drylands are very fragile to external disturbance and take decades to recover from even slight damage (J. F. Reynolds *et al.*, 2007) (see also 3.2.1.4).

Climate change is one of main drivers of changes in deserts and semi-deserts. Based on projected results, climate warming in the Middle East is strongest in summer although it is normally stronger in winter elsewhere. The warming in summer extends the thermal low at the surface from South Asia across the Western Asia over North Africa, as the hot desert climate intensifies and becomes more extreme (Lelieveld *et al.*, 2016). This trend has important biological implication for the desert organisms, because most of them live at the edge of their tolerance and might not survive in a hotter climate. In Australia, fire frequency maps from 1997 to 2006 illustrate higher frequencies of fire occurring in the central arid lands and northern Savannahs, showing a significant relationship with extended aridity (Australian government, 2009).

Like other eco-regions the change of rainfall pattern in deserts and semi-deserts are uncertain. Deserts and semi-deserts in North-East Asia are predicted to be most likely receive more rainfall associated with a warming trend in the future (Miao *et al.*, 2015). However, over the Arabian Peninsula, from 1979 to 2009, observed annual mean rainfall declined by 47.8 millimeters each decade, while mean temperatures increased by 0.6°C (Almazroui *et al.*, 2012). According to most global climate models, projections suggest a decrease in rainfall in the Western Asia by 20 per cent over the next 50 years (Meslemani, 2008). In general, a warmer planet will bring more rainy pulses to winter-rain deserts and more drought pulses to summer-rain deserts (UNEP, 2006). Water flow of large desert-rivers could thus be influenced by the change of rainfall pattern. Decreased rainfall in some deserts as a result of climate change also increases the frequency and magnitude of cross-border dust storm such as in North-East Asia (Q. Zhao *et al.*, 2010).

The spread of land degradation and desertification is one of the most critical challenges facing arid and semi-arid areas in the Asia-Pacific region owing to its obviously negative impacts on economic development and environmental conservation (UNEP, 2016a; 2016b). It was estimated that about 40 per cent of Western Asia's land area is subject to desertification (UNEP, 2016b). As to the causes of desertification prevailing in the arid and semi-arid region, wind erosion is one of the most common drivers leading to the loss of the fertile top soils, which further resulting in the encroachment and accumulation of sands on productive pastures and agricultural lands (Abahussain *et al.*, 2002). In Western Asia wind erosion accounts for 27 per cent of land degradation (UNEP, 2016b). Droughts result in soil moisture deficits in desert margins and then easy erosion by wind. This trend has increased in severity and is projected to become even more intense in the future (UNEP, 2006). Even in India, it is estimated that nearly 30 per cent of its land area is degraded or facing desertification. Key reasons for the increased degraded in India is identified as water erosion, vegetation loss, and wind erosion (Centre for Science and Environment, 2017).

The traditional livelihoods in deserts were of three types — hunter-gatherers, pastoralists, and farmers. For most of desert and semi-desert areas livestock grazing is the only way for traditional land use. Desert agriculture occurring mostly around oases and along the semi-desert margin provide most of cereal and animal products (Abahussain *et al.*, 2002). Recently, in addition to frequent drought, overgrazing and uprooting woody species for use as fuel, tillage and mismanagement of water resources have become the principal causes for a large-scale rangeland deterioration in arid and semi-arid areas of Western Asia, South Asia and North-East Asia (Abahussain *et al*., 2002; UNEP, 2016a; 2016b; see also 4.4.2). Irreversible damages have also been caused in previously good agricultural and pastoral grounds in deserts and semi-deserts by large-scale modern developments (UNEP, 2016b). Petroleum and minerals exploration, energy-intensive urban developments, and tourism, have increasingly driven the changes in environment and livelihood in the Asia-Pacific deserts and semi-deserts (UNEP, 2010).

The Western Asia has a relatively high urban population with over 70 per cent of the total population living in urban areas (United Nations, 2014). Particularly, in some countries nearly the whole population is urban (e.g. Qatar, 99 per cent; Kuwait, 98 per cent; Jordan, 83 per cent; Saudi Arabia 83 per cent and United Arab Emirates, 85 per cent) (United Nations, 2014). Newly emergent cities encroach onto semi-deserts with a fast expanding urban peripheries (Abahussain *et al*., 2002). Growing urban populations and accompanying aspirations for improved living standards, demanding more resources and services such as housing, health, water, energy and education (UNEP, 2010). Agricultural intensification accelerates the depletion of groundwater, especially in the Arabian Peninsula, and then increases soil salinity (UNEP, 2010). Population growth in urbans also leads to rapidly increasing amounts of wastes (solid and liquid) which further aggravates environmental problems in arid and semi-arid areas such as increasing pollution of land and water resources (UNEP, 2006).

Some desert and semi-desert areas in the Asia-Pacific region are rich in oil and natural gas reserves, especially in Western Asia, such as Saudi Arabia, Iraq, Kuwait, UAE, and Qatar, where oil is the major driver of global economic growth with high GDP (Gross Domestic Product) per person (UNEP, 2016b). In last few decades, a lot of investment in the extraction of oil, gas, and minerals has driven environmental changes in desert and semi-desert areas (UNEP, 2006). A continuation of the energy- and water-intensive development model, in which water with subsidized costs is used for low-value purposes, has resulted in even more severe natural resource depletion and environmental degradation (UNEP, 2010). Because of mining and power engineering, transport infrastructure has been improved, large-scale water extraction and supply technologies applied, and previous wildness lost (UNEP, 2010; 2016b). Exploration for and production of petroleum have caused local detrimental impacts to soils, surface and groundwater, and desert ecosystems (UNEP, 2006; 2016b).

Recently, deserts have much to offer for tourism development from Western Asia, North-East Asia to Australia, although there are concerns that this fast growing industry may become new driver in ecosystem damage (UNWTO, 2012). In Western Asia political instability and even armed conflict pose a number of critical challenges to environmental and social security in deserts and semi-deserts (UNEP, 2016b). The negative impact of instability on biodiversity and protected areas has been observed in several Western Asian countries such as Iraq, Syria and Yemen (UNEP, 2016b). The war's toxic footprint (e.g. releasing heavy metals from munitions) is also severe, contaminating water and soil, and finally affecting human health directly or indirectly through food chain (UNEP, 2016b).

4.4.5 Agro-ecosystems (Agricultural/Silvicultural/Aquacultural)

Biodiversity in the Asia-Pacific region faces threats from increasing agricultural, aquacultural and livestock production (Butler & Laurance, 2008). Biodivesity in agro-ecosystems is essential sources for food security, insurance for pest and disease outbreaks and losses due to weather extremes. However, increasing reliance on monocultures of high yield and fast growing varieties associated with intensive application of chemical fertilizer and pesticide, have reduced biodiversity and increased non-point source pollution. Intensification of agro-ecosystems is being driven by changing demand and supply of globalized markets, leading to poor management of marginal lands and overexploitation of agricultural lands, which further accelerated biodiversity losses, water and soil erosion, and greenhouse gases (GHGs) emissions such as cases happened in Bangladesh (Nath *et al.*, 2016) and South-East Asia (Devendra, 2012; Dressler *et al.*, 2017).

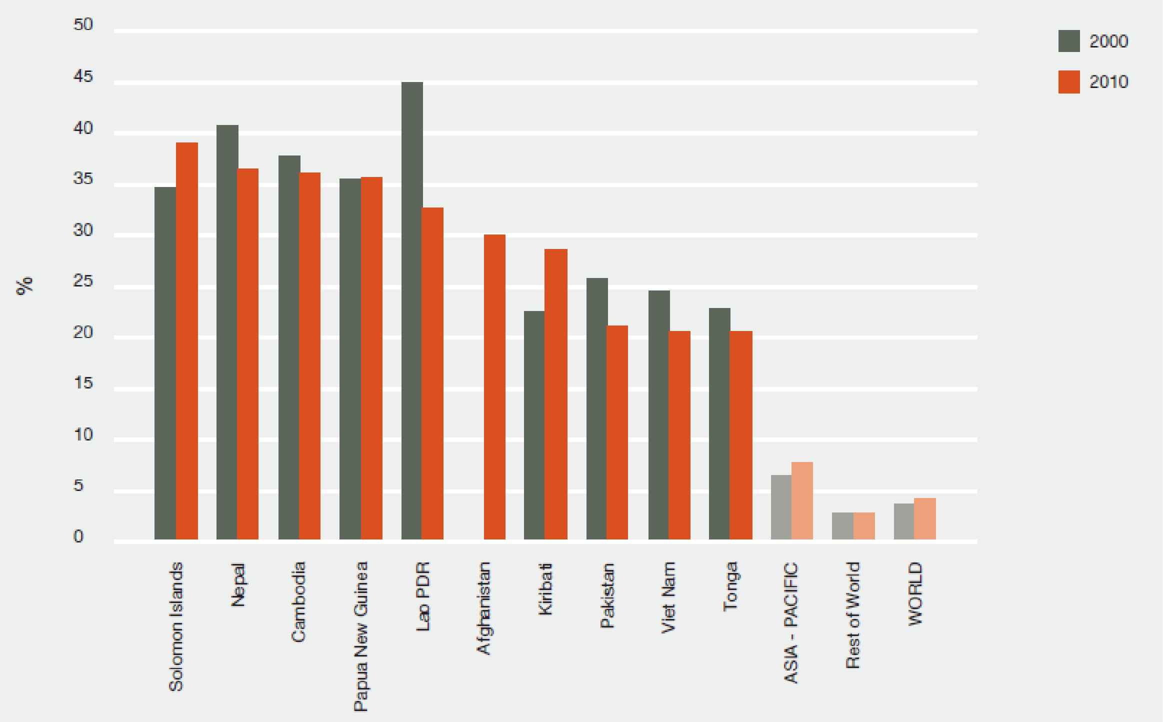

Figure 4.14 Countries in the Asia-Pacific region with largest share of agriculture in GDP in 2010. Source: FAO (2012).

Although the share of agriculture in GDP of developing Asia-Pacific countries is generally decreasing (Figure 4.14) (World Bank, 2018), the area of land used for agriculture in the Asia-Pacific region has increased enormously due to the increased demands resulted from demographic growth, economic development, intensified agriculture and urbanization. These in turn have brought various impacts on biodiversity and ecosystem services (see 4.1.1; 4.1.2; 4.2.1; 4.2.2; Figure 4.15). During the 10 years' from 1999 to 2009, rapid increases in the percentage of land devoted to agriculture occurred in most countries of South-East Asia (FAO, 2012), where extensive agricultural lands are used for the palm plantation for bio-fuel production (Wicke *et al.*, 2011) and fast-growing tree plantation for pulp and paper industry (Squires, 2014).

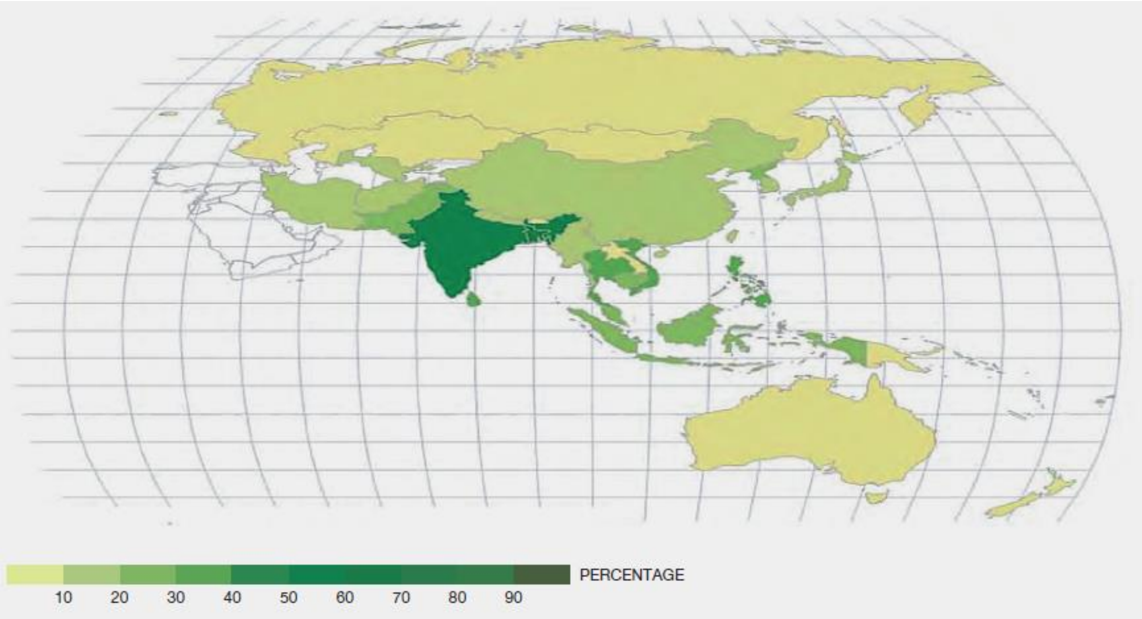

Figure 4.15 Agricultural land as percentage of total land in the Asia-Pacific region in 2009. Source: FAO (2012).

In the Asia-Pacific region, aquatic environments provide substantial food resources although some species are harvested for other economic returns (e.g. oysters producing pearls for jewellery). Seafood is globally recognised as an important source of protein and healthy fats and has been exploited for thousands of years in many Asia-Pacific countries. Many indigenous cultures have fished sustainably and are still reflected in some current fishing practices. In the Philippines, for instance, the traditional fishing practices have been used by Tagbanua people to maintain fish populations. Fishing specific species is only allowed during certain times of the year for the purpose of replenishing fish stocks. Certain areas (e.g. coral reefs) are also set aside as protected spots where fishing is prohibited. In Polynesia, livelihood has mainly relied on the ocean's resources. Traditional methods targeted fish consider sustainable fishing because it targets one fish at a time and results in very little by catch (S. K. Mishra, 2015).

Inland capture fisheries production in the Asia-Pacific region provided 7.5 million tonnes fish production in 2010, making up over two third of the global total (Funge-Smith *et al.*, 2012). China is the top producer with its production representing 34 per cent of the total regional catch (about 2.2 million tonnes in 2008). Enhancement and conservation of inland fisheries resources in many Asian countries has contributed to the increase of inland capture fisheries in last decades (De Silva & Funge-Smith, 2005). However, increasing use of agrochemicals, excessive fertilizer runoff, discharge of untreated municipal solid waste and urban sewage mismanagement are challenging the inland fisheries and aquaculture ecosystems (see 4.1.3; 4.1.4; and 4.4.7; Figure 4.16). The consequences of these pollution are increased biological oxygen demand, poor water oxygen, and eutrophication (Mekong River Commission, 2007; Ramírez, Pringle, & Wantzen, 2008). As global aquaculture production has increased in recent years, so have concerns around food safety, quality and environmental sustainability. New technologies are required to ensure a balance between fish nutrition, human health and environmental sustainability (Hixson 2014).

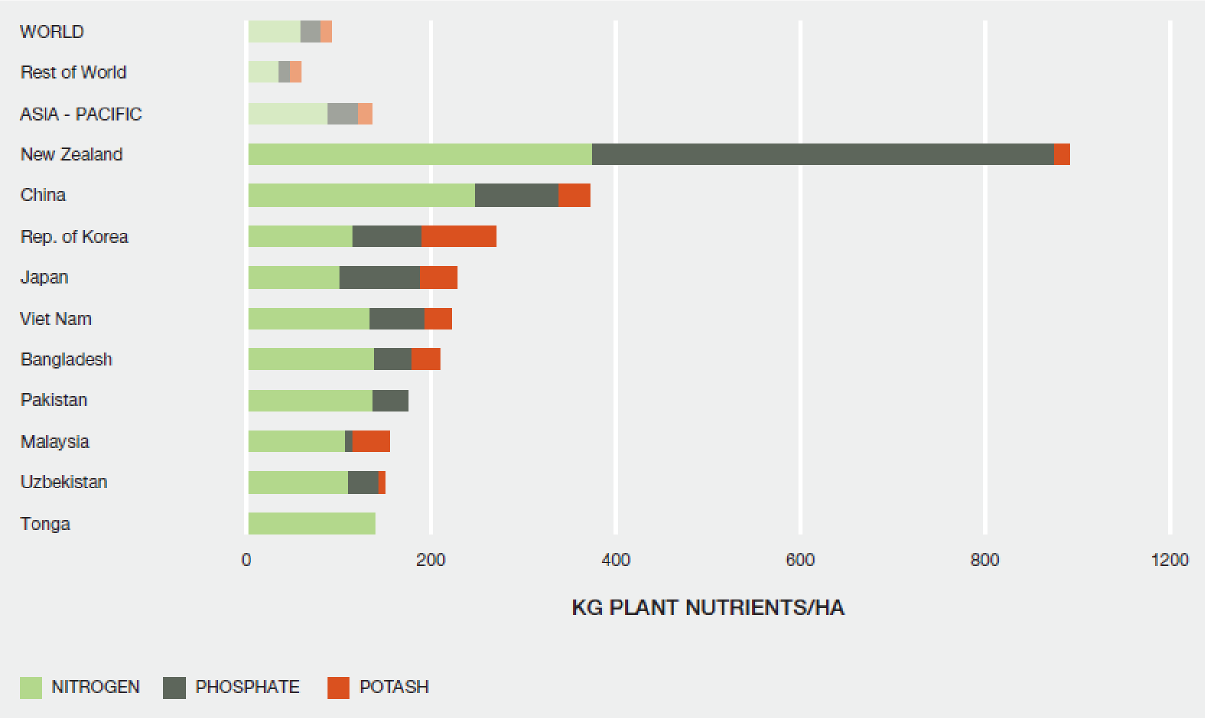

Figure 4.16 Counties in the Asia-Pacific region with most input (mineral fertilizers) intensive agriculture in 2009. Source: FAO (2012).

Pest control is often regarded as an important practice for increasing agriculture productivity and human well-being. However, pesticides and other control measures also impact on non-target organisms. Pest management is a significant ongoing cost to both conservation and the agricultural sector (Biosecurity New Zealand, 2009). Agro-ecosystems are vulnerable to new pests in New Zealand, thus biosecurity control at the border is very strong, for example, control on fruit flies (Ministry of Agriculture and Forestry New Zealand, 2015). Biosecurity measures to prevent impacts on Australian agro-ecosystems are also strong (section 4.1.4). In semi-arid and arid grazing ecosystems, *Prosopis juliflora* (CABI, 2017b) and *Vachellia nilotica* (CABI, 2017a) have spread rapidly since their introduction as a fuelwood/fodder species during the 1950's from India to Indonesia to Australia where coverage is expected to continue to massively increase with high associated agricultural and environmental impacts (Kriticos *et al*. 2005; Adhikari *et al*, 2015). Invasive species compete for the pool of nutrients and water alongside native biodiversity (Peh, 2010; see 4.1.5). As such, pest control might have co-benefits for biodiversity conservation: for example, possums in New Zealand pose a threat to cattle because they can carry bovine tuberculosis. The pest control of possum for economic reasons to reduce Tuberculosis (TB) also has biodiversity benefits in indigenous forests (Animal Health Board, 2007).

Agro-ecosystem sector in the Asia-Pacific region has already become a major contributor in the greenhouse gases emission. For example, in New Zealand about half its greenhouse gases emission budget came from the agricultural sector based on an inventory in 1990-2013 (New Zealand Ministry for the Environment, 2015). However, there are potentially some positive impacts of climate change on primary production (through the so-called CO_2 fertilization effect) but these are then offset by the changes in the hydrological cycle, greater risk of increased distribution of pests and diseases, and increasingly frequent and extreme events such as floods, droughts and storms, all of which could damage agricultural production and indigenous biodiversity (New Zealand Ministry for the Environment, 2016).

4.4.6 Urban and semi-urban ecosystems

Urbanization is a complex and multidimensional process that concentrates large numbers of people in relatively small areas, with substantial implications for land use patterns (Elmqvist *et al.*, 2013). The growth rate of urban area over the recent three decades (1970-2000) remains high in Asia, especially in China and India, but has declined in Oceania as well as Europe and North America (Seto *et al.*, 2011). Urban agglomerations in East and South-East Asia has still expanded with over 22 per cent increase in urban land area from 2000 to 2010, and those in China (particularly the Pearl River Delta, Yangtze River Delta and Beijing) have experienced large urban expansion (Schneider & Mertes, 2014) with mainly by occupying cropland (M. Xu *et al.*, 2016). Apart from on-going physical expansion, urban land-use change is predominantly characterized by peri-urbanization (Lee, Ahern & Yeh, 2015) where rural areas both close to and distant from city centres become enveloped by, or transformed into, extended metropolitan regions (Aguilar, Wa rd, & Smith Sr, 2003; Simon, McGregor & Nsiah-Gyabaah, 2004). This produces a complex mosaic of traditional and modern land uses and associated governance systems (Elmqvist *et al.*, 2013; Holt *et al.*, 2015).

With the urbanizing process in the world, sustainable development of cities is being increasingly challenged, particularly in the emergent Asia-Pacific countries where the pace of urbanization is fastest (UNDESA, 2015c, 2015b). Urban expansion thus is becoming one of the most influential drivers for loss of biodiversity and degradation of semi- and natural ecosystems. In addition, the process and pattern of urban ecosystem growth are also impacted by various driving forces which characterize the newly emerged urban ecosystems and their services (Müller, Ignatieva, & Nilon, 2013).

4.4.6.1 Habitat modification

Urban expansion involves the conversion of adjacent agricultural lands, pastures and forests to urban lands (Seto *et al.*, 2013). In the case of Monsoon Asia, this conversion has lead to a massive loss of croplands especially rice paddy fields (Deng *et al*., 2009; Kontgis *et al*., 2014; Quan *et al*., 2015; Song, Pijanowski, & Tayyebi, 2015; Zhang, 2000). Loss of farmlands within and surrounding urban area is likely to threaten sustainable food supply in cities because food production from urban and peri-urban agriculture has an important role for urban food security (Gómez-Baggethun *et al.*, 2013) and as income source for urban poor (Orsini *et al.*, 2013). The role of these food supply areas becomes even more important during economic and political crisis, as revealed that peri-urban agriculture supported urban resilience during Asian economic crisis in the Jabodetabek Metropolitan Area, Indonesia (Pribadi & Pauleit, 2015).

In many Asian countries, urban expansion into already densely populated rural areas is the most prominent form of unprecedented rapid growth (Seto *et al.*, 2013). Consequently areas with a chaotic mixture of agricultural, urban and industrial land uses, so-called “desakota” (McGee, 1991), a combination of Indonesian words “desa” (village) and “kota” (city or town), have emerged and grown, and characterize peri-urban landscapes of Asia (Sui & Zeng, 2001). Rapid and unplanned change of land uses, economic activities and socio-cultural livelihoods in the “desakota” areas pose serious socio-political challenges for both urban and rural development (McGranahan *et al.*, 2004).

In the process of urbanization, native habitat has been replaced by managed habitat and impervious surfaces. Many studies from the Asia-Pacific region reveal that fragmentation and loss of natural habitat are the main cause of extinctions of native flora and fauna (Ramalho, Laliberté, Poot, & Hobbs, 2014; Sudhira & Nagendra, 2013; Tan & Hamid, 2014). As urbanization progresses towards the remote areas of the Asia-Pacific region, more and more biodiversity hotspots are likely to be affected (Seto *et al.*, 2011). Some protected areas with their endemic flora and fauna will thus be threatened by urban expansion (Mcdonald *et al.*, 2008). It has been predicted that by 2030, new urban expansion will take over an additional 1.8 per cent of all biodiversity hotspots (Seto *et al.*, 2012) and about 90 percent of the protected areas are likely to be affected by rapid urbanization in the rapidly developing subregions or countries (Mcdonald *et al.*, 2008).

Ecosystems in urban areas need to be large enough to maintain ecosystem functions and services; large urban vegetation remnants can also be resistant to invasion by exotic plants (Teo *et al.*, 2003). Examples of large urban habitats in the Asia-Pacific region include the Bukit Timah Nature Reserve in Singapore, Riccarton Bush in Christchurch, natural bush remnants in Australian cities such as Perth, Sydney and Brisbane, and the Ridge Forest in New Delhi (Müller *et al.*, 2013). Smaller remnants left following ecosystem fragmentation have also been found to provide important habitat if these are sufficiently large and close enough to more substantial remnants. Studies show that small remnants ranging from tropical to temperate cities of the Asia-Pacific region can support a range of native species such as plants including epiphytes, birds, mammals, reptiles, amphibians, ground beetles and butterflies from tropical to temperate cities of the Asia-Pacific region (Bickford *et al.*, 2010; Garden *et al.*, 2010; Izuddin & Webb, 2015; Kim *et al.*, 2007; Koh & Sodhi, 2004; Ramalho *et al.*, 2014; Shanahan *et al.*, 2011; Soga & Koike, 2013; Watts & Larivière, 2004). However, there is limited information on the response of species to urbanization in rapidly growing cities in South, South-East Asia, and Western Asia in semi- and arid environments to determine whether these are responding in a similar manner to species in other climate zones (Chace & Walsh, 2006).

Artificial urban green spaces such as public parks, street trees, and even private gardens can also help to enrich urban biodiversity of native species (Doody *et al.*, 2010; Luck *et al.*, 2013). The combined actions of city-level management strategies and decisions for creating and distributing public open spaces across a city (top-down), and integrated outcomes of individual- and household-scale choices or actions (bottom-up) approaches for improving a matrix part of fragmented landscapes are necessary to create habitat mosaic and species distribution in urban ecosystems (Kinzig *et al.*, 2005; Müller *et al.*, 2013).

4.4.6.2 Invasive alien species

Urban and infrastructure expansion provides the opportunities for invasive alien species due to the increasing rate of introduction events and the disturbed areas for alien species established (Secretariat of the Convention on Biological Diversity, 2012). A cause of increasing non-native species in urban ecosystems is species introduction through human mediated activities and consequent naturalization.

Although not all introduced species become invasive to semi- and natural habitats within and surrounding urban ecosystems, many plant invaders originate from ornamental and greening materials introduced intentionally for aesthetic purposes (Mack & Lonsdale, 2001). In addition, such introduced species can lead to intra- and inter-specific hybridization, which often proceeds to the evolution of invasiveness (Schierenbeck & Ellstrand, 2009). Accidental introduction of non-native species in urban ecosystems also occurs frequently because cities are centres of trade, traffic and horticulture (Kowarik, 2011). The majority of invasive insects and some of worst vertebrate invaders have been accidently introduced (Mack *et al*., 2000).

Since the aforementioned habitat modification promotes increase of non-native species and decline of native species, it is difficult to distinguish whether invasive alien species are direct causes of native species loss in urban ecosystems, or just 'passengers' riding on urban environments (Didham *et al*., 2005). In the case of the common myna bird (*Acridotheres tristis*), one of world's worst invasive species in Australian urban environments, both habitat modification and high abundance of the bird affect native bird species (Grarock *et al*., 2014). The other case of a harmful invasive hornet (*Vespa velutina*) in South Korea also shows the interactive effects, indicating that urban area provides a suitable habitat for the hornet likely causing displacement of native Vespa species (Choi *et al.*, 2012). Conservation management for urban native species thus needs context-dependent solutions by integrating habitat restoration and invasive species control based on deep understanding the mechanisms of biodiversity loss (Didham *et al*., 2007). Another key threat to urban areas are tramp ants; exotic ants spread mainly in soil mainly from the America's that form super colonies and bite or sting residents, kill native fauna, but also affect agriculture and infrastructure (*https://soe.environment.gov.au*). In Australia, where 31 exotic species have naturalised, fire ants have established in the Brisbane metropolitan area, and eradication program has been underway for many years with over $400 million since 2001 and another $400 million budgeted has been agreed to try and complete the task over the next 10 years (Magee *et al.*, 2016). Tramp ants prose and increasing threat to the Asia-Pacific region, but eradication early in establishment is possible (https://soe.environment.gov.au).

Finally perhaps the most impactful invasive species are exotic mosquitos uniquely adapted to living in human communities from urban, peri-urban to rural. Species like *Aedes aegypti* the dengue mosquito and *Aedes albapictus* the Asian tiger mosquito are endemic now in many areas and spreading into others bringing with them the threats of human disease outbreaks like dengue fever, Japanese encephalitis and chikungunya throughout the region, these pose significant risks to all members of the community but will likely have greatest impacts on isolated indigenous communities (WHO, 2014).

4.4.6.3 Climate change and hazards

Urbanization and associated infrastructure modifies local and regional climate through urban heat island effect, changes of precipitation pattern, and impacts to atmospheric cycle and quality (ADB, 2017; Ren, 2015; Solecki and Marcotullio, 2013). At the same time, urbanization contributes to global climate change with no less than 40 per cent of greenhouse gas emissions (Rosenzweig *et al.*, 2011), caused by not only increasing anthropogenic emissions in the energy and transportation sectors particularly (Marcotullio *et al.*, 2013) , but also reducing net primary productivity (NPP) by converting vegetation covers.

Urban expansion along coasts increases exposure levels of urban peoples to hazards (ADB, 2017; de Sherbinin, Schiller, *et al.*, 2007). In South, South-East and North-East Asia as well as Europe more than a quarter of the global population lives near coasts where the most densely populated areas are found (Small & Nicholls, 2003). Many cities in the Asia-Pacific region located in coastal lowland are vulnerable to extreme events or meteorological hazards such as tsunamis, cyclones/typhoons, intense storm surges and flooding regardless to country's wealth level (Seto *et al*., 2013; Romero-Lankao & Dodman, 2011; Solecki & Marcotullio, 2013).

Drawing on the inevitable natural hazards exacerbated by anthropogenic activities, actions for disaster risk reduction together with climate change adaptation in cities are given much attention (Solecki *et al.*, 2011). There is a new emerged vision in risk management and vulnerability reduction based on wise combinations in the use of built infrastructure and ecological infrastructure, capturing roles of water and vegetation within and around urban areas in delivering various ecosystem services (Gómez-Baggethun *et al.*, 2013). An incidence of the 2004 Indian Ocean Tsunami revealed that ecological infrastructure formed by mangroves and other coastal vegetation in front of settlements drastically reduced the damage (Danielsen *et al.*, 2005). In order to achieve sustainable and effective coastal risk management, Laso Bayas *et al*. (2011) emphasizes protecting coastal vegetation should be regarded as an important livelihood provider rather than just as a bio-shield.

4.4.6.4 Socio-economic change

Economic factors (e.g. rapid industrialization, expanding industry parks, and intensifying process bases) are responsible for a large percentage of urban expansion in rapid urbanizing countries such as China and India together with demographic factors (Seto *et al*., 2011) (see the sections 4.2.1 for urban population changes). At the national level, there is positive and high correlation between proportion of urban population and economic status such as gross national income (GNI) and gross domestic product (GDP), but the causal relationship between the two is likely bidirectional (Tacoli *et al.*, 2015; UNDESA, 2015d). Although it is true that urbanization can lead to economic growth under favourable conditions, it is still uncertain whether rapid urban population growth contributes to the rate of economic growth (Bloom *et al*., 2008; UNDESA, 2015d).

In pursuit of advantages obtained from external economies of scale or agglomeration economies, continuous concentrations of population and economic activities in cities likely occur (Tacoli *et al.*, 2015); consequently urban area expands. Many case studies in Asia reveal that inflows of foreign direct investment in industrial and service sectors. The resultant off- and on-farm wage disparity becomes a strong driver promoting land conversion from agricultural to urban uses (Quan *et al*., 2015; Seto & Kaufmann, 2003; Seto, 2005; Sit & Yang, 1997). The presence of agglomeration forces can be observed in the Pearl River Delta, China, and Bangalore, India (Seto *et al.*, 2010). However, urbanization forced by agglomeration economies does not always contribute to economic growth, because the benefits are often overtaken by negative externalities such as congestion, insufficient public infrastructure, pollution, and unaffordable increase of living cost, which tend to increase along haphazard urban expansion (Turok & McGranahan, 2013).

Environmental sustainability is challenged by rapid urbanization and result changes in consumption patterns and increased energy and water demands. Changes in lifestyles and consumption patterns associated with urbanization will especially increase energy and water demands (Hubacek *et al*., 2009). Today urban areas consume over two-thirds of the world's energy and contribute up to 70 per cent of greenhouse gas emissions globally (World Bank, 2010). Low-density urban areas tend to consume more than high-density areas (UNDESA, 2015c).

4.4.6.5 Governance

Spatial planning of land uses and infrastructure building is a potential determinant to manage growth rate, scale, and pattern of urbanization. However, there has been few case succeeded controlling and orienting urban growth, because of inadequate human, technical and financial resources, and top-down and non-adaptive planning (Huang *et al*., 2010; Seto *et al*., 2010; Hammer *et al*., 2011). Urban containment policies and often urban growth management measures have been practiced primarily in Europe (Kühn, 2003). Of these policies, greenbelts limiting urban sprawl physically by protecting open green spaces around a city were applied to Asian mega-cities such as Tokyo, Seoul, Hong Kong and Bangkok, and also to Melbourne, but many studies reveal difficulties to control urban growth even using the restrict land governance (Bengston & Youn, 2006; Buxton & Goodman, 2003; Tang *et al*., 2007; Yokohari *et al*., 2000). Given the rapid growth and the nature of urbanization process toward rural areas in most Asian cities, a planning concept respecting the mixture and linking the functions of urban and rural land uses with those of biodiversity and ecosystem services would be necessary for achieving sustainable urban growth (Yokohari *et al.*, 2000).

Policies limiting rural to urban migration to manage haphazard urbanization is known to have little effects on controlling urban growth rate (McDonald *et al.*, 2013; Rondinelli, 1991). Restrictions have a negative impact on the migrants' livelihoods and on economic growth (Bloom *et al.*, 2008; Tacoli *et al.*, 2015). Turok & McGranahan (2013) summarized that removing barriers to rural–urban mobility may enable economic growth along with supportive policies, markets and infrastructure investments. In India, for example, divergent economic growth at the district level is attributed to differences in public infrastructure such as electricity supply, transportation policies, education, labour laws and state's border policies to control interstate migration (Das *et al.*, 2015).

4.4.7 Inland Fresh water and wetlands

The livelihood, food security, economic and cultural activities of millions of people in the Asia-Pacific region is dependent upon the health of inland freshwater and wetlands, leading to water security challenges. According to the Asian Development Bank, water security can be defined by five key dimensions including household, economic, urban, environmental, and resilience to water-related disasters (ADB, 2016). Advanced economies in the Asia-Pacific region like Australia, Japan and New Zealand followed by almost the whole North-East Asia have strengthened water security in the past decades. The remaining regions show mixed performance across the key dimensions of water security index, with South Asia more challenged with slow progress in household, urban, environmental and resilience water security (ADB, 2016).

Several studies highlight that the biodiversity of freshwater wetlands of Asia is rich with several endemic species which are threatened (Allen *et al.*, 2010; 2012; Garcia *et al*., 2015; Molur *et al*., 2011). It is reported that human activities including anthropogenic climate change are direct threat to the freshwater ecosystems across the world (Vörösmarty, 2010). The major threats to freshwater biodiversity are broadly grouped under five interacting categories as overexploitation, water pollution, flow modification, destruction or degradation of habitat, and biological invasion (Dudgeon *et al.*, 2006; Finlayson *et al.*, 2005).

These drivers of freshwater biodiversity loss operate at various spatial scales. For example, in the Western Ghats of India, pollution, unsustainable harvest of biological resources, urban and agricultural development, invasive species, dams and mines are identified as important drivers (Molur *et al.*, 2011). Similarly, in the Eastern Himalaya hydropower and irrigation dams, deforestation, siltation, unsustainable use of biodiversity resources and pollution are identified as significant drivers (D. J. Allen *et al.*, 2012). In the Arabian Peninsula, habitat loss, degradation, flow modification, changes in flow regime, over abstraction, pollution, climate change, and alien invasive species are reported as important drivers of freshwater biodiversity loss (Garcia *et al*., 2015).

4.4.7.1 Changes in land use and land cover

Urbanization is known to have detrimental effects on waterways by increasing catchment imperviousness, increasing toxic pollution, degrading both hydrology and stream biota (Braimoh *et al*., 2010; Davies *et al*., 2010; Tippler *et al*., 2012) but also putting pressure on fresh water for meeting water demand of a growing population such as in India (Bassi *et al*., 2014). This is also posing serious human health threats due to contamination of drinking water sources in many South and South-East Asian countries (e.g. in Vietnam) (Berg *et al.*, 2001). Many wetland borders have been changed due to pressures from rapid urbanization and industrialization (Secretariat of the Convention on Biological Diversity, 2012).

There is escalating pressure on freshwater systems as agriculture expands to increase food security and eradicate hunger (Hunsberger & Evans, 2012) (Figure 4.17), and water demand across the region is projected to more than double by 2050 (UNEP, 2016a). Water requirements for agriculture are high, and account for up to 90 per cent of total withdrawals in South and South-East Asia. Energy is the next sector highly demanding in water, especially for oil, (with water demand expected to increase by 2.1 per cent for the next 25 years), nuclear, coal thermal plants and bioethanol production (UNEP, 2016a). It is estimated that some 5,000 km^2 of Indian wetlands are lost each year to agriculture, dams and other uses (Bassi *et al.*, 2014) while some 27 per cent of Asian peatlands have been drained for intensive agriculture (Finlayson *et al.*, 2005). Demand for food production has impacted on freshwater system, as it led to the drainage of natural swamp areas in China (23 per cent of freshwater swamp lost) (An *et al.*, 2007), New Zealand (90 per cent freshwater wetland lost) (Ausseil *et al.*, 2011), South-East Asia (peat swamp converted for oil palm production), and India (Bassi *et al.*, 2014). A recent index based on wetland extent trend showed a consistent decline that all Ramsar sites with 39 per cent decline in Asia and 17 per cent decline in Oceania (Dixon *et al.*, 2016). This has consequences for ecosystem services, in particular carbon emissions (e.g. South-East Asia) and loss of carbon storage (An *et al.*, 2007), reduction in water storage capacity (China, 8.5 per cent of total storage lost) (An *et al.*, 2007), loss in water purification capacity (China 151 per cent of Total Nitrogen and 64 per cent of Total Phosphorus discharge in 2000) (An *et al.*, 2007). Conversion of peatlands to agriculture has been important source of atmospheric carbon through peat oxidisation in South-East Asia (Settele *et al.*, 2014) (incl. Chapter 4 Hooijer *et al.*, 2010; Limpens *et al.*, 2008), leading to irreversible changes in peat systems (FooYuen *et al.*, 2016). In South-East Asia decreased dry season precipitation and longer dry seasons are predicted to lower water tables and increase fire risk (incl. Chapter 4 Frolking *et al.*, 2011; Li *et al.*, 2007; Rieley *et al.*, 2008; Settele *et al.*, 2014).

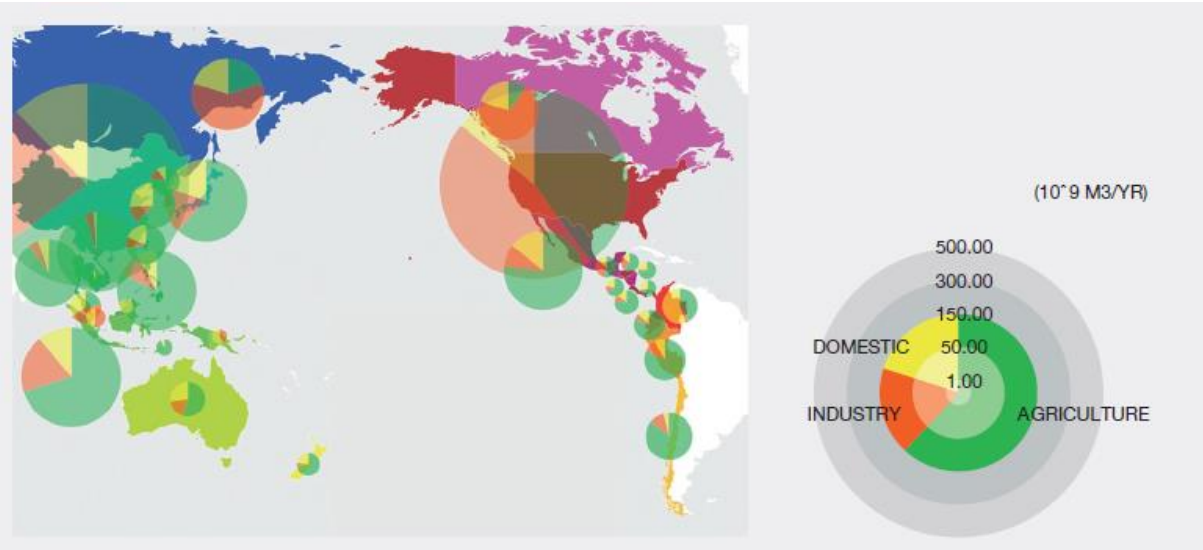

Figure 4.17 Water consumption for agriculture, industry and domestic sectors in 2010. Source: Taniguchi *et al.* (2017).

4.4.7.2 Physical modification

Increased pumping of groundwater to meet agricultural and urban demand (e.g. eastern India) is impacting on wetland condition with many wetlands now lost through urban sprawl (Bassi *et al.*, 2014). Increased use of groundwater for agriculture in eastern Indian (West Bengal) may add further pressure to wetlands in this region particularly as they are generally fed by shallow aquifers (Bassi *et al.*, 2014). More than 50 per cent of Australian floodplain wetlands on developed rivers no longer flood with dams, diversions and river management impacting on wetland ecology, resulting in degradation and invasion by exotic species (Kingsford, 2000; Whalley, Price, Macdonald, & Berney, 2011). Water diversion has had major impacts on high conservation wetlands, for example the Mesopotamian marshlands in Iraq, where only 3 per cent remained in 2000 (Finlayson *et al.*, 2005; Partow, 2001). However recent policy changes have partly reversed this trend with a current 45 per cent of its original extent. Challenges remain as to satisfy competing interests and influence drivers of change (water diversion, urbanization, climate change) (United Nations Integrated Water Task Force for Iraq, 2011). Another example is the Murray-Darling basin in Australia. Prolonged drought events in recent years combined with upstream diversion of water dropped the water levels of the lake below sea level, exposing hazardous acid sulphate soils and impacting on local flora and fauna (Kingsford *et al*., 2011). In Singapore land use change like canalization causes the loss of 11 native fish species (Giam *et al*., 2011).

Dams have been built on rivers to meet the needs of irrigation or electricity generation (Acreman, 2012). Consequently, the continuity of a stream is blocked and the flow regimes are modified. Combined with water extractions, smoothing has reduced the total volume of flows, thereby reducing the seasonality, frequency and duration of wet and dry cycles. These alterations change the natural flows of material and energy (Tonkin, Death, & Joy, 2009), and further have profoundly affected basin ecology, including loss or alteration of services; blocking the migration routes used by fish; decline in extent and condition of vegetation on floodplains (Baran and Myschowoda, 2009); decline in the abundance and diversity of native fishes, invertebrates and water birds; reduction in water quality; and invasions of non-native species (Morton *et al.*, 2014), increasing sediment supply to the sea (Yang *et al*., 2005). Large reservoirs are believed to likely reduce freshwater biodiversity. For instance, the construction of dams on the Mekong not only has already affected river ecosystem (Dudgeon, 2011; Dudgeon *et al.*, 2006), but those planned dams are likely to reduce fish biomass by 20 per cent, with 0.7 to 1.6 million tonnes per year of migratory fish resource likely to be at risk (Barlow *et al.*, 2008). It is projected that migratory fish biomass may decline up to 70 per cent if all planned projects are completed (Ziv *et al*., 2011; Welcomme *et al*., 2015).

The Asian region has the greatest number of dams in the world (Hughes, 2017). Most major Indian river basins have also been converted to meet growing water demands (Bassi *et al.*, 2014), which changed the native riparian ecosystems. These modification leads to increase in artificial wetlands (e.g. 122 per cent in China) for water storage (Russi *et al.*, 2013). Impoundments and dams are the major root cause of aquatic biodiversity loss and has major effect on upstream and downstream species in South and South-East Asian countries (Ferguson *et al*., 2011; Baran and Myschowoda, 2009; Baran, 2010; Jutagate *et al*., 2001). The presence of dams alters the habitat conditions in a stream and prevent migratory fish from completing their natural lifecycle due to the blockage of movement (Dauble *et al*., 2003; Baran and Myschowoda, 2009). These structures have hindered the passage of fish to feeding, spawning, or sheltering habitats and diminished their ability to recolonize after droughts or high flows (Morton *et al.*, 2014). Dam building in the Indian Himalayan basins is predicted to impact on dense forest ecosystems including 54,117 hectare would be submerged and 114,361 hectare damaged by dam-related activities (Pandit & Grumbine, 2012). Habitat fragmentation occurs when weirs, dams, pipes, regulators and irrigation diversions prevent dispersal or access to breeding habitats.

4.4.7.3 Invasive alien species

Invasive alien species affect freshwater biodiversity via competition, physical dominance predation, introduction of pathogens, and hybridization (Welcomme & Vidthayanom, 2003). It may also affect alteration of flows, seasonality of flows, reduction or loss of hydrological benefits of wetland function and effects downstream across international borders (Howard, 2004). In Japan, invasion of piscivore fish from North America leads to a substantial decline in lake fishery (Matsuzaki & Kadoya, 2015). In New Zealand, the introduction of trout has benefited tourism with New Zealand becoming one of the most well-known trout fishing destination (Matsuzaki & Kadoya, 2015). However, recent reviews are showing a reduction in native fish population that has now to be considered for future conservation actions (McIntosh *et al.*, 2010). Introduced invasive fish and a number of globally important aquatic weeds cause significant environmental (biodiversity loss) and social (navigation and fishing) impacts across the major river systems of the Asia-Pacific region. In Australia eastern gambusia is threatening several species of native frogs and fish. Many aquatic weeds have been targets of successful weed biological control programs as aquatic weed biological control has been more successful than the control of terrestrial weeds (Forno & Julien, 2000).

4.4.7.4 Pollution

Freshwater systems in the Asia-Pacific region are mainly affected by pathogens, suspended solids, eutrophication pesticides, and salinization issues. A river health index analysis developed by Asian Development Bank showed a high disparity between Asia-Pacific countries, with relatively high scores for countries such as Australia and New Zealand compared to India and China (ADB, 2016). Changes were small between 2013 and 2016 although tending to decline (especially around the lower Yangtze River, Northern Vietnam and Southern Mekong Delta) due to agricultural intensification, and ongoing economic development (Figure 4.18).

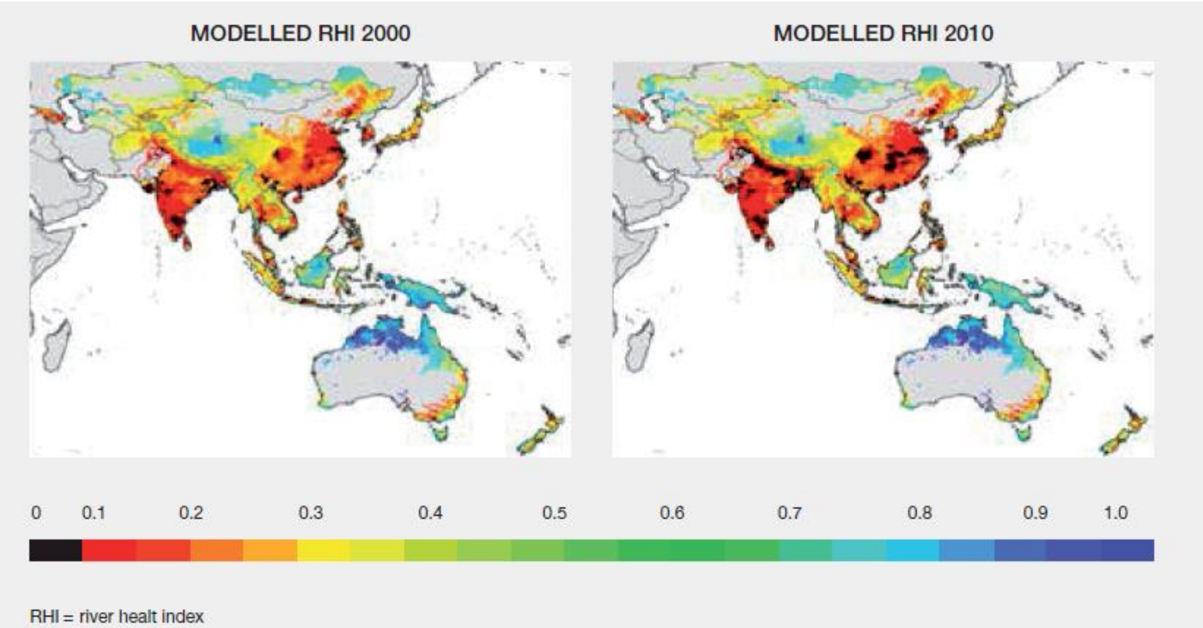

Figure 4.18 Modelled river health index for Asia-Pacific region. Source: ADB (2016).

Causes for freshwater pollution are multiple. Pathogen contamination affects human health and basic sanitation for many developing countries is necessary to progress on such pollution, especially in South Asia (UNEP, 2012b). Eutrophication resulted from excessive nutrient pollution causes hypoxic conditions and dead zones in coastal areas. The increase in fertiliser use and untreated wastewater in South Asia has led to eutrophication of surface water bodies (Bassi *et al*., 2014). In Japanese agricultural ponds, eutrophication was the most influential driver of aquatic biodiversity loss along with invasive piscivore fish (bluegill) and concrete bank construction (Kadoya *et al*., 2011). Pesticide use increase (see 4.1.3.3) is affecting water security in the Asia-Pacific region. For instance, mussels from Cambodia, China, India, Indonesia, Japan, Korea, Malaysia, Philippines, and Vietnam were reportedly contaminated with PCBs (Polychlorinated Biphenyls), DDTs (Dichlorodiphenyltrichloroethanes), PBDEs (Polybrominated Diphenyl Ethers), synthetic musk and benzotriazole UV stabilizers (Nakata *et al.*, 2012).

Salinization is another emerging threat across Asia-Pacific region due to increasing human activities. Biota have tolerances to salinity levels so further increases in salinization will likely also impact biodiversity and the provisioning of ecosystem services. Causes for salinization are multiple, and include decrease in freshwater flows (e.g. Yellow River, China), storm discharges and river channel modifications (e.g. Mekong River Delta, Vietnam), sea-level rise, land clearing, irrigation and rising saline groundwater (e.g. Murray-Darling Basin, Australia) (Herbert *et al.*, 2015). Salinization is expected to increase due to a combination of climate change (Mosley, 2015) and human alterations of the hydrologic cycle (Herbert *et al*., 2015).

4.4.7.5 Climate change and hazards

Climate change is profoundly affecting the region's aquatic biodiversity, water resources, and economy, all of which in turn impacts the region's people. Main issues related to climate change on freshwater resources are related to elevated ecosystems, flooding, cyclones, and droughts (UNEP, 2016a), with implications for both fisheries (Sriskanthan & Funge-Smith, 2011) and water security.

Melting of glaciers and snow due to climate change is likely to lead to great changes in water supply, with the Himalayan region a particularly important source for many of Asia's largest rivers (Zhao *et al*., 2016; Lutz *et al*., 2014; Gopal, 2013). Projections over the medium term (up to 2050), suggest rivers are likely to experience increased run off from increased precipitation and melting glaciers, leading to increased risk from natural hazards (Lutz *et al.*, 2014), including glacial lake outburst floods (Nie, Liu & Liu, 2013). Recent work has highlighted the glacial area of the Tibetan Plateau has shrunk significantly over the past 20 years (Editorial Committee of the Third National Assessment Report on Climate Change, 2016; Racoviteanu *et al*., 2015), with the largest losses in the Himalayas (Yao *et al.*, 2012). New Zealand's glaciers are also retreating with the 11 per cent decrease in ice volume reported between 1977 and 2005. Recent glacial retreat has caused an increase of over 5.5 per cent in river runoff from the Tibetan Plateau (Zhang, Liu, Xu & Shangguan, 2008), and resulted in rising lake levels in the Hindu Kush Himalayan region (Yao *et al*., 2007; Nie, Liu & Liu, 2013) which is leading to a high potential risk for outburst floods (ADB, 2017).

Flooding hazards are likely to change due to climate change with noticeable differences at the subregional level. South, South-East, and North-East Asia are projected to have increased flood frequency and runoffs by the end of the 21st century, while Western Asia might have decreased runoffs (ADB, 2017). The probability of flooding is also related to global atmospheric cycles such as El Niño or La Niña phases (P. J. Ward *et al.*, 2014). In the Asia-Pacific region, higher flood volumes were observed during historical El Niño years, in Bangladesh and Papua New Guinea, and lower flood volume in regions such as central north China and Pakistan (P. J. Ward *et al.*, 2014). By contrast, South-East Asia is more likely to be affected by flooding due to tropical storms during La Niña years (Lim *et al.*, 2012). These flood risks are important to understand for future management, especially in the Asia-Pacific region where 75 per cent of population exposed to floods are located, with the highest proportion of people and assets in Cambodia, Bangladesh and Vietnam (ADB, 2017). Floods and tropical cyclones may also exacerbate the impact of saltwater intrusion on water supply and increase risks to aquaculture and freshwater fisheries (Macusi *et al.*, 2015).

Water systems in the Asia-Pacific region have been impacted by droughts, thus impacting on livelihoods, e.g. Afghanistan (Bhattacharya *et al.*, 2004). Risks of drought are expected to increase in parts of South Asia, particularly part of India, Pakistan and Afghanistan (Vinke *et al.*, 2017), posing serious threats to water access, water quality (Mosley, 2015) and human health. Drought frequency consequently increase the risks in fire, that have already destroyed more than 3 out of the 24 million hectares of peatlands in South-East Asia between 1997 and 2005 (Braimoh *et al*., 2010), notably in Indonesia (Gopal, 2013). In the Pacific Islands, freshwater resources will likely be under threat with climate change, as for example a 10 per cent reduction in average rainfall could reduce the freshwater lens on Tarawa (Kiribati) by 20 per cent, with sea-level rise potentially reducing the lens to a further 29 per cent (UNEP, 2011a).

4.4.7.6 Governance and policies

Lack of appropriate government policies impedes proper protection of freshwater ecosystems. However, some local initiatives are noticeable across Asia-Pacific region. In New Zealand, the extent of current wetlands protected in conservation land has increased from 48 per cent to 60 per cent in the last 20 years although this still represents only 6 per cent of the historical extent (Robertson, 2016). Restoration projects in Japan are increasing, with exponential initiatives to restore rivers with the River Law to increase flood control and conserve aquatic ecosystems (Nakamura *et al.*, 2006). In India, in addition to several wetland protected areas, a formal system of conservation of wetlands and regulation of certain activities is being carried out through enactment of Wetland Conservation and Management Rules 2010 and implementing National Wetland Conservation Programme (MoEFCC, India).

Peat soil erosion from degraded and drained peatlands in Indonesia are currently responsible for over 60 per cent of Indonesia’s greenhouse gas emissions (Indonesia’s National Climate Change Council (DNPI, 2010). By restoring the hydrology of these peatlands, emissions from these areas could decrease or even stop, helping Indonesia commit to reducing their greenhouse gas emissions by the year 2020. Some restoration projects have been underway to restore hydrology and ecological functions of drained peatlands, including the Central Kalimantan Peatlands Project from Wetlands International and the current Katingan REDD-plus project(Terra Global Capital, n.d.).

Benefits from wetlands are starting to be recognised for their benefits for public health, leading to an increase impetus to include wetland restoration plans into water resources management (Horwitz & Finlayson, 2011). The Ramsar Convention proposed a revision to record information on ecosystem services for Ramsar wetlands, a significant step forward that recognise benefits wetland provide to people. But progress is still needed as only half of Asia-Pacific wetlands are reporting ecosystem services from Ramsar sites (McInnes *et al.*, 2017). The number of sites designated as Ramsar sites has steadily increased since 1974, although the cumulative protected area has recently slowed down, with a third more area in the Asia-Pacific region in the last 10 years (from 20 to 27 million hectare between 2006 and 2016) (https://rsis.ramsar.org/).

4.4.8 Coastal and marine ecosystems

4.4.8.1 Overexploitation

Mangrove forests cover many shorelines of South and South-East Asia and are an important habitat for the unique biodiversity that thrives in this coastal environment. Mangroves also provide important services and goods to regional populations including food provision such as fish and crabs, coastal protection against storms and flooding, and the mitigation of climate change through the uptake and storage of carbon from the atmosphere. However, mangroves exist in coastal areas where development demand is high and are being highly threatened by land-use change (see 4.1.2; 4.4.1). An estimated 1,140 km^2 of mangroves have been lost between 2000 and 2012 in South-East Asia (Richards *et al.*, 2016), with an average rate of 0.7-3.0 per cent per year (Mcleod *et al.*, 2011). In the Asia-Pacific region mangroves are being increasingly cleared and modified for human uses in many countries including Australia, the Philippines, India and many other areas (Jupiter *et al*., 2007; Lovelock and Ellison, 2007; Millennium Ecosystem Assessment, 2005).

In Asia, more than 50 per cent of mangroves have been lost to support aquaculture, with 40 per cent of mangroves in the Philippines lost to agriculture (Millennium Ecosystem Assessment, 2005). Clear cutting of mangroves may cause a threat to mangrove ecosystems, as the remaining mangrove forests would be under huge pressure from surrounding land-use change, hydrological alterations, pollution and climate change (Blasco *et al.*, 2001). Poor health of mangroves (e.g. top-dying) has also been reported for the Asia-Pacific region (Spalding, Blasco, & Field, 1997). In the Philippines, a change in mangrove and residual forest was reported where mangroves were converted to fish ponds, agriculture lands and build up areas, which further resulted in the loss of biodiversity (APN, 2011). In total the area of mangrove loss in Asia due to clearing for shrimp culture is estimated to be 12,000 km^2, which makes up 41.4 per cent of the total loss of mangrove forests in Asia (Vincelli, 2015).

However, other commodities such as rice were also important causes of change, accounting for 22 per cent of loss in the region, though accounting for 88 per cent of loss in Myanmar. Oil palm is usually a driver associated with terrestrial or freshwater peat swamp loss (Richards *et al.*, 2016) but may be a further under-recognized cause of mangrove loss in South-East Asia (Sandilyan & Kathiresan, 2012). Mangroves are cleared or modified to meet resource and changed land use requirements, and this has resulted in a net loss of mangrove habitat in the Asia-Pacific region. Historically, Australia contributed to that loss in the 1970's to 1990's through significant coastal infrastructure development (S. D. Jupiter *et al.*, 2007; Lovelock & Ellison, 2007; Millennium Ecosystem Assessment, 2005b). However, Australian mangrove habitat has increased in area throughout the 2000's, reflecting their significant expansion into saltmarsh habitats during this time, as well as implementation of better environmental protections and improved remote sensing capability (Kelleway *et al.*, 2015; Montreal Process Implementation Group for Australia, 2008; Rogers *et al.*, 2005; Saintilan *et al.*, 2015) . However, Australian mangrove habitats have increased in area throughout the 2000s, reflecting their significant expansion into saltmarsh habitats during this time, as well as implementation of environmental protections, and improved remote sensing capability (Kelleway *et al.*, 2015; Saintilan *et al.*, 2015) .

Poor fisheries management and overfishing have long lasting direct effects on all fish communities with decreasing size, density biomass and age at maturity with strong cascading effects that can lead to ecosystem phase shifts and strong modification in nature's contributions to people (A. C. Hughes, 2017). Loss of predators leads to increased urchin abundance with associated episodes of seagrass overgrazing and a loss of seagrass cover (Rose *et al*., 1999; Heck and Valentine, 2007). In the Asia-Pacific region some large marine species, such as Pacific bluefin tuna and the whale shark, were harvested heavily, showing no signs of recovery (Nakatsuka *et al.*, 2017). The numbers of turtles, dugongs and coastal dolphins have also declined since European settlement in Australia (Morton *et al*., 2014). Aquarium trade may put stress on coral reef ecosystems (Rhyne *et al*., 2012; see Box 4.2).

Box 4.2 What is LRFFT?

The live reef fish for food trade (LRFFT) is a kind of large international trade in luxury seafood items (Sadovy de Mitcheson *et al.*, 2013). Consumers are able to select their own favourite, an alive fish in the market prior to cooking. This selection however has become a driver in both the capture and demise of a number of specific fish populations in the Asia-Pacific region (Fabinyi & Dalabajan, 2011). Under the continuously fishing pressure and the popular use of sodium cyanide to catch live fish, fish stocks have declined significantly with the degradation of coral reef. Since the LRFFT has become an important livelihood and specific fish populations have declined, fishers now increasingly have to travel a long distance to find fish. While this market continues to increase in size and value, the sustainability of reef fish is hard to achieve and coastal ecosystems in source countries will be anxious.

4.4.8.2 Pollution

In South-East Asia, the major concerns of pollution are eutrophication, marine litter, toxics, and sediments. The situation is expected to continue because approximately 70 per cent of South-East Asia's human population lives in coastal waters. The pollution problem is generally caused by intensive farming and aquaculture, rapid urbanization and industrialization, greater shipping traffic and fishing effort, as well as widespread deforestation and near shore development (Todd *et al.*, 2010). Aquacultures would induce unwanted environmental effects such as increased nutrients. For example, salmon farming has added nutrients to the Huon Estuary and D'Entrecasteaux Channel in Tasmania, which has knock-on effects up the food chain by increasing phytoplankton abundance (Morton *et al*., 2014). The outbreak of Crown-of-thorns starfish (*Acanthaster plancii*) has been partly responsible for the loss of coral cover on the Great Barrier Reef (Morton *et al*., 2014). Increased water nutrients caused by flooding linked to agricultural runoff would fuel an increase in phytoplankton, which is the food source of Crown-of-thorns starfish. Since plastics were mass-produced in the 1940s, microplastics are distributed over a wide area, with high concentrations in coastlines and within mid-ocean gyres. Ingestion of microplastics may facilitate the transfer of chemical pollutants within marine food web (Cole *et al.*, 2011).

Oil spill had more severe impacts on benthic macrofauna than on microalgae (Lee & Lin, 2013). The effects on sedentary infauna were more severe than on mobile epifauna (Lee & Lin, 2013). The large oil spills of the 1991 Gulf War had also affected subtidal benthic metabolism (Burns, Ehrhardt, & Howes, 1993). Increases in grain size on intertidal flats derived from surface runoff due to mining operations in the catchment has caused localised declines in community abundance and species richness (Schooler *et al*., 2017). Heavy metals and trace elements are often by-products of industrial processes and may enter marine environment via atmospheric and terrestrial effluent sources. They are dangerous to living organisms in the form of cation with capacity to bind with short carbon chains and bio-accumulate within marine organisms and concentrate year after year, showing a bio-magnification process (Islam & Tanaka, 2004).

4.4.8.3 Harmful algal blooms

The impacts caused by harmful algal blooms (HABs) primarily due to increased nutrients have increased over the past few decades (Gilbert, 2017). HABs are usually planktonic and some have acute toxic effects. When aquatic organisms are exposed to high levels of toxic blooms, mass mortalities and shellfish-poisoning event scan result. Unexplained fish kills and bird and marine mammal mortalities have been caused by bio-toxin transfer through their diet. However, the overall effects on food webs and ecosystems are little known (Landsberg, 2002). Nontoxic HABs can cause damage to ecosystems due to the accumulated high biomass , which would create noxious scums and foam, shade phytoplankton and seagrass beds from light, and cause faunal mortalities through decay and anoxia (Anderson, Cembella, & Hallegraeff, 2012).

4.4.8.4 Invasive alien species

Since the advent of sea travel, people have inadvertently carried diseases, rats and marine organisms to new locations. At present, at any given moment some 10,000 different species are being transported between biogeographic regions in ballast tanks alone (Bax *et al*., 2003). Many of the alien species become part of the background flora and fauna. Some even become invasive, dominate the native communities and alter ecosystem services. For example, the New Zealand screw shell, *Maoricolpus roseus*, introduced to Tasmania in the 1920s, has spread across the continental shelf as far north as Sydney. This screw-shell changes the seabed habitat, covering soft sediments with its hard shell, providing attachment points for other marine fauna, thus shifting the pre-invasion food web. Invasive seaweeds such as *Caulerpa*, native of northern Australia but now a significant invader in southern Australia and other parts of the world (Glasby, 2013), can impact seagrass ecosystems by changing the competitive relationships within the habitat (Unsworth & Cullen-Unsworth, 2013).

4.4.8.5 Habitat change

The land-sea margin has long been actively altered by humans due to economic incentives to expand arable land, harvest resources and protect infrastructure investments (Gedan *et al*., 2009). Difficulties in controlling coastal development due to rapid population growth and limited land for agricultural and urban expansion are predicted to continue to place pressure on coastal ecosystems in the Asia-Pacific region, with Indonesia, Thailand, Borneo, India and Bangladesh being of particular concern (Crooks *et al.*, 2011). Between 1990 and 2006 many Malaysia coastlines were also converted to agriculture (Olaniyi *et al*., 2012). Globally, population growth in coastal areas is escalating pressures on sandy beaches as are pressures from pollution, mining, transport development and eco-tourism, impacting on biota often confined to these ecosystems (Brown & McLachlan, 2002; Schlacher *et al*., 2007).

Tidal flat areas in Asia are popular as sites for aquaculture and other urban development and are reclaimed for salt production. A hugely detrimental consequence of the loss of tidal flats is the threat to migratory water birds (Miththapala, 2013). Further, loss of these wetlands may also release centuries to millennia of accumulated carbon in just a few decades (Crooks *et al*., 2011).

Human induced activities such as bottom trawling (dragging fishing nets along the seafloor), harbour dredging, break water constructions (for the development of ports and harbours), mining (seabed/sand mining, gravel extraction and other extractive industries) and growing amounts of marine pollution (including plastic waste) destroy critical marine habitats, physical damage to the ocean floor, accelerate sea erosion or coastline changes (Dattatri, 2015; United Nations, 1992).

Humans have cleared or modified salt marshes for human use, although recently these changes have slowed down in some developed countries. These changes can disrupt connectivity, increase nutrient inputs, and alter water and sediment dynamics in salt marshes. The decline of salt marsh habitat may release the huge carbon pool stored in the sediments to coastal waters or the atmosphere (Irving *et al.*, 2011). Biodiversity loss is also likely with reductions in salt marsh habitat and encroachment of mangroves into marshes. Declines in wetland cover can reduce sediment trapping, carbon sequestration and nutrient cycling, which may result in higher turbidity and nutrient loading in coastal waters. The productivity of coastal food webs and fishery can also be reduced due to the reduction of carbon and nutrient subsidies to coastal waters (Garbutt *et al.*, 2017). Reduced rainfall or runoff due to dam construction and water diversion in the catchment, however, may cause salinization and mangrove invasion of saltmarsh and freshwater wetlands (Shih, Yang, & Lee, 2011).

4.4.8.6 Storms

Intense storms are considered to have moderate impacts on mangrove forests. Damage can occur during storms. The trees would eventually recover from the effects of wind and waves, prolonged inundation and sediment deposition if the physical environment is restored (Bell *et al.*, 2011). Seagrasses are considered to be highly vulnerable to storms, with the exception of seagrasses growing in tide pools or relatively deep water. Increased wave exposure and current speed associated with mechanical disturbance can damage seagrasses and re-suspended sediments, which may make it difficult for seedlings to establish or persist (Herbeck *et al*., 2011). Small species of seagrass are generally more vulnerable than large species. However, seagrasses have the capacity to recover rapidly so that the effects may only be short-term if propagules are available to re-establish the meadows (Bell *et al.*, 2011).

Intense storms can suspend fine sediments and their offshore transport and the increased grain size on intertidal flats can result in declining abundance and species richness of benthic community (Schooler *et al*., 2017). The effects of storms on coral reefs are similar to fires in terrestrial systems, releasing space and preventing monopolization by a small subset of species (Hughes & Connell, 1999). Storms can cause the destruction of close to 100 per cent of coral reefs exposed to the disturbance, leading to long-term changes in the coral and fish community when they recover (Lamy *et al*. , 2015).

4.4.8.7 Rainfall and runoff

Mangroves are expected to have some benefits to plant growth possibly from increasing rainfall and nutrient delivery, and decreasing salinity. However, the vulnerability of mangroves would increase particularly in areas that experience declining rainfall as the lower precipitation may also increase salinity stress (Bell *et al*. , 2011), especially in conjunction with increasing temperatures.

Changes in irradiance in estuaries or in coastal habitats subject to runoff are expected to have great impacts on seagrasses. Such vulnerability is high around islands with large, steep catchments, or where runoff remains in bays and lagoons for long periods. If turbidity and irradiance persist at below the minimum light requirements for periods > 100 days, complete loss of seagrass may occur (Bell *et al*., 2011). Reductions in salinity and increases in sediments and toxic chemicals resulting from increased rainfall and runoff are alos expected to have a moderate to high impact on seagrasses. Modest increases in nutrient availability may have a small enhancement on seagrasses. Where levels of runoff and nutrients are high, however, the potential benefits may be over-ridden by the adverse effects of low salinities, reduced irradiance due to turbidity or algal blooms and, the effects of chemical pollutants, especially in poorly managed catchments (Bell *et al*., 2011).

Streams and rivers often carry substantial sediment loads during heavy precipitation. Deposition of fine sediments can reduce coral growth, prevent recruitment and development of larvae, and even change growth morphologies (Syvitski *et al.*, 2005). Fine sediments may become re-suspended, which may directly damage corals by abrasion, or, indirectly via decreasing irradiance. Such a decrease in irradiance may then lead to decreased rates of photosynthesis and coral growth (Philipp & Fabricius, 2003). Sedimentation can also reduce coral's ability to compete with other organisms in coral reefs (Liu *et al*., 2015), which may cause replacement of corals by sea anemones on certain coral reefs.

4.4.8.8 Undersea earthquakes

After the tsunami of 26 December 2004, corals in the Gulf of Mannar showing partial bleaching, infestation with disease, silt-smothered live corals, recently killed corals, broken corals and upturned corals. The live coral cover was reduced from 49 per cent to 36 per cent. Seagrass damage was also observed (Kumaraguru *et al.*, 2005). In addition, strong noise produced by earthquakes can kill or injure whales living within seismically active regions (Gallo-Reynose *et al.*, 2011). In 2016, the Kaikoura Earthquake in New Zealand resulted in meters of coastal uplift and the destruction of paua habitat (Howe & Morrah, 2016).

4.4.8.9 Offshore wind farms

The effects of offshore wind farms are least understood and are expected to be species- and season-specific. Ecosystem responses are also expected to differ significantly between regions and localities, as well as depend on technology and foundation type used (Wilhelmsson, 2010). Offshore wind farms may be beneficial on fish and benthos as they can have the effects of artificial reefs and trawling exclusion (Wilhelmsson, 2010). This may potentially have positive benefits for humans. However, they may cause injuries of fish and marine mammals by producing sound pulses during construction and noise masking bioacoustics during operation. They may cause habitat loss, collision with turbines and form migration barriers for birds. They may also change the community structure of benthos directly due to turbines (Bergström *et al.*, 2014).

4.4.8.10 Climate change

Climate change impacts can shift coastal ecosystems beyond thresholds or tipping points, causing the ecosystem no longer functioning in the same way (Bruno & Selig, 2007; Hoegh-Guldberg *et al.*, 2007). When a threshold or tipping point is crossed, the change can happen abruptly in a discontinuous, non-linear form. Coral reefs and seagrass beds are predicted to be most vulnerable to the future impacts of sea level rise, temperature warming and ocean acidification (Chiu *et al.*, 2017; Gattuso *et al.*, 2015). Coral reefs are in decline globally resulted from overexploitation, pollution, disease and climate change (A. C. Hughes, 2017). The loss in coral cover are well documented in the Great Barrier Reef (De'ath *et al.*, 2012). However, the scale of coral loss in most of the Indo-Pacific region was poorly documented until recently (T Lamy *et al.*, 2016; J. E. Smith *et al.*, 2016) . A large-scale, long-term study of coral data from this region contributing three-quarters of the world's coral reefs revealed an early onset of coral decline, generally low coral cover across all subregions, and coral loss rates of 1 per cent–2 per cent annually, even on the most intensively managed reefs in this region (Bruno & Selig, 2007). Phase-shifts can thus occur from coral- to macro-algal-dominated systems (P. J. Liu *et al.*, 2009).

Effects of sea-level rise

The Pacific Islands Regional Climate Assessment identified the highest sea-level rise occurred in the Western Pacific between 1993 and 2010 (Figure 4.19). When sea-level rise related to longer-term climate change combines with seasonal high tides, inter-annual and inter-decadal sea-level variations, and surge or high run-up associated with storms, extreme water levels would be expected (Keener *et al.*, 2012).

Sea-level rise can result in the gradual inundation of coastal ecosystems. The topography and sediment budgets, or the balance between sediment input and output, would regulate the response of coastal ecosystems to sea-level rise. There is an opportunity for landward migration of intertidal and sub-tidal vegetation such as seagrasses, mangroves and salt marshes as sea level rises if the land is uninhabited. However, built structures can prevent this migration landward and lead these ecosystems to decline, a process called 'coastal squeeze' (Torio & Chmura, 2013).

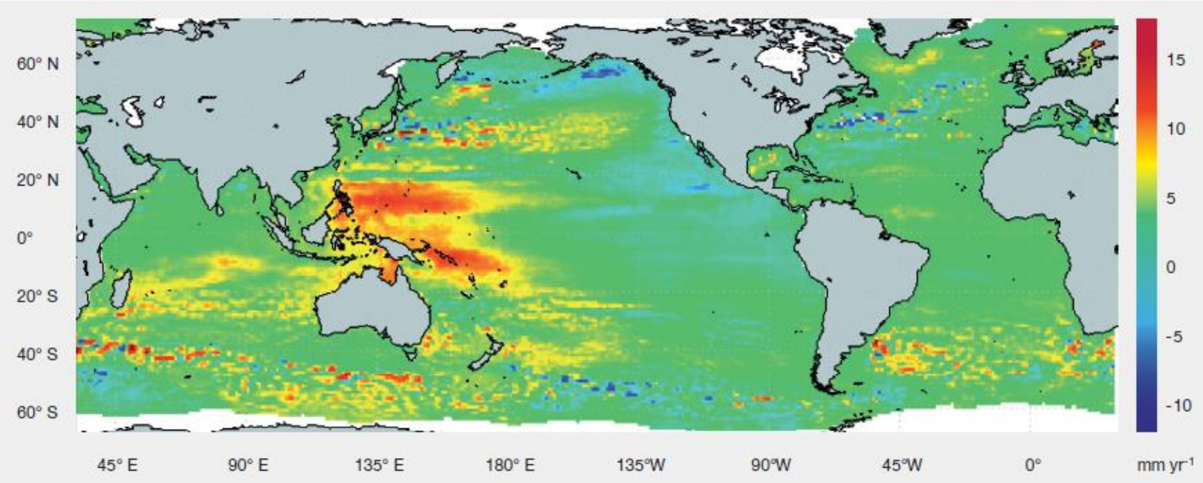

Figure 4.19 Mean sea levels are rising, particularly in the Western Pacific. Source: Keener *et al.* (2012); Merrifield (2011)

Compared to coral growth rates, sea-level rise is slow, which may not be a major challenge. However, the projected increasing rates of sea-level rise, coupled with the slower growth and accretion rates due to temperature warming and ocean acidification, may compromise the resistance of coral reefs to keep pace with future sea-level rise (Woodroffe and Webster, 2014).

The projected sea-level rise can have high vulnerability on mangroves, particularly in area where the coastline is subsiding and sedimentation rates are low (Woodroffe *et al.*, 2016). Vulnerability can be very high where landward migration is blocked by coastal intensive land use and steep gradients (Bell *et al*., 2011). Consequences of climate change impacts as well as anthropogenic impacts may induce a productivity loss, with a potentially disastrous knock on effect to many important commercial species of fish and shellfish in mangroves (Bezuijen, Morgan, & Mather, 2011). The projected sea-level rise can have moderate vulnerability on seagrasses because the distribution depth is limited by irradiance. Vulnerability can be very high where expansion landward is blocked (Bell *et al.*, 2011). Salt marshes can also be trapped by a coastal squeeze (Garbutt *et al.*, 2017). Building structures such as roads and sea walls along the coastline may prevent landward migration of salt marshes as sea-levels rise, severely reducing the resistance of salt marsh (Torio & Chmura, 2013).

Intertidal flats are likely to be highly sensitive to sea-level rise, especially where sedimentation rate does not keep pace with sea-level rise, or where they cannot expand landward. Permanent inundation, especially many high islands due to steep terrain or infrastructure barriers can result in the loss of intertidal flats. The exposure of intertidal flats to sea-level rise can cause dramatic changes on benthic microalgal communities and the associated epifauna and in fauna. A loss of biodiversity is expected because many intertidal organisms preferentially inhabit vertical zones corresponding to a subtle change in the intertidal zone (Bell *et al*., 2011).

Supra-littoral zone or beaches above the high tide zone would be lost first as sea-level rises, which may eliminate fauna of greatest conservation concern, including turtles and birds. The unique fauna may be replaced by those of sea walls and surf zones, which may result in changes in biodiversity and ecosystem functioning. The source-sink dynamics between fine-grained, gently sloping beaches and coarse-sand, steep beaches might be disrupted if a large area of beaches are lost. This may lead to further reductions in biodiversity on steep, coarse-sand beaches (Schooler *et al*., 2017).

Effects of increasing temperature

Increasing temperatures may cause a movement of some populations or ecosystems toward the pole. For example, ocean warming has facilitated the expansion of toxic algal blooms in the North Pacific Ocean (Gobler *et al.*, 2017). A southward shift in the latitudinal limit of some species of seaweed has already been recorded in the coastal waters of New South Wales, which leading to a reduction of kelp in north-eastern Tasmania (Department of Climate Change, 2009). The New South Wales sea urchin, *Centrostephanus rodgersii*, has been extending its range down the east coast and is now established off Tasmania, which has knock-on effects up the food chain (Morton, Sheppard, & Lonsdale, 2014). Higher temperatures, together with higher nutrient levels caused by human activities, are also likely to result in more frequent events of harmful algal blooms in coastal waters, resulting in impacts on coastal and marine species via food chain (Paerl *et al*., 2016).

Sea birds can be affected by high temperatures, leading to reproductive failure and adult mortality (Oro, 2014). Some turtles and estuarine crocodiles can also be affected by warm temperatures by changing the sex ratios of embryos and reducing incubation success. Mass coral bleaching events have been reported to be associated with warm temperatures (Mayfield *et al*., 2013). Bleaching occurs when the symbiotic zooxanthellae that live within the coral tissues disintegrates by exposing to water temperatures 2°C above maximum summer temperatures for two weeks. However, bleached corals may recover their symbiotic algae populations if warming is short-lived.

Because different coral species have distinct sensitivity to bleaching, bleaching events may result in a shift in coral community (Donner *et al.*, 2017). Damaged reefs can recover in a decade or two if environments are favourable. However, the recovery may be longer or even prevented if affected reefs are exposed to elevated nutrients, sediments or contaminants, or if stressful temperatures recur. Corals' sensitivity to bleaching may be exacerbated by increasing input of sediments and nutrients from land runoff (Liu *et al*., 2015). Overfishing on coral reefs can also reduce the ability of corals to recover from bleaching events (Liu *et al*., 2009). Increasing intensity of storm and alteration of water salinity and water movement may also influence coral's sensitivity to bleaching (Fujimura & Riegl, 2017, McClanahan, 2017, Wooldridge *et al*., 2016).

Increasing temperatures are considered to have moderate to high impacts on seagrasses. Shallow intertidal seagrasses are likely to be at the greatest risk. They have high vulnerability to increasing temperature because their relatively high respiration demands are expected to exceed their capacity for gaining carbon through photosynthesis (Bell *et al*., 2011). Temperature is often a major factor regulating the biogeographic distributions of seagrasses. Tropical species are expected to extend their ranges toward the pole with increasing temperatures andtemperate species would retreat, depending on resource availability and dispersal abilities. Such result will cause a shift in community composition as a consequence of variability in species responses. Seasonal or rapid increases or drops in temperature can also trigger seagrass flowering, and increasing temperatures can disrupt these seasonal triggers (McDonald *et al*., 2016).

Warming affect most severely those species living close to their upper thermal limit, especially those unable to acclimatise or adapt (Lah *et al.*, 2017). Species lacking dispersive larval stages could be at particular risk of extinction. Moreover, even dominant filter feeders such as bivalves (molluscs) on intertidal flats can be highly sensitive to temperature change, which in some cases can result in mass mortalities. The aforementioned loss of species may cause a dramatic change of community structure.

Effects of elevated CO_2 and ocean acidification

Ocean acidification as a results of elevated CO_2 can reduce the calcification rates of corals, which may result in a switch from net calcification to net dissolution and exacerbate coral bleaching, increasing coral sensitivity to increasing temperatures (Albright *et al*., 2016; Hoegh-Guldberg *et al*., 2007), which is likely to affect both physical conditions and biological communities of intertidal flats. This is because many sediments have high (often biogenic) carbonate fractions. In addition, many species have calcified exoskeletons (outer shells). However, the magnitude and extent of such effects remains little known due to the lack of relevant studies.

An increase in atmospheric CO_2 can lead to a higher proportion of dissolved CO_2 in ocean waters, which may stimulate seagrass productivity as seagrasses tend to be carbon-limited. Similarly, mangroves are expected to grow faster and become carbon sinks by increasing allocation to belowground biomass with elevated CO_2, resulting in greater gains in soil surface elevation and stability under sea-level rise (Department of Climate Change, 2009). Ocean acidification can narrow the upper thermal and lower salinity tolerance of the Sydney rock oyster *Saccostrea glomerata* (Parker *et al.*, 2011). Finally, ocean acidification can impact on the replenishment of fish populations and loss of food production by impairing olfactory discrimination and homing ability (Munday *et al*., 2010).

4.5 Integrated ecosystem complex

Both oceanic islands and mountains are often not one specific ecosystem but contain various ecosystems occurring in a limit spatial landscape, forming an integrated ecosystem complex. The geographic isolation has led to the establishment and evolution of distinct and endemic species as well as some unique ecosystem interfaces in these complexes (Reaser, Meyerson, & Cronk et. al., 2007; Ning, Rawat & Joshi et. al., 2013), which can also be strongholds for species declining in mainland or lowland habitats (like a biological refuge) (Towns & Ballantine, 1993). In fact, mountains are also considered as ecological islands of endemism because of their isolation and verticality (H. R. Mishra, 2002). At the same time, islands and mountains are vulnerable to effects of climate and non-climate changes than mainland or lowlands. Thus, these ecosystem complexes containing highly endemic species with highly restricted distributions make them highly vulnerable to perturbation.

4.5.1 Islands

Islands boast unique assemblages of life that are found nowhere else on earth such as isolated cloud forests scattered across Pacific Islands (e.g. Gnarled Mossy Cloud Forest on Lord Howe Island; Auld & Leishman, 2015 and refs therein). Islands often harbour more endemic species but have only moderate levels of species richness when compared with mainland areas (Kier *et al.*, 2009). Island endemism appears to rise with increasing isolation, island size and topographic variability (CBD Secretariat, n.d.-c). The importance of oceanic island biodiversity is recognised by the Convention on Biological Diversity (CBD) especially for highly vulnerable Small Island Developing States (SIDS) (CBD Secretariat, n.d.-b). While islands are geographically and culturally diverse, these share many economic and sustainable development challenges (Sterling *et al.*, 2017) such as small but rapidly growing populations, remoteness and susceptibility to natural disasters (Gombos *et al.*, 2014). Islands communities also often produce very low levels of greenhouse gas emissions but are already disproportionally suffering from the damaging impacts of climate change (Betzold, 2016).

Island species and ecosystems are particularly susceptible to invasive alien species (IAS) with a disproportionately high percentage of all recent of bird, mammal, reptile, land snails, freshwater fish and plant extinctions occurring on islands; historic devastation of important food and commercial crops and animals, and death of large numbers of indigenous human populations have also been attributed to invasive alien species with oceanic island, species, ecosystems and human communities have little resistance to this driver (S. Jupiter *et al.*, 2014; Simberloff *et al.*, 2013; R. R. Thaman, 2011, 2013). Invasive alien species are implicated in 86 per cent of island plant and vertebrate extinctions (C. Bellard *et al.*, 2015) where native bird communities are collapsing from exotic mosquito vectored avian malaria and native trees are being driven extinct by exotic fungal pathogens diseases.

4.5.1.1 Tropical islands

Terrestrial invasive species are impacting many tropical islands such as crazy ant invasions on Guam and Christmas Islands substantially impacting island ecosystems including the displacement of keystone species (O'Dowd, Green, & Lake, 2003; Reaser, Meyerson & Cronk et. al., 2007). Australian brown tree snakes have also impacted bird species on Guam (Reaser *et al.*, 2007) while golden apple snails are disrupting rice production in the Philippines as well as many Asian and Pacific islands; these invasive alien species are also known to carry diseases (Reaser *et al.*, 2007). Asian subterranean termites on Fiji have caused damage and costs amounting to millions of dollars, while the spread of the deliberately introduced green iguana is threatening both vegetation and the endemic Fiji iguanas (R. R. Thaman, 2013). The coral tree (*Erythrina variegate* var. *orientalis*), an important nitrogen-fixing cultural tree, has been virtually eliminated in Fiji, Hawaii and Samoa due to the invasion of African Erythrina gall wasp (*Quadrastichus erythrinae*) (R. R. Thaman, 2011) , while Kou leafworm (*Ethmia nigroapicella*) has substantially impacted on beach cordia (*Cordia subcordata*) which is an important species used for woodcarving and plays a role of coastal protection on Tuvalu in the Nanumea Atoll (R. R. Thaman & O'Brien, 2011). Information regarding drivers for coral reefs can be found in Section 4.4.8.

4.5.1.2 Temperate islands

Many temperate islands in the Asia-Pacific region are also being significantly impacted by invasive species. Cats and foxes on many Australian islands is strongly associated with native mammal extinctions (Reaser *et al*., 2007) while rats on New Zealand islands are impacting on vertebrate communities (St Clair, 2011) and depressing coastal tree recruitment, sometimes to the point of local extinction (Campbell & Atkinson, 2002). Pigs and goats also consume plants and seed and also cause physical environmental damage as seen on Lord Howe Island (Auld & Hutton, 2004). Rabbits have been eradicated on Cabbage Tree Island (Australia) to protect Gould's petrel (Priddel *et al.*, 2000). Brushtail possums introduced to New Zealand not only spread tuberculosis (Reaser *et al.*, 2007) but also threaten native birds. Mongoose introduced to the Japanese islands of Okinawa and Amami-Oshima have had a profound effect on the agriculture and poultry industries as well as on biodiversity but active management is improving the status of some endangered species (Goldson, 2011; Ministry of the Environment Government of Japan, n.d.; Reaser *et al*., 2007). Pathogens such as the fungus *Phytophthora cinnamomi* are also found in some Australian islands (Auld & Hutton, 2004; Pickering & Hill, 2007) while weeds are also highly problematic on many temperate Asia-Pacific islands (e.g. Lord Howe Island) (Auld & Hutton, 2004) and Carnac Island (Abbott *et al.*, 2000).

Tourism can also be a major driver of change in island ecosystems. For example, dune systems provide important ecosystem services such as erosion control, habitat and nesting for birds but 4WD tourism is causing damage on Fraser Island, Australia (Thompson & Schlacher, 2008). This is also leading to weed invasion and spread (Pickering & Hill, 2007). Clearing associated with island settlement is problematic on Lord Howe Island as protective vegetation has been removed, exposing forest trees to salt laden winds and causing declining tree health and death (Auld & Hutton, 2004). Draining of wetlands and land reclamation since European settlement has impacted Rottnest Island, affecting waterfowl habitat, some of which are trans equatorial migrants (Saunders & Derebeira, 1986).

4.5.1.3 Antarctic and sub-Antarctic islands

Whilst warming has been reported across the Southern Ocean, the interplay between increasing westerly winds and surface water temperatures has resulted in increased inter-annual temperature variability across the southwest Pacific (Turney *et al*., 2015), preventing a rise in tree line altitude on the islands in the region (Harsch *et al.*, 2014), potentially acting as a multi-stressor on sensitive marine vertebrate populations (Boyd *et al.*, 2014; Trathan *et al.*, 2007; Weimerskirch *et al*., 2003).

At high latitudes in the Southern Ocean, due to the scarcity of island breeding sites sub-Antarctic penguins particularly sensitive to climate change and related changes in marine system. Penguins can respond to changes of available food owing to varying marine parameters through retracting or expanding their distributions as well as regulating their population size or breeding phenology (Weimerskirch *et al.*, 2003). Alternatively, climate change can affect penguin numbers due to changes in conditions ashore. At Campbell Island, New Zealand there have been pronounced declines in the numbers of both Eastern Rockhopper penguins (*Eudyptes filholi*) and Erect Crested penguins (*E. sclateri*) (Bailey & Sorensen, 1962; Cunningham & Moors, 1994). It was observed that the decline of Rockhopper penguins number began in the mid-1940s but a further loss began from the middle of 1970s (Cunningham & Moors, 1994). It is important to note that the changes in Rockhopper penguin population is correlated with changes in sea water temperatures recorded which were warm at the end of 1940s and then after 1970, but became cool during the period from 1950 and 1965 (Cunningham & Moors, 1994; Morrison *et al*., 2015).

4.5.2 Mountains

Mountain, an ecosystem complex, has long been admired and protected on the grounds of their serenity, wilderness, and landscape beauty (Messerli and Ives, 1997; Antonelli, 2015). In general, direct human influence on mountains is thought to be low with only 6.5 per cent of the world's mountain areas having high level of direct human influence and more than half having only a low level (Huber *et al.*, 2005). Mountain regions are also highly diverse with some 25 per cent of the Global Biodiversity Hotspots and 40 per cent of the Global 2000 Eco-regions (ICIMOD, 2009). Not surprisingly, for the Asia-Pacific region the most heavily influenced mountain areas are located in the most densely populated regions such as those distributed in North-East Asia and South Asia. Despite their remoteness and the relatively low density of human population, many mountain ecosystems are strongly affected by drivers of global change such as land-use and land-cover change, climate change and globalization (Miehe *et al.*, 2009; Singh *et al.*, 2011).

Mountains occupy 22 per cent of the global land surface (about 32 million km^2), and Asia alone hosts more than one-third of the world's mountains (FAO, 2015d). In 2012, there were some 13 per cent of the global human population (about 915 million) living in mountain areas (FAO, 2015d); of these, over half live in the Asia-Pacific region (ICIMOD, 2010; FAO, 2015d). Biodiversity is always high and unique in these mountainous areas because of their heterogeneous habitats, diverse micro-climates, and environmental verticality. These elements lead to highly diverse genetic resources including various crops and livestock breeds and the associated indigenous and local knowledge in mountains (Schild & Sharma, 2011).

4.5.2.1 Land-use and land-cover change

Change in land use and land cover occurs in many parts of mountainous region with natural habitats shrinking through forest fragmentation and rangeland degradation (Fox *et al*., 2012; Pandit *et al*., 2007; Reddy *et al*., 2013; Uddin *et al*., 2015). Generally, the area used for agriculture in mountains is growing. Forest transition due to plantation and agroforestry expansion, agricultural intensification, and infrastructure development have led to large-scale land-use and land-cover change in mountains (Kim *et al*., 2014; Trincsi *et al*., 2014; Xu, Grumbine & Shrestha, 2009). Annual loss of forest area of 0.2 per cent has been reported for Indian mountains (Reddy *et al.*, 2013) and 0.3 per cent for Myanmar (Leimgruber *et al.*, 2005), although in Bhutan forest cover is increasing at an annual rate of 0.22 per cent (Gilani *et al*., 2015).

With the gradual integration into globalized markets and improved infrastructure, mountain societies in the Asia-Pacific region have shifted progressively from subsistent to market-orientated agriculture. Emergent urbanization and intensive agriculture in mountains with cultivating introduced varieties and high-value cash crops, have led to the conversion of farming fields for other uses (Tulachan, 2001). Agricultural lands in some mountains have been abandoned, such as in South Asia, because of the low returns and the shortage of labour caused by rural outmigration for additional earnings

(Khanal & Watanabe, 2006). The development of tourism infrastructure has also led to the changes in land use and land cover in mountains. In the Genting and Cameron Highlands of peninsular Malaysia and on Mount Kinabalu in Sabah, montane cloud forests have been replaced by hotels, entertainment venues and golf courses, illustrating the increasing impacts of tourism development on mountain landscape (H. R. Mishra, 2002). Note that in New Zealand, most of mountain tops are unthreatened by land-use change as they are included in National Parks and managed by the Department of Conservation New Zealand (2015). They have recreational, landscape tourism and sacred values to Māoris (Harmsworth & Awatere, 2013).

4.5.2.2 Natural resource overexploitation

The growth in population and economic activity is leading to an increased demand for natural resources and ecosystem services as far as from remote mountains (Lam, 2011). In many mountain areas, pressure from dependent populations through poverty, inequality, immigration, and cultural change including international pressure (macro-economic policies, international trade factors), and policy responses (policy failure, poor environmental law, weak enforcement, unsustainable development projects) are seen as the underlying drivers of the overexploitation of natural resources (Chettri & Sharma, 2002; Jha & Bawa, 2006; Lambin *et al*., 2001), which has been accompanied by a marked loss in biodiversity (MacDougall & McCann, 2013; McKee *et al*., 2004). In the central and eastern Himalayan region, for instance, unsustainable trade in caterpillar fungus (*Ophiocordyceps sinensis*), the world's most expensive biological resource, is regarded as a major driver of population decline. In Nepal, after legalization of trade in 2001, trade volume of caterpillar fungus increased sharply in following ten years with the local market price increasing by up to 2300 per cent at the same period (U. B. Shrestha & Bawa, 2013).

4.5.2.3 Pollution

Despite the risks of pollution and the potential impacts on ecosystems and human health, it still receives little attention in mountainous areas and has yet to become a priority topic. At present, there is increasing evidence indicating that air pollution (consisting mainly of anthropogenic aerosols) originating in the rural areas and cities of South Asia is contributing significantly to the cryospheric changes in the Himalayan region (Flanner *et al*., 2009; Qian & Flanner, 2011; Singh *et al*., 2011; Xu *et al.*, 2009). 'Black carbon' emitted from the Himalayan region and neighbouring areas has amounted to 3.2 Tg/yr and increased dramatically (Koch, Bauer, & Perlwitz et. al., 2009). This increase of black carbon on high mountains is reducing glacier albedo and leading to additional yields of meltwater (Yasunari *et al.*, 2010).

Large amounts of absorbing particles such as black carbon can have multiple effects on biodiversity and ecosystems overall (Carrico *et al*., 2003; Gautam *et al*., 2010; Ménégoz *et al*., 2014). High concentrations of pollutants can lead to serious health issues for both ecosystems and local people (Ebi *et al*., 2007; Sarkar, 2010; Sharma, 2012). Vertical upward transport of air masses, especially during the pre-monsoon season, carry rich anthropogenic pollutants and mineral dust and deposit on the Himalayan range (Bonasoni *et al*., 2010; Shrestha & Devkota, 2010). While acute pollution events characterized by high levels of ozone (64.7 ± 8.6 nmol mol^{-1}), black carbon (1077 ± 470 ng m^{-3}), and PM1–10 (typically more than 12 μgm^{-3}), have been identified during the monsoon season itself (Marinoni *et al.*, 2013).

4.5.2.4 Invasive alien species

Studies of invasive species in mountain areas are sporadic but cover a wide range of latitudes (Dobhal, 2011; Khuroo *et al.*, 2007; Kosaka *et al*., 2010; Kunwar, 2003) and altitudinal gradients (Kosaka *et al*., 2010). In India overall, the most recent inventory listed 1,599 species belonging to 842 genera in 161 families, 8.5 per cent of the total Indian vascular flora (Khuroo *et al*., 2012), while 190 invasive alien species belonging to 112 genera in 47 families were identified in the Indian Himalayas (Sekar, 2012). In Nepal, inventory and assessment carried out by IUCN Nepal has identified 166 different invasive plant species (Tiwari *et al*., 2005). Some studies provide evidence that anthropogenic and natural disturbances might act together to facilitate the introduction and spread of exotic species such as creation of tourism infrastructure particularly construction of roads, recreational activity like hiking and put the mountain ecosystems of the region at higher risk of invasion (H Chen *et al.*, 2012; Dar *et al.*, 2015; Dobhal *et al.*, 2011; Kosaka Y, Saikia B, Mingki T, Tag H, 2010) . Agricultural inputs particularly seed stocks provided from areas outside the mountains is also another source of invasion (Kunwar, 2003). Even though ecological studies have been quite substantial (Bajpai & Inderjit, 2013; Bhatt *et al*., 2011; Inderjit *et al*., 2011; Kohli *et al*., 2012; Tripathi *et al*., 2012; Tripathi, Yadav, *et al*., 2012) and at different scales (Shah *et al*., 2014), little effort has been made to study the impact on indigenous biodiversity, ecosystems, or human well-being.

4.5.2.5 Hazards and risks

Mountain hazard is likely to be more severe in the high and steep areas especially in those mountains being young and still growing which are thus inherently vulnerable to earthquakes, landslips, avalanche and erosion. Data analysis suggests that of the total annual disasters in the Hindu Kush Himalayan region, 45 per cent are hydrological (36 per cent flood and 9 per cent mass movement), 23 per cent are meteorological like storm, 14 per cent are geophysical include earthquakes and landslide, 10 per cent are climatological (6 per cent extreme temperature events, 3 per cent drought, and 1 per cent wild fires), 8 per cent are other types such as epidemics (Guha-Sapir *et al*., 2011). The habitats and safety of flora, fauna as well as local communities are needed for protection from mountain hazard and for slope stabilizations.

As most of the mountain areas are always located in tectonically active zones, susceptibility to earthquakes and volcanos are higher than in other lowlands, such as the Hindu Kush and Himalaya in South Asia, Kelud and Merapi on Java. Earthquakes can lead to huge loss in both people’s life and properties, and triggered vegetation degradation, landslides, rock-fall and soil erosion (Lu *et al.*, 2012; Ministry of Science, 2015). It is believed that many mountain areas have been becoming increasingly disaster-prone in last few decades, and the frequency of natural disasters in mountain regions also increased (Guha-Sapir *et al*., 2011; Pathak *et al.*, 2010).

In South-East Asia and Oceania subregions volcanic eruptions resulted in complete destruction of ecosystems close to the volcano (https://volcanoes.usgs.gov/index.html). Extremely large volcanic eruptions can have global effects due to releases of large amount of carbon dioxide, sulfur dioxide, hydrogen sulfide and hydrogen halides (HF, HCl, HBr) (Zuskin *et al.*, 2007). Erupted ash particles are often coated with these hydrogen halides. Once deposited, these coated ash particles can have a variety of toxic effects on drinking water, agricultural crops, and grazing land (Zuskin *et al.*, 2007). Lahars from Crater Lake are a significant hazard on the volcano and in its draining valleys and surrounding plains such as the case in the central North Island of New Zealand. To reduce the risk of lahar New Zealand undertakes specific management in Mt. Ruapehu as this is the largest ski area of the North Island (Department of Conservation New Zealand, 2006; Keys, 2006).

Due to the more frequent weather extremes, flood and drought have become popular natural disasters in mountains. Increased river flow modifies the morphology of stream channel, which further changes the habitat requirements of freshwater species as well as their population structures. Accelerated river erosion destabilise those valley slopes which are saturated with water after prolonged intense rains. Moreover, mountain ecosystems related to snow, ice and permafrost on high mountains are also being affected by enlarging glacial lakes, increasing ground instability, and rock or snow avalanches, which further impact the hydrological process in mountain system.

4.5.2.6 Climate change and weather variability

The climate change has been a major driver of change in the high Asia (Gong & Ho, 2002; Xu & Grumbine, 2014). Changes in temperature and precipitation could have serious implications for biodiversity and ecosystem services (Singh *et al*., 2011; Tse-ring *et al*., 2010) including food security

(Mendelsohn, 2014) and water resources (Rasul, 2014). Observational evidence indicates that climate warming is already leading to visible effects in the Hindu Kush Himalayan region with indications of changes in phenology (Hart *et al*., 2014; Li *et al*., 2013; Ranjitkar *et al*., 2013) and degradation of vegetation (Arthur *et al*., 2007). There are also indications of changes in ecosystems (Shrestha *et al*., 2012); some ecoregions are likely to be more vulnerable to climate change than others (Chettri *et al*., 2010; Tse-ring *et al*., 2010; Shrestha & Aryal, 2011).

Mountain habitats are believed to provide asylum or refuge for species migrating away from a warming world (ICIMOD, 2009; 2010). It is also underlined that climate change in many high mountain areas is advancing faster than in lowlands (Shrestha & Aryal, 2011), creating high concern for species with narrow habitat ranges (Chettri *et al.*, 2010). The estimation of treeline shifting upwards ranges from 45 m in northwest Yunnan, China (Baker & Moseley, 2007) to 110 m in the eastern Himalayas (Xu *et al*., 2009). It was also observed in the western Himalayas that the extent of treeline species' upward shift was smaller on the north aspect than on the south aspect (Dubey *et al*., 2003). However, the causes of these upslope shifts sometimes are questionable (Körner, 2012) and should be still explored based on long-term monitoring data in high mountains, such as through the recently established and further developing interdisciplinary monitoring approach in the Hindu Kush Himalaya region (Nakul Chettri *et al.*, 2015) and the international GLORIA network (Global Observation Research Initiative in Alpine environments) of permanent vegetation plots (Pauli *et al.*, 2015).

4.5.2.7 Persistent Poverty

With a 37 percent proportion of total mountain area in the world, the Asia-Pacific mountains support over 52 percent of global mountain population, among whom there are over 40 percent suffering food insecurity (FAO, 2015d). In additions, poverty reduction rates are also very low in these mountain regions (Hunzai *et al.*, 2011). According to FAO (2015d), in Asia mountain people who were considered vulnerable to food security increased over 40 million i.e. about 26 per cent from 2000 to 2012. Harsh climates and inaccessible terrain, combined with political instability and social marginality certainly contribute to the poverty and vulnerability of mountain societies in general. Environmental degradation due to forest destruction, overgrazing and overexploitation of natural resources in mountains, combined with the conversion of farming lands and inappropriate cropping practices, exacerbates the livelihood of mountain communities and increases environmental risks in not only mountain area itself but also downstream areas (Hunzai *et al*., 2011). Hardships in mountain areas, along with low economic opportunities in agricultural sector, have led to large-scale outmigration from mountain areas (Banerjee *et al.*, 2014), further affected mountain areas to achieve sustainable development goals.

4.6 Discussion and Conclusion

The Aichi 2020 Targets, under the Convention on Biological Diversity (CBD), aim to halt the loss of biodiversity by 2020 to ensure that ecosystems continue to provide essential services. For Aichi Targets particularly relevant to this chapter, indicators are used to assess the general trends of changes in biodiversity and ecosystem services in the Asia-Pacific region (see Table 4.4). However, it remains difficult to reach a consensus about some of these trends due to lack of empirical or regionally comprehensive data and insufficient information flows. Generally, it can be clearly established that many impediments are impacting the regional delivery of these Aichi Targets. According to published local, national and regional data, it appears that current efforts remain insufficient to secure an overall improvement in the base state of biodiversity by 2020. Measures taken to conserve and enhance biodiversity and associated ecosystem services, and thus enhance associated human well-being are worthy of further focused attention both to secure the delivery of the Aichi Targets and for guiding longer-term actions for the conservation of biodiversity beyond 2020 (Hill *et al.*, 2015).

In the Asia-Pacific region, most of the direct and indirect drivers are having a strong influence on ecosystems and their services, and many of them are changing, with primarily negative consequences (Table 4.4). For the Aichi targets, several indicators were chosen to represent the direction of change towards reaching the respective goals; indicators that relate to drivers of change are listed in Table 4.4.

Sustainable fishery (Target 6). The demand for fish is high in the Asia-Pacific region (see section 4.1.2.3). The Convention of Biological Diversity (CBD) fifth national reports noted that while global marine captures have decreased from unsustainable levels a decade ago, certain fisheries (e.g. bigeye tuna, yellowfin tuna) are still heavily overexploiting stocks beyond sustainable yields. While commercial fisheries are usually the first consideration, the importance of small-scale fisheries shouldn't be under-estimated. Recent reports highlighted that for 25 Pacific island countries, the total catches were 1.7 times more than that reported by FAO in 2010 (Zeller *et al.*, 2015). This discrepancy is largely due to the underrepresentation of subsistence fisheries, and highlights their importance for food security, and poverty eradication in policy development. Many drivers remain to be resolved such as excess and uncontrolled fishing, socio-economic factors like access to market infrastructure and overpopulation[72] (Lavides *et al.*, 2016).

Although there is a positive trend in certification for wild capture fisheries, the uptake is small and represents 3.36 per cent of the total fish caught in the Asia-Pacific region (UNEP-WCMC, 2016). A major lift in efforts for sustainable fisheries is needed to reach Target 6. The FAO (FAO, 2016b) recommends sharing of stock information for effective fisheries management. As noted by UNEP 2016: "Currently, around 25 per cent of the fish stocks in Western Central Pacific are under an unknown amount of fishing pressure". Conservation of traditional ways of fishing are also recommended, with example for South-East Asia (Ruddle & Satria, 2010).

Sustainable agriculture (Target 7) is impeded by the fundamental issue of growing regional and global economies and populations. Thus, rapid demographic and economic growth within and beyond the region and associated urbanization, industrialization, agricultural expansion are increasing demands on natural resources contributing to biodiversity declines and a general overexploitation of natural resources; this is also associated with habitat fragmentation in most areas of the Asia-Pacific region. High production costs and instability in prices for farm products prevent farmers from trialing sustainable systems; agriculture, aquaculture and widespread monoculture forestry also often produce ecosystem-disservices including soil erosion, pest outbreaks, nutrient and pesticide run-offs; with trade-offs between yield and biodiversity apparently intractable (Hill *et al.*, 2015). This is even more so true for Pacific Islands, as urbanization, increased population, mono-cropping and plantation forestry are leading to loss of fuelwood and medicinal plants, destruction of wildlife habitat and increased vulnerability of coastal areas to erosion, saltwater incursion and flooding (Randolph Thaman, 2008). The increased reliance on nutritionally inferior and highly processed imported food is also leading to increased health problems and loss of traditional knowledge.
Food demand has increased (in particular for livestock and dairy products), as has aquaculture production (see Section 4.4.5), with the Asia-Pacific region being the largest producer of aquaculture products globally. Although the FAO "blue growth" initiative is promoting sustainable practices for aquaculture production, the fifth CBD reports suggest that progress is still insufficient to reach Target 7. For forestry, a similar trend can be observed, with an increased area of certified sustainably managed forests (UNEP, 2016). While investments in agriculture development have declined, some progress towards a sustainable agriculture should be noted such as in Indonesia, Lao and Philippines where sustainable practices are being implemented for rice production (UNEP, 2016).

Pollution controlled (Target 8). Increased intensification and growth in agricultural production is occurring in the Asia-Pacific region. Consequently, fertilizer and pesticide use are increasing in many countries, with a decreasing nitrogen use efficiency (i.e. the ratio of nitrogen outputs e.g. yield to inputs, e.g. total fertilizers) (Lassaletta *et al*., 2014; FAO, 2015c) showing that the increased

[72] http://www.coraltriangleinitiative.net/

fertilization has limited gain in crop performance. This puts biodiversity and ecosystem services provided by land and soils at risk and contributing to added pressure from pollution. Nitrogen and phosphorus applications vary greatly across the region with highest rates found in China, India, Indonesia and part of Vietnam and generally higher nitrogen than phosphorus loads (UNEP, 2016a).

Invasive alien species (IAS) controlled (Target 9). Recent efforts have started to develop indicators for Target 9 and active management plans (for example in Republic of Korea and New Zealand) (Department of Conservation New Zealand, 2013; Ministry of Environment of the Republic of Korea, 2014) but information is still patchy for large parts of the Asia-Pacific region (see Section 4.1.4). Some studies have highlighted a global trend towards an increase in invasive alien species, with central Asia identified as a priority control area (Turbelin *et al.*, 2017). UNEP (2016a) also noted that in Pacific Islands more than anywhere in the Asia-Pacific region, control of invasive alien species is very poor and considerable efforts are needed to make progress towards Target 9. On the other hand, the strong integration and cooperation in assessing the threats by invasive alien species and in managing and controlling the species accordingly between some of the countries in this region, also provide some hope that further progress can be achieved (SPREP, 2009). The number of countries in the Asia-Pacific region with relevant national legislation increased from 47 per cent (20/43) in 2010 to 65 per cent (28/43) (data courtesy of http://bipindicator.net). On average 74 per cent of Asia-Pacific countries have signed up to the invasive alien species-relevant international agreements, demonstrating that there is widespread international support for such agreements that support some degree of prevention and control of invasive alien species. About 36 per cent (19) of countries have to date signed up to the most recent multinational agreement, the International Convention for the Control and Management of Ship's Ballast Water and Sediments (BWM), which was adopted in 2004 and enters into force in September 2017. For the future, a compilation of all invasive alien species for the region in a central database, similar to the DAISIE (Delivering Alien Invasive Species Inventories for Europe; http://www.europe-aliens.org/) database, that would ideally also directly link to the IUCN Global invasive species database (http://www.iucngisd.org/gisd/) could greatly support future progress towards addressing the issues associated with Target 9.

Pressures reduced (Target 10) With the increase in air, soil, and water pollution (see section 4.1.3), and the increased risk of climate change impacts, especially on high mountains (section 4.4.7) and coral reefs (section 4.4.8), pressures on biodiversity are unlikely to decrease in the near-future unless targeted economic instruments and governance systems are put in place.

Protected areas (Target 11). In the Asia-Pacific region, the coverage of protected areas has significantly increased between 1990 and 2012, but has slowed down in recent years (Juffe-Bignoli *et al.*, 2014; UNEP, 2016a, 2016b) in association with a consolidation of the existing protected area network. The governance and management systems of protected Asian areas are complex (see e.g. Li *et al*., 2016), but there are good examples of management systems in Indonesia, Japan, and the Philippines (UNEP, 2016a). Further efforts are still needed to ensure progress towards improved effectiveness of management (See: Gidda, 2016)

Biodiversity strategies and action plans (Target 17). National Biodiversity Strategies and Action Plans (NBSAPs) are effective tools to ensure implementation of the Convention of Biological Diversity (CBD) goals. 35 countries out of the 62 nation states in the Asia-Pacific region have developed a NBSAP pre-2010. After the Strategic Plan for biodiversity 2011-2020 was adopted at the tenth meeting of the conference of the Parties (COP-10), the Parties were requested to develop or update their NBSAPs by developing national and regional targets and integrating biodiversity targets into national policies and strategies (Secretariat of the Convention on Biological Diversity, 2011). Since then, thirteen Asian countries have submitted a NBSAP, with three under development, which is considered a considerable progress towards Target 17. It is expected that further progress will be made in this area (UNEP, 2016a; 2016b).

Table 4.4 Assessment of drivers related to Aichi Targets

Targets	IPBES Indicators - Core	Trends	Source of evidence for trend/confidence	Relevant section
Target 6: Sustainable fishery	Trends in fisheries certified by the Marine Stewardship Council	↗	(Funge-Smith *et al* 2012).	4.1.2, 4.4.8
	Estimated fisheries catch and fishing effort	↗	(Funge-Smith *et al* 2012). (Lavides *et al*., 2016) (Zeller *et al*., 2015) (http://www.seaaroundus.org/)	4.1.2
	Inland fishery production	↗	Table 5 in FAO (2016) supports an increase as is the text in Section 4.4.5	4.1.2, 4.4.5
Target 7: Sustainable agriculture	Total wood removals	↗	See section 4.1.2.1	4.1.2.1
	Proportion of area of forest production under FSC and PEFC certification	↗	(Forest Stewardship Council, n.d.) (UNEP, 2016a) Asia FSC = growing from 2012 to 2017 from 4.98Mha to 8.3Mha, Oceania = growing from 2012 to 2017 from 2.2Mha to 2.6Mha PEFC area: increased by 75% since 2015, currently around 37Mha	
	Nitrogen Use Efficiency	↘	(Lassaletta *et al*., 2014) (Lassaletta, n.d.)	
	Nitrogen + Phosphate Fertilizers (N+P 205 total nutrients)	↗	(FAO, 2015d)	4.4.5
Target 8: Pollution controlled	Trends in pesticide use	↗	(FAO, n.d.-a) NB. The trends are variable between countries.	4.1.3.3
	Trends in nitrogen deposition	↗	(Lamarque *et al*., 2013)	4.1.3.1
Target 9: IAS controlled	Number of new IAS found every two decades		(UNEP, 2016a)	4.1.4
	Trends in national legislation relevant to the prevention or control of Invasive alien species (IAS)	↗	(The BIP Secretariat, n.d.)	4.1.4
Target 10: Pressures reduced	Reductions in pollutants			4.1.3
	Reductions in areas affected by soil erosion			
	Climate change impacts on biodiversity	↗	(UNEP, 2016a; 2016b)	4.1.5
Target 11: Protected areas	Species protection index		(Squires, 2014)	
	Protected area management effectiveness	→	(UNEP, 2016a; 2016b)	
	Percentage of areas covered by protected areas - marine, coastal, terrestrial, inland water	↗	(UNEP, 2016a; 2016b)	4.2.5, 4.4.1

	Protected area coverage of Key Biodiversity Areas	↗	(IPBES, 2017, p. 10) (https://www.protectedplanet.net/) (http://www.keybiodiversityareas.org/home) presented for the Asia-Pacific region by (Brooks *et al.*, 2016)	
	Protected area connectedness index	↗	(IPBES, n.d.) (GEO BON Secretariat, 2015)	
Target 17: Biodiversity strategies and action plans	Number of countries with developed or revised NBSAPs	↗	(UNEP, 2016a)	

Note: ↗ = increased; ↘ = decreased; → = stable; <blank> = no adequate data

Regionally, land-use and land-cover change, climate change, the future spread of invasive alien species and transboundary pollution are expected to have a strong negative effect on socio-economic development and the well-being of its human population, especially in developing Asia-Pacific countries. Global climate change policy initiatives are increasingly impeded by growing public skepticism related primarily to socio-cultural factors rather than scientific uncertainty. Control of diffuse pollution from intensive farming, aquaculture, urbanization, industrialization, shipping traffic and fishing is still impeded by information asymmetries and stochastic effects that render both market and regulatory mechanisms ineffective and slow to respond. Invasive species' control and eradication, especially preventing the spread of potentially invasive species as the most effective measure to reach Target 9 requires support from multiple stakeholders. It also requires significant enhancement of biosecurity measures underpinning trade and immigration from regional to global scales. Overall, it is therefore necessary for all regional countries to mainstream adaptation concerns into development policies and plans, promote clean energy, strengthen technology transfer, establish systems for emission reduction, and reinforce systems to control illegal trade through close collaboration with the international community.

In the last three decades, modernization and globalization in the Asia-Pacific region have impacted markedly on lifestyles, consumption patterns, Indigenous and Local Knowledge (ILK) systems and cultures of local people, and are having a profound effect on the demand for ecosystem services. On the other hand, recent changes in this region together with rapidly economic growth and significant scientific and technological advances constitute new opportunities (not least through better access to and communication of information) for the sustainable development of regional countries especially for the developing countries. The global Agenda 2030 (SDGs) and new mechanisms for climate or development finance provide avenues for more investment in developing economies. Therefore, regional governments can increase and combine their efforts to benefit from these new global opportunities, accelerate legislative formulation, green fiscal policy, and improve inclusiveness of economic growth.

4.7 References

Abahussain, A. A., Abdu, A. S., Al-Zubari, W. K., El-Deen, N. A., & Abdul-Raheem, M. (2002). Desertification in the Arab Region: Analysis of current status and trends. *Journal of Arid Environments*. https://doi.org/10.1016/S0140-1963(02)90975-4

Abbott, I., Marchant, N., & Cranfield, R. (2000). Long-term change in the floristic composition and vegetation structure of Carnac Island, Western Australia. *Journal of Biogeography*, *27*(2), 333–346. https://doi.org/10.1046/j.1365-2699.2000.00409.x

Abram, N. J., McGregor, H. V, Tierney, J. E., Evans, M. N., McKay, N. P., Kaufman, D. S., & Consortium, the P. 2k. (2016). Early onset of industrial-era warming across the oceans and continents. *Nature*, *536*(7617), 411–418. Retrieved from http://dx.doi.org/10.1038/nature19082

Acreman, M. C. (2012). *Wetlands and water storage: current and future trends and issues. Technical Briefing Note no. 2.* Gland, Switzerland.

ADB. (2013). *Food Security in Asia and the Pacific*.

ADB. (2016). *Asian Water Development Outlook 2016; Strengthening Water Security in Asia and the Pacific*.

ADB. (2017). *A Region at Risk: The Human Dimensions of Climate Change in Asia and the Pacific*. Manila, Philippines. https://doi.org/10.22617/TCS178839-2

Adger, N. W., Barnett, J., Brown, K., & Marshall, N. (2012). Cultural dimensions of climate change impacts and adaptation. *Nature Climate Change*, *3*. https://doi.org/10.1038/NCLIMATE1666

Adhikari, D., Tiwary, R., & Barik, S. K. (2015). Modelling hotspots for invasive alien plants in India. *PLoS ONE*, *10*(7), 7–18. https://doi.org/10.1371/journal.pone.0134665

Agarwal, C., Green, G. M., Grove, J. M., Evans, T. P., & Schweik, C. M. (2002). A Review and Assessment of Land-Use Change Models: Dynamics of Space, Time, and Human Choice. *Apollo The International Magazine Of Art And Antiques*, 62. https://doi.org/10.1289/ehp.6514

Agrawal, A., Cashore, B., Hardin, R., Shepherd, G., Benson, C., & Miller, D. (2013). *ECONOMIC CONTRIBUTIONS OF FORESTS*.

Aguilar, A. G., Ward, P. M., & Smith Sr, C. . (2003). Globalization, regional development, and mega-city expansion in Latin America: Analyzing Mexico City's peri-urban hinterland. *Cities*, *20*(1), 3–21. https://doi.org/10.1016/S0264-2751(02)00092-6

Al-Jamal, K., & Schiffler, M. (2009). *Desalination Opportunities and Challenges in the Middle East and North Africa Region*.

Al-Tawfiq, J. A., Zumla, A., & Memish, Z. A. (2014). Travel implications of emerging coronaviruses: SARS and MERS-CoV. *Travel Medicine and Infectious Disease*, *12*(5), 422–428. https://doi.org/10.1016/j.tmaid.2014.06.007

Allen, B. L., Allen, L. R., & Leung, L. K.-P. (2015). Interactions between two naturalised invasive predators in Australia: are feral cats suppressed by dingoes? *Biological Invasions*, *17*(2), 761–776. https://doi.org/10.1007/s10530-014-0767-1

Allen, D. J., Molur, S., & Daniel, B. A. (2010). *The Status and Distribution of Freshwater Biodiversity in the Eastern Himalaya.* Cambridge, UK and Gland, Switzerland: IUCN, and Coimbatore, India: Zoo Outreach Organisation.

Allen, D. J., Smith, K. G., & Darwall, W. R. T. (2012). *The Status and Distribution of Freshwater Biodiversity in Indo-Burma.* . Cambridge, UK and Gland, Switzerland: IUCN. x+158pp+4pp cover.

Almazroui, M., Islam, M. N., Jones, P. D., Athar, H., & Rahman, M. A. (2012). Recent climate change in the Arabian Peninsula: Seasonal rainfall and temperature climatology of Saudi Arabia for 1979–2009. *Atmospheric Research*, *111*(Supplement C), 29–45. https://doi.org/https://doi.org/10.1016/j.atmosres.2012.02.013

Aloalii, I., Masamdu, R., Theunis, W., & Thistleton, B. (1993). Prospects for Biological Control of Taro Beetles, Papuana spp. (coleoptera: scarabaeidae), in the South Pacific. *Research Extension Series: Hawaii Institute of Tropical Agriculture and Human Resources*, 66–70.

An, S., Li, H., Guan, B., Zhou, C., Wang, Z., Deng, Z., Zhi, Y., Liu, Y., Xu, C., Fang, S., Jiang, J., & Li, H. (2007). China's Natural Wetlands: Past Problems, Current Status, and Future Challenges. *AMBIO: A Journal of the Human Environment*, *36*(4), 335–342. https://doi.org/10.1579/0044-7447(2007)36[335:CNWPPC]2.0.CO;2

Anderson, A. (2002). Faunal collapse, landscape change and settlement history in Remote Oceania. *World Archaeology*, *33*(3), 375–390. https://doi.org/10.1080/00438240120107431

Anderson, D. M., Cembella, A. D., & Hallegraeff, G. M. (2012). Progress in Understanding Harmful Algal Blooms: Paradigm Shifts and New Technologies for Research, Monitoring, and Management. *Annual Review of Marine Science*, *4*(1), 143–176. https://doi.org/10.1146/annurev-marine-120308-081121

Andrew, R., & Dymond, J. R. (2013). Expansion of lifestyle blocks and urban areas onto high-class land: an update for planning and policy. *Journal of The Royal Society of New Zealand*, *43*(3), 128–140. https://doi.org/10.1080/03036758.2012.736392

Animal Health Board. (2007). Review of the National Bovine Tuberculosis Pest Management Strategy. Retrieved from http://www.tbfree.org.nz/Portals/0/2014AugResearchPapers/Review of the National Bovine Tuberculosis Pest Management Strategy.pdf

Anticamara, J. A., Watson, R., Gelchu, A., & Pauly, D. (2011). Global fishing effort (1950-2010): Trends, gaps, and implications. *Fisheries Research*, *107*(1–3), 131–136. https://doi.org/10.1016/j.fishres.2010.10.016

Antonelli, A. (2015). Multiple origins of mountain life. *Nature*, *524*(7565), 300–301. https://doi.org/http://dx.doi.org/10.1038/nature14645

APN. (2011). Land Use and Land Cover Change (LUCC) for South East Asia, APN E-Lib. Retrieved October 23, 2015, from http://www.apn-gcr.org/resources/items/show/1459

Araújo, M. B., Nogués-Bravo, D., Diniz-Filho, J. A. F., Haywood, A. M., Valdes, P. J., & Rahbek, C. (2008). Quaternary climate changes explain diversity among reptiles and amphibians. *Ecography*, *31*(1), 8–15. https://doi.org/10.1111/j.2007.0906-7590.05318.x

Arthur, A. D., Pech, R. P., Jiebu, Zhang, Y., & Lin, H. (2007). *Grassland degradation on the Tibetan Plateau: The role of small mammals and methods of control*. *ACIAR Technical Reports* (Vol. 67).

Arunakumara, K. K. I. U., Walpola, B. C., & Yoon, M. H. (2013). Current status of heavy metal contamination in Asia's rice lands. *Reviews in Environmental Science and Biotechnology*. https://doi.org/10.1007/s11157-013-9323-1

Ashcroft, M. B., Gollan, J. R., Warton, D. I., & Ramp, D. (2012). A novel approach to quantify and locate potential microrefugia using topoclimate, climate stability, and isolation from the matrix. *Global Change Biology*, *18*(6), 1866–1879. https://doi.org/10.1111/j.1365-2486.2012.02661.x

Ashraf, J., Pandey, R., & de Jong, W. (2017). Assessment of bio-physical, social and economic drivers for forest transition in Asia-Pacific region. *Forest Policy and Economics*, *76*, 35–44. https://doi.org/10.1016/j.forpol.2016.07.008

Auld, T. D., & Hutton, I. (2004). Conservation issues for the vascular flora of Lord Howe Island. *Cunninghamia*, *8*(4), 490–500.

Auld, T. D., & Leishman, M. R. (2015). Ecosystem risk assessment for Gnarled Mossy Cloud Forest, Lord Howe Island, Australia. *Austral Ecology*, *40*(4), 364–372. https://doi.org/10.1111/aec.12202

Ausseil, A.-G. E., Chadderton, W. L., Gerbeaux, P., Theo Stephens, R. T., & Leathwick, J. R. (2011). Applying systematic conservation planning principles to palustrine and inland saline wetlands of New Zealand. *Freshwater Biology*, *56*(1), 142–161. https://doi.org/10.1111/j.1365-2427.2010.02412.x

Australian Biosecurity Group. (2005). *Invasive Weeds, Pests and Diseases: Solutions to Secure Australia*. Invasive Animals Co-operative Research Centre.

Australian government. (2009). *Australia ' s Terrestrial Biodiversity*. Retrieved from http://www.environment.gov.au/biodiversity/publications/assessment-australias-terrestrial-biodiversity-2008

Australian Government. (2017). Species Profile and Threats Database. Retrieved December 28, 2017, from http://www.environment.gov.au/cgi-bin/sprat/public/spratlookupcommunity.pl?name=grassland&searchtype=wildcard

Axmacher, J. C., & Sang, W. (2013). Plant Invasions in China - Challenges and Chances. *PLoS ONE*, *8*(5), 1–9. https://doi.org/10.1371/journal.pone.0064173

Bailey, A. M., & Sorensen, J. H. (1962). *Subantarctic Campbell Island* (Vol. Proceeding). Denver Museum of Natural History.

Bajpai, D., & Inderjit. (2013). Impact of nitrogen availability and soil communities on biomass accumulation of an invasive species. *AoB PLANTS*, *5*, plt045-plt045. https://doi.org/10.1093/aobpla/plt045

Baker, B., & Moseley RK. (2007). Advancing Treeline and Retreating Glaciers: Implications for Conservation in Yunnan, P.R. China. *Arctic, Antarctic, and Alpine Research*, *39*(2), 200–209.

Balbo, N., Billari, F. C., & Mills, M. (2013). Fertility in Advanced Societies: A Review of Research. *European Journal of Population / Revue Européenne de Démographie*, *29*(1), 1–38. https://doi.org/10.1007/s10680-012-9277-y

Baller, S., Dutta, S., & Lanvin, B. (2016). *The global information technology report 2016 – Innovating in the digital economy*. Geneva, World Economic Forum.

Balodi, K. N., Naithani, S., Kaur, J., Singh, A., & Chauhan, A. S. (2014). Eco-tourism A Sustainable Livelihood Option for Mountainous Communities in Uttarkashi, Uttarakhand, India. *Journal of Studies in Dynamics and Change Journal of Studies in Dynamics and Change Journal of Studies in Dynamics and Change*, *1*(4), 2348–7038. Retrieved from http://www.jsdc.lokkatha.com

Banerjee, S., Black, R., Kniveton, D., & Kollmair, M. (2014). *The Changing Hindu Kush Himalayas: Environmental Change and Migration*. Springer Netherlands.

Banks, P. B., Newsome, A. E., & Dic man, C. R. (2000). Predation by red foxes limits recruitment in populations of eastern grey kangaroos. *Austral Ecol.*, *25*, 283–291.

Baran, E., & Myschowoda, C. (2009). Dams and fisheries in the Mekong Basin. *Aquatic Ecosystem Health and Management*, *12*(3), 227–234.

Barbet-Massin, M., & Jetz, W. (2015). The effect of range changes on the functional turnover, structure and diversity of bird assemblages under future climate scenarios. *Global Change Biology*, *21*(8), 2917–2928. https://doi.org/10.1111/gcb.12905

Barlow, C., Baran, E., Halls, A. S., & Kshatriya, M. (2008). How much of the Mekong fish catch is at risk from mainstream dam development? *Catch and Culture*, *14*(3), 16–21.

Bassi, N., Kumar, M. D., Sharma, A., & Pardha-Saradhi, P. (2014). Status of wetlands in India: A review of extent, ecosystem benefits, threats and management strategies. *Journal of Hydrology: Regional Studies*, *2*, 1–19. https://doi.org/http://dx.doi.org/10.1016/j.ejrh.2014.07.001

Bawa, K. S., & Dayanandan, S. (1997). Socioeconomic factors and tropical deforestation. *Nature*, *386*(6625), 562–563. https://doi.org/10.1038/386562a0

Bax, N., Williamson, A., Aguero, M., Gonzalez, E., & Geeves, W. (2003). Marine invasive alien species: A threat to global biodiversity. *Marine Policy*, *27*(4), 313–323. https://doi.org/10.1016/S0308-597X(03)00041-1

Beaumont, L. J., Graham, E., Duursma, D. E., Wilson, P. D., Cabrelli, A., Baumgartner, J. B., Hallgren, W., Esperón-Rodríguez, M., Nipperess, D. A., Warren, D. L., Laffan, S. W., & VanDerWal, J. (2016). Which species distribution models are more (or less) likely to project broad-scale, climate-induced shifts in species ranges? *Ecological Modelling*, *342*(Supplement C), 135–146. https://doi.org/https://doi.org/10.1016/j.ecolmodel.2016.10.004

Beaumont, L. J., Pitman, A. J., Poulsen, M., & Hughes, L. (2007). Where will species go? Incorporating new advances in climate modelling into projections of species distributions. *Global Change Biology*, *13*(7), 1368–1385. https://doi.org/10.1111/j.1365-2486.2007.01357.x

Bell, J. D., Johnson, J. E., & Hobday, A. J. (2011). *Vulnerability of tropical Pacific fisheries and aquaculture to climate change.* Noumea, New Caledonia.: Secretariat of the Pacific Community.

Bellard, C., Bertelsmeier, C., Leadley, P., Thuiller, W., & Courchamp, F. (2012). Impacts of climate change on the future of biodiversity. *Ecology Letters*, *15*(4), 365–377. https://doi.org/10.1111/j.1461-0248.2011.01736.x

Bellard, C., Russell, J., Hoffmann, B. D., Leclerc, C., & Courchamp, F. (2015). Adapting island conservation to climate change. *Trends in Ecology & Evolution*, *30*(1), 2–3.

Bengsen, A. J., Gentle, M. N., Mitchell, J. L., Pearson, H. E., & Saunders, G. R. (2014). Impacts and management of wild pigs Sus scrofa in australia. *Mammal Review*, *44*(2), 135–147. https://doi.org/10.1111/mam.12011

Bengston, D. N., & Youn, Y. C. (2006). Urban containment policies and the protection of natural areas: The case of Seoul’s greenbelt. *Ecology and Society*, *11*(1). https://doi.org/10.1016/j.amepre.2008.01.018

Berg, M., Tran, H. C., Nguyen, T. C., Pham, H. V, Schertenleib, R., & Giger, W. (2001). Arsenic

contamination of groundwater and drinking water in Vietnam: A human health threat. *Environmental Science and Technology*, *35*, 2621–2626.
Bergström, L., Kautsky, L., Malm, T., Rosenberg, R., Wahlberg, M., Capetillo, N., & Wilhelmsson, D. (2014). Effects of offshore wind farms on marine wildlife—a generalized impact assessment. *Environmental Research Letters*, *9*(3), 34012. Retrieved from http://stacks.iop.org/1748-9326/9/i=3/a=034012
Betzold, C. (2016). Fuelling the Pacific: Aid for renewable energy across Pacific Island countries. *Renewable and Sustainable Energy Reviews*, *58*, 311–318. https://doi.org/http://dx.doi.org/10.1016/j.rser.2015.12.156
Bewsell, D., Bigsby, H., & Cullen, R. (2012). Using involvement to understand individual responses to an issue: the case of New Zealand biosecurity. *New Zealand Journal of Agricultural Research*, *55*(1), 73–88. https://doi.org/10.1080/00288233.2011.647354
Bezuijen, M. R., Morgan, C., & Mather, R. J. (2011). *A Rapid Vulnerability Assessment of Coastal Habitats and Selected Species to Climate Risks in Chanthaburi and Trat (Thailand), Koh Kong and Kampot (Cambodia), and Kien Giang, Ben Tre, Soc Trang and Can Gio (Vietnam).* Gland, Switzerland: IUCN.
Bhat, D. M., Murali, K. S., & Ravindranath, N. H. (2001). Formation and recovery of secondary forests in India: A particular reference to Western Ghats in South India. *Journal of Tropical Forest Science*, *13*(4), 601–620.
Bhatt, J. R., Singh, J. S., Singh, S. P., Tripathi, R. S., & Kohli, R. K. (2011). *Invasive Alien Plants An Ecological Appraisal for the Indian Subcontinent (Vol. 1)*. Wallingford, Oxon, UK: CAB International Publishing.
Bhattacharya, K., Azizi, P. M., Shobair, S. S., & Mohsini, M. Y. (2004). *Drought impacts and potential for their mitigation in southern and western Afghanistan*. Working paper 91. Colombo, Sri Lanka: International Water Management Institute.
Bickford, D., Howard, S. D., Ng, D. J. J., & Sheridan, J. A. (2010). Impacts of climate change on the amphibians and reptiles of Southeast Asia. Biodiversity and Conservation. *Biodiversity and Conservation*, *19*, 1043–1062.
Bickford, D., Ng, T. H., Qie, L., Kudavidanage, E. P., & Bradshaw, C. J. A. (2010). Forest Fragment and Breeding Habitat Characteristics Explain Frog Diversity and Abundance in Singapore. *Biotropica*, *42*(1), 119–125. https://doi.org/10.1111/j.1744-7429.2009.00542.x
Biosecurity New Zealand. (2009). Economic costs of pests to New Zealand. Retrieved from http://www.biosecurity.govt.nz/files/pests/surv-mgmt/economic-costs-of-pests-to-new-zealand.pdf
Black, R., Adger, W. N., Arnell, N. W., Dercon, S., Geddes, A., & Thomas, D. (2011). The effect of environmental change on human migration. *Global Environmental Change*, *21*(SUPPL. 1), S3–S11. https://doi.org/10.1016/j.gloenvcha.2011.10.001
Blasco, F., Aizpuru, M., & Gers, C. (2001). Depletion of the mangroves of Continental Asia. *Wetlands Ecology and Management*, *9*, 245–256. https://doi.org/10.1023/a:1011169025815
Blasiak, R., & Ichikawa, K. (2012). Revitalising Socio-ecological Production Landscapes. Retrieved December 28, 2017, from https://ourworld.unu.edu/en/revitalising-socio-ecological-production-landscapes
Bloom, D. E., Canning, D., & Fink, G. (2008). Urbanization and the Wealth of Nations. *Science*, *319*(5864), 772–775. https://doi.org/10.1126/science.1153057
Bloom, D. E., Canning, D., & Sevilla, J. (2003). *The demographic dividend: a new perspective on the economic consequences of population change.* Retrieved from http://www.rand.org/content/dam/rand/pubs/monograph_reports/2007/MR1274.pdf
Bloom, D. E., & Williamson, J. G. (1998). Demographic Transitions and Economic Miracles in Emerging Asia. *The World Bank Economic Review*, *12*(3), 419–455. https://doi.org/10.1093/wber/12.3.419
Bohra-Mishra, P., Oppenheimer, M., & Hsiang, S. M. (2014). Nonlinear permanent migration response to climatic variations but minimal response to disasters. *Proceedings of the National Academy of Sciences of the United States of America*, *111*(27), 9780–9785. https://doi.org/10.1073/pnas.1317166111
Bonasoni, P., Laj, P., Marinoni, A., Sprenger, M., Angelini, F., Arduini, J., Bonafe`, U., Calzolari, F.,

Colombo, T., Decesari, S., Biagio, C. D., di Sarra, A. G., Evangelisti, F., Duchi, R., Facchini, M. C., Fuzzi, S., & Gobbi, G. P. (2010). Atmospheric Brown Clouds in the Himalayas: first two years of continuous observations at the Nepal climate observatory-pyramid (5079 m). *Atmospheric Chemistry and Physics*, *10*(15), 7515–7531.
Bosch, A., Schmidt, K., He, J. S., Doerfer, C., & Scholten, T. (2017). Potential CO2 emissions from defrosting permafrost soils of the Qinghai-Tibet Plateau under different scenarios of climate change in 2050 and 2070. *Catena*, *149*, 221–231. https://doi.org/10.1016/j.catena.2016.08.035
Bouwman, A. F., Van der Hoek, K. W., Eickhout, B., & Soenario, I. (2005). Exploring changes in world ruminant production systems. *Agricultural Systems*, *84*(2), 121–153. https://doi.org/10.1016/j.agsy.2004.05.006
Boyd, J., & Banzhaf, S. (2007). What are ecosystem services? The need for standardized environmental accounting units. *Ecological Economics*. https://doi.org/10.1016/j.ecolecon.2007.01.002
Boyd, P. W., Lennartz, S. T., Glover, D. M., & Doney, S. C. (2014). Biological ramifications of climate-change-mediated oceanic multi-stressors. *Nature Climate Change*, *5*(1), 71–79. https://doi.org/10.1038/nclimate2441
Braimoh, A. K., Subramanian, S. M., Elliot, W. S., & Gasparatos, A. (2010). *Climate and Human-Related Drivers of Biodiversity Decline in Southeast Asia*. UNU-IAS Policy report.
Brander, L. M., Wagtendonk, A. J., Hussain, S. S., McVittie, A., Verburg, P. H., de Groot, R. S., & van der Ploeg, S. (2012). Ecosystem service values for mangroves in Southeast Asia: A meta-analysis and value transfer application. *Ecosystem Services*, *1*(1), 62–69. https://doi.org/10.1016/j.ecoser.2012.06.003
Brandt, J. S., Haynes, M. A., Kuemmerle, T., Waller, D. M., & Radeloff, V. C. (2013). Regime shift on the roof of the world: Alpine meadows converting to shrublands in the southern Himalayas. *Biological Conservation*, *158*, 116–127. https://doi.org/10.1016/j.biocon.2012.07.026
Bremner, J., & Hunter, L. M. (2014). *Migration and the Environment*. *Population Bulletin* (Vol. 69).
Briske, D. D., Zhao, M., Han, G., Xiu, C., Kemp, D. R., Willms, W., Havstad, K., Kang, L., Wang, Z., Wu, J., Han, X., & Bai, Y. (2015). Strategies to alleviate poverty and grassland degradation in Inner Mongolia: Intensification vs production efficiency of livestock systems. *Journal of Environmental Management*. https://doi.org/10.1016/j.jenvman.2014.07.036
Brooks, T. M., Akçakaya, H. R., Burgess, N. D., Butchart, S. H. M., Hilton-Taylor, C., Hoffmann, M., Juffe-Bignoli, D., Kingston, N., MacSharry, B., Parr, M., Perianin, L., Regan, E. C., Rodrigues, A. S. L., Rondinini, C., Shennan-Farpon, Y., & Young, B. E. (2016). Analysing biodiversity and conservation knowledge products to support regional environmental assessments. *Scientific Data*, *3*, 160007. https://doi.org/10.1038/sdata.2016.7
Brown, a. C., & McLachlan, A. (2002). Sandy shore ecosystems and the threats facing them: some predictions for the year 2025. *Environmental Conservation*, *29*(01), 62–77. https://doi.org/10.1017/S037689290200005X
Bruno, J. F., & Selig, E. R. (2007). Regional decline of coral cover in the Indo-Pacific: Timing, extent, and subregional comparisons. *PLoS ONE*, *2*(8). https://doi.org/10.1371/journal.pone.0000711
Bulian, G., & Nakano, Y. (Eds.). (2018). *Small-scale Fisheries in Japan. Environmental and Socio-cultural Perspectives*. Venezia: Edizioni Ca 'Foscari - Digital Publishing. Retrieved from http://edizionicafoscari.unive.it/media/pdf/books/978-88-6969-242-0/978-88-6969-242-0_BewS1yi.pdf
Burns, K. A., Ehrhardt, M. G., Howes, B. L., & Taylor, C. D. (1993). Subtidal benthic community respiration and production near the heavily oiled Gulf coast of Saudi Arabia. *Marine Pollution Bulletin*, *27*(C), 199–205. https://doi.org/10.1016/0025-326X(93)90025-F
Burrows, M. T., Schoeman, D. S., Buckley, L. B., Moore, P., Poloczanska, E. S., Brander, K. M., Brown, C., Bruno, J. F., Duarte, C. M., Halpern, B. S., Holding, J., Kappel, C. V., Kiessling, W., O'Connor, M. I., Pandolfi, J. M., Parmesan, C., Schwing, F. B., Sydeman, W. J., & Richardson, a. J. (2011). The Pace of Shifting Climate in Marine and Terrestrial Ecosystems. *Science*, *334*(6056), 652–655. https://doi.org/10.1126/science.1210288
Butler, R. A., & Laurance, W. F. (2008). New strategies for conserving tropical forests. *Trends in Ecology & Evolution*, *23*(9), 469–472. https://doi.org/10.1016/j.tree.2008.05.006

Buxton, M., & Goodman, R. (2003). Protecting Melbourne's Green Belt. *Urban Policy and Research*, *21*(2), 205–209. https://doi.org/10.1080/08111140309954
CABI. (2017a). Acacia nilotica. Retrieved January 2, 2018, from www.cabi.org/isc.
CABI. (2017b). Prosopis juliflora (mesquite). Retrieved January 2, 2018, from www.cabi.org/isc
Cairns, M. F. (2015). *Shifting cultivation and environmental change – Indigenous people, agriculture and forest conservation.* London and New York: Routledge.
Campbell, D. J., & Atkinson, I. A. E. (2002). Depression of tree recruitment by the Pacific rat (Rattus exulans Peale) on New Zealand's northern offshore islands. *Biological Conservation*, *107*(1), 19–35. https://doi.org/10.1016/S0006-3207(02)00039-3
Campbell, M. L., Gould, B., & Hewitt, C. L. (2007). Survey evaluations to assess marine bioinvasions. *Marine Pollution Bulletin*, *55*(7–9), 360–378. https://doi.org/10.1016/j.marpolbul.2007.01.015
Cantrell, R., & Hettel, G. (2004). New challenges and technological opportunities for rice-based production systems for food security and poverty alleviation in Asia and the Pacific. *FAO International Rice Year, 2004 Symposium. Food …*, (February), 12–13. Retrieved from http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:NEW+CHALLENGES+AND+TECHNOLOGICAL+OPPORTUNITIES+FOR+RICE-BASED+PRODUCTION+SYSTEMS+FOR+FOOD+SECURITY+AND+POVERTY+ALLEVIATION+IN+ASIA+AND+THE+PACIFIC#0
Carrico, C. M., Bergin, M. H., Shrestha, A. B., Dibb, J. E., Gomes, L., & Harris, J. M. (2003). The importance of carbon and mineral dust to seasonal aerosol properties in the Nepal Himalaya. *Atmospheric Environment*. https://doi.org/10.1016/S1352-2310(03)00197-3
CBD Secretariat. (n.d.-a). Health and Biodiversity. Retrieved December 28, 2017, from https://www.cbd.int/health/
CBD Secretariat. (n.d.-b). Island Biodiversity - Why is it Important? Retrieved January 3, 2018, from https://www.cbd.int/island/whymatters.shtml
CBD Secretariat. (n.d.-c). What is Island Biodiversity? Retrieved January 3, 2018, from https://www.cbd.int/island/intro.shtml
CDC-NIOSH. (2014). *Filling the Knowledge Gaps for Safe Nanotechnology in the Workplace* (Vol. TTY). Retrieved from http://www.cdc.gov/niosh.
Centre for Climate and Energy Solutions. (2010). *Science. What is black carbon?* Retrieved from C2ES.ORG
Centre for Science and Environment. (2017). *State of India's Environment 2017 in Figures*. New Delhi, India. Retrieved from http://www.downtoearth.org.in/reviews/state-of-india-s-environment-2017-in-figures-ebook--57874
Chace, J. F., & Walsh, J. J. (2006). Urban effects on native avifauna: a review. *Landscape and Urban Planning*, *74*(1), 46–69. https://doi.org/10.1016/j.landurbplan.2004.08.007
Chang, C. P., Lei, Y., Sui, C. H., Lin, X., & Ren, F. (2012). Tropical cyclone and extreme rainfall trends in East Asian summer monsoon since mid-20th century. *Geophysical Research Letters*, *39*(17), 1–6. https://doi.org/10.1029/2012GL052945
Chaturvedi, S., & Srinivas, K. R. (2010). *Asia-Pacific Biotechnology Report 2010 Survey on Biotechnology Capacity in Asia-Pacific: Opportunities for National Initiatives and Regional Cooperation*.
Chauhan, C. (2015). 13 out of world's top 20 polluted cities in India, only three in China. Retrieved December 18, 2017, from http://www.hindustantimes.com/india/13-out-of-world-s-top-20-polluted-cities-in-india-only-three-in-china/story-myTrPZM8DHmQOhxB9cc5hI.html
Chen, H., Liu, J., Xue, T., & Wang, R. (2012). Roads Accelerate the Invasion Process of Alien Species. *Advanced Materials Research*, 1483–1487.
Chen, H., Zhu, Q., Peng, C., Wu, N., Wang, Y., Fang, X., Gao, Y., Zhu, D., Yang, G., Tian, J., Kang, X., Piao, S., Ouyang, H., Xiang, W., Luo, Z., Jiang, H., Song, X., Zhang, Y., Yu, G., Zhao, X., Gong, P., Yao, T., & Wu, J. (2013). The impacts of climate change and human activities on biogeochemical cycles on the Qinghai-Tibetan Plateau. *Global Change Biology*, *19*(10), 2940–2955. https://doi.org/10.1111/gcb.12277
Chettri N, Sharma E, Shakya B, Thapa R, Bajracharya B, Uddin K, Oli K P, C. D. (2010). *Biodiversity in the Eastern Himalayas: Status, trends and vulnerability to climate change;*

Climate change impact and vulnerability in the Eastern Himalayas – Technical report 2. Kathmandu: ICIMOD.

Chettri N, Sharma E, D. D. C. and S. R. C. (2002). Effect of firewood extraction on tree structure, regeneration, and woody biomass productivity in a trekking corridor of the Sikkim Himalaya. *Mountain Research and Development* , *22*(2), 150–158.

Chettri N. (2014). Reconciling Mountain Biodiversity Conservation in a Changing Cli -mate: A Hindu Kush-Himalayan Perspective. *Conservation Science*, *2*, 17–27.

Chettri, N., Bubb, P., Kotru, R., Rawat, G., Ghate, R., Murthy, M. S. R., Wallrapp, C., Pauli, H., Shrestha, A. B., & Mool, P. K. (2015). *Long-term Environmental and Socio-ecological Monitoring in Transboundary Landscapes: An Interdisciplinary Implementation Framework*. International Centre for Integrated Mountain Development (ICIMOD).

Chettri, N., Shakya, B., Thapa, R., & Sharma, E. (2008). Status of protected area system in the Hindu Kush Himalaya: an analysis of PA coverage. *International Journal of Biodiversity Science and Management*, *4*(3), 164–178.

Chiu, M.-C., Pan, C.-W., & Lin, H.-J. (2017). A framework for assessing risk to coastal ecosystems in Taiwan due to climate change. *Terrestrial, Atmospheric and Oceanic Sciences*, *28*(1), 057. https://doi.org/10.3319/TAO.2016.06.30.01(CCA)

Choi, M. B., Martin, S. J., & Lee, J. W. (2012). Distribution, spread, and impact of the invasive hornet Vespa velutina in South Korea. *Journal of Asia-Pacific Entomology*, *15*(3), 473–477. https://doi.org/10.1016/j.aspen.2011.11.004

Chomik, R., & Piggott, J. (2015). Population Ageing and Social Security in Asia. *Asian Economic Policy Review*, *10*(2), 199–222. https://doi.org/10.1111/aepr.12098

Christian Korner. (2003). *Alpine plant life: Functional plant ecology of high mountain ecosystems*. Berlin Heidelberg: Springer Verlag.

Chu, L., & Kompas, T. (2014). Targets and Fisheries Management in the Asia and Pacific Region. *Asia & the Pacific Policy Studies*, *1*(3), 615–622. https://doi.org/10.1002/app5.56

Chuluun, T., & Ojima, D. (2002). Land use change and carbon cycle in and and semi-arid lands of East and Central Asia. *Science in China Series C-Life Sciences*, *45*(October), 48–+.

Clothier, B., Hall, S., & Green, S. (2012). Chapter 6. Horticulture. In *Impacts of Climate Change on Land-based Sectors and Adaptation Options. Clark, A.J.; Nottage, R.A.C. (eds) Technical Report to the Sustainable Land Management and Climate Change Adaptation Technical Working Group, Ministry for Primary Industries, 408 p*. Retrieved from http://www.climatecloud.co.nz/CloudLibrary/2012-33-CC-Impacts-Adaptation_SLMACC-Chapter6.pdf

Cohen, J. I. (2005). Poorer nations turn to publicly developed GM crops. *Nature Biotechnology*, *23*(1), 27–33. https://doi.org/10.1038/nbt0305-366b

Cole, M., Lindeque, P., Halsband, C., & Galloway, T. S. (2011). Microplastics as contaminants in the marine environment: A review. *Marine Pollution Bulletin*, *62*, 2588–2597.

Coles, S. L., Reath, P. R., Skelton, P. A., Bonito, V., DeFelice, R. C., & Basch, L. (2003). Introduced marine species in Pago Pago Harbor, Fagatele Bay and the National Park Coast, American Samoa, (December).

Collins, M., Knutti, R., Arblaster, J., Dufresne, J.-L., Fichefet, T., Friedlingstein, P., Gao, X., Gutowski, W. J., Johns, T., Krinner, G., Shongwe, M., Tebaldi, C., Weaver, A. J., & Wehner, M. (2013). Long-term Climate Change: Projections, Commitments and Irreversibility. *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, 1029–1136. https://doi.org/10.1017/CBO9781107415324.024

Connell, J., Page, S. J., & Bentley, T. (2009). Towards sustainable tourism planning in New Zealand: Monitoring local government planning under the Resource Management Act. *Tourism Management*, *30*(6), 867–877. https://doi.org/10.1016/j.tourman.2008.12.001

Cook, B. I., Palmer, J. G., Cook, E. R., Turney, C. S. M., Allen, K., Fenwick, P., O'Donnell, A., Lough, J. M., Grierson, P. F., Ho, M., & Baker, P. J. (2016). The paleoclimate context and future trajectory of extreme summer hydroclimate in eastern Australia. *Journal of Geophysical Research: Atmospheres*, *121*(21), 12,812-820,838. https://doi.org/10.1002/2016JD024892

Cook, E. R., Anchukaitis, K. J., Buckley, B. M., D'Arrigo, R. D., Jacoby, G. C., & Wright, W. E.

(2010). Asian Monsoon Failure and Megadrought During the Last Millennium. *Science*, *328*(5977), 486 LP-489. Retrieved from http://science.sciencemag.org/content/328/5977/486.abstract

Cooke, B. D. (2012). Rabbits: manageable environmental pests or participants in new Australian ecosystems? *Wildlife Research*, *39*(4), 279–289. https://doi.org/10.1071/WR11166

Cooper, A., Turney, C., Hughen, K. A., Barry, W., Mcdonald, H. G., & Bradshaw, C. J. A. (2015). Abrupt warming events drove Late Pleistocene Holarctic megafaunal turnover. *Science Express*, *349*(July), 1–8. https://doi.org/10.1126/science.aac4315

Costello, C., Ovando, D., Clavelle, T., Strauss, C. K., Hilborn, R., Melnychuk, M. C., Branch, T. A., Gaines, S. D., Szuwalski, C. S., Cabral, R. B., Rader, D. N., & Leland, A. (2016). Global fishery prospects under contrasting management regimes. *Proceedings of the National Academy of Sciences*, *113*(18), 5125–5129. https://doi.org/10.1073/pnas.1520420113

Cranfield, H. J., Gordon, D. P., Willan, R. C., Marshall, B. a., Battershill, C. N., Francis, M. P., Nelson, W. a., Glasby, C. J., & Read, G. B. (1998). Adventive marine species in New Zealand. *NIWA Technical Report*, *34*(January 1998), 48.

Crooks, S., Herr, D., & Tamelander, J. (2011). Mitigating climate change through restoration and management of coastal wetlands and near-shore marine ecosystems: challenges and opportunities. *Environment Department …*, (121). Retrieved from http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:Mitigating+Climate+Change+through+Restoration+and+Management+of+Coastal+Wetlands+and+Near-shore+Marine+Ecosystems+Challenges+and+Opportunities#0

Cunningham, D., & Moors, P. (1994). The Decline of Rockhopper Penguins Eudyptes chrysocome at Campbell Island, Southern Ocean and the Influence of Rising Sea Temperatures. *Emu*, *94*(1), 27. https://doi.org/10.1071/MU9940027

Curran-Cournane, F., Vaughan, M., Memon, A., & Fredrickson, C. (2014). Trade-offs between high class land and development: Recent and future pressures on Auckland's valuable soil resources. *Land Use Policy*, *39*, 146–154. https://doi.org/http://dx.doi.org/10.1016/j.landusepol.2014.02.020

D'Almeida, K. (2015). The Asia-Pacific Region Is 'Growing', but Millions Are Living in Poverty. Retrieved December 19, 2017, from http://www.ipsnews.net/2015/05/the-asia-pacific-region-is-growing-but-millions-are-living-in-poverty/

Daigneault, A., & Brown, P. (2013). Invasive species management in the Pacific using survey data and benefit-cost analysis.

Damania, R., Seidenstick, J., & Whitten, T. (2008). *A Future for Wild Tigers*. Washington, D.C.: World Bank.

Danielsen, F., Sørensen, M. K., Olwig, M. F., Selvam, V., Parish, F., Burgess, N. D., Hiraishi, T., Karunagaran, V. M., Rasmussen, M. S., Hansen, L. B., Quarto, A., & Suryadiputra, N. (2005). The Asian Tsunami: A Protective Role for Coastal Vegetation. *Science*, *310*(5748), 643. https://doi.org/10.1126/science.1118387

Dar, P. A., Reshi, Z. A., & Shah, M. A. (2015). Roads act as corridors for the spread of alien plant species in the mountainous regions: A case study of Kashmir Valley, India. *Tropical Ecology*, *56*(2), 183–190.

Das, S., Ghate, C., & Robertson, P. E. (2015). Remoteness, Urbanization, and India's Unbalanced Growth. *World Development*, *66*, 572–587. https://doi.org/10.1016/j.worlddev.2014.09.013

Dattatri, S. (2015). *India's Disappearing Beaches - A wake up call*. You Tube. Retrieved from https://www.youtube.com/watch?v=KgTn6Qpgjok

Dauble, D. D., Hanrahan, T. P., & Geist, D. R. (2003). Impacts of the Columbia River hydroelectric system on main-stem habitats of fall Chinook salmon. *North American Journal of Fisheries Management*, *23*, 641–659.

Davidson, A. D., Campbell, M. L., Hewitt, C. L., & Chaffelke, B. (2015). Assessing the impacts of nonindigenous marine macroalgae: an update of current knowledge. *Botanica Marina*, *58*, 55–79. https://doi.org/10.1515/bot-2014-0079

Davidson, A. D., & Hewitt, C. L. (2014). How often are invasion-induced ecological impacts missed? *Biological Invasions*, *16*(5), 1165–1173. https://doi.org/10.1007/s10530-013-0570-4

Davies, P., Wright, I., Findlay, S., Jonasson, O., & Burgin, S. (2010). Impact of urban development on aquatic macroinvertebrates in south eastern Australia: degradation of in-stream habitats and comparison with non-urban streams. *Aquatic Ecology*, *44*(4), 685–700. https://doi.org/10.1007/s10452-009-9307-y

Dawson, M., Navie, S., James, T., Heenan, P., & Champion, P. (2010). Weeds Key – interactive key to the weed species of New Zealand. Retrieved November 17, 2015, from http://www.landcareresearch.co.nz/resources/identification/plants/weeds-key

Dawson, T. P., Jackson, S. T., House, J. I., Prentice, I. C., & Mace, G. M. (2011). Beyond predictions: biodiversity conservation in a changing climate. *Science (New York, N.Y.)*, *332*(6025), 53–58. https://doi.org/10.1126/science.1200303

De'ath, G., Fabricius, K. E., Sweatman, H., & Puotinen, M. (2012). The 27–year decline of coral cover on the Great Barrier Reef and its causes. *Proceedings of the National Academy of Sciences* , *109*(44), 17995–17999. https://doi.org/10.1073/pnas.1208909109

De Clercq, P., Mason, P. G., & Babendreier, D. (2011). Benefits and risks of exotic biological control agents. *BioControl*, *56*(4), 681–698. https://doi.org/10.1007/s10526-011-9372-8

de Sherbinin, A., Carr, D., Cassels, S., & Jiang, L. (2007). Population and Environment. *Annual Review of Environment and Resources*, *32*(1), 345–373. https://doi.org/10.1146/annurev.energy.32.041306.100243

de Sherbinin, A., Schiller, A., & Pulsipher, A. (2007). The vulnerability of global cities to climate hazards. *Environment and Urbanization*, *19*(1), 39–64. https://doi.org/10.1177/0956247807076725

De Silva, S. S., & Funge-Smith, S. J. (2005). *A review of stock enhancement practices in the inland water fisheries of Asia.* . Asia-Pacific Fishery Commission, Bangkok, Thailand. RAP Publication No. 2005/12, 93 p.

DeFries, R. S., Rudel, T., Uriarte, M., & Hansen, M. (2010). Deforestation driven by urban population growth and agricultural trade in the twenty-first century. *Nature Geoscience*, *3*(3), 178–181. https://doi.org/10.1038/ngeo756

Delmer, D. P. (2005). Agriculture in the developing world: Connecting innovations in plant research to downstream applications. *Proceedings of the National Academy of Sciences of the United States of America* , *102*(44), 15739–15746. https://doi.org/10.1073/pnas.0505895102

Deng, H., Chen, Y., Wang, H., & Zhang, S. (2015). Climate change with elevation and its potential impact on water resources in the Tianshan Mountains, Central Asia. *Global and Planetary Change*, *135*, 28–37. https://doi.org/10.1016/j.gloplacha.2015.09.015

Deng, J. S., Wang, K., Hong, Y., & Qi, J. G. (2009). Spatio-temporal dynamics and evolution of land use change and landscape pattern in response to rapid urbanization. *Landscape and Urban Planning*, *92*(3–4), 187–198. https://doi.org/10.1016/j.landurbplan.2009.05.001

Department of Climate Change. (2009). Climate change risks to Australia's coast—a first pass national assessment. Retrieved from http://www.environment.gov.au/climate-change/adaptation/publications/climate-change-risks-australias-coasts

Department of Conservation. (2015). *Annual report 2015*. Retrieved from http://www.doc.govt.nz/Documents/about-doc/role/publications/doc-annual-report-2015.pdf

Department of Conservation, N. (2013). New Zealand ' s Fifth National Report to the United Nations Convention on Biological Diversity Reporting period : 2009 – 2013, 2009–2013.

Devendra, C. (2012). *Agroforestry and Silvopastoral Systems Potential to Enhance Food Security and Environmental Sustainability in South East Asia*. *Open Access Scientific Reports* (Vol. 1). https://doi.org/10.4172/scientificreports.1

Dewan, A. M., & Yamaguchi, Y. (2009). Using remote sensing and GIS to detect and monitor land use and land cover change in Dhaka Metropolitan of Bangladesh during 1960-2005. *Environmental Monitoring and Assessment*, *150*(1–4), 237–249. https://doi.org/10.1007/s10661-008-0226-5

Dexter, N., Hudson, M., James, S., MacGregor, C., & Lindenmayer, D. B. (2013). Unintended Consequences of Invasive Predator Control in an Australian Forest: Overabundant Wallabies and Vegetation Change. *PLoS ONE*, *8*(8). https://doi.org/10.1371/journal.pone.0069087

Dhir, R. K. (2015). *Indigenous Peoples in the World of Work in Asia and the Pacific*.

Didham, R. K., Tylianakis, J. M., Hutchison, M. A., Ewers, R. M., & Gemmell, N. J. (2005). Are invasive species the drivers of ecological change? *Trends in Ecology & Evolution*, *20*(9), 470–

474. https://doi.org/10.1016/j.tree.2005.07.006
Didham, R., Tylianakis, J., Gemmell, N., Rand, T., & Ewers, R. (2007). Interactive effects of habitat modification and species invasion on native species decline. *Trends in Ecology & Evolution*, *22*(9), 489–496. https://doi.org/10.1016/j.tree.2007.07.001
Dietz, T., Rosa, E. a., & York, R. (2007). Driving the human ecological footprint. *Frontiers in Ecology and the Environment*, *5*(1), 13–18. https://doi.org/10.1890/1540-9295(2007)5[13:DTHEF]2.0.CO;2
Ding, J., Chen, L., Ji, C., Hugelius, G., Li, Y., Liu, L., Qin, S., Zhang, B., Yang, G., Li, F., Fang, K., Chen, Y., Peng, Y., Zhao, X., He, H., Smith, P., Fang, J., & Yang, Y. (2017, June). Decadal soil carbon accumulation across Tibetan permafrost regions . *Nature Geoscience* . https://doi.org/10.1038/ngeo2945
Dixon, M. J. R., Loh, J., Davidson, N. C., Beltrame, C., Freeman, R., & Walpole, M. (2016). Tracking global change in ecosystem area: The Wetland Extent Trends index. *Biological Conservation*, *193*, 27–35. https://doi.org/10.1016/j.biocon.2015.10.023
DLA Piper. (2014). *RENEWABLE ENERGY IN THE ASIA PACIFIC*.
Dobhal, P. K., Kohli, R. K., & Batish, D. R. (2011). Impact of Lantana camara L. invasion on riparian vegetation of Nayar region in Garhwal Himalayas (Uttarakhand, India). *Journal of Ecology and the Natural Environment*, *3*(1), 11–22.
Donat, M. G., Lowry, A. L., Alexander, L. V, O'Gorman, P. A., & Maher, N. (2016). More extreme precipitation in the world[rsquor]s dry and wet regions. *Nature Clim. Change*, *6*(5), 508–513. Retrieved from http://dx.doi.org/10.1038/nclimate2941
Donner, S. D., Rickbeil, G. J. M., & Heron, S. F. (2017). A new, high-resolution global mass coral bleaching database. *PLOS ONE*, *12*(4), e0175490. Retrieved from https://doi.org/10.1371/journal.pone.0175490
Doody, B. J., Sullivan, J. J., Meurk, C. D., Stewart, G. H., & Perkins, H. C. (2010). Urban realities: the contribution of residential gardens to the conservation of urban forest remnants. *Biodiversity and Conservation*, *19*(5), 1385–1400. https://doi.org/10.1007/s10531-009-9768-2
Douglas, M., Ling, S., Low, T., Nowakowski, M., & Trebilco, R. (2008). *Climate Change & Invasive Species: A Review of Interactions November 2006 Workshop Report*. Commonwealth of Australia.
Dressler, W. H., Wilson, D., Clendenning, J., Cramb, R., Keenan, R., Mahanty, S., Bruun, T. B., Mertz, O., & Lasco, R. D. (2017). The impact of swidden decline on livelihoods and ecosystem services in Southeast Asia: A review of the evidence from 1990 to 2015. *Ambio*, *46*(3), 291–310. https://doi.org/10.1007/s13280-016-0836-z
Du, M., Yonemura, S., Zhang, X., He, Y., Liu, J., & Kawashima, S. (2012). Climatic Warming due to Overgrazing on the Tibetan Plateau -An Example at Damxung in the Central Part of the Tibetan Plateau. *Journal of Arid Land Studies*, *22*(1), 119–122.
Duan, W., He, B., Takara, K., Luo, P., Hu, M., Alias, N. E., & Nover, D. (2015). Changes of precipitation amounts and extremes over Japan between 1901 and 2012 and their connection to climate indices. *Climate Dynamics*, *45*(7–8), 2273–2292. https://doi.org/10.1007/s00382-015-2778-8
Dubey, B., Yadav, R. R., Singh, J., & Chaturvedi, R. (2003). Upward shift of Himalayan pine in Western Himalaya, India. *Current Science*.
Dudgeon, D. (2011). Asian river fishes in the Anthropocene: Threats and conservation challenges in an era of rapid environmental change. *Journal of Fish Biology*, *79*(6), 1487–1524. https://doi.org/10.1111/j.1095-8649.2011.03086.x
Dudgeon, D., Arthington, A. H., Gessner, M. O., Kawabata, Z., Knowler, D., Lévêque, C., Naiman, R. J., Prieur-Richard, A.-H., Soto, D., Stiassny, M. L. J., & Sullivan, C. A. (2006). Freshwater biodiversity: importance, threats, status and conservation challenges. *Biological Reviews*, *81*, 163–182.
Dudley, N., Bhagwat, S., Higgins-Zogib, L., Lassen, B., Verschuuren, B., & Wild, R. (2010). Conservation of biodiversity in sacred natural sites in Asia and Africa: A review of the scientific literature. In B. Verschuuren, R. Wild, J. A. McNeely, & G. Oviedo (Eds.), *Sacred natural sites – Conserving nature and culture* (pp. 19–32). London & Washington: Earthsacan; Gland: IUCN.
Dugan, P. J., Barlow, C., Agostinho, A. A., Baran, E., Cada, G. F., Chen, D., Cowx, I. G., Ferguson,

J. W., Jutagate, T., Mallen-Cooper, M., Marmulla, G., Nestler, J., Petrere, M., Welcomme, R. L., & Winemiller, K. O. (2010). Fish migration, dams, and loss of ecosystem services in the Mekong basin. *Ambio*, *39*(344–348).
Durack, P. J., Gleckler, P. J., Landerer, F. W., & Taylor, K. E. (2014). Quantifying underestimates of long-term upper-ocean warming. *Nature Climate Change*, *4*(October), 1–7. https://doi.org/10.1038/nclimate2389
Duraiappah, A. K., Nakamura, K., Takeuchi, K., Watanabe, M., & Nishi, M. (2012). *Satoyama–Satoumi Ecosystems and Human Well-Being: Socio-Ecological Production Landscapes of Japan*. United Nations University Press. Retrieved from https://collections.unu.edu/view/UNU:2536
Durán, A. P., Rauch, J., & Gaston, K. J. (2013). Global spatial coincidence between protected areas and metal mining activities. *Biological Conservation*, *160*, 272–278. https://doi.org/10.1016/j.biocon.2013.02.003
Dutta, S., & Bibao-Osorio, B. (2012). *The global information technology report 2012 – Living in a hyperconnected world.* Geneva, World Economic Forum. Retrieved from www.weforum.org/gitr
Ebi, K. L., Woodruff, R., von Hildebrand, A., & Corvalan, C. (2007). Climate change-related health impacts in the Hindu Kush–Himalayas. *EcoHealth*, *4*(3), 264–270.
ECTNARCC (Editorial Committee of the Third National Assessment Report on Climate Change). (2016). *The Third National Assessment Report on Climate Change*. Beijing, China.
Edwards, F. A., Edwards, D. P., Larsen, T. H., Hsu, W. W., Benedick, S., Chung, A., Vun Khen, C., Wilcove, D. S., & Hamer, K. C. (2014). Does logging and forest conversion to oil palm agriculture alter functional diversity in a biodiversity hotspot? *Animal Conservation*, *17*(2), 163–173. https://doi.org/10.1111/acv.12074
EIA. (2017). *International energy outlook 2017*.
Eldredge, L. G. (1994). Perspectives in aquatic exotic species management in the Pacific Islands, *78*(7), 127.
Elimelech, M., & Phillip, W. A. (2011). The Future of Seawater Desalination: Energy, Technology, and the Environment. *Science*. https://doi.org/10.1126/science.1200488
Ellis, E. C., Goldewijk, K. K., Siebert, S., Lightman, D., & Ramankutty, N. (2010). Anthropogenic transformation of the biomes, 1700 to 2000. *Global Ecology and Biogeography*, *19*(5), 589–606. https://doi.org/10.1111/j.1466-8238.2010.00540.x
Elmqvist, T., Fragkias, M., Goodness, J., Güneralp, B., Marcotullio, P. J., McDonald, R. I., Parnell, S., Schewenius, M., Sendstad, M., Seto, K. C., & Wilkinson, C. (Eds.). (2013). *Urbanization, Biodiversity and Ecosystem Services: Challenges and Opportunities: A Global Assessment*. Dordrecht: Springer Netherlands. https://doi.org/10.1007/978-94-007-7088-1
Emerton, L. (2000). *Using economic incentives for biodiversity conservation*. Retrieved from https://portals.iucn.org/library/efiles/documents/PDF-2000-002.pdf
Erisman, J. W., Galloway, J. N., Dise, N. B., Sutton, M. A., Bleeker, A., Grizzetti, B., Leach, A. M., & de Vries, W. (2015). *Nitrogen Too much of a vital resource*. WWF Netherlands.
Erni, C. (2015). *Shifting Cultivation, Livelihood and Food Security New and Old Challenges for Indigenous Peoples in Asia*.
Evans, A. E. V., Hanjra, M. A., Jiang Yunlu, Qadir, M., & Drechsel, P. (2012). *Water pollution in Asia: The urgent need for prevention and monitoring*. *Water Quality, Global Water Forum*.
EY. (2016). EY Renewable energy country attractiveness index Issue 47 May 2016, RECAI.
EY. (2017). *Renewable energy country attractiveness index.pdf*. Retrieved from https://emeia.ey-vx.com/4864/93958/landing-pages/recai-issue-50---download-full-report.asp
Fabinyi, M., & Dalabajan, D. (2011). Policy and practice in the live reef fish for food trade: A case study from Palawan, Philippines. *Marine Policy*, *35*(3), 371–378. https://doi.org/10.1016/j.marpol.2010.11.001
FAO. (n.d.-a). FAOSTAT Search Data (pesticides). Retrieved January 11, 2018, from http://www.fao.org/faostat/en/#search/pesticides
FAO. (n.d.-b). Prevalence of undernourishment (% of population). Retrieved from https://data.worldbank.org/indicator/SN.ITK.DEFC.ZS
FAO. (2010a). *Asia-Pacific forests and forestry to 2020. Asia-Pacific Forestry Sector Outlook Study*

II. Asia-Pacific Forestry Commission. Bangkok. Retrieved from http://www.fao.org/fileadmin/templates/rap/files/NRE/Forestry_Group/1_Forests_for_a_greener_future.pdf
FAO. (2010b). *Asia-Pacific forests and forestry to 2020. Forest Policy Brief 01 Asia-Pacific Forestry Commission*. Bangkok.
FAO. (2010c). *Challenges and opportunities for carbon sequestration in grassland systems. A technical report on grassland management and climate change mitigation*. Rome: Food and Agricultural Organization.
FAO. (2012). *Selected Indicators for food and agricultural development in Asia Pacific region 2001-2011*.
FAO. (2013a). *Solutions for sustainable agriculture and food systems - Global scenario on crop biotechnology*. China Agricultural University.
FAO. (2013b). *Solutions for sustainable agriculture and food systems - Global scenario on crop biotechnology*. Rome, Italy.
FAO. (2014). *Restoration of grasslands and forests for climate change mitigation and adaptation, and the promotion of ecosystem services. 32nd FAO Regional Conference for Asia and the Pacific*. Ulaanbaatar, Mongolia.
FAO. (2015a). *Global Forest Products Facts and Figures*. Rome, Italy. Retrieved from http://www.fao.org/3/a-i6669e.pdf
FAO. (2015b). *Global forest resource assessment 2015. Desk reference.* Rome, Italy.
FAO. (2015c). *Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries in the Context of Food Security and Poverty Eradication*.
FAO. (2015d). *World fertilizer trends and outlook to 2018*. FAO.
FAO. (2016a). *The state of food and agriculture - Climate change, agriculture and food security*.
FAO. (2016b). *The State of World Fisheries and Aquaculture 2016: Contributing to food security and nutrition for all*. Rome: Food and Agriculture Organization of the United Nations. Retrieved from http://www.fao.org/3/a-i5555e.pdf
FAO and RECOFTC. (2016). *Forest landscape restoration for Asia-Pacific forests*.
Farinotti, D., Longuevergne, L., Moholdt, G., Duethmann, D., Mölg, T., Bolch, T., Vorogushyn, S., & Güntner, A. (2015). Substantial glacier mass loss in the Tien Shan over the past 50 years. *Nature Geoscience*, *8*(9), 716–722. https://doi.org/10.1038/ngeo2513
Fenner, F. (2010). Deliberate introduction of the European rabbit, Oryctolagus cuniculus, into Australia. *Rev. Sci. Tecj. Off. Int. Epiz*, *29*(1), 103–111.
Ferguson, J. W., Healey, M., Dugan, P., & Barlow, C. (2011). Potential Effects of Dams on Migratory Fish in the Mekong River: Lessons from Salmon in the Fraser and Columbia Rivers. *Environmental Management*, *47*(1), 141–159. https://doi.org/10.1007/s00267-010-9563-6
Ferraro, P. J., & Hanauer, M. M. (2014). Quantifying causal mechanisms to determine how protected areas affect poverty through changes in ecosystem services and infrastructure. *Proceedings of the National Academy of Sciences* , *111*(11), 4332–4337. https://doi.org/10.1073/pnas.1307712111
Fifth National Reports to the Convention on Biological Diversity. (n.d.). Retrieved from https://www.cbd.int/reports/nr5/
Finlayson, M., D'Cruz, R., & Davidson, N. (2005). Millenium Ecosystem Assessment - Chapter 20: Inland Water Systems.
Fisher, B., Bateman, I., & Turner, R. K. (2011). *Valuing Ecosystem Services: Benefits, Values, Space and Time Ecosystem Services Economics (ESE) Working Paper Series Environment for Development*. UNEP.
Fitzherbert, E., Struebig, M., Morel, A., Danielsen, F., Brühl, C., Donald, P., & Phalan, B. (2008). How will oil palm expansion affect biodiversity? *Trends in Ecology & Evolution*, *23*(10), 538–545. Retrieved from https://doi.org/10.1016/j.tree.2008.06.012
Flanner, M., Zender, C., Hess, P., Mahowald, N., Painter, T., Ramanathan, V., & Rasch, P. (2009). Springtime warming and reduced snow cover from carbonaceous particles. *Atmospheric Chemistry and Physics*, *9*(7), 2481–2497.
Fleming, P. J. S., Allen, L. R., Lapidge, S. J., Robley, A., Saunders, G. R., & Thomson, P. C. (2006). A strategic approach to mitigating the impacts of wild canids: proposed activities of the Invasive

Animals Cooperative Research Centre. *Australian Journal of Experimental Agriculture*, *46*(7), 753–762. Retrieved from https://doi.org/10.1071/EA06009

Fong-Sam, Y., Renaud, K., Shi, L., Wacaster, S., Wilburn, D. R., Hastorun, S., & Xun, S. (2016). The Mineral Industries of Asia and the Pacific. In *2013 Minerals Yearbook: ASIA AND THE PACIFIC [ADVANCE RELEASE]*. U.S. Geological Survey.

FooYuen, N., Basiron, Y., & Sundram, K. (2016). A historical perspective of peat exploitation in Europe and its sustainability. *Journal of Oil Palm, Environment & Health*, *7*, 1–18.

Forest Stewardship Council. (n.d.). Facts and Figures. Retrieved from https://ic.fsc.org/en/facts-and-figures

Forno, I., & Julien, M. (2000). Success in biological control of aquatic weeds by arthropods. In G. Gurr, J. Waage, & S. D. Wratten (Eds.), *Biological Control: Measures of Success*. Springer Netherlands. Retrieved from https://books.google.co.nz/books?id=v4xqCQAAQBAJ

Forrest, J. L., Wikramanayake, E., Shrestha, R., Areendran, G., Gyeltshen, K., Maheshwari, A., Mazumdar, S., Naidoo, R., Thapa, G. J., & Thapa, K. (2012). Conservation and climate change: Assessing the vulnerability of snow leopard habitat to treeline shift in the Himalaya. *Biological Conservation*, *150*(1), 129–135. https://doi.org/10.1016/j.biocon.2012.03.001

Foucaud, J., Orivel, J., Loiseau, A., Delabie, J. H. C., Jourdan, H., Konghouleux, D., Vonshak, M., Tindo, M., Mercier, J. L., Fresneau, D., Mikissa, J. B., McGlynn, T., Mikheyev, A. S., Oettler, J., & Estoup, A. (2010). Worldwide invasion by the little fire ant: Routes of introduction and eco-evolutionary pathways. *Evolutionary Applications*. https://doi.org/10.1111/j.1752-4571.2010.00119.x

Fox, B. J. (1998). Loss of Vertebrate Diversity Following European Settlement of Australian Mediterranean Regions (pp. 333–347). https://doi.org/10.1007/978-3-662-03543-6_19

Fox, J., Vogler, J. B., Sen, O. L., Giambelluca, T. W., & Ziegler, A. D. (2012). Simulating land-cover change in montane mainland southeast Asia. *Environmental Management*, *49*(5), 968–979.

Frey, M., Simard, N., Robichaud, D., Martin, J. L., & Therriault, T. W. (2014). Fouling around: vessel sea-chests as a vector for the introduction and spread of aquatic invasive species. *Management of Biological Invasions*, *5*(1), 21–30. https://doi.org/10.3391/mbi.2014.5.1.02

Frolking, S., Talbot, J., Jones, M. C., Treat, C. C., Kauffman, J. B., Tuittila, E.-S., & Roulet, N. (2011). Peatlands in the Earth's 21st century climate system. *Environmental Reviews*, *19*(NA), 371–396. https://doi.org/10.1139/a11-014

Frost, G. V, & Epstein, H. E. (2014). Tall shrub and tree expansion in Siberian tundra ecotones since the 1960s. *Global Change Biology*, *20*(4), 1264–1277. https://doi.org/10.1111/gcb.12406

Frost, G. V, Epstein, H. E., Walker, D. a, Matyshak, G., & Ermokhina, K. (2013). Patterned-ground facilitates shrub expansion in Low Arctic tundra. *Environmental Research Letters*, *8*(1), 015035. https://doi.org/10.1088/1748-9326/8/1/015035

Fu, Wan, & Zhang. (2016). *China Air 2015 – Air pollution prevention and control progress in Chinese cities*. Beijing, China.

Funge-Smith, S., Briggs, M., & Miao, W. (2012). *Regional overview of fisheries and aquaculture in Asia and the Pacific 2012*. (Asia-Pacific Fishery Commision (APFIC), Ed.), *RAP publication*. Bangkok, Thailand: Food and Agriculture Organisation of the United Nations. Retrieved from http://www.fao.org/documents/card/en/c/951b0503-aece-5bdf-a4fa-500b868b55a1/

Gallo-Reynose, J. P., Égido-Villarreal, J., & Martińez-Villalba, G. (2011). Reaction of fin whales Balaenoptera physalus to an earthquake. *Bioacoustics*, *20*(3), 317–329. https://doi.org/10.1080/09524622.2011.9753654

Garbutt, A., de Groot, A., Smit, C., & Pétillon, J. (2017). European salt marshes: ecology and conservation in a changing world. *Journal of Coastal Conservation*, *21*(3), 405–408. https://doi.org/10.1007/s11852-017-0524-6

Garcia, N., Harrison, I., Cox, N., & Tognelli, M. F. (2015). *The Status and Distribution of Freshwater Biodiversity in the Arabian Peninsula.* Gland, Switzerland, Cambridge, UK and Arlington, USA: IUCN.

Garcia, R. a, Cabeza, M., Rahbek, C., & Araújo, M. B. (2014). Multiple dimensions of climate change and their implications for biodiversity. *Science (New York, N.Y.)*, *344*(6183), 1247579. https://doi.org/10.1126/science.1247579

Garden, J. G., McAlpine, C. A., & Possingham, H. P. (2010). Multi-scaled habitat considerations for conserving urban biodiversity: native reptiles and small mammals in Brisbane, Australia. *Landscape Ecology*, *25*(7), 1013–1028. https://doi.org/10.1007/s10980-010-9476-z

Gattuso, J.-P., Magnan, A., Bille, R., Cheung, W. W. L., Howes, E. L., Joos, F., Allemand, D., Bopp, L., Cooley, S. R., Eakin, C. M., Hoegh-Guldberg, O., Kelly, R. P., Portner, H.-O., Rogers, A. D., Baxter, J. M., Laffoley, D., Osborn, D., Rankovic, A., Rochette, J., Sumaila, U. R., Treyer, S., & Turley, C. (2015). Contrasting futures for ocean and society from different anthropogenic CO2 emissions scenarios. *Science*, *349*(6243), aac4722-aac4722. https://doi.org/10.1126/science.aac4722

Gautam, R., Hsu, N. C., & Lau, K. M. (2010). Premonsoon aerosol characterization and radiative effects over the Indo-Gangetic plains: Implications for regional climate warming. *Journal of Geophysical Research Atmospheres*. https://doi.org/10.1029/2010JD013819

Gedan, K. B., Silliman, B. R., & Bertness, M. D. (2009). Centuries of human-driven change in salt marsh ecosystems. *Annual Review of Marine Science*, *1*, 117–141. https://doi.org/10.1146/annurev.marine.010908.163930

Geddes, J. A., & Martin, R. V. (2017). Global deposition of total reactive nitrogen oxides from 1996 to 2014 constrained with satellite observations of NO 2 columns. *Atmos. Chem. Phys*, *175194*, 10071–10091. https://doi.org/10.5194/acp-17-10071-2017

Geist, H. J., & Lambin, E. F. (2004). Dynamic Causal Patterns of Desertification. *BioScience*, *54*(9), 817. https://doi.org/10.1641/0006-3568(2004)054[0817:DCPOD]2.0.CO;2

Gellert A. (2017). Technological Advancement and the Effect on the Ecosystem. *Nature*. Retrieved from http://sciencing.com/technological-advancement-effect-ecosystem-23107.html

Gemenne, F. (2011). Why the numbers don't add up: A review of estimates and predictions of people displaced by environmental changes. *Global Environmental Change*, *21*(SUPPL. 1), 41–49. https://doi.org/10.1016/j.gloenvcha.2011.09.005

GEO BON Secretariat. (2015). Global Biodiversity Change Indicators Version 1.2, 1–20. Retrieved from www.geobon.org

Ghaffour, N. (2009). The challenge of capacity-building strategies and perspectives for desalination for sustainable water use in MENA. *Desalination and Water Treatment*. https://doi.org/10.5004/dwt.2009.564

Giam, X., Ng, T. H., Lok, A. F. S. L., & Ng, H. H. (2011). Local geographic range predicts freshwater fish extinctions in Singapore. *Journal of Applied Ecology*, *48*(2), 356–363. https://doi.org/10.1111/j.1365-2664.2010.01953.x

Gidda, S. B. (2016). Sub-regional Analysis of the Status of Aichi Biodiversity Target 11. Nadi, Fiji.

Gilani, H., Shrestha, H. L., Murthy, M. S. R., Phuntso, P., Pradhan, S., Bajracharya, B., & Shrestha, B. (2015). Decadal land cover change dynamics in Bhutan. *Journal of Environmental Management*, *148*, 91–100.

Gilbert, P. M. (2017). Eutrophication, harmful algae and biodiversity-Challenging paradigms in a world of complex nutrient changes. *Marine Pollution Bulletin*. Retrieved from http://dx.doi.org/10.1016/j.marpolbul.2017.04.027.

Gillispie, E. C., Sowers, T. D., Duckworth, O. W., & Polizzotto, M. L. (2015). Soil Pollution Due to Irrigation with Arsenic-Contaminated Groundwater: Current State of Science. *Current Pollution Reports*. https://doi.org/10.1007/s40726-015-0001-5

Glasby, T. M. (2013). Caulerpa taxifolia in seagrass meadows: Killer or opportunistic weed? *Biological Invasions*, *15*(5), 1017–1035. https://doi.org/10.1007/s10530-012-0347-1

Glen, A. S., Atkinson, R., Campbell, K. J., Hagen, E., Holmes, N. D., Keitt, B. S., Parkes, J. P., Saunders, A., Sawyer, J., & Torres, H. (2013). Eradicating multiple invasive species on inhabited islands: the next big step in island restoration? *Biological Invasions*, *15*(12), 2589–2603. https://doi.org/10.1007/s10530-013-0495-y

Global Witness. (2013). Sarawak ' s Forests : Myths & Reality. Retrieved from https://www.globalwitness.org/sites/default/files/library/Sarawak myths and reality.doc.pdf

Gobler, C. J., Doherty, O. M., Hattenrath-Lehmann, T. K., Griffith, A. W., Kang, Y., & Litaker, R. W. (2017). Ocean warming since 1982 has expanded the niche of toxic algal blooms in the North Atlantic and North Pacific oceans. *Proceedings of the National Academy of Sciences* , *114*(19), 4975–4980. https://doi.org/10.1073/pnas.1619575114

Goka, K. (2010). Biosecurity measures to prevent the incursion of invasive alien species into Japan and to mitigate their impact The Invasive Alien Species Act in Japan. *Rev. Sci. Tech. Off. Int. Epiz.*, *29*(2), 299–310.

Goldson, S. L. (2011). Biosecurity, risk and policy: A New Zealand perspective. *Journal Fur Verbraucherschutz Und Lebensmittelsicherheit*, *6*(SUPPL. 1), 41–47. https://doi.org/10.1007/s00003-011-0673-8

Golley, J., & Tyers, R. (2012). Demographic dividends, dependencies, and economic growth in China and India. *Asian Economic Papers*, *11*(3), 1–26. https://doi.org/10.1162/ASEP_a_00156

Gombos, M., Ramsay, D., Webb, A., Marra, J., Atkinson, S., & Gorong, B. (2014). Coastal Change in the Pacific Islands, Volume Two: A Guide to Support Community Decision-Making on Coastal Erosion and Flooding Issues. Pohnpei, Federated States of Micronesia: Micronesia Conservation Trust.

Gómez-Baggethun, E., Gren, Å., Barton, D. N., Langemeyer, J., McPhearson, T., O'Farrell, P., Andersson, E., Hamstead, Z., & Kremer, P. (2013). Urban Ecosystem Services. In *Urbanization, Biodiversity and Ecosystem Services: Challenges and Opportunities* (pp. 175–251). Dordrecht: Springer Netherlands. https://doi.org/10.1007/978-94-007-7088-1_11

Gong, D. Y., & Ho, C. H. (2002). The Siberian High and climate change over middle to high latitude Asia. *Theoretical and Applied Climatology*. https://doi.org/10.1007/s007040200008

Gong, W., Sinden, J., Braysher, M., & Jones, R. (2009). *The economic impacts of vertebrate pests in Australia*. Canberra: Invasive Animals Cooperative Research Centre.

Gong, Y. (2016). *Estimating the Impact of Weather Shocks on Agricultural Production and Migration in China*. Retrieved from https://ideas.repec.org/p/eep/report/rr20160318.html

Gooden, B., French, K., & Turner, P. J. (2009). Invasion and management of a woody plant, Lantana camara L., alters vegetation diversity within wet sclerophyll forest in southeastern Australia. *Forest Ecology and Management*, *257*(3), 960–967. https://doi.org/10.1016/j.foreco.2008.10.040

Gopal, B. (2013). Future of wetlands in tropical and subtropical Asia, especially in the face of climate change. *Aquatic Sciences*, *75*(1), 39–61. https://doi.org/10.1007/s00027-011-0247-y

Gottfried, M., Pauli, H., Futschik, A., Akhalkatsi, M., Barančok, P., Alonso, B., Luis, J., Coldea, G., Dick, J., Erschbamer, B., Calzado, F., Rosa, M., Kazakis, G., Krajči, J., Larsson, P., Mallaun, M., Michelsen, O., Moiseev, D., Moiseev, P., Molau, U., Merzouki, A., Nagy, L., Nakhutsrishvili, G., Pedersen, B., Pelino, G., Puscas, M., Rossi, G., Stanisci, A., Theurillat, J.-P., Tomaselli, M., Villar, L., Vittoz, P., Vogiatzakis, I., & Grabherr, G. (2012). Continent-wide response of mountain vegetation to climate change. *Nature Climate Change*, *2*(January), 5. https://doi.org/10.1038/nclimate1329

Gotzek, D., Axen, H. J., Suarez, A. V., Helms Cahan, S., & Shoemaker, D. (2015). Global invasion history of the tropical fire ant: A stowaway on the first global trade routes. *Molecular Ecology*, *24*(2), 374–388. https://doi.org/10.1111/mec.13040

Gouveia, S. F., Hortal, J., Cassemiro, F. A. S., Rangel, T. F., & Diniz-Filho, J. A. F. (2013). Nonstationary effects of productivity, seasonality, and historical climate changes on global amphibian diversity. *Ecography*, *36*(1), 104–113. https://doi.org/10.1111/j.1600-0587.2012.07553.x

Grafton, Q. (2000). Governance of the Commons: A Role for the State? *Land Economics*, *76*(4), 504–517. https://doi.org/10.2307/3146949

Grafton, R. Q., McLindin, M., Hussey, K., Wyrwoll, P., Wichelns, D., Ringler, C., Garrick, D., Pittock, J., Wheeler, S., Orr, S., Matthews, N., Ansink, E., Aureli, A., Connell, D., De Stefano, L., Dowsley, K., Farolfi, S., Hall, J., Katic, P., Lankford, B., Leckie, H., McCartney, M., Pohlner, H., Ratna, N., Rubarenzya, M. H., Sai Raman, S. N., Wheeler, K., & Williams, J. (2016). Responding to Global Challenges in Food, Energy, Environment and Water: Risks and Options Assessment for Decision-Making. *Asia & the Pacific Policy Studies*, *3*(2), 275–299. https://doi.org/10.1002/app5.128

Grarock, K., Tidemann, C. R., Wood, J. T., & Lindenmayer, D. B. (2014). Are invasive species drivers of native species decline or passengers of habitat modification? A case study of the impact of the common myna (Acridotheres tristis) on Australian bird species. *Austral Ecology*, *39*(1), 106–114. https://doi.org/10.1111/aec.12049

Gray, A. (2015). The Australian quarantine and biosecurity legislation : Constitutionality and critique. *Journal of Law and Medicine*, *22*, 788–810.

Gray, C., Frankenberg, E., Gillespie, T., Sumantri, C., & Thomas, D. (2014). Studying Displacement After a Disaster Using Large-Scale Survey Methods: Sumatra After the 2004 Tsunami. *Annals of the Association of American Geographers*, *104*(3), 594–612. https://doi.org/10.1080/00045608.2014.892351

Gregr, E. J., & Chan, K. M. A. (2015). Leaps of Faith: How Implicit Assumptions Compromise the Utility of Ecosystem Models for Decision-making. *BioScience*, *65*(1), 43–54. https://doi.org/10.1093/biosci/biu185

Gribble, J. N., & Bremner, J. (2012). *Achieving a Demographic Dividend* (Vol. 67).

Grumbine, R. E., Dore, J., & Xu, J. (2012). Mekong hydropower: Drivers of change and governance challenges. *Frontiers in Ecology and the Environment*, *10*(2), 91–98. https://doi.org/10.1890/110146

Gu, D. E., Ma, G. M., Zhu, Y. J., Xu, M., Luo, D., Li, Y. Y., Wei, H., Mu, X. D., Luo, J. R., & Hu, Y. C. (2015). The impacts of invasive Nile tilapia (Oreochromis niloticus) on the fisheries in the main rivers of Guangdong Province, China. *Biochemical Systematics and Ecology*, *59*, 1–7. https://doi.org/10.1016/j.bse.2015.01.004

Gu, D., Gerland, P., Andreev, K. F., Li, N., Spoorenberg, T., & Heilig, G. (2013). Old age mortality in Eastern and South-Eastern Asia. *Demographic Research*, *29*(November), 999–1038. https://doi.org/10.4054/DemRes.2013.29.38

Guha-Sapir D, Vos F, Below R, P. S. (2011). *Annual disaster statistical review 2010: The numbers and trends*. Brussels, Belgium: CRED.

Guo, K., Wells, S., Han, F. X., Arslan, Z., Sun, H., & Zhang, J. Q. (2017). Trace elements and heavy metals in Asian rice-derived food products. *Water, Air & Soil Pollution*, *228*(2), 1–7.

Gupta, K., Karihaloo, J. L., & Khetarpal, R. K. (2008). *BIOSAFETY REGULATIONS OF ASIA-PACIFIC COUNTRIES*. *Asia-Pacific Consortium on Agricultural Biotechnology*.

Gurran, N., & Blakely, E. (2007). Suffer a Sea Change? Contrasting perspectives towards urban policy and migration in coastal Australia. *Australian Geographer*, *38*(1), 113–131. https://doi.org/10.1080/00049180601175899

Gyory, S. (2007). Nanotechnology and the Environment: The Nano-Atomic reconstruction of Nature. *Chain Reaction*, *97*, 23–26.

Hall, R. N., Mahar, J. E., Haboury, S., Stevens, V., Holmes, E. C., & Strive, T. (2015). Emerging Rabbit Hemorrhagic Disease Virus 2 (RHDVb), Australia. *Emerging Infectious Diseases*, *21*(12), 2276–2278. https://doi.org/10.3201/eid2112.151210

Halloy, S. R. P., & Mark, A. F. (2003). Climate-Change Effects on Alpine Plant A New Zealand Biodiversity : on Quantifying the Threat Perspective. *Arctic, Antarctic and Alpine Research*, *35*(2), 248–254.

Harashima, Y. (2000). Environmental Governance in Selected. *Governance An International Journal Of Policy And Administration*, *1*(1), 193–207.

Harmsworth, G. R., & Awatere, S. (2013). Indigenous Māori Knowledge and Perspectives of Ecosystems. In *Ecosystem Services in New Zealand – conditions and trends* (pp. 274–286).

Harris, R. B. (2010). Rangeland degradation on the Qinghai-Tibetan plateau: A review of the evidence of its magnitude and causes. *Journal of Arid Environments*, *74*(1), 1–12. https://doi.org/10.1016/j.jaridenv.2009.06.014

Harsch, M. A., McGlone, M. S., & Wilmshurst, J. M. (2014). Winter climate limits subantarctic low forest growth and establishment. *PLoS ONE*, *9*(4), 1–8. https://doi.org/10.1371/journal.pone.0093241

Hart R, Salick J, R. S. and X. J. (2014). Herbarium specimens show contrasting phenological responses to Himalayan climate. *Proc Natl Acad Sci USA* , *111*(29), 10615–10619.

Hashim J.H. and Hashim Z. (2016). Climate Change, Extreme Weather Events, and Human Health Implications in the Asia Pacific Region. *Asia Pacific Journal of Public Health*, *28*, 8–14.

Hayden, B. J., Inglis, G. J., & Schiel, D. R. (2009). Marine invasions in New Zealand: A history of complex supply-Side dynamics. *Biological Invasions in Marine Ecosystems*, 409–423.

Hayes, K., Sliwa, C., Migus, S., Mcennulty, F., & Dunstan, P. (2005). National priority pests : Part II Ranking of Australian marine pests. *Department of Environment and Heritage by CSIRO Marine Research*, 106.

Heck, K. L., & Valentine, J. F. (2007). The primacy of top-down effects in shallow benthic ecosystems. *Estuaries and Coasts*, *30*(3), 371–381. https://doi.org/10.1007/BF02819384

Heidenreich, B. (2009). What are global temperate grasslands worth. *A Case for Their Protection: A Review of Current Research on Their Total Economic Value. Vancouver: Temperate Grassland Conservation Iniciative. 21p*.

Henderson, C. P., & Hancock, I. R. (1988). *A guide to the useful plants of Solomon Islands*. Honiara.

Hequet, V., le Corre, M., Rigault, F., & Blanfort, V. (2009). Les Espèces Exotiques Envahissantes De Nouvelle-Calédonie, 87.

Herbert, E. R., Boon, P., Burgin, A. J., Neubauer, S. C., Franklin, R. B., Ardón, M., Hopfensperger, K. N., Lamers, L. P. M., & Gell, P. (2015). A global perspective on wetland salinization: ecological consequences of a growing threat to freshwater wetlands. *Ecosphere*, *6*(10), art206. https://doi.org/10.1890/ES14-00534.1

Herring, S. C., Hoell, A., Hoerling, M. P., Kossin, J. P., Schreck, C. J., & Stott, P. A. (2016). Explaining Extreme Events of 2015 from a Climate Perspective. *Bulletin of the American Meteorological Society*, *97*(12), S1–S145. https://doi.org/10.1175/BAMS-ExplainingExtremeEvents2015.1

Hewitt, C. L. (2002). Distribution and Biodiversity of Australian Tropical Marine Bioinvasions. *Pacific Science*, *56*(2), 213–222. https://doi.org/10.1353/psc.2002.0016

Hewitt, C. L., & Campbell, M. L. (2010). *The relative contribution of vectors to the introduction and translocation of invasive marine species. Commissioned by The Department of Agriculture, Fisheries and Forestry (DAFF)*. Canberra.

Hewitt, C. L., Campbell, M. L., Thresher, R. E., Martin, R. B., Boyd, S., Cohen, B. F., Currie, D. R., Gomon, M. F., Keough, M. J., & Lewis, J. A. (2004). Introduced and cryptogenic species in Port Phillip Bay, Victoria, Australia. *Marine Biology*, *144*(1), 183–202.

Hewitt, C. L., Willing, J., Bauckham, A., Cassidy, a. M., Cox, C. M. S., Jones, L., & Wotton, D. M. (2004). New Zealand marine biosecurity: Delivering outcomes in a fluid environment. *New Zealand Journal of Marine and Freshwater Research*, *38*(March 2015), 429–438. https://doi.org/10.1080/00288330.2004.9517250

Hijioka, Y., Lin, E., Pereira, J. J., Corlett, R. T., Cui, X., Insarov, G. E., Lasco, R. D., Lindgren, E., & Surjan, A. (2014). Asia. In V. R. Barros, C. B. Field, D. J. Dokken, M. D. Mastrandrea, K. J. Mach, T. E. Bilir, M. Chatterjee, K. L. Ebi, Y. O. Estrada, R. C. Genova, B. Girma, E. S. Kissel, A. N. Levy, S. MacCracken, P. R. Mastrandrea, & L. L. White (Eds.), *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel of Climate Change* (pp. 1327–1370). Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press.

Hildebrand, L. P., Liu, W.-H., & Chuang, C.-T. (2013). Marine Environmental Governance in the East Asian Seas Region. *Coastal Management*, *41*(2), 89–98. https://doi.org/10.1080/08920753.2013.769786

Hill, R., Dyer, G. A., Lozada-Ellison, L. M., Gimona, A., Martin-Ortega, J., Munoz-Rojas, J., & Gordon, I. J. (2015). A social-ecological systems analysis of impediments to delivery of the Aichi 2020 Targets and potentially more effective pathways to the conservation of biodiversity. *Global Environmental Change*. https://doi.org/10.1016/j.gloenvcha.2015.04.005

Hirschman, C. (1994). Why Fertility Changes. *Annual Review of Sociology*, *20*(1), 203–233. https://doi.org/10.1146/annurev.soc.20.1.203

Hixson, S. M. (2014). Fish Nutrition and Current Issues in Aquaculture: The Balance in Providing Safe and Nutritious Seafood, in an Environmentally Sustainable Manner. *Journal of Aquaculture Research & Development*, *03*(03). https://doi.org/10.4172/2155-9546.1000234

Hoegh-Guldberg, O., Mumby, P. J., Hooten, A. J., Steneck, R. S., Greenfield, P., Gomez, E., Harvell, C. D., Sale, P. F., Edwards, a J., Caldeira, K., Knowlton, N., Eakin, C. M., Iglesias-Prieto, R., Muthiga, N., Bradbury, R. H., Dubi, A., & Hatziolos, M. E. (2007). Coral Reefs Under Rapid Climate Change and Ocean Acidification. *Science*, *318*(5857), 1737–1742. https://doi.org/10.1126/science.1152509

Hoffmann, A. A., & Sgro, C. M. (2011). Climate change and evolutionary adaptation. *Nature*, *470*(7335), 479–485. https://doi.org/10.1038/nature09670

Holder, A. L., Vejerano, E. P., Zhou, X., & Marr, L. C. (2013). Nanomaterial disposal by incineration.

Environ. Sci.: Processes Impacts. https://doi.org/10.1039/C3EM00224A

Holt, A. R., Mears, M., Maltby, L., & Warren, P. (2015). Understanding spatial patterns in the production of multiple urban ecosystem services. *Ecosystem Services*, *16*, 33–46. https://doi.org/10.1016/j.ecoser.2015.08.007

Honey, M., & Krantz, D. (2007). Global Trends in Coastal Tourism. *Washington DC: Center on Ecotourism and Sustainable Development*, (December), 1–140. Retrieved from http://ttracanada-torc.ca/torc/downs1/global coastal tourism trends.pdf

Hooijer, A., Page, S., Canadell, J. G., Silvius, M., Kwadijk, J., Wösten, H., & Jauhiainen, J. (2010). Current and future CO2 emissions from drained peatlands in Southeast Asia. *Biogeosciences*, *7*(5), 1505–1514. https://doi.org/10.5194/bg-7-1505-2010

Hope, G. (2014). The Sensitivity of the High Mountain Ecosystems of New Guinea to Climatic Change and Anthropogenic Impact. *Arctic, Antarctic, and Alpine Research*, *46*(4), 777–786. https://doi.org/10.1657/1938-4246-46.4.777

Hortal, J., Diniz-Filho, J. A. F., Bini, L. M., Rodríguez, M. Á., Baselga, A., Nogués-Bravo, D., Rangel, T. F., Hawkins, B. A., & Lobo, J. M. (2011). Ice age climate, evolutionary constraints and diversity patterns of european dung beetles. *Ecology Letters*, *14*(8), 741–748. https://doi.org/10.1111/j.1461-0248.2011.01634.x

Horwitz, P., & Finlayson, C. M. (2011). Wetlands as Settings for Human Health: Incorporating Ecosystem Services and Health Impact Assessment into Water Resource Management. *Bioscience*, *61*(9), 678–688. https://doi.org/10.1525/bio.2011.61.9.6

Hosking, J. R., Sullivan, P. R., & Welsby, S. M. (1994). Biological control of Opuntia stricta(Haw.) Haw. var. stricta using Dactylopius opuntiae(Cockerell) in an area of New South Wales, Australia, where Cactoblastis cactorum(Berg) is not a successful biological control agent. *Agriculture, Ecosystems & Environment*, *48*(3), 241–255.

Howard, G. W. (2004). Invasive Species in Water-Dependent Ecosystems. In M. V Gupta, D. M. Bartley, & B. O. Acosta (Eds.), *Use of Genetically Improved and Alien Species for Aquaculture and conservation of aquatic biodiversity in Africa*. Nairobi Kenya: IUCN - The World Conservation Union. Retrieved from http://pubs.iclarm.net/Pubs/alien_species/pdf/04.pdf

Howe, S., & Morrah, M. (2016). Paua threatened after quake lifts Kaikoura seabed. Retrieved from http://www.newshub.co.nz/home/new-zealand/2016/11/paua-threatened-after-quake-lifts-kaikoura-sea-bed.html

Huang, S.-L., Yeh, C.-T., & Chang, L.-F. (2010). The transition to an urbanizing world and the demand for natural resources. *Current Opinion in Environmental Sustainability*, *2*(3), 136–143. https://doi.org/10.1016/j.cosust.2010.06.004

Hubacek, K., Guan, D., Barrett, J., & Wiedmann, T. (2009). Environmental implications of urbanization and lifestyle change in China: Ecological and Water Footprints. *Journal of Cleaner Production*, *17*(14), 1241–1248. https://doi.org/10.1016/j.jclepro.2009.03.011

Huber, U. M., Bugmann, H. K. M., & Reasoner, M. A. (Eds.). (2005). *Global Change and Mountain Regions* (Vol. 23). Dordrecht: Springer Netherlands. https://doi.org/10.1007/1-4020-3508-X

Huddleston, B., & Ataman, E. (2003). *Towards a GIS-based analysis of mountain environments and populations. Environment and Natural Resources Working Paper No. 10.* Rome: FAO.

Hughes, A. C. (2017). Understanding the drivers of Southeast Asian biodiversity loss. *Ecosphere*, *8*(January). https://doi.org/10.1002/ECS2.1624

Hughes, T. P., & Connell, J. H. (1999). Multiple stressors on coral reefs: a long-term perspective. *Symposium on the Effects of Multiple Stressors on Freshwater and Marine Ecosystems at the Annual Meeting of the American-Society-of-Limnology-and-Oceanography*, *44*, 932–940. https://doi.org/10.4319/lo.1999.44.3_part_2.0932

Hui, C., Richardson, D. M., Visser, V., & Wilson, J. R. U. (2014). Macroecology meets invasion ecology: Performance of Australian acacias and eucalypts around the world revealed by features of their native ranges. *Biological Invasions*, *16*(3), 565–576. https://doi.org/10.1007/s10530-013-0599-4

Hulme, M. (2009). *Why We Disagree about Climate Change.* Cambridge: Cambridge Univ. Press.

Hummel, D., Adamo, S., de Sherbinin, A., Murphy, L., Aggarwal, R., Zulu, L., Liu, J., & Knight, K. (2013). Inter- and transdisciplinary approaches to population–environment research for sustainability aims: a review and appraisal. *Population and Environment*, *34*(4), 481–509.

https://doi.org/10.1007/s11111-012-0176-2
Hunsberger, C., & Evans, T. (2012). Land. In *Global Environmental Outlook 5* (pp. 66–96). UNEP.BIOLOGICAL INVASIONS 16, 565-576.
Hunter, D., Pouono, K., & Semisi, S. (1998). The impact of taro leaf blight in the Pacific Islands with special reference to Samoa. *Journal of South Pacific Agriculture*, *5*(2), 44–56. Retrieved from http://www.spc.int/tarogen/Documents/Misc_Publications/TLBimpact2.pdf
Hunzai, K., Gerlitz, J. ., & Hoermann, B. (2011). *Understanding Mountain Poverty in the Hindu Kush-Himalayas*. ICIMOD.
IBT STAFF REPORTER. (2010). Electric Vehicle sales in Asia Pacific to surpass 1.4 million by 2015. Retrieved from http://www.ibtimes.com/electric-vehicle-sales-asia-pacific-surpass-14-million-2015-249448
ICIMOD. (2009). *Mountain Biodiversity and Climate Change*. Nepal.
ICIMOD. (2010). *Mountains of the world – Ecosystem services in a time of global and climate change: Seizing opportunities – meeting challenges*. Kathmandu: ICIMOD.
Inderjit, Evans, H., Crocoll, C., Bajpai, D., Kaur, R., Feng, Y.-L., Silva, C., Carreón, J. T., Valiente-Banuet, A., Gershenzon, J., & Callaway, R. M. (2011). Volatile chemicals from leaf litter are associated with invasiveness of a Neotropical weed in Asia. *Ecology*, *92*(2), 316–324. Retrieved from http://onlinelibrary.wiley.com/doi/10.1890/10-0400.1/full
Indonesia's National Climate Change Council (DNPI). (2010). *Indonesia's green house gas abatement cost curve*. Retrieved from http://www.mmechanisms.org/document/country/IDN/Indonesia_ghg_cost_curve_english.pdf
Indonesia Investments. (2017). Palm Oil. Retrieved December 28, 2017, from https://www.indonesia-investments.com/business/commodities/palm-oil/item166?
Industrial Research Institute. (2016). *GLOBAL R&D FUNDING FORECAST*. Industrial Research Institute. Retrieved from https://www.iriweb.org/sites/default/files/2016GlobalR%26DFundingForecast_2.pdf
International Council on Mining and Metals (ICMM). (2006). *Good practice guidance for mining and biodiversity*. London, UK.
International Maritime Organization. (n.d.). Biofouling. Retrieved December 19, 2017, from http://www.imo.org/en/OurWork/Environment/Biofouling/Pages/default.aspx
IPBES. (n.d.). PARC-connectedness Index. Retrieved from http://www.ipbes.net/sites/default/files/storyline_geo_bon_csiro_protected_area_connectedness_index.pdf
IPBES. (2016). *Summary for policymakers of the asssessment report of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) on pollinators, pollination and food production*. (S. G. Potts, V. L. Imperatriz-Fonseca, H. T. Ngo, J. C. Biesmeijer, T. D. Breeze, L. V. Dicks, L. A. Garibaldi, R. Hill, J. Settele, A. J. Vanbergen, M. A. Aizen, S. A. Cunningham, C. Eardley, B. M. Freitas, N. Gallai, P. G. Kevan, A. Kovács-Hostyánszki, P. K. Kwapong, J. Li, X. Li, D. J. Martins, G. Nates-Parra, J. S. Pettis, R. Rader, & B. F. Vianamperatriz-Fonseca, Eds.), *UNEP/GRID Europe* (Secretaria). Bonn, Germany. https://doi.org/10.1007/s00442-010-1809-8
IPBES. (2017). Update on the work on knowledge and data (deliverables 1 (d)and 4 (b)).IPBES/5/INF/5. Bonn, Germany: IPBES. Retrieved from https://www.ipbes.net/system/tdf/downloads/pdf/ipbes-5-inf-5.pdf?file=1&type=node&id=540
IPCC. (2012). *Renewable energy sources and climate change mitigation SPM*. Ralph Sims.
IPCC. (2014a). *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Field, C.B., V.R. Barros, D.J. Dokken, K.J.* Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press.
IPCC. (2014b). *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Barros, V.R., C.B. Field, D.J. Dokken, M.D. Mastrandre*. Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press.
Irving, A. D., Connell, S. D., & Russell, B. D. (2011). Restoring coastal plants to improve global

carbon storage: reaping what we sow. *PLoS ONE*, *6*(3:e18311). https://doi.org/10.1371/journal.pone.0018311.

Islam, M. S., & Tanaka, M. (2004). Impacts of pollution on coastal and marine ecosystems including coastal and marine fisheries and approach for management: A review and synthesis. *Marine Pollution Bulletin*, *48*(7–8), 624–649. https://doi.org/10.1016/j.marpolbul.2003.12.004

IUCN. (2017). *Programmatic Strategy for Strengthening the Presence of IUCN in Asia*.

Izuddin, M., & Webb, E. L. (2015). The influence of tree architecture, forest remnants, and dispersal syndrome on roadside epiphyte diversity in a highly urbanized tropical environment. *Biodiversity and Conservation*, *24*(8), 2063–2077. https://doi.org/10.1007/s10531-015-0932-6

Jackson, W. (2017). *Australia state of the environment 2016: drivers*. Canberra, Australia.

Jay, M., & Morad, M. (2006). The Socioeconomic Dimensions of Biosecurity: the New Zealand Experience. *International Journal of Environmental Studies*, *63*(3), 293–302. https://doi.org/10.1080/00207230600773125

Jha, S., & Bawa, K. S. (2006). Population growth, human development, and deforestation in biodiversity hotspots. *Conservation Biology*. https://doi.org/10.1111/j.1523-1739.2006.00398.x

Jha, S., & Strous, L. (2007). *ICT for Development and Prosperity*. *Development*.

Johnson, A. E., Cinner, J. E., Hardt, M. J., Jacquet, J., Mcclanahan, T. R., & Sanchirico, J. N. (2013). Trends, current understanding and future research priorities for artisanal coral reef fisheries research. *Fish and Fisheries*, *14*(3), 281–292. https://doi.org/10.1111/j.1467-2979.2012.00468.x

Johnson R. N., Wilson-Wilde L., and L. A. (2014). Current and future directions of DNA in wildlife forensic science. *Forensic Sci. Int. Genet.*, *10*, 1–11. https://doi.org/10.1016/j.fsigen.2013.12.007

Jolly, C. J., Shine, R., & Greenlees, M. J. (2015). The impact of invasive cane toads on native wildlife in southern Australia. *Ecology and Evolution*, *5*(18), 3879–3894. https://doi.org/10.1002/ece3.1657

Jones, D. A., Collins, D. A., McGree, S., Trewin, B., Skilling, E., Diamond, H., Fa'anunu, O., Hiriasia, D., Hugony, S., & Hutchinson, R. (2013). An updated analysis of homogeneous temperature data at Pacific Island stations. *Aust. Meteorol. Mag*, *61*, 285–302.

Jones, H., Clough, P., Höck, B., & Phillips, C. (2008). *Economic costs of hill country erosion and benefits of mitigation in New Zealand : Review and recommendation of approach Economic costs of hill country erosion and benefits of mitigation in New Zealand : Review and recommendation of approach* (Vol. 1).

Joshi, S., Jasra, W. A., Ismail, M., Shrestha, R. M., Yi, S. L., & Wu, N. (2013). Herders' perceptions of and responses to climate change in Northern Pakistan. *Environmental Management*. https://doi.org/10.1007/s00267-013-0062-4

Juffe-Bignoli, D., Burgess, N. D., Bingham, H., Belle, E. M. S., de Lima, M. G., Deguignet, M., Bertzky, B., Milam, a N., Martinez-Lopez, J., Lewis, E., Eassom, A., Wicander, S., Geldmann, J., van Soesbergen, A., Arnell, a P., O'Connor, B., Park, S., Shi, Y. N., Danks, F. S., MacSharry, B., & Kingston, N. (2014). *Protected Planet Report 2014*. *Protected Planet Report*. https://doi.org/DEW/1233/CA

Julien, M. H., McFadyen, R. E., & Cullen, J. (2012). *Biological control of weeds in Australia*.

Jupiter, S. D., Potts, D. C., Phinn, S. R., & Duke, N. C. (2007). Natural and anthropogenic changes to mangrove distributions in the Pioneer River Estuary (QLD, Australia). *Wetlands Ecology and Management*, *15*(1), 51–62. https://doi.org/10.1007/s11273-006-9011-9

Jupiter, S., Mangubhai, S., & Kingsford, R. T. (2014). Conservation of Biodiversity in the Pacific Islands of Oceania: Challenges and Opportunities. *Pacific Conservation Biology*.

Kadoya, T., Akasaka, M., Aoki, T., & Takamura, N. (2011). A proposal of framework to obtain an integrated biodiversity indicator for agricultural ponds incorporating the simultaneous effects of multiple pressures. *Ecological Indicators*, *11*(5), 1396–1402. Retrieved from http://www.sciencedirect.com/science/article/pii/S1470160X11000549

Kanel, K. R., & Shrestha, K. (2001). Tropical secondary forests in Nepal and their importance to local people. *Journal of Tropical Forest Science*.

Kang, B., He, D., Perrett, L., Wang, H., Hu, W., Deng, W., & Wu, Y. (2009). Fish and fisheries in the Upper Mekong: current assessment of the fish community, threats and conservation. *Reviews in Fish Biology and Fisheries*, *19*(4), 465. https://doi.org/10.1007/s11160-009-9114-5

Kannan, R., Shackleton, C. M., & Shaanker, R. U. (2013). Playing with the forest: Invasive alien plants, policy and protected areas in india. *Current Science*, *104*(9), 1159–1165.

Kar, S. P., & Jacobson, M. G. (2012). NTFP income contribution to household economy and related socio-economic factors: Lessons from Bangladesh. *Forest Policy and Economics*, *14*(1), 136–142. https://doi.org/10.1016/j.forpol.2011.08.003

Karki, M., Hill, R., Xue, D., Alangui, W., Ichikawa, K., & Bridgewater, P. (2017). Knowing our Lands and Resources: Indigenous and Local Knowledge and Practices related to Biodiversity and Ecosystem Services in Asia. *Knowledges of Nature*, *10*. Retrieved from www.unesco.org/new/links/ipbes-pubs%5Cnhttp://www.unesco.org/new/fileadmin/MULTIMEDIA/HQ/SC/temp/LINKS/IPBES_AP_2017_V3LR.pdf

Kashwan, P. (2013). The politics of rights-based approaches in conservation. *Land Use Policy*, *31*, 613–626. Retrieved from http://www.elsevier.com/copyright

Katayama, N., Baba, Y. G., Kusumoto, Y., & Tanaka, K. (2015). A review of post-war changes in rice farming and biodiversity in Japan. *Agricultural Systems*, *132*, 73–84. https://doi.org/10.1016/j.agsy.2014.09.001

Keener, V. W., Marra, J. J., Finucane, M. L., Spooner, D., & Smith, M. H. (2012). *Climate Change and Pacific Islands: Indicators and Impacts. Report for the 2012 Pacific Islands Regional Climate Assessment*. Washington, DC: Island Press. Retrieved from http://www.cakex.org/sites/default/files/documents/NCA-PIRCA-FINAL-int-print-1.13-web.form_.pdf

Kelleway, J. J., Saintilan, N., Macreadie, P., & Ralph, P. (2015). Seventy years of continuous encroachment substantially increases 'blue carbon' capacity as mangroves replace intertidal salt marshes. *Global Change Biology*, *22*(3), 1097–1109.

Kelley, A. C., & Schmidt, R. M. (2005). Evolution of recent economic-demographic modeling: A synthesis. *Journal of Population Economics*, *18*(2), 275–300. https://doi.org/10.1007/s00148-005-0222-9

Kelley, T., & Slaney, D. (2006). A comparison of environmental legislation and regulation in New Zealand and the United States. *J Environ Health*, *69*(1), 20–22. Retrieved from http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=16910105

Kennett, D. J., Anderson, A. J., & Winterhalder, B. (2006). The ideal free distribution, food production, and the colonization of Oceania. *Behavioral Ecology and the Transition to Agriculture*, (Hastorf 1999), 265–288.

Kent, R., & Dorward, A. (2014). Livelihood responses to Lantana camara invasion and biodiversity change in southern India: application of an asset function framework. *Regional Environmental Change*, *15*(2), 353–364. https://doi.org/10.1007/s10113-014-0654-4

Keyfitz, N. (1991). Population and Development within the Ecosphere: One View of the Literature. *Population Index*, *57*(1), 5–22. https://doi.org/10.2307/3643719

Keys, H. J. R. (2006). Lahars from Mount Ruapehu - mitigation and management. Retrieved from http://www.doc.govt.nz/Documents/science-and-technical/SciencePoster87.pdf

Khan, M. F., & Panikkar, P. (2009). Assessment of impacts of invasive fishes on the food web structure and ecosystem properties of a tropical reservoir in India. *Ecological Modelling*, *220*(18), 2281–2290. https://doi.org/10.1016/j.ecolmodel.2009.05.020

Khanal NR and Watanabe T. (2006). Abandonment of agricultural land and its consequences: A case study in the Sikles area, Gandaki Basin, Nepal Himalaya. *Mountain Research and Development*, *26*(1), 32–40.

Khuroo A A, Rashid I, Reshi Z, D. G. H. and W. B. A. (2007). The alien flora of Kashmir Himalaya. *Biological Invasions*, *9*(3), 269–292.

Khuroo A A, Reshi Z A, Malik A H, Weber E, R. I. and D. G. H. (2012). Alien flora of India: taxonomic composition, invasion status and biogeographic affiliations. *Biological Invasions*, *14*(1), 99–113.

Kier, G., Kreft, H., Lee, T. M., Jetz, W., Ibisch, P. L., Nowicki, C., Mutke, J., & Barthlott, W. (2009). A global assessment of endemism and species richness across island and mainland regions. *Proceedings of the National Academy of Sciences*, *106*(23), 9322–9327.

https://doi.org/10.1073/pnas.0810306106
Kilroy, G. (2015). A review of the biophysical impacts of climate change in three hotspot regions in Africa and Asia. *Regional Environmental Change*, *15*(5), 771–782. https://doi.org/10.1007/s10113-014-0709-6
Kim, I., Le, Q. B., Park, S. J., Tenhunen, J., & Koellner, T. (2014). Driving Forces in Archetypical Land-Use Changes in a Mountainous Watershed in East Asia. *Land*, *3*(3), 957–980.
Kim, J., Chae, J., & Koo, T.-H. (2007). Variation in Bird Diversity in Relation to Habitat Size in the Urban Landscape of Seoul, South Korea. *Acta Ornithologica*, *42*(1), 39–44. https://doi.org/10.3161/068.042.0111
Kingsford, R. T. (2000). Ecological impacts of dams, water diversions and river management on floodplain wetlands in Australia. *Austral Ecology*, *25*(2), 109–127. https://doi.org/10.1046/j.1442-9993.2000.01036.x
Kingsford, R. T., Walker, K. F., Lester, R. E., Young, W. J., Fairweather, P. G., Sammut, J., & Geddes, M. C. (2011). A Ramsar wetland in crisis – the Coorong, Lower Lakes and Murray Mouth, Australia. *Marine and Freshwater Research*, *62*(3), 255–265. https://doi.org/http://dx.doi.org/10.1071/MF09315
Kinnear J. E., Sumner N. R., O. M. L. (2002). The red fox in Australia: an exotic predator turned biocontrol agent. *Biol Cons.*, *108*, 335–359.
Kinzig, A. P., Warren, P., Martin, C., Hope, D., & Katti, M. (2005). The effects of human socioeconomic status and cultural characteristics on urban patterns of biodiversity. *Ecology and Society*, *10*(1), 23. Retrieved from http://www.ecologyandsociety.org/vol10/iss1/art23/
Kirtman, B., Power, S. B., Adedoyin, J. A., Boer, G. J., Bojariu, R., Camilloni, I., Doblas-Reyes, F. J., Fiore, A. M., Kimoto, M., Meehl, G. A., Prather, M., Sarr, A., Schär, C., Sutton, R., van Oldenborgh, G. J., Vecchi, G., & Wang, H.-J. (2013). Near-term Climate Change: Projections and Predictability. *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, 953–1028. https://doi.org/10.1017/CBO9781107415324.023
Kissinger, G., Herold, M., & De Sy, V. (2012). *Drivers of Deforestation and Forest Degradation: A Synthesis Report for REDD+ Policymakers*. Vancouver Canada: Lexeme Consulting.
Kissinger, G., Patterson, C., & Neufeldt, H. (2013). *Payments for ecosystem services schemes: project-level insights on benefits for ecosystems and the rural poor*. ICRAF.
Koch, D., Bauer, S., Perlwitz, J., Miller, R., Schulz, M., Balkanski, Y., Textor, C., & Kinne, S. (2009). Evaluation of black carbon estimations in global aerosol models. *Atmospheric Chemistry and Physics*, *9*(22), 9001–9026.
Koh, L. P., & Sodhi, N. S. (2004). Importance of reserves, fragments, and parks for butterfly conservation in a tropical urban landscape. *Ecological Applications*, *14*(6), 1695–1708. https://doi.org/10.1890/03-5269
Kohli, R. K., Batish, D. R., Singh, J. S., Singh, H. P., & Bhatt, J. R. (2012). Plant invasion in India: an overview. In *Invasive alien plants: an ecological appraisal for the Indian subcontinent* (pp. 1–9). Wallingford: CABI. https://doi.org/10.1079/9781845939076.0001
Kontgis, C., Schneider, A., Fox, J., Saksena, S., Spencer, J. H., & Castrence, M. (2014). Monitoring peri-urbanization in the greater Ho Chi Minh City metropolitan area. *Applied Geography, 53,* 377–388. https://doi.org/10.1016/j.apgeog.2014.06.029
Körner, C. (2012). High elevation treelines. *Alpine Treelines*, 1–10. https://doi.org/10.1007/978-3-0348-0396-0_1
Kosaka, Y., Saikia, B., Mingki, T., Tag, H., Riba, T., & Ando, K. (2010). Roadside distribution patterns of invasive alien plants along an altitudinal gradient in Arunachal Himalaya, India. *Mountain Research and Development*, *30*(3), 252–258.
Kowarik, I. (2011). Novel urban ecosystems, biodiversity, and conservation. *Environmental Pollution*, *159*(8–9), 1974–1983. https://doi.org/10.1016/j.envpol.2011.02.022
KPMG. (2016). *Global Trends in Renewable Energy*.
Kruk, E. (2011). Tourism and sustainable mountain development in the Hindu Kush Himalayas. In K. H. and R. J. Kruk E. (Ed.), *Integrated Tourism concepts to contribute to sustainable mountain development in Nepal – Proceedings of the Regional Workshop.* GIZ, ICIMOD, BMZ.
Kudo, G., Amagai, Y., Hoshino, B., & Kaneko, M. (2011). Invasion of dwarf bamboo into alpine

snow-meadows in northern Japan: Pattern of expansion and impact on species diversity. *Ecology and Evolution*, *1*(1), 85–96. https://doi.org/10.1002/ece3.9

Kühn, M. (2003). Greenbelt and Green Heart: separating and integrating landscapes in European city regions. *Landscape and Urban Planning*, *64*(1–2), 19–27. https://doi.org/10.1016/S0169-2046(02)00198-6

Kumaraguru, A. K., Jayakumar, K., Wilson, J. J., & Ramakritinan, C. M. (2005). Impact of the tsunami of 26 December 2004 on the coral reef environment of Gulf of Mannar and Palk Bay in the southeast coast of India. *Current Science*, *89*(10), 1729–1741.

Kunwar, R. M. (2003). Invasive alien plants and Eupatorium: Biodiversity and livelihood. *Himalayan Journal of Sciences*, *1*(2), 129–133.

Kunz, T. H., de Torrez, E. B., Bauer, D., Lobova, T., & Fleming, T. H. (2011). Ecosystem services provided by bats. *Annals of the New York Academy of Sciences*, *1223*(1), 1–38. https://doi.org/10.1111/j.1749-6632.2011.06004.x

Kwazo, H. A., Muhammad, M. U., Tafida, G. M., & Mohammed, S. (2014). Environmental Impact of Technologies. *Academic Journal of Interdisciplinary Studies; Vol 3, No 7 (2014): Special Issue - November 2014*. Retrieved from http://www.mcser.org/journal/index.php/ajis/article/view/5328

Lach, L., & Thomas, M. L. (2008). Invasive ants in Australia: Documented and potential ecological consequences. *Australian Journal of Entomology*, *47*(4), 275–288. https://doi.org/10.1111/j.1440-6055.2008.00659.x

Lah, R. A., Benkendorff, K., & Bucher, D. (2017). Thermal tolerance and preference of exploited turbinid snails near their range limit in a global warming hotspot. *Journal of Thermal Biology*, *64*, 100–108. https://doi.org//doi.org/10.1016/j.jtherbio.2017.01.008

Lam D. (2011). How the World Survived the Population Bomb: Lessons From 50 Years of Extraordinary Demographic History. *Demography*, *48*(1), 1231–1262.

Lamarque, J.-F., Dentener, F., McConnell, J., Ro, C.-U., Shaw, M., Vet, R., Bergmann, D., Cameron-Smith, P., Dalsoren, S., Doherty, R., Faluvegi, G., Ghan, S. J., Josse, B., Lee, Y. H., MacKenzie, I. A., Plummer, D., Shindell, D. T., Skeie, R. B., Stevenson, D. S., Strode, S., Zeng, G., Curran, M., Dahl-Jensen, D., Das, S., Fritzsche, D., & Nolan, M. (2013). Multi-model mean nitrogen and sulfur deposition from the Atmospheric Chemistry and Climate Model Intercomparison Project (ACCMIP): evaluation of historical and projected future changes. *Atmos. Chem. Phys.*, *13*(16), 7997–8018. https://doi.org/10.5194/acp-13-7997-2013

Lamb, D. (2011). *Regreening the Bare Hills* (Vol. 8). Dordrecht: Springer Netherlands. https://doi.org/10.1007/978-90-481-9870-2

Lambert, G. (2002). Nonindigenous ascidians in tropical waters. *Pacific Science*, *56*(3), 291–298. https://doi.org/10.1353/psc.2002.0026

Lambin, E. F., Geist, H. J., & Lepers, E. (2003). Dynamics of Land-use and Land-cover change in tropical regions. *Annual Review of Environment and Resources*, *28*(1), 205–241. https://doi.org/10.1146/annurev.energy.28.050302.105459

Lambin, E. F., Turner, B. L., Geist, H. J., Agbola, S. B., Angelsen, A., Bruce, J. W., Coomes, O. T., Dirzo, R., Fischer, G., Folke, C., George, P. S., Homewood, K., Imbernon, J., Leemans, R., Li, X., Moran, E. F., Mortimore, M., Ramakrishnan, P. S., Richards, J. F., Skånes, H., Steffen, W., Stone, G. D., Svedin, U., Veldkamp, T. A., Vogel, C., & Xu, J. (2001). The causes of land-use and land-cover change: moving beyond the myths. *Global Environmental Change*, *11*(4), 261–269. https://doi.org/10.1016/S0959-3780(01)00007-3

Lamy, T., Galzin, R., Kulbicki, M., de Loma, T., & Claudet, J. (2016). Three decades of recurrent declines and recoveries in corals belie ongoing change in fish assemblages. *Coral Reefs*, *35*(1), 293–302. https://doi.org/10.1007/s00338-015-1371-2

Lamy, T., Legendre, P., Chancerelle, Y., Siu, G., & Claudet, J. (2015). Understanding the spatio-temporal response of coral reef fish communities to natural disturbances: Insights from beta-diversity decomposition. *PLoS ONE*, *10*(9), 1–18. https://doi.org/10.1371/journal.pone.0138696

Landsberg, J. H. (2002). The Effects of Harmful Algal Blooms on Aquatic Organisms. *Reviews in Fisheries Science*, *10*(2), 113–390. https://doi.org/10.1080/20026491051695

Larsen, J. N., Anisimov, O. A., Constable, A., Hollowed, A. B., Maynard, N., Prestrud, P., Prowse, T. D., & Stone, J. M. R. (n.d.). Polar regions. In V. R. Barros, C. B. Field, D. J. Dokken, M. D. Mastrandrea, K. J. Mach, T. E. Bilir, M. Chatterjee, K. L. Ebi, Y. O. Estrada, R. C. Genova, B.

Girma, E. S. Kissel, A. N. Levy, S. MacCracken, P. R. Mastrandrea, & L. L. White (Eds.), *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel of Climate Change* (pp. 1567–1612). Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press.

Laso Bayas, J. C., Marohn, C., Dercon, G., Dewi, S., Piepho, H. P., Joshi, L., van Noordwijk, M., & Cadisch, G. (2011). Influence of coastal vegetation on the 2004 tsunami wave impact in west Aceh. *Proceedings of the National Academy of Sciences of the United States of America*, *108*(46), 18612–18617. https://doi.org/10.1073/pnas.1013516108

Lassaletta, L. (n.d.). IPBES GLOBAL/REGIONAL INDICATOR FACTSHEET (VISUALS & STORYLINES). IPBES.

Lassaletta, L., Billen, G., Grizzetti, B., Anglade, J., & Garnier, J. (2014). 50 Year Trends in Nitrogen Use Efficiency of World Cropping Systems: the Relationship Between Yield and Nitrogen Input To Cropland. *Environmental Research Letters*, *9*(10), 105011. https://doi.org/10.1088/1748-9326/9/10/105011

Lavides, M. N., Molina, E. P. V, de la Rosa Jr, G. E., Mill, A. C., Rushton, S. P., Stead, S. M., & Polunin, N. V. C. (2016). Patterns of Coral-Reef Finfish Species Disappearances Inferred from Fishers' Knowledge in Global Epicentre of Marine Shorefish Diversity. *PLOS ONE*, *11*(5), e0155752. Retrieved from https://doi.org/10.1371/journal.pone.0155752

Leadley, P., Pereira, H., Alkemade, R., Fernandez-Manjarres, J., Proenca, V., Scharlemann, J., & Walpole, M. (2010). *Biodiversity Scenarios: Projections of 21st century change in biodiversity and associated ecosystem services*. *Secretariat of the Convention on Biological Diversity, Montreal.* (Vol. 50). https://doi.org/Technical Series no. 50

Lee, L. H., & Lin, H. J. (2013). Effects of an oil spill on benthic community production and respiration on subtropical intertidal sandflats. *Marine Pollution Bulletin*, *73*(1), 291–299. https://doi.org/10.1016/j.marpolbul.2013.05.006

Lee, R. (2011). The Outlook for Population Growth. *Science*, *333*(6042), 569–573. https://doi.org/10.1126/science.1208859

Lee, Y. C., Ahern, J., & Yeh, C. T. (2015). Ecosystem services in peri-urban landscapes: The effects of agricultural landscape change on ecosystem services in Taiwan's western coastal plain. *Landscape and Urban Planning*, *139*, 137–148. https://doi.org/10.1016/j.landurbplan.2015.02.023

Leimgruber, P., Kelly, D. S., Steininger, M., Brunner, J., Müller, T., & Songer, M. (2005). Forest cover change patterns in Myanmar (Burma) 1990–2000. *Environmental Conservation*, *32*(4), 356–364.

Lelieveld, J., Proestos, Y., Hadjinicolaou, P., Tanarhte, M., Tyrlis, E., & Zittis, G. (2016). Strongly increasing heat extremes in the Middle East and North Africa (MENA) in the 21st century. *Climatic Change*, *137*(1), 245–260. https://doi.org/10.1007/s10584-016-1665-6

Lenzen, M., Moran, D., Kanemoto, K., Foran, B., Lobefaro, L., & Geschke, a. (2012). International trade drives biodiversity threats in developing nations. *Nature*, *486*, 109–112. https://doi.org/10.1038/nature11145

Li, J., Wang, W., Axmacher, J. C., Zhang, Y., & Zhu, Y. (2016). Streamlining China's protected areas. *Science*, *351*, 1160.

Li, P., Feng, X. B., Qiu, G. L., Shang, L. H., & Li, Z. G. (2009). Mercury pollution in Asia: A review of the contaminated sites. *Journal of Hazardous Materials*, *168*(2–3), 591–601. https://doi.org/10.1016/j.jhazmat.2009.03.031

Li, W., Dickinson, R. E., Fu, R., Niu, G.-Y., Yang, Z.-L., & Canadell, J. G. (2007). Future precipitation changes and their implications for tropical peatlands. *Geophysical Research Letters*, *34*(1), n/a-n/a. https://doi.org/10.1029/2006gl028364

Li, Y., Li, Z., Li, Z., Geng, X., & Deng, X. (2013). Numerical simulation of the effects of grassland degradation on the surface climate in overgrazing area of Northwest China. *Advances in Meteorology*. Retrieved from http://dx.doi.org/10.1155/2013/270192

Li, Z., Wu, N., Gao, X., Wu, Y., & Oli, K. P. (2013). Species-level phenological responses to 'global warming' as evidenced by herbarium collections in the Tibetan Autonomous Region. *Biodiversity and Conservation*, *22*(1), 141–152.

Lim, H. S., Boochabun, K., & Ziegler, A. D. (2012). Modifiers and Amplifiers of High and low Flows on the Ping River in Northern Thailand (1921--2009): The Roles of Climatic Events and Anthropogenic Activity. *Water Resources Management*, *26*(14), 4203–4224. https://doi.org/10.1007/s11269-012-0140-z

Limpens, J., Berendse, F., Blodau, C., Canadell, J. G., Freeman, C., Holden, J., Roulet, N., Rydin, H., & Schaepman-Strub, G. (2008). Peatlands and the carbon cycle: from local processes to global implications – a synthesis. *Biogeosciences*, *5*(5), 1475–1491. https://doi.org/10.5194/bg-5-1475-2008

Liu, D. (2015). New environment law shows its fangs. *Nature*, *525*, 321. https://doi.org/10.1038/525321a

Liu, L., Johnson, H. L., Cousens, S., Perin, J., Scott, S., Lawn, J. E., Rudan, I., Campbell, H., Cibulskis, R., Li, M., Mathers, C., & Black, R. E. (2012). Global, regional, and national causes of child mortality: An updated systematic analysis for 2010 with time trends since 2000. *The Lancet*, *379*(9832), 2151–2161. https://doi.org/10.1016/S0140-6736(12)60560-1

Liu, P. J., Hsin, M. C., Huang, Y. H., Fan, T. Y., Meng, P. J., Lu, C. C., & Lin, H. J. (2015). Nutrient enrichment coupled with sedimentation favors sea anemones over corals. *PLoS ONE*, *10*(4), 1–14. https://doi.org/10.1371/journal.pone.0125175

Liu, P. J., Lin, S. M., Fan, T. Y., Meng, P. J., Shao, K. T., & Lin, H. J. (2009). Rates of overgrowth by macroalgae and attack by sea anemones are greater for live coral than dead coral under conditions of nutrient enrichment. *Limnology and Oceanography*, *54*(4), 1167–1175. https://doi.org/10.4319/lo.2009.54.4.1167

Liu, Y. Y., Evans, J. P., McCabe, M. F., de Jeu, R. A. M., van Dijk, A. I. J. M., Dolman, A. J., & Saizen, I. (2013). Changing Climate and Overgrazing Are Decimating Mongolian Steppes. *PLoS ONE*, *8*(2), 4–9. https://doi.org/10.1371/journal.pone.0057599

Llewellyn, R. S., Ronning, D., Ouzman, J., Walker, S., Mayfield, A., & Clarke, M. (2016). *Impact of Weeds on Australian Grain Production: the cost of weeds to Australian grain growers and the adoption of weed management and tillage practices*.

Lorenz, M., Clarke, N., Paoletti, E., Bytnerowicz, A., Grulke, N., Lukina, N., Sase, H., & Staelens, J. (2010). *Air Pollution Impacts on Forests in a Changing Climate*.

Lovelock, C., & Ellison, J. (2007). Vulnerability of mangroves and tidal wetlands of the Great Barrier Reef to climate change. *Climate Change and the Great Barrier Reef: A Vulnerability Assessment*, 237–269.

Lozano, R., Wang, H., Foreman, K. J., Rajaratnam, J. K., Naghavi, M., Marcus, J. R., Dwyer-Lindgren, L., Lofgren, K. T., Phillips, D., Atkinson, C., Lopez, A. D., & Murray, C. J. (2011). Progress towards Millennium Development Goals 4 and 5 on maternal and child mortality: an updated systematic analysis. *The Lancet*, *378*(9797), 1139–1165. https://doi.org/10.1016/S0140-6736(11)61337-8

Lu, T., Zeng, H., Luo, Y., Wang, Q., Shi, F., Sun, G., Wu, Y., & Wu, N. (2012). Monitoring vegetation recovery after China's May 2008 Wenchuan earthquake using Landsat TM time-series data: A case study in Mao County. *Ecological Research*. https://doi.org/10.1007/s11284-012-0976-y

Luck, G. W., Smallbone, L. T., & O'Brien, R. (2009). Socio-Economics and Vegetation Change in Urban Ecosystems: Patterns in Space and Time. *Ecosystems*, *12*(4), 604–620. https://doi.org/10.1007/s10021-009-9244-6

Luo, J., Yan, D., Song, J., Zhang, D., Xing, X., Han, Y., Yang, M., Dong, X., Peng, C., Chen, S., & Xiao, X. (2013). A strategy for trade monitoring and substitution of the organs of threatened animals. *Scientific Reports*, *3*, 3108. https://doi.org/10.1038/srep03108

Luo, Z., Jiang, Z., & Tang, S. (2015). Impacts of climate change on distributions and diversity of ungulates on the Tibetan Plateau. *Ecological Applications*, *25*, 24–38.

Lutz, A. F., Immerzeel, W. W., Shrestha, A. B., & Bierkens, M. F. P. (2014). Consistent increase in High Asia's runoff due to increasing glacier melt and precipitation. *Nature Clim. Change*, *4*(7), 587–592. Retrieved from http://dx.doi.org/10.1038/nclimate2237

Lymer, D., Funge-Smith, S., & Miao, W. (2010). *Status and potential of fisheries and aquaculture in Asia and the Pacific 2010*. (F. A. O. R. O. for A. and the Pacific, Ed.). RAP Publication 2010/17.: FAO.

MacDiarmid, A., McKenzie, A., Sturman, J., Beaumont, J., Mikaloff-Fletcher, S., & Dunne, J. (2012). *Assessment of anthropogenic threats to New Zealand marine habitats.* (New Zealand Aquatic Environment and Biodiversity Report No. 93).

MacDougall, A. S., McCann, K. S., Gellner, G., & Turkington, R. (2013). Diversity loss with persistent human disturbance increases vulnerability to ecosystem collapse. *Nature*, *494*, 86–90.

Mack, R. N., & Lonsdale, W. M. (2001). Humans as global plant dispersers: getting more than we bargained for. *BioScience*, *51*(2), 95. https://doi.org/10.1641/0006-3568(2001)051[0095:HAGPDG]2.0.CO;2

Mack, R. N., Simberloff, D., Mark Lonsdale, W., Evans, H., Clout, M., & Bazzaz, F. A. (2000). Biotic invasions: causes, epidemiology, global consequences, and control. *Ecological Applications*, *10*(3), 689–710. https://doi.org/10.1890/1051-0761(2000)010[0689:BICEGC]2.0.CO;2

Maclean, J., Dawe, D., Hardy, B., & Hettel, G. (2002). *Rice almanac: sourcebook for the most important economic activity on earth*. Wallingford, UK: CABI Publishing.

Macusi, E. D., Abreo, N. A. S., Cuenca, G. C., Ranara, C. T. B., Cardona, L. T., Andam, M. B., Guanzon, G. C., Katikiro, R. E., & Ashoka Deepananda, K. H. M. (2015). The potential impacts of climate change on freshwater fish, fish culture and fishing communities. *Journal of Natural Studies*, *14*(2), 14–31.

Magee, B., Oi, D., Parkes, J., Adamson, D., Hyne, N., Langford, D., Holtkamp, R., & Lawson, S. (2016). *Independent Review Panel of the National Red Imported Fire Ant Eradication Program*.

Mahat, T. B. S., Griffin, D. M., & Sheperd, K. R. (1987). Human impact of some forest of middle hills of Nepal part 4. A detail study in southeast Sindhu Palchok and northeast Kabre Palanchok. *Mountain Research and Development*, *7*(2), 111–134.

Majumdar, S. (2017). Emerging Trends in TVET in Asia and the Pacific Region: CPSC's response. In *Emerging Challenges and Trends in TVET in the Asia-Pacific Region* (pp. 3–17). Springer International Publishing AG.

Mandal, J., & Sengupta, P. (2015). ILEE, Vol: 38(1) June, 2015, *38*(1), 1–9.

Mao, D. H., Wang, Z. M., Luo, L., Ren, C. Y., & Jia, M. M. (2016). Monitoring the evolution of wetland ecosystem pattern in Northeast China from 1990 to 2013 based on remote sensing. *Journal of Natural Resources*, *31*(8), 1253–1263.

Marcotullio, P. J., Sarzynski, A., Albrecht, J., Schulz, N., & Garcia, J. (2013). The geography of global urban greenhouse gas emissions: an exploratory analysis. *Climatic Change*, *121*(4), 621–634. https://doi.org/10.1007/s10584-013-0977-z

Marinoni, A., Cristofanelli, P., Laj, P., Duchi, R., Putero, D., Calzolari, F., Landi, T. C., Vuillermoz, E., Maione, M., & Bonasoni, P. (2013). High black carbon and ozone concentrations during pollution transport in the Himalayas: Five years of continuous observations at NCO-P global GAW station. *Journal of Environmental Sciences*, *25*(8), 1618–1625. https://doi.org/10.1016/S1001-0742(12)60242-3

Mark, A. F., Barratt, B. I. P., & Weeks, E. S. (2013). Ecosystem services in New Zealand's indigenous grasslands: conditions and trends. In J. R. Dymond (Ed.), *Ecosystem services in New Zealand - conditions and trends*. Lincoln, New Zealand: Manaaki Whenua Press.

Mason-D'Croz, D., Vervoort, J., Palazzo, A., Islam, S., Lord, S., Helfgott, A., Havlík, P., Peou, R., Sassen, M., Veeger, M., van Soesbergen, A., Arnell, A. P., Stuch, B., Arslan, A., & Lipper, L. (2016). Multi-factor, multi-state, multi-model scenarios: Exploring food and climate futures for Southeast Asia. *Environmental Modelling & Software*, *83*, 255–270. https://doi.org/10.1016/j.envsoft.2016.05.008

Massey, D. S., Axinn, W. G., & Ghimire, D. J. (2010). Environmental change and out-migration: evidence from Nepal. *Population and Environment*, *32*(2–3), 109–136. https://doi.org/10.1007/s11111-010-0119-8

Mateo-Sagasta, J., Raschid-Sally, L., & Thebo, A. (2015). Chapter2: Global Wastewater and Sludge Production, Treatment and Use. In P. Drechsel, M. Qadir, & D. Wichelns (Eds.), *Wastewater: Economic Asset in an Urbanizing World* (pp. 15–38). Springer Dordrecht Heidelberg New York London.

Matsubara, H., Morimoto, S., Sase, H., Ohizumi, T., Sumida, H., Nakata, M., & Ueda, H. (2009). Long-Term Declining Trends in River Water pH in Central Japan. *Water, Air, and Soil*

Pollution, *200*(1), 253–265. https://doi.org/10.1007/s11270-008-9909-3
Matsuzaki, S. S., & Kadoya, T. (2015). Trends and stability of inland fishery resources in Japanese lakes: Introduction of exotic piscivores as a driver. *Ecological Applications*, *25*(5), 1420–1432. https://doi.org/10.1890/13-2182.1.sm
Matyssek, R., & Sandermann, H. (2003). Impact of ozone on trees: an ecophysiological perspective. *Progress in Botany*, *64,* 349–404.
Maxwell, S., Fuller, R. A., Brooks, T. M., & Watson, J. E. M. (2016). The ravages of guns, nets and bulldozers. *Nature*, *536*, 143–145.
Mayfield, A. B., Chen, M. N., Meng, P. J., Lin, H. J., Chen, C. S., & Liu, P. J. (2013). The physiological response of the reef coral Pocillopora damicornis to elevated temperature: Results from coral reef mesocosm experiments in Southern Taiwan. *Marine Environmental Research*, *86,* 1–11. https://doi.org/10.1016/j.marenvres.2013.01.004
Mcdonald, R. I., Kareiva, P., & Forman, R. T. T. (2008). The implications of current and future urbanization for global protected areas and biodiversity conservation. *Biological Conservation*, *141*(6), 1695–1703. https://doi.org/10.1016/j.biocon.2008.04.025
McDonald, R. I., Marcotullio, P. J., & Güneralp, B. (2013). Urbanization and Global Trends in Biodiversity and Ecosystem Services. In *Urbanization, Biodiversity and Ecosystem Services: Challenges and Opportunities* (pp. 31–52). Dordrecht: Springer Netherlands. https://doi.org/10.1007/978-94-007-7088-1_3
McGee, T. G. (1991). The emergence of desakota regions in Asia: expanding a hypothesis. In N. S. Ginsburg, B. Koppel, & T. G. McGee (Eds.), *The Extended metropolis: Settlement Transition in Asia* (pp. 3–25). Honolulu: University of Hawaii Press. Retrieved from http://ci.nii.ac.jp/ncid/BA12850345
McGranahan, G., Satterthwaite, D., & Tacoli, C. (2004). *Rural–urban change, boundary problems and environmental burdens*. Retrieved from http://www.iied.org/pubs/display.php?o=9500IIED&n=14&l=34&a=C Tacoli
Mcgree, S., Whan, K., Jones, D., Alexander, L. V., Imielska, A., Diamond, H., Ene, E., Finaulahi, S., Inape, K., Jacklick, L., Kumar, R., Laurent, V., Malala, H., Malsale, P., Moniz, T., Ngemaes, M., Peltier, A., Porteous, A., Pulehetoa-Mitiepo, R., Seuseu, S., Skilling, E., Tahani, L., Teimitsi, F., Toorua, U., & Vaiimene, M. (2014). An updated assessment of trends and variability in total and extreme rainfall in the western Pacific. *International Journal of Climatology*, *34*(8), 2775–2791. https://doi.org/10.1002/joc.3874
McInnes, R. J., Simpson, M., Lopez, B., Hawkins, R., & Shore, R. (2017). Wetland Ecosystem Services and the Ramsar Convention: an Assessment of Needs. *Wetlands*, *37*(1), 123–134. https://doi.org/10.1007/s13157-016-0849-1
McIntosh, A. R., McHugh, P. A., Dunn, N. R., Goodman, J. M., Howard, S. W., Jellyman, P. G., O’Brien, L. K., & Nyström, P. (2010). The impact of trout on galaxiid fishes in New Zealand. *New Zealand Journal of Ecology*, *34*(1), 195–206.
Mcivor, J. G. (2005). Australian Grasslands. In J. M. Suttie, S. G. Reynolds, & C. Batello (Eds.), *Grasslands of the world*. Rome: Food and Agriculture Organization of the United Nations. Retrieved from http://www.fao.org/docrep/008/y8344e/y8344e0g.htm
McKee, J. K., Sciulli, P. W., Fooce, C. D., & Waite, T. A. (2004). Forecasting global biodiversity threats associated with human population growth. *Biological Conservation*, *115*(1), 161–164. Retrieved from http://www.sciencedirect.com/science/article/pii/S0006320703000995
McKeown, R. E. (2009). The Epidemiologic Transition: Changing Patterns of Mortality and Population Dynamics. *American Journal of Lifestyle Medicine*, *3*(1 Suppl), 19S–26S. https://doi.org/10.1177/1559827609335350
Mcleod, E., Chmura, G. L., Bouillon, S., Salm, R., Björk, M., Duarte, C. M., Lovelock, C. E., Schlesinger, W. H., & Silliman, B. R. (2011). A blueprint for blue carbon: toward an improved understanding of the role of vegetated coastal habitats in sequestering CO2. *Frontiers in Ecology and the Environment*, *9*(10), 552–560. https://doi.org/10.1890/110004
Mekong River Commission. (2007). Diagnostic study of water quality in the Lower Mekong Basin. *MRC Technical Paper No.15*, (15), 57pp.
Mendelsohn, R. (2014). The impact of climate change on agriculture in Asia. Journal of Integrative Agriculture. *Journal of Integrative Agriculture* , *13*(4), 660–665.

Ménégoz, M., Krinner, G., Balkanski, Y., Boucher, O., Cozic, A., Lim, S., & Jacobi, H. W. (2014). Snow cover sensitivity to black carbon deposition in the Himalayas: from atmospheric and ice core measurements to regional climate simulations. *Atmos Chem Phys*, *14*(8), 4237–4249.

Menzi, H., Oenema, O., Burton, C., Shipin, O., Gerber, P., Robinson, T. P., & Franceschini, G. (2010). Impacts of intensive livestock production and manure managment on the environment. In H. Steinfeld, H. A. Mooney, F. Schneider, & L. E. Neville (Eds.), *Livestock in a Changing Landscape* (Vol. 1).

Merrifield, M. A. (2011). A Shift in Western Tropical Pacific Sea Level Trends during the 1990s. *Journal of Climate*, *24*(15), 4126–4138. https://doi.org/10.1175/2011JCLI3932.1

Meslemani, Y. (2008). *Climate change impacts and adaptation in the Eastern Mediterranean/Syria: draft UNFCCC initial national communication for Syria*.

Messerli, B., & Ives, J. D. (1997). *Mountains of the World: A Global Priority*. (B. Messerli and J. D. Ives, Ed.). New York and Carnforth: Parthenon Publishing.

Miao, L., Ye, P., He, B., Chen, L., & Cui, X. (2015). Future climate impact on the desertification in the dry land asia using AVHRR GIMMS NDVI3g data. *Remote Sensing*. https://doi.org/10.3390/rs70403863

Michinaka, T., Miyamoto, M., Yokota, Y., Sokh, H., Lao, S., & Ma, V. (2013). Factors Affecting Forest Area Changes in Cambodia: An Econometric Approach. *Journal of Sustainable Development*, *6*(5), p12. https://doi.org/10.5539/jsd.v6n5p12

Miehe, G., Miehe, S., & Schlütz, F. (2009). Early human impact in the forest ecotone of southern High Asia (Hindu Kush, Himalaya). *Quaternary Research*, *71*(3), 255–265. Retrieved from http://www.sciencedirect.com/science/article/pii/S0033589409000246

Miettinen, J., Shi, C., & Liew, S. C. (2012). Two decades of destruction in Southeast Asia's peat swamp forests. *Frontiers in Ecology and the Environment*, *10*(3), 124–128. https://doi.org/10.1890/100236

Millennium Ecosystem Assessment. (2005a). *Ecosystems and Human Well-being: Biodiversity Synthesis*. Washington, DC: World Resources Institute.

Millennium Ecosystem Assessment. (2005b). *Ecosystems and Human Well-being: Synthesis*. Washington, DC: Island Press.

Mingfang Zhang, Qingshan Ren, Xiaohua Wei, Jingsheng Wang, Xiaolin Yang, & Zishan Jiang. (2011). Climate change, glacier melting and streamflow in the Niyang River Basin, Southeast Tibet, China. *Ecohydrology*, *4*(2), 288–298.

Ministry for the Environment, & Statistics New Zealand. (2015). *New Zealand's Environmental Reporting Series: Environment Aotearoa 2015*. Wellington, New Zealand. Retrieved from www.mfe.govt.nz

Ministry of Agriculture and Forestry. (2015). New Zealand's National Fruit Fly Surveillance Programme 2014-2015. Retrieved from http://www.biosecurity.govt.nz/pests/ surv-mgmt/surv/fruit-fly

Ministry of Environment of the Republic of Korea. (2014). The Fifth National Report ot the Convention on Biological Diversity, (April).

Ministry of Environmental Protection of China. (2006). Eco-Compensation Mechanisms and Policies in China. Retrieved from http://english.sepa.gov.cn/Events/Special_Topics/AGM_1/Pub06AGM/meetingdoc06/201605/t20160524_344864.shtml

Ministry of Environmental Protection of China. (2013). *China's Fifth National Report to Implementation of the Convention on Biological Diversity*. Beijing, China: China Environmental Science Press.

Ministry of Science Technology and Environment (MoSTE). (2015). *Nepal Earthquake 2015 Rapid Environmental Assessment*. Kathmandu: Ministry of Science, Technology and Environment (MoSTE), Government of Nepal.

Ministry of the Environment Government of Japan. (n.d.). Mongoose eradication project in Yambaru, Okinawa. (N. N. C. Office, Ed.). Japan.

Mishra, H. R. (2002). Mountains of the developing world: Pockets of poverty or pinnacles for prosperity. *Unasylva*.

Mishra, S. K. (2015). *Practices, Management and Interventions Required in Sustainable Fishing*.

USA: Social Science Electronic Publishing, Inc. Retrieved from http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2658021
Miththapala, S. (2013). *Tidal flats. Coastal Ecosystems Series (Vol 5).* Colombo, Sri Lanka: IUCN.
Mohandass, D., Zhao, J. L., Xia, Y. M., Campbell, M. J., & Li, Q. J. (2015). Increasing temperature causes flowering onset time changes of alpine ginger Roscoea in the Central Himalayas. *Journal of Asia-Pacific Biodiversity*, *8*(3), 191–198. https://doi.org/10.1016/j.japb.2015.08.003
Molur, S., Smith, K. G., Daniel, B. A., & Darwall, W. R. T. (2011). *The Status and Distribution of Freshwater Biodiversity in the Western Ghats, India.* . Cambridge, UK and Gland, Switzerland: IUCN, and Coimbatore, India: Zoo Outreach Organisation.
Mondal, A., Khare, D., & Kundu, S. (2015). Spatial and temporal analysis of rainfall and temperature trend of India. *Theoretical and Applied Climatology*, *122*(1–2), 143–158. https://doi.org/10.1007/s00704-014-1283-z
Montreal Process Implementation Group for Australia. (2008). *Australia's state of the forests report*. Retrieved from http://apo.org.au/node/8430
Mordor Intelligence. (2017). Asia Pacific Automotive High Performance Electric Vehicles market – Growth, Trends & Forecast (2017 – 2022). Retrieved from https://www.mordorintelligence.com/industry-reports/asia-pacific-automotive-high-performance-electric-vehicles-market
Morrison, K. W., Battley, P. F., Sagar, P. M., & Thompson, D. R. (2015). Population dynamics of Eastern Rockhopper Penguins on Campbell Island in relation to sea surface temperature 1942–2012: current warming hiatus pauses a long-term decline. *Polar Biology*, *38*(2), 163–177. https://doi.org/10.1007/s00300-014-1575-x
Morton, S., Sheppard, A., & Lonsdale, M. (2014). *Biodiversity : science and solutions for Australia*. CSIRO Publishing.
Mortreux, C., & Barnett, J. (2009). Climate change, migration and adaptation in Funafuti, Tuvalu. *Global Environmental Change*, *19*(1), 105–112. https://doi.org/10.1016/j.gloenvcha.2008.09.006
Mosley, L. M. (2015). Drought impacts on the water quality of freshwater systems; review and integration. *Earth-Science Reviews*, *140*, 203–214. https://doi.org/10.1016/j.earscirev.2014.11.010
MRC (Mekong River Commission). (2010). *State of the basin report 2010*. Vientiane, Lao PDR.
Mueller, V., Gray, C., & Kosec, K. (2014). Heat stress increases long-term human migration in rural Pakistan. *Nature Climate Change*, *4*(3), 182–185. https://doi.org/10.1038/nclimate2103
Muhlfeld, C. C., Kovach, R. P., Jones, L. a., Al-Chokhachy, R., Boyer, M. C., Leary, R. F., Lowe, W. H., Luikart, G., & Allendorf, F. W. (2014). Invasive hybridization in a threatened species is accelerated by climate change. *Nature Climate Change*, *4*(7), 620–624. https://doi.org/10.1038/nclimate2252
Mukul, S. A., Rashid, A. M., Uddin, B. M., & Khan, N. A. (2016). Role of non-timber forest products in sustaining forest-based livelihoods and rural households' resilience capacity in and around protected area: a Bangladesh study. *Journal of Environmental Planning and Management*, *59*(4), 628–642. Retrieved from http://dx.doi.org/10.1080/09640568.2015.1035774
Müller, N., Ignatieva, M., Nilon, C. H., Werner, P., & Zipperer, W. C. (2013). Patterns and Trends in Urban Biodiversity and Landscape Design. In *Urbanization, Biodiversity and Ecosystem Services: Challenges and Opportunities* (pp. 123–174). Dordrecht: Springer Netherlands. https://doi.org/10.1007/978-94-007-7088-1_10
Munday, P. L., Dixson, D. L., McCormick, M. I., Meekan, M., Ferrari, M. C. O., & Chivers, D. P. (2010). Replenishment of fish populations is threatened by ocean acidification. *Proceedings of the National Academy of Sciences*, *107*(29), 12930–12934. https://doi.org/10.1073/pnas.1004519107
Murakami, H., Vecchi, G. A., Delworth, T. L., Wittenberg, A. T., Underwood, S., Gudgel, R., Yang, X., Jia, L., Zeng, F., Paffendorf, K., & Zhang, W. (2016). Dominant Role of Subtropical Pacific Warming in Extreme Eastern Pacific Hurricane Seasons: 2015 and the Future. *Journal of Climate*, *30*(1), 243–264. https://doi.org/10.1175/JCLI-D-16-0424.1
Myers-Smith, I. H., Elmendorf, S. C., Beck, P. S. A., Wilmking, M., Hallinger, M., Blok, D., Tape, K. D., Rayback, S. A., Macias-Fauria, M., Forbes, B. C., Speed, J. D. M., Boulanger-Lapointe, N., Rixen, C., Levesque, E., Schmidt, N. M., Baittinger, C., Trant, A. J., Hermanutz, L., Collier, L.

S., Dawes, M. A., Lantz, T. C., Weijers, S., Jorgensen, R. H., Buchwal, A., Buras, A., Naito, A. T., Ravolainen, V., Schaepman-Strub, G., Wheeler, J. A., Wipf, S., Guay, K. C., Hik, D. S., & Vellend, M. (2015). Climate sensitivity of shrub growth across the tundra biome. *Nature Clim. Change*, *5*(9), 887–891. Retrieved from http://dx.doi.org/10.1038/nclimate2697

Myers, N. (2002). Environmental refugees: a growing phenomenon of the 21st century. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *357*(1420), 609–613. https://doi.org/10.1098/rstb.2001.0953

Nagelkerken, I., & Connell, S. D. (2015). Global alteration of ocean ecosystem functioning due to increasing human CO 2 emissions. *Proceedings of the National Academy of Sciences*, *2015*, 201510856. https://doi.org/10.1073/pnas.1510856112

Nair, M., & Kumar, D. (2012). Water desalination and challenges: The Middle East perspective: a review. *Desalination and Water Treatment*. https://doi.org/10.1080/19443994.2013.734483

Nakamura, K., Tockner, K., & Amano, K. (2006). River and Wetland Restoration: Lessons from Japan. *Bioscience*, *56*(5), 419–429. https://doi.org/10.1641/0006-3568(2006)056[0419:rawrlf]2.0.co;2

Nakata, H., Shinohara, R.-I., Nakazawa, Y., Isobe, T., Sudaryanto, A., Subramanian, A., Tanabe, S., Zakaria, M. P., Zheng, G. J., Lam, P. K. S., Kim, E. Y., Min, B.-Y., We, S.-U., Viet, P. H., Tana, T. S., Prudente, M., Frank, D., Lauenstein, G., & Kannan, K. (2012). Asia–Pacific mussel watch for emerging pollutants: Distribution of synthetic musks and benzotriazole UV stabilizers in Asian and US coastal waters. *Marine Pollution Bulletin*, *64*(10), 2211–2218. https://doi.org/10.1016/j.marpolbul.2012.07.049

Nakatsuka, S., Ishida, Y., Fukuda, H., & Akita, T. (2017). A limit reference point to prevent recruitment overfishing of Pacific bluefin tuna. *Marine Policy*, *78*(107–113).

Nath, T. K., Jashimuddin, M., Kamrul Hasan, M., Shahjahan, M., & Pretty, J. (2016). The sustainable intensification of agroforestry in shifting cultivation areas of Bangladesh. *Agroforestry Systems*, *90*(3), 405–416. https://doi.org/10.1007/s10457-015-9863-1

Nautiyal, M. C., Nautiyal, B. P., & Prakash, V. (2004). Effect of Grazing and Climatic Changes on Alpine Vegetation of Tungnath, Garhwal Himalaya, India. *Environmentalist*, *24*(2), 125–134. https://doi.org/10.1007/s10669-004-4803-z

Negi, C. S. (2012). Culture and Biodiversity Conservation: Case studies from Uttarakhand, Central Himalaya. *Indian Journal of Traditional Knowledge*, *11*(2), 273–278.

Nelson, M., Roffey, P., McNevin, D., Lennard, C., & Gahan, M. E. (2014). An overview of biosecurity in Australia. *Australian Journal of Forensic Sciences*, *0618*(March). https://doi.org/10.1080/00450618.2014.882986

New Zealand Ministry for the Environment. (2015). New Zealand's Greenhouse Gas Inventory 1990–2013. Retrieved January 2, 2018, from http://www.mfe.govt.nz/publications/climate-change/new-zealands-greenhouse-gas-inventory-1990-2013

New Zealand Ministry for the Environment. (2016). Climate change impacts in New Zealand. Retrieved April 19, 2017, from http://www.mfe.govt.nz/climate-change/how-climate-change-affects-nz/climate-change-impacts

New Zealand Ministry for the Environment. (2017). *The Status of New Zealand ' s Fisheries*. Wellington.

Nghiem, Le TP, Hugh TW Tan, and R. T. C. (2015). Invasive trees in Singapore: are they a threat to native forests? *Tropical Conservaion Science*, *8*(1), 201–214.

Nghiem, L. T. P., Soliman, T., Yeo, D. C. J., Tan, H. T. W., Evans, T. A., Mumford, J. D., Keller, R. P., Baker, R. H. A., Corlett, R. T., & Carrasco, L. R. (2013). Economic and Environmental Impacts of Harmful Non-Indigenous Species in Southeast Asia. *PLoS ONE*, *8*(8). https://doi.org/10.1371/journal.pone.0071255

Nie, Y., Liu, Q., & Liu, S. (2013). Glacial Lake Expansion in the Central Himalayas by Landsat Images, 1990?2010. *PLoS ONE*, *8*(12), e83973. https://doi.org/10.1371/journal.pone.0083973

Ning, W., Ismail, M., Joshi, S., Qamar, F., Phuntsho, K., Weikang, Y., Khan, B., Shaoliang, Y., Kotru, R., & Sharma, E. (2014). *Understanding the Transboundary Karakoram-Pamir Landscape* (Feasibility and Baseline Studies.). Kathmandu, ICIMOD.

Noroozi, J., Pauli, H., Grabherr, G., & Breckle, S.-W. (2011). *The subnival-nival vascular plant species of Iran: A unique high-mountain flora and its threat from climate warming*. *Biodiversity*

and Conservation (Vol. 20). https://doi.org/10.1007/s10531-011-0029-9
Norton-Griffiths, M. (2007). How many wildebeest do you need? *World Economics*, *8*(2), 41–64.
Nurse, L. A., McLean, R. F., Agard, J., Briguglio, L. P., Duvat-Magnan, V., Pelesikoti, N., Tompkins, E., & Webb, A. (n.d.). Small islands. In V. R. Barros, C. B. Field, D. J. Dokken, M. D. Mastrandrea, K. J. Mach, T. E. Bilir, M. Chatterjee, K. L. Ebi, Y. O. Estrada, R. C. Genova, B. Girma, E. S. Kissel, A. N. Levy, S. MacCracken, P. R. Mastrandrea, & L. L. White (Eds.), *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel of Climate Change* (pp. 1613–1654). Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press.
O'Brien, K. L., & Wolf, J. (2010). A values-based approach to vulnerability and adaptation to climate change. *Wiley Interdisciplinary Reviews: Climate Change*, *1*(2), 232–242. https://doi.org/10.1002/wcc.30
O'Donnell, A. J., Cook, E. R., Palmer, J. G., Turney, C. S. M., Page, G. F. M., & Grierson, P. F. (2015). Tree rings show recent high summer-autumn precipitation in northwest Australia is unprecedented within the last two centuries. *PLoS ONE*, *10*(6), 1–18. https://doi.org/10.1371/journal.pone.0128533
O'Dowd, D. J., Green, P. T., & Lake, P. S. (2003). Invasional "meltdown" on an oceanic island. *Ecology Letters*, *6*(9), 812–817. https://doi.org/10.1046/j.1461-0248.2003.00512.x
Oberheu, C. (2017). Top 10 Wood Charcoal Producing Countries. Retrieved December 15, 2017, from https://www.worldatlas.com/articles/top-10-wood-charcoal-producing-countries.html
Obokata, R., Veronis, L., & McLeman, R. (2014). Empirical research on international environmental migration: a systematic review. *Population and Environment*, *36*(1), 111–135. https://doi.org/10.1007/s11111-014-0210-7
OECD. (2010). *Paying for Biodiversity enhancing the cost-effectiveness of payments for ecosystem services.* Retrieved from https://www.keepeek.com//Digital-Asset-Management/oecd/environment/paying-for-biodiversity_9789264090279-en#.WrMlVihubD4%23page1
Ojaveer, H., Galil, B. S., Campbell, M. L., Carlton, J. T., Canning-Clode, J., Cook, E. J., Davidson, A. D., Hewitt, C. L., Jelmert, A., Marchini, A., McKenzie, C. H., Minchin, D., Occhipinti-Ambrogi, A., Olenin, S., & Ruiz, G. (2015). Classification of Non-Indigenous Species Based on Their Impacts: Considerations for Application in Marine Management. *PLoS Biology*, *13*(4), 1–13. https://doi.org/10.1371/journal.pbio.1002130
Olaniyi, A. O., Abdullah, A. M., Ramli, M. F., & Alias, M. S. (2012). Assessment of drivers of coastal land use change in Malaysia. *Ocean and Coastal Management*, *67*(October), 113–123. https://doi.org/10.1016/j.ocecoaman.2012.05.029
Olsen, B., Munster, V. J., Wallensten, A., Waldenström, J., Osterhaus, A. D. M. E., & Fouchier, R. A. M. (2006). Global Patterns of Influenza A Virus in Wild Birds. *Science*, *312*(5772), 384 LP-388. Retrieved from http://science.sciencemag.org/content/312/5772/384.abstract
Orlowsky, B., & Seneviratne, S. I. (2012). Global changes in extreme events: Regional and seasonal dimension. *Climatic Change*, *110*(3–4), 669–696. https://doi.org/10.1007/s10584-011-0122-9
Orsini, F., Kahane, R., Nono-Womdim, R., & Gianquinto, G. (2013). Urban agriculture in the developing world: A review. *Agronomy for Sustainable Development*, *33*(4), 695–720. https://doi.org/10.1007/s13593-013-0143-z
Osman, K. T. (2014). *Soil Degradation, Conservation and Remediation*. Dordrecht: Springer Netherlands. https://doi.org/10.1007/978-94-007-7590-9
Osseiran, N., & Chriscaden, K. (2016a). Air pollution levels rising in many of the world's poorest cities. Retrieved from http://www.who.int/mediacentre/news/releases/2016/air-pollution-rising/en/
Osseiran, N., & Chriscaden, K. (2016b). WHO releases country estimates on air pollution exposure and health impact. Retrieved December 18, 2017, from http://www.who.int/mediacentre/news/releases/2016/air-pollution-estimates/en/
Oviedo, G., & Jeanrenaud, S. (2007). Protecting Sacred Natural Sites of Indigenous and Traditional Peoples. *Protected Areas and Spirituality. Proceedings of the First Workshop of The Delos Initiative - Monserrat 2006*, (June), 77–100. Retrieved from

http://www.silene.es/documentos/Protected_areas_spirituality_Part_I.pdf
Pacific Invasives Initiative. (2010). *Invasive Species Management in the Pacific: a review of national plans and current activities. Unpublished report for the Pacific Invasives Partnership. Prepared by Natasha Doherty and Souad Boudjelas.* Pacific Invasives Initiative, Auckland, New Zealand.
Page, A. R., & Lacey, K. L. (2006). *Economic Impact Assessment of Australian Weed Biological Control*. *CRC for Australian Weed Management, Technical Series* (Vol. 10).
Pallewatta, N., Reaser, J.K., Gutierrez, A. . (Ed.). (2003). *Invasive Alien Species in SouthSoutheast Asia*. Cape Town, South Africa.
Palmer, J., Cook, E., Turney, C., Allen, K., Fenwick, P., Cook, B., O'Donnell, A., Lough, J., & Baker, P. (2015). Drought variability in the eastern Australia and New Zealand summer drought atlas (ANZDA, CE 1500–2012) modulated by the Interdecadal Pacific Oscillation. *Environmental Research Letters*, *10*(12), 124002. Retrieved from http://stacks.iop.org/1748-9326/10/i=12/a=124002
Pandey, A. K., Tripathi, Y. C., & Kumar, A. (2016). Non-timber forest products (NTFPs) for sustained livelihood: Challenges and strategies. *Research Journal of Forestry*, *10*, 1–7.
Pandit, M. K., & Grumbine, R. E. (2012). Potential Effects of Ongoing and Proposed Hydropower Development on Terrestrial Biological Diversity in the Indian Himalaya. *Conservation Biology*, *26*(6), 1061–1071. https://doi.org/10.1111/j.1523-1739.2012.01918.x
Pandit, M. K., Sodhi, N. S., Koh, L. P., Bhaskar, A., & Brook, B. W. (2007). Unreported yet massive deforestation driving loss of endemic biodiversity in Indian Himalaya. *Biodiversity and Conservation*, *16*(1), 153–163. https://doi.org/10.1007/s10531-006-9038-5
Parker, L. M., Ross, P. M., & O'Connor, W. A. (2011). Populations of the Sydney rock oyster, Saccostrea glomerata, vary in response to ocean acidification. *Marine Biology*, *158*(3), 689–697. https://doi.org/10.1007/s00227-010-1592-4
Parmesan, C. (2006). Ecological and Evolutionary Responses to Recent Climate Change. *Annual of Ecology, Evolution and Systematics*, *37*, 637–669. https://doi.org/10.2307/annurev.ecolsys.37.091305.30000024
Parmesan, C., & Yohe, G. (2003). A globally coherent fingerprint of climate change impacts across natural systems. *Nature*, *421*(6918), 37–42. https://doi.org/10.1038/nature01286
Parrotta, J., Hin Fui, L., Jinlong, L., Ramakrishnan, P. S., & Yeo-Chang, Y. (2009). Traditional forest-related knowledge and sustainable forest management in Asia. *Forest Ecology and Management*, *257*, 1987–1988. https://doi.org/10.1016/S0378-1127(09)00221-7
Partow, H. (2001). *The Mesopotamian Marshlands: Demise of an Ecosystem*. Division of Early Warning and Assessment United Nations Environment Programme Nairobi, Kenya.
Pascoe, S., Kahui, V., Hutton, T., & Dichmont, C. (2016). Experiences with the use of bioeconomic models in the management of Australian and New Zealand fisheries. *Fisheries Research*, *183*, 539–548. https://doi.org/10.1016/j.fishres.2016.01.008
Pascual, U., Balvanera, P., Díaz, S., Pataki, G., Roth, E., Stenseke, M., Watson, R. T., Başak Dessane, E., Islar, M., Kelemen, E., Maris, V., Quaas, M., Subramanian, S. M., Wittmer, H., Adlan, A., Ahn, S. E., Al-Hafedh, Y. S., Amankwah, E., Asah, S. T., Berry, P., Bilgin, A., Breslow, S. J., Bullock, C., Cáceres, D., Daly-Hassen, H., Figueroa, E., Golden, C. D., Gómez-Baggethun, E., González-Jiménez, D., Houdet, J., Keune, H., Kumar, R., Ma, K., May, P. H., Mead, A., O'Farrell, P., Pandit, R., Pengue, W., Pichis-Madruga, R., Popa, F., Preston, S., Pacheco-Balanza, D., Saarikoski, H., Strassburg, B. B., van den Belt, M., Verma, M., Wickson, F., & Yagi, N. (2017). Valuing nature's contributions to people: the IPBES approach. *Current Opinion in Environmental Sustainability*. https://doi.org/10.1016/j.cosust.2016.12.006
Pathak, D., Gajurel, A. P., & Mool, P. K. (2010). *Climate Change Impacts on Hazards in the Eastern Himalayas*.
Paulay, G. (2003). Marine biodiversity of Guam and the Marianas: overview. *Micronesica*, (May 1990), 3–25. Retrieved from http://university.uog.edu/up/micronesica/abstracts_35-36/pdfs_3536/1-intro.pdf
Paulay, G., Kirkendale, L., Lambert, G., & Meyer, C. (2002). Anthropogenic biotic interchange in a coral reef ecosystem: a case study from Guam. *Pacific Science*, *56*(4), 403–422. https://doi.org/10.1353/psc.2002.0036
Pauli, H., Gottfried, M., Lamprecht, A., Niessner, S., Rumpf, S., Winkler, M., Steinbauer, K., &

Grabherr, G. (2015). *The GLORIA field manual - standard Multi-Summit approach, supplementary methods and extra approaches*. Vienna.
Pauly, D., Belhabib, D., Blomeyer, R., Cheung, W. W. W. L., Cisneros-Montemayor, A. M., Copeland, D., Harper, S., Lam, V. W. Y., Mai, Y., Le Manach, F., Österblom, H., Mok, K. M., van der Meer, L., Sanz, A., Shon, S., Sumaila, U. R., Swartz, W., Watson, R., Zhai, Y., & Zeller, D. (2014). China's distant-water fisheries in the 21st century. *Fish and Fisheries*, *15*(3), 474–488. https://doi.org/10.1111/faf.12032
Pauly, D., & Zeller, D. (2016). Catch reconstructions reveal that global marine fisheries catches are higher than reported and declining. *Nature Communications*, *7*, 10244. Retrieved from http://dx.doi.org/10.1038/ncomms10244
Pauly, D., & Zeller, D. (2017a). Comments on FAOs State of World Fisheries and Aquaculture (SOFIA 2016). *Marine Policy*, *77*, 176–181. https://doi.org/https://doi.org/10.1016/j.marpol.2017.01.006
Pauly, D., & Zeller, D. (2017b). The best catch data that can possibly be? Rejoinder to Ye et al. "FAO's statistic data and sustainability of fisheries and aquaculture." *Marine Policy*, *81*, 406–410. https://doi.org/https://doi.org/10.1016/j.marpol.2017.03.013
Peh, K. S. H. (2010). Invasive species in Southeast Asia: The knowledge so far. *Biodiversity and Conservation*, *19*(4), 1083–1099. https://doi.org/10.1007/s10531-009-9755-7
Pei, S. J. (2010). The road to the future? The biocultural values of the Holy Hill forests of Yunnan Province, China. In B. Verschuuren, R. Wild, J. A. McNeely, & G. Oviedo (Eds.), *Sacred natural sites – Conserving nature and culture* (pp. 98–106). London & Washington: Earthsacan; Gland: IUCN: IUCN.
Pelley, J. (2008). Invasive snake threatens Pacific islands. *Frontiers in Ecology and the Environment*, *6*, 296.
Peltzer, D. A. (2013). An Ecosystem View of Links Between Pest Species and Services. In D. J. R. Dymond (Ed.), *Ecosystem Services in New Zealand: Conditions and Trends* (pp. 400–407). Lincoln, New Zealand: Manaaki Whenua Press.
Peluffo, A., & Neger, Y. (2014). *Seawater desalination : technical, environmental and social aspects*. Paris: Environmental Research and Teaching Institute.
Perrings, C., Dehnen-Schmutz, K., Touza, J., & Williamson, M. (2005). How to manage biological invasions under globalization. *Trends in Ecology and Evolution*, *20*(5), 212–215. https://doi.org/10.1016/j.tree.2005.02.011
Philipp, E., & Fabricius, K. (2003). Photophysiological stress in scleractinian corals in response to short-term sedimentation. *Journal of Experimental Marine Biology and Ecology*, *287*(1), 57–78. https://doi.org/10.1016/S0022-0981(02)00495-1
Philippe, V. (2007). Trends in GM crop, food and feed safety literature. *Nature Biotechnology*, *25*(6), 624.
Phoenix, G. K., Hicks, W. H., Cinderby, S., Kuylenstierna, J. C. I., Stock, W. D., Dentener, F. J., Giller, K. E., Austin, A. T., Lefroy, R. D. B., Gimeno, B. S., Ashmore, M. R., & Ineson, P. (2006). Atmospheric nitrogen deposition in world biodiversity hotspots: the need for a greater global perspective in assessing N deposition impacts. *Global Change Biology*, *12*, 1–7.
Pickering, C. M., & Hill, W. (2007). Impacts of recreation and tourism on plant biodiversity and vegetation in protected areas in Australia. *Journal of Environmental Management*, *85*(4), 791–800. https://doi.org/10.1016/j.jenvman.2006.11.021
Pingali, P. (2007). Westernization of Asian diets and the transformation of food systems: Implications for research and policy. *Food Policy*. https://doi.org/10.1016/j.foodpol.2006.08.001
Pingali, P., & McCullough, E. (2010). Drivers of change in global agriculture and livestock systems. In H. Steinfeld & E. Al. (Eds.), *Livestock in a changing landscape: drivers, consequences, and responses, volume 1*. Island Press.
Poiani, K. A., Goldman, R. L., Hobson, J., Hoekstra, J. M., & Nelson, K. S. (2011). Redesigning biodiversity conservation projects for climate change: examples from the field. *Biodiversity and Conservation*, *20*(1), 185–201. https://doi.org/10.1007/s10531-010-9954-2
Pollard, D. A., & Hutchings, P. A. (1990a). A review of exotic marine organisms introduced to the Australian region: I. Fishes. *Asian Fisheries Science*, *3*(2), 205–221.
Pollard, D. A., & Hutchings, P. A. (1990b). A review of exotic marine organisms introduced to the

Australian region. II. Invertebrates and algae. *Asian Fisheries Science*, *3*(2), 223–250.
Pomeroy, R. (2012). Managing overcapacity in small-scale fisheries in Southeast Asia. *Marine Policy*, *36*(2), 520–527. https://doi.org/10.1016/j.marpol.2011.10.002
Pomeroy, R., Parks, J., Pollnac, R., Campson, T., Genio, E., Marlessy, C., Holle, E., Pido, M., Nissapa, A., Boromthanarat, S., & Thu Hue, N. (2007). Fish wars: Conflict and collaboration in fisheries management in Southeast Asia. *Marine Policy*, *31*(6), 645–656. https://doi.org/10.1016/j.marpol.2007.03.012
Porter, J. R., Xie, L., Challinor, A. J., Cochrane, K., Howden, S. M., Iqbal, M. M., Lobell, D. B., & Travasso, M. I. (2014). Food security and food production systems. In C. B. Field, V. R. Barros, D. J. Dokken, K. J. Mach, M. D. Mastrandrea, T. E. Bilir, M. Chatterjee, K. L. Ebi, Y. O. Estrada, R. C. Genova, B. Girma, E. S. Kissel, A. N. Levy, S. MacCracken, P. R. Mastrandrea, & L. L. White (Eds.), *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel of Climate Change* (pp. 485–533). Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press.
Pretty, J., Adams, B., Berkes, F., de Athayde, S. F., Dudley, N., Hunn, E., Maffi, L., Milton, K., Rapport, D., Robbins, P., Sterling, E., Stolton, S., Tsing, A., Vintinnerk, E., & Pilgrim, S. (2009). The Intersections of Biological Diversity and Cultural Diversity: Towards Integration. *Conservation and Society*, *7*(2), 100–112. https://doi.org/10.4103/0972-4923.58642
Pribadi, D. O., & Pauleit, S. (2015). The dynamics of peri-urban agriculture during rapid urbanization of Jabodetabek Metropolitan Area. *Land Use Policy*, *48*, 13–24. https://doi.org/10.1016/j.landusepol.2015.05.009
Priddel, D., Carlile, N., & Wheeler, R. (2000). Eradication of European rabbits (Oryctolagus cuniculus) from Cabbage Tree Island, NSW, Australia, to protect the breeding habitat of Gould's petrel (Pterodroma leucoptera leucoptera). *Biological Conservation*, *94*(1), 115–125. https://doi.org/10.1016/S0006-3207(99)00155-X
Pritchard, H. D. (2017). Asia's glaciers are a regionally important buffer against drought. *Nature*, *545*, 169–174.
QBE Asia Pacific. (2017). *Asia-Pacific ICT trends 2017 – The future of the information communication and technology market in Asia-Pacific*.
Qian, Y., Flanner, M. G., Leung, L. R., & Wang, W. (2011). Sensitivity studies on the impacts of Tibetan Plateau snowpack pollution on the Asian hydrological cycle and monsoon climate. *Atmos. Chem. Phys.*, *11*(5), 1929–48.
Qiu, W., Wang, B., Jones, P. J. S., & Axmacher, J. C. (2009). Challenges in developing China's marine protected area system. *Marine Policy*, *33*(4), 599–605. https://doi.org/10.1016/j.marpol.2008.12.005
Quan, B., Bai, Y., Römkens, M. J. M., Chang, K., Song, H., Guo, T., & Lei, S. (2015). Urban land expansion in Quanzhou City, China, 1995–2010. *Habitat International*, *48*, 131–139. https://doi.org/10.1016/j.habitatint.2015.03.021
Racoviteanu, A. E., Arnaud, Y., Williams, M. W., & Manley, W. F. (2015). Spatial patterns in glacier characteristics and area changes from 1962 to 2006 in the Kanchenjunga–Sikkim area, eastern Himalaya. *The Cryosphere*, *9*(2), 505–523. https://doi.org/10.5194/tc-9-505-2015
Raleigh, C., Jordan, L., & Salehyan, I. (2008). *Assessing the Impact of Climate Change on Migration and Conflict*. The World Bank.
Ramalho, C. E., Laliberté, E., Poot, P., & Hobbs, R. J. (2014). Complex effects of fragmentation on remnant woodland plant communities of a rapidly urbanizing biodiversity hotspot. *Ecology*, *95*(9), 2466–2478. https://doi.org/10.1890/13-1239.1
Ramírez, A., Pringle, C., & Wantzen, K. (2008). Tropical stream conservation. In D. D (Ed.), *Tropical Stream Ecology* (pp. 285–304). London: Academic Press.
Rands, M. R. W., Rands, M. R. W., Adams, W. M., Bennun, L., Butchart, S. H. M., Clements, A., Coomes, D., Entwistle, A., Hodge, I., Kapos, V., Scharlemann, J. P. W., Sutherland, W. J., & Vira, B. (2010). Biodiversity Conservation : Challenges Beyond 2010, *1298*(September). https://doi.org/10.1126/science.1189138
Ranjitkar, S., Luedeling, E., Shrestha, K., Guan, K., & Xu, J. (2013). Flowering phenology of tree rhododendron along an elevation gradient in two sites in the Eastern Himalayas. *International*

Journal of Biometeorology, *57*(2), 225–240.
Rasul, G. (2014). Food, water, and energy security in South Asia: A nexus perspective from the Hindu Kush Himalayan region. *Environmental Science & Policy*, *39*, 35–48.
Ravindranath, N. H., Chaturvedi, R. K., & Murthy, I. K. (2008). Forest conservation, afforestation and reforestation in India: Implications for forest carbon stocks. *Current Science*, *95*(2), 216–222.
Rawal, D. S., Kasel, S., Keatley, M. R., & Nitschke, C. R. (2015). Herbarium records identify sensitivity of flowering phenology of eucalypts to climate: Implications for species response to climate change. *Austral Ecology*, *40*, 117–125.
Reaser, J., Meyerson, L., Cronk, Q., De Poorter, M., Eldrege, L. G., Green, E., Kairo, M., Latasi, P., Mack, R., Mauremootoo, J., O'Dowd, D., Orapa, W., Sastroutomo, S., Saunders, A., Shine, C., Thrainsson, S., & Vaiutu, L. (2007). Ecological and socioeconomic impacts of invasive alien species in island ecosystems. *Environmental Conservation*, *34*(02), 98. https://doi.org/10.1017/S0376892907003815
Reddy, C. S., Sreelekshmi, S., Jha, C. S., & Dadhwal, V. K. (2013). National assessment of forest fragmentation in India: Landscape indices as measures of the effects of fragmentation and forest cover change. *Ecological Engineering*, *60*, 453–464. Retrieved from http://www.sciencedirect.com/science/article/pii/S0925857413004102
Redoña, E. D. (2004). Rice Biotechnology for Developing Countries in Asia THE CHALLENGE TO INCREASE RICE PRODUCTIVITY.
Reisinger, A., Kitching, R. L., Chiew, F., Hughes, L., Newton, P. C. D., Schuster, S. S., Tait, A., & Whetton, P. (2014). Australasia. In V. R. Barros, C. B. Field, D. J. Dokken, M. D. Mastrandrea, K. J. Mach, T. E. Bilir, M. Chatterjee, K. L. Ebi, Y. O. Estrada, R. C. Genova, B. Girma, E. S. Kissel, A. N. Levy, S. MacCracken, P. R. Mastrandrea, & L. L. White (Eds.), *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel of Climate Change* (pp. 1371–1438). Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press.
Rejmanek, M. (2014). Invasive trees and shrubs: where do they come from and what we should expect in the future? *Biological Invasions*, *16*, 483–498.
REN 21. (2017). *RENEWABLES 2017 GLOBAL STATUS REPORT*.
Ren, D., & Leslie, L. M. (2015). Changes in tropical cyclone activity over Northwest Western Australia in the past 50 years and a view of the future 50 years. *Earth Interactions*, *19*(15). https://doi.org/10.1175/EI-D-14-0006.1
Ren G. Y. (2015). Urbanization as a major driver of urban climate change. *Advances in Climate Change Research*.
Reynolds, J. F., Smith, D. M. S., Lambin, E. F., Turner, B. L., Mortimore, M., Batterbury, S. P. J., Downing, T. E., Dowlatabadi, H., Fernandez, R. J., Herrick, J. E., Huber-Sannwald, E., Jiang, H., Leemans, R., Lynam, T., Maestre, F. T., Ayarza, M., & Walker, B. (2007). Global desertification: building a science for dryland development. *Science (New York, N.Y.)*, *316*(5826), 847–851. https://doi.org/10.1126/science.1131634
Reynolds, S. G. (2005). Introduction. In J. M. Suttie, S. G. Reynolds, & C. Batello (Eds.), *Grassland of the World*. Rome: Food and Agriculture Organization of the United Nations.
Rhyne, A. L., Tlusty, M. F., Schofield, P. J., Kaufman, L., Morris, J. A., & Bruckner, A. W. (2012). Revealing the appetite of the marine aquarium fish trade: The volume and biodiversity of fish imported into the united states. *PLoS ONE*, *7*(5). https://doi.org/10.1371/journal.pone.0035808
Richards, D. R., Friess, D. A., & Hansen, M. C. (2016). Rates and drivers of mangrove deforestation in Southeast Asia, 2000–2012. *PNAS*, *113*(2), 344–349. https://doi.org/10.1073/pnas.1510272113
Rieley, J. O., Wust, R. A. J., Jauhiainen, J., Page, S. E., Ritzema, H., Wosten, H., Hooijer, A., Siegert, F., Limin, S., Vasander, H., Stahlhut, M., & Strack, M. (2008). Tropical Peatlands, Carbon stores, Carbon Gas Emissions and Contribution to Climate Change Processes. In *Peatlands and Climate Change* (pp. 148–181). Jyvaskyla, Finland: International Peat Society.
Robertson, H. (2016). Wetland reserves in New Zealand: the status of protected areas between 1990 and 2013. *New Zealand Journal of Ecology*, *40*(1), 1–11. https://doi.org/https://doi.org/10.20417/nzjecol.40.1

Roe, D. (2008). Trading Nature. *Development*.
Roger, E., Duursma, D. E., Downey, P. O., Gallagher, R. V., Hughes, L., Steel, J., Johnson, S. B., & Leishman, M. R. (2015). A tool to assess potential for alien plant establishment and expansion under climate change. *Journal of Environmental Management*, *159*, 121–127. https://doi.org/10.1016/j.jenvman.2015.05.039
Rogers, K., Saintilan, N., & Heijnis, H. (2005). Mangrove encroachment of salt marsh in Western Port Bay, Victoria: The role of sedimentation, subsidence, and sea level rise. *Estuaries*, *28*(4), 551–559. https://doi.org/10.1007/BF02696066
Romanelli, C., Cooper, D., Campbell-Lendrum, D., Maiero, M., Karesh, W. B., Hunter, D., & Golden, C. D. (2015). *Connecting Global Priorities: Biodiversity and Human Health*.
Rondinelli, D. A. (1991). Asian urban development policies in the 1990s: From growth control to urban diffusion. *World Development*, *19*(7), 791–803. https://doi.org/10.1016/0305-750X(91)90133-3
Rood, S., & Cole, W. S. (2015). Drivers and Trends in a Changing Asia. Retrieved December 28, 2017, from https://asiafoundation.org/2015/04/22/drivers-and-trends-in-a-changing-asia/
Root, T., Price, J., Hall, K., & Schneider, S. (2003). Fingerprints of global warming on wild animals and plants. *Nature*, *421*(6918), 57–60. https://doi.org/10.1038/nature01309.1.
Rose, C. D., Sharp, W. C., Kenworthy, W. J., Hunt, J. H., Lyons, W. G., Prager, E. J., Valentine, J. F., Hall, M. O., Whitfield, P. E., & Fourqurean, J. W. (1999). Overgrazing of a large seagrass bed by the sea urchin Lytechinus variegatus in Outer Florida Bay. *Marine Ecology Progress Series*, *190*(February 2016), 211–222. https://doi.org/10.3354/meps190211
Rosenzweig, C., Elliott, J., Deryng, D., Ruane, A. C., Müller, C., Arneth, A., Boote, K. J., Folberth, C., Glotter, M., Khabarov, N., Neumann, K., Piontek, F., Pugh, T. A. M., Schmid, E., Stehfest, E., Yang, H., & Jones, J. W. (2014). Assessing agricultural risks of climate change in the 21st century in a global gridded crop model intercomparison. *Proceedings of the National Academy of Sciences of the United States of America*, *111*(9), 3268–3273. https://doi.org/10.1073/pnas.1222463110
Rosenzweig, C., Solecki, W. D., Hammer, S. A., & Mehrotra, S. (2011). *Climate Change and Cities: First Assessment Report of the Urban Climate Change Research Network*. Cambridge, UK: Cambridge University Press.
Roy, P. S., Roy, A., Joshi, P. K., Kale, M. P., Srivastava, V. K., Srivastava, S. K., Dwevidi, R. S., Joshi, C., Behera, M. D., Meiyappan, P., Sharma, Y., Jain, A. K., Singh, J. S., Palchowdhuri, Y., Ramachandran, R. M., Pinjarla, B., Chakravarthi, V., Babu, N., Gowsalya, M. S., Thiruvengadam, P., Kotteeswaran, M., Priya, V., Yelishetty, K. M. V. N., Maithani, S., Talukdar, G., Mondal, I., Rajan, K. S., Narendra, P. S., Biswal, S., Chakraborty, A., Padalia, H., Chavan, M., Pardeshi, S. N., Chaudhari, S. A., Anand, A., Vyas, A., Reddy, M. K., Ramalingam, M., Manonmani, R., Behera, P., Das, P., Tripathi, P., Matin, S., Khan, M. L., Tripathi, O. P., Deka, J., Kumar, P., & Kushwaha, D. (2015). Development of decadal (1985-1995-2005) land use and land cover database for India. *Remote Sensing*, *7*(3), 2401–2430. https://doi.org/10.3390/rs70302401
Ruddle, K., & Satria, A. (2010). *Managing Coastal and Inland Waters: Pre-existing Aquatic Management Systems in Southeast Asia*. Springer Netherlands. Retrieved from https://books.google.co.nz/books?id=56VEt5GBUckC
Rudel, T. K., DeFries, R., Asner, G. P., & Laurance, W. F. (2009). Changing drivers of deforestation and new opportunities for conservation. *Conservation Biology*, *23*(6), 1396–1405. https://doi.org/10.1111/j.1523-1739.2009.01332.x
Runting, R. K., Bryan, B. A., Dee, L. E., Maseyk, F. J. F., Mandle, L., Hamel, P., Wilson, K. A., Yetka, K., Possingham, H. P., & Rhodes, J. R. (2017). Incorporating climate change into ecosystem service assessments and decisions: a review. *Global Change Biology*, *23*(1), 28–41. https://doi.org/10.1111/gcb.13457
Ruscoe, W. A., Sweetapple, P. J., Perry, M., & Duncan, R. P. (2013). Effects of Spatially Extensive Control of Invasive Rats on Abundance of Native Invertebrates in Mainland New Zealand Forests. *Conservation Biology*, *27*(1), 74–82. https://doi.org/10.1111/j.1523-1739.2012.01932.x
Russi, D., ten Brink, P., Farmer, A., Badura, T., Coates, D., Förster, J., Kumar, R., & Davidson, N. (2013). *The Economics of Ecosystems and Biodiversity for water and wetlands*. London and

Brussels; Gland: IEEP; Ramsar Secretariat.
Rutledge, D., Ausseil, A.-G., Baisden, T., Bodeker, G., Booker, D., Cameron, M., Collins, D., Daigneault, A., Fernandez, M., Frame, B., Keller, E., Kremser, S., Kirschbaum, M., Lewis, J., Mullan, B., Reisinger, A., Sood, A., Stuart, S., Tait, A., Teixeira, E., Timar, L., & Zammit, C. (2017). *Climate Change Impacts and Implications for New Zealand to 2100 Identifying Feedbacks , Understanding Cumulative Impacts and recognising limits: A national integrated assessment*. Retrieved from http://ccii.org.nz/wp-content/uploads/2017/07/RA3-Synthesis-report.pdf
RVC. (2016). *THE STATE OF SOCIAL MEDIA AND MESSAGING IN ASIA PACIFIC: TRENDS AND STATISTICS*.
Sadovy de Mitcheson, Y., Craig, M. T., Bertoncini, A. A., Carpenter, K. E., Cheung, W. W. L., Choat, J. H., Cornish, A. S., Fennessy, S. T., Ferreira, B. P., Heemstra, P. C., Liu, M., Myers, R. F., Pollard, D. A., Rhodes, K. L., Rocha, L. A., Russell, B. C., Samoilys, M. A., & Sanciangco, J. (2013). Fishing groupers towards extinction: A global assessment of threats and extinction risks in a billion dollar fishery. *Fish and Fisheries*, *14*(2), 119–136. https://doi.org/10.1111/j.1467-2979.2011.00455.x
Saintilan, N., Wilson, N., Rogers, K., Rajkaran, A., & Krauss, K. W. (2015). Mangrove expansion and salt marsh decline at mangrove poleward limits. *Global Change Biology*, *20*(1), 147–157.
Saito, T., Hirabayashi, Y., Suzuki, K., Watanabe, K., & Saito, H. (2016). Recent Decline of Pink Salmon (Oncorhynchus gorbuscha) Abundance in Japan. *North Pacific Anadromous Fish Commission Bulletin*, (6), 279–296. https://doi.org/10.23849/npafcb6/279.296
Sandel, B., Arge, L., Dalsgaard, B., Davies, R. G., Gaston, K. J., Sutherland, W. J., & Svenning, J.-C. (2011). The Influence of Late Quaternary Climate-Change Velocity on Species Endemism. *Science*, *334*(6056), 660–664. https://doi.org/10.1126/science.1210173
Sandilyan, S., & Kathiresan, K. (2012). Mangrove conservation: A global perspective. *Biodiversity and Conservation*, *21*(14), 3523–3542. https://doi.org/10.1007/s10531-012-0388-x
Sang, W., Ma, K., & Axmacher, J. C. (2011). Securing a Future for China's Wild Plant Resources. *BioScience*, *61*(9), 720–725. https://doi.org/10.1525/bio.2011.61.9.11
Sarkar S. (2010). Climate change and disease risk in the Himalayas. *Himalayan Journal of Sciences*, *6*(8), 7.
Sato, T., Qadir, M., Yamamoto, S., Endo, T., & Zahoor, A. (2013). Global, regional, and country level need for data on wastewater generation, treatment, and use. *Agricultural Water Management*, *130*, 1–13. https://doi.org/10.1016/j.agwat.2013.08.007
Saunders, D. A., & Derebeira, C. P. (1986). Seasonal Occurrence of Members of the Suborder Charadrii (Waders or Shorebirds) on Rottnest Island, Western-Australia. *Australian Wildlife Research*, *13*(2), 225–244.
Saxena, K. G., & Ramakrishnan, P. S. (1984). Growth and patterns of resources allocation in Eupatorium odoratum in secondary successional environment following slash and burn agriculture. *Weed Res*, *24*(127–34).
Schaffelke, B., & Hewitt, C. L. (2007). Impacts of introduced seaweeds. *Botanica Marina*, 397–417. https://doi.org/10.1515/9783110211344
Scheyvens, H., Hyakumura, K., & Seki, Y. (2007). *Decentralization and state-sponsored community forestry in Asia: Seven country studies of transitions in forest governance, contemporary forest management and the prospects for communities to contribute to and benefit from sustainable forest management*. Retrieved from https://pub.iges.or.jp/pub/decentralisation-and-state-sponsored-community
Scheyvens, H., & Lopez-Casero, F. (2013). Managing forests as a renewable asset for present and future generations: Verifying legal compliance in forestry in Papua New Guinea.
Schierenbeck, K. A., & Ellstrand, N. C. (2009). Hybridization and the evolution of invasiveness in plants and other organisms. *Biological Invasions*, *11*(5), 1093–1105. https://doi.org/10.1007/s10530-008-9388-x
Schild, A.; Sharma, E. (2011). Sustainable mountain development revisited. *Mountain Research and Development*, *31*(3), 237–241.
Schirmel, J., Bundschuh, M., Entling, M. H., Kowarik, I., & Buchholz, S. (2016). Impacts of invasive plants on resident animals across ecosystems, taxa, and feeding types: A global assessment.

Global Change Biology, *22*(2), 594–603. https://doi.org/10.1111/gcb.13093

Schlacher, T. A., Dugan, J., Schoeman, D. S., Lastra, M., Jones, A., Scapini, F., McLachlan, A., & Defeo, O. (2007). Sandy beaches at the brink. *Diversity and Distributions*, *13*(5), 556–560. https://doi.org/10.1111/j.1472-4642.2007.00363.x

Schlaepfer, D. R., Bradford, J. B., Lauenroth, W. K., Munson, S. M., Tietjen, B., Hall, S. A., Wilson, S. D., Duniway, M. C., Jia, G., Pyke, D. A., Lkhagva, A., & Jamiyansharav, K. (2017). Climate change reduces extent of temperate drylands and intensifies drought in deep soils, *8*, 14196. Retrieved from http://dx.doi.org/10.1038/ncomms14196

Schneider, A., & Mertes, C. M. (2014). Expansion and growth in Chinese cities, 1978–2010. *Environmental Research Letters*.

Scholes, R. J. (2016). Climate change and ecosystem services. *Wiley Interdisciplinary Reviews: Climate Change*, *7*(4), 537–550. https://doi.org/10.1002/wcc.404

SEAFDEC. (2017). The Southeast Asian State of Fisheries and Aquaculture, 130.

Secretariat of the Convention on Biological Diversity. (2010). *Linking Biodiversity Conservation and Poverty Alleviation: A State of Knowledge Review*. *Pubsiiedorg* (Vol. 55). Retrieved from http://pubs.iied.org/pubs/display.php?o=G02789

Secretariat of the Convention on Biological Diversity. (2011). *NBSAP training modules version 2.1 – Module 1. An Introduction to National Biodiversity Strategies and Action Plans. Montréal, Canada.*

Secretariat of the Convention on Biological Diversity. (2012). *Cities and Biodiversity Outlook. Executive Summary*. Montreal. https://doi.org/doi:10.6084/m9.figshare.99889

Sekar, K. C., Manikandan, R., & Srivastava, S. K. (2012). Invasive alien plants of Uttarakhand Himalaya. *Proceedings of the National Academy of Sciences, India Section B: Biological Sciences*, *82*(3), 375–383.

Sekercioglu, C. H. (2012). Bird functional diversity and ecosystem services in tropical forests, agroforests and agricultural areas. *Journal of Ornithology*, *153*(SUPPL. 1), 153–161. https://doi.org/10.1007/s10336-012-0869-4

Senjen, R., Foladori, G., & Azoulay, D. (2013). *Social and environmental implications of nano-technology development in Asia-Pacific*.

Seo, K. S., & Lee, Y. (2009). A First Assessment of Invasive Marine Species on Chinese and Korean Coasts. In G. Rilov & J. A. Crooks (Eds.), *Biological Invasions in Marine Ecosystems* (Vol. 204, p. 642). Berlin, Heidelberg: Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-540-79236-9

Seto, K. C. (2005). Economies, Societies, and Landscapes in Transition: Examples from the Pearl River Delta, China, and the Red River Delta, Vietnam. In B. Entwisle & P. C. Stern (Eds.), *Population, Land Use, and Environment: Research Directions* (pp. 193–216). National Academies Press. Retrieved from http://www.google.se/books?hl=en&lr=&id=N85_Vb3g45gC&pgis=1

Seto, K. C., Fragkias, M., Güneralp, B., & Reilly, M. K. (2011). A Meta-Analysis of Global Urban Land Expansion. *PLoS ONE*, *6*(8), e23777. https://doi.org/10.1371/journal.pone.0023777

Seto, K. C., Güneralp, B., & Hutyra, L. R. (2012). Global forecasts of urban expansion to 2030 and direct impacts on biodiversity and carbon pools. *Proceedings of the National Academy of Sciences of the United States of America*, *109*(40), 16083–16088. https://doi.org/10.1073/pnas.1211658109

Seto, K. C., & Kaufmann, R. K. (2003). Modeling the Drivers of Urban Land Use Change in the Pearl River Delta, China: Integrating Remote Sensing with Socioeconomic Data. *Land Economics*, *79*(1), 106–121. https://doi.org/10.3368/le.79.1.106

Seto, K. C., Parnell, S., & Elmqvist, T. (2013). A Global Outlook on Urbanization. In T. Elmqvist, M. Fragkias, J. Goodness, B. Güneralp, P. J. Marcotullio, R. I. McDonald, S. Parnell, M. Schewenius, M. Sendstad, K. C. Seto, & C. Wilkinson (Eds.), *Urbanization, Biodiversity and Ecosystem Services: Challenges and Opportunities* (pp. 1–12). Dordrecht: Springer Netherlands. https://doi.org/10.1007/978-94-007-7088-1_1

Seto, K. C., Sánchez-Rodríguez, R., & Fragkias, M. (2010). The New Geography of Contemporary Urbanization and the Environment. *Annual Review of Environment and Resources*, *35*(1), 167–194. https://doi.org/10.1146/annurev-environ-100809-125336

Settele, J., Scholes, R., Betts, R., Bunn, S., Leadley, P., Nepstad, D., Overpeck, J. T., & Taboada, M. A. (2014). Terrestrial and inland water systems. In and L. L. W. Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea (Ed.), *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (pp. 271–359). Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press.

Shackleton, C., Shackleton, S., & Shanley, P. (2011). *Non-TImber Forest Products in the Global Context. Tropical Forestry*. Berlin: Springer-Verlag.

Shah, M., Callaway, R., Shah, T., Houseman, G., Pal, R., Xiao, S., Luo, W., Rosche, C., Reshi, Z., Khasa, D., & Chen, S. (2014). Conyza canadensis suppresses plant diversity in its nonnative ranges but not at home: a transcontinental comparison. *New Phytologist*, *202*(4), 1286–1296.

Shah, V. (2016). *Asia Pacific at the heart of global renewables boom (07 April 2016)*. Retrieved from https://www.futurereadysingapore.com/2016/asia-pacific-at-the-heart-of-global-renewables-boom.html

Shanahan, D. F., Miller, C., Possingham, H. P., & Fuller, R. a. (2011). The influence of patch area and connectivity on avian communities in urban revegetation. *Biological Conservation*, *144*(2), 722–729. https://doi.org/10.1016/j.biocon.2010.10.014

Sharma, S., Singh, S. (2004). Survival of drown oak forest in the Himalaya in the face of global climate change coupled with anthropogenic factors. In *18th Annual Meeting of Society for Conservation Biology - Conservation in an Urbanized World* (pp. 257–258). New York, USA: Columbia University.

Sharma, R. (2012). Impacts on Human Health of Climate and Land Use Change in the Hindu Kush–Himalayan Region. *Mountain Research and Development*, *32*(4), 480–486.

Shirsath, P. B., Aggarwal, P. K., Thornton, P. K., & Dunnett, A. (2017). Prioritizing climate-smart agricultural land use options at a regional scale. *Agricultural Systems*, *151*, 174–183. https://doi.org/10.1016/j.agsy.2016.09.018

Shrestha, A. B., & Devkota, L. P. (2010). *Climate Change in the Eastern Himalayas : Observed Trends and Model Projections*. Kathmandu, Nepal: ICIMOD.

Shrestha, A. B., Wake, C. P., Mayewski, P. A., & Dibb, J. E. (1999). Maximum temperature trends in the Himalaya and its vicinity: An analysis based on temperature records from Nepal for the period 1971-94. *Journal of Climate*. https://doi.org/10.1175/1520-0442(1999)012<2775:MTTITH>2.0.CO;2

Shrestha, K. B., Hofgaard, A., & Vandvik, V. (2014). Recent treeline dynamics are similar between dry and mesic areas of Nepal, central Himalaya. *Journal of Plant Ecology*, *8*(4), rtu035. https://doi.org/10.1093/jpe/rtu035

Shrestha, U. B., & Bawa, K. S. (2013). Trade, harvest, and conservation of caterpillar fungus (Ophiocordyceps sinensis) in the Himalayas. *Biological Conservation*, *159*, 514–520. https://doi.org/10.1016/j.biocon.2012.10.032

Shrestha, U. B., Gautam, S., & Bawa, K. S. (2012). Widespread climate change in the Himalayas and associated changes in local ecosystems. *PloS One*. https://doi.org/10.1371/journal.pone.0036741

Simberloff, D., Martin, J.-L., Genovesi, P., Maris, V., Wardle, D. A., Aronson, J., Courchamp, F., Galil, B., García-Berthou, E., Pascal, M., Pyšek, P., Sousa, R., Tabacchi, E., & Vilà, M. (2013). Impacts of biological invasions: what's what and the way forward. *Trends in Ecology & Evolution*, *28*(1), 58–66. https://doi.org/http://dx.doi.org/10.1016/j.tree.2012.07.013

Simon, D., McGregor, D., & Nsiah-Gyabaah, K. (2004). The changing urban-rural interface of African cities: Defi nitional issues and an application to Kumasi, Ghana. *Environment and Urbanization*, *16*(2), 235–248.

Sinden, J., Jones, R., Hester, S., Odom, D., Kalisch, C., James, R., & Cacho, O. (2004). *The economic impact of weeds in Australia : report to the CRC for Australian Weed Management*. CRC for Australian Weed Management, Glen Osmond, S.A.

Singh, S. P., Bassignana-Khadka, I., Karky, B. S., & Sharma, E. (2011). Climate change in the Hindu Kush-Himalayas: the state of current knowledge. *ICIMOD*, 88.

Singh, S. P., Rawat, Y., & Garkoti, S. (1997). Failure of brown oak (Quercus semecarpifolia) to

regenerate in central Himalaya: A case of environmental semisurprise. *Current Science*, *73*, 371–374.
Sit, V., & Yang, C. (1997). Foreign-investment-induced exo-urbanisation in the Pearl River Delta, China. *Urban Studies*, *34*(4), 647–677. https://doi.org/10.1080/0042098975961
Sliwa, C., Migus, S., McEnnulty, F., & Hayes, K. (2009). Marine bioinvasions in Australia. *Biological Invasions in Marine Ecosystems*, 425–437. https://doi.org/10.1007/978-3-540-79236-9_25
Small, C., & Nicholls, R. (2003). A global analysis of human settlement in coastal zones. *Journal of Coastal Research*, *19*(3), 584–599.
Smith, J. E., Brainard, R., Carter, A., Grillo, S., Edwards, C., Harris, J., Lewis, L., Obura, D., Rohwer, F., Sala, E., Vroom, P. S., & Sandin, S. (2016). Re-evaluating the health of coral reef communities: baselines and evidence for human impacts across the central Pacific. *Proceedings of the Royal Society B: Biological Sciences*, *283*(1822). Retrieved from http://rspb.royalsocietypublishing.org/content/283/1822/20151985.abstract
Smith, L. E. D., & Siciliano, G. (2015). A comprehensive review of constraints to improved management of fertilizers in China and mitigation of diffuse water pollution from agriculture. *Agriculture, Ecosystems and Environment*, *209*, 15–25. https://doi.org/10.1016/j.agee.2015.02.016
Sodhi, N. S., Koh, L. P., Brook, B. W., & Ng, P. K. L. (2004). Southeast Asian biodiversity: an impending disaster. *Trends in Ecology & Evolution*, *19*(12), 654–660.
Sodhi, N. S., Koh, L. P., Clements, R., Wanger, T. C., Hill, J. K., Hamer, K. C., Clough, Y., Tscharntke, T., Posa, M. R. C., & Lee, T. M. (2010). Conserving Southeast Asian forest biodiversity in human-modified landscapes. *Biological Conservation*, *143*(10), 2375–2384. https://doi.org/10.1016/J.BIOCON.2009.12.029
Sodhi, N. S., Posa, M. R. C., Lee, T. M., Bickford, D., Koh, L. P., & Brook, B. W. (2010). The state and conservation of Southeast Asian biodiversity. *Biodiversity and Conservation*, *19*(2), 317–328. https://doi.org/10.1007/s10531-009-9607-5
Soga, M., & Koike, S. (2013). Large forest patches promote breeding success of a terrestrial mammal in urban landscapes. *PLoS ONE*, *8*(1), e51802. https://doi.org/10.1371/journal.pone.0051802
Solecki, W., Leichenko, R., & O'Brien, K. (2011). Climate change adaptation strategies and disaster risk reduction in cities: connections, contentions, and synergies. *Current Opinion in Environmental Sustainability*, *3*(3), 135–141. https://doi.org/10.1016/j.cosust.2011.03.001
Solecki, W., & Marcotullio, P. J. (2013). Climate Change and Urban Biodiversity Vulnerability. In *Urbanization, Biodiversity and Ecosystem Services: Challenges and Opportunities* (pp. 485–504). Dordrecht: Springer Netherlands. https://doi.org/10.1007/978-94-007-7088-1_25
Song, W., Pijanowski, B. C., & Tayyebi, A. (2015). Urban expansion and its consumption of high-quality farmland in Beijing, China. *Ecological Indicators*, *54*, 60–70. https://doi.org/10.1016/j.ecolind.2015.02.015
Spalding, M., Blasco, F., & Field, C. (1997). *World mangrove atlas*. Okinawa, Japan.
SPREP. (2009a). *Guidelines for invasive species management in the Pacific : a Pacific strategy for managing pests, weeds and other invasive species / compiled by Alan Tye*. Apia, Samoa.
SPREP. (2009b). *Guidelines for invasive species management in the Pacific: a Pacific strategy for managing pests, weeds and other invasive species*. Apia, Samo.
Squires, D. (2014). Biodiversity Conservation in Asia. *Asia & the Pacific Policy Studies*, *1*(1), 144–159. https://doi.org/10.1002/app5.13
Sriskanthan, G., & Funge-Smith, S. J. (2011). *The potential impact of climate change on fisheries and aquaculture in the Asian region.* FAO Regional Office for Asia and the Pacific, Bangkok, Thailand. RAP Publication 2011/16, 41 pp.
St Clair, J. J. H. (2011). The impacts of invasive rodents on island invertebrates. *Biological Conservation*, *144*(1), 68–81. https://doi.org/10.1016/j.biocon.2010.10.006
Stachowicz, J. J., Terwin, J. R., Whitlatch, R. B., & Osman, R. W. (2002). Linking climate change and biological invasions: Ocean warming facilitates nonindigenous species invasions. *Proceedings of the National Academy of Sciences of the United States of America*, *99*(24), 15497–15500. https://doi.org/10.1073/pnas.242437499
Stavi, I., & Lal, R. (2015). Achieving Zero Net Land Degradation: Challenges and opportunities.

Journal of Arid Environments, *112*(PA), 44–51. https://doi.org/10.1016/j.jaridenv.2014.01.016
Sterling, E. J., Filardi, C., Sigouin, A., Betley, E., Newell, J., Albert, S., Alvira, D., Bergamini, N., Blair, M., Boseto, D., Burrows, K., Bynum, N., Caillon, S., Caselle, J. E., Claudet, J., Cullman, G., Dacks, R., Eyzaguirre, P. B., Gazit, N., Gray, S., Herrera, J., Kenilorea, P., Kinney, K., Kurashima, N., Macey, S., Malone, C., Mauli, S., McCarter, J., McMillen, H., Pascua, P., Pikacha, P., Porzecanski, A. L., de Robert, P., Salpeteur, M., Sirikolo, M., Stege, M. H., Stege, K., Ticktin, T., Toomey, A., Vave, R., Wali, A., West, P., Winter, K. B., & Jupiter, S. D. (2017). Biocultural approaches to local and global sustainability indicators. *Nature Ecology and Evolution*.
Stratford, C., McCartney, M. P., Mountford, O., & Llewellyn, N. (2004). *Wetlands and water quality.* . (C. Neal & I. Littlewood, Eds.), *Managing our aquatic environment in the 21st century, Occasional Paper No. 14*. British Hydrological Society.
Sudhira, H. S., & Nagendra, H. (2013). Local Assessment of Bangalore: Graying and Greening in Bangalore – Impacts of Urbanization on Ecosystems, Ecosystem Services and Biodiversity. In *Urbanization, Biodiversity and Ecosystem Services: Challenges and Opportunities* (pp. 75–91). Dordrecht: Springer Netherlands. https://doi.org/10.1007/978-94-007-7088-1_7
Sui, D. Z., & Zeng, H. (2001). Modeling the dynamics of landscape structure in Asia's emerging desakota regions: A case study in Shenzhen. *Landscape and Urban Planning*, *53*(1–4), 37–52. https://doi.org/10.1016/S0169-2046(00)00136-5
Sun, X. Z., & Zhou, H. L. (2008). Establishing eco-compesation system in China: Practice, problems and strategies. *China Population, Resources and Environment*, *18*(5), 139–143. Retrieved from https://doi.org/10.1016/S1872-583X(09)60019-X
Sundriyal, R. C., & Sharma, E. (1996). Anthropogenic pressure on tree structure and biomass in the temperate forest of Mamlay watershed in Sikkim. *Forest Ecology and Management*, *81*(1–3), 113–134. Retrieved from http://www.sciencedirect.com/science/article/pii/0378112795036571
Suttie, J. M. (2005). Grazing management in Mongolia. In J. M. Suttie, S. G. Reynolds, & C. Batello (Eds.), *Grassland of the World*. Rome: Food and Agriculture Organization of the United Nations.
Suttie, J. M., Reynolds, S. G., & Batello, C. (2005a). Chapter 12 Grassland Perspective. In *Glasslands of the world*. Rome: Food and Agriculture Organization of the United Nations.
Suttie, J. M., Reynolds, S. G., & Batello, C. (2005b). *Grasslands of the world*. *Grasslands of the world*. Rome. https://doi.org/10.1111/j.1365-2494.2006.00522.x
Swartz, W., Sala, E., Tracey, S., Watson, R., & Pauly, D. (2010). The spatial expansion and ecological footprint of fisheries (1950 to present). *PLoS ONE*, *5*(12), 1–7. https://doi.org/10.1371/journal.pone.0015143
Syed, A., Ahmad, S., Bialowas, A., Richardson, E., Nowakowski, D., & Nicholson, P. (2014). Asia-Pacific Renewable Energy Assessment.
Syvitski, J. P. M., Vo, C. J., Kettner, A. J., & Green, P. (2005). Impact of humans on the flux of terrestrial sediment to the global coastal ocean. *Science*, *308*, 376–380.
Tacoli, C., Mcgranahan, G., & Satterthwaite, D. (2015). *Urbanisation, rural–urban migration and urban poverty*. London: International Institute for Environment and Development. Retrieved from http://pubs.iied.org/10725IIED
Tan, N. Q. (2011). *Payment for Environmental Services in Vietnam: An Analysis of the Pilot Project in Lam Dong Province*. Hayama, Japan.
Tan, P. Y., & Abdul Hamid, A. R. Bin. (2014). Urban ecological research in Singapore and its relevance to the advancement of urban ecology and sustainability. *Landscape and Urban Planning*, *125*, 271–289. https://doi.org/10.1016/j.landurbplan.2014.01.019
Tang, B. S., Wong, S. W., & Lee, A. K. W. (2007). Green belt in a compact city: A zone for conservation or transition? *Landscape and Urban Planning*, *79*, 358–373. https://doi.org/10.1016/j.landurbplan.2006.04.006
Taniguchi, M., Masuhara, N., & Burnett, K. (2017). Water, energy, and food security in the Asia Pacific region. *Journal of Hydrology: Regional Studies*, *11*, 9–19. https://doi.org/10.1016/j.ejrh.2015.11.005
Task Force for Eco-Compensation Mechanisms and Policies in China. (2007). *Eco-Compensation Mechanisms and Policies in China*. Beijing: Science Press.

Taylor, D. A. (2006). New environmental law for Afghanistan. *Environmental Health*, *114*(3), A152.
Teh, L. C. L., & Pauly, D. (2018). Who Brings in the Fish? The Relative Contribution of Small-Scale and Industrial Fisheries to Food Security in Southeast Asia. *Frontiers in Marine Science*, *5*, 44. https://doi.org/10.3389/fmars.2018.00044
Teh, L. C. L., & Sumaila, U. R. (2013). Contribution of marine fisheries to worldwide employment. *Fish and Fisheries*, *14*(1), 77–88. https://doi.org/10.1111/j.1467-2979.2011.00450.x
Teh, L. S. L., Witter, A., Cheung, W. W. L., Sumaila, U. R., & Yin, X. (2017). What is at stake? Status and threats to South China Sea marine fisheries. *Ambio*, *46*(1), 57–72. https://doi.org/10.1007/s13280-016-0819-0
Teixeira, E. I., Fischer, G., van Velthuizen, H., Walter, C., & Ewert, F. (2013). Global hot-spots of heat stress on agricultural crops due to climate change. *Agricultural and Forest Meteorology*, *170*, 206–215. https://doi.org/10.1016/j.agrformet.2011.09.002
Teixeira, E. I., Zhao, G., Ruiter, J. de, Brown, H., Ausseil, A.-G., Meenken, E., & Ewert, F. (2017). The interactions between genotype, management and environment in regional crop modelling. *European Journal of Agronomy*, *88*, 106–115. https://doi.org/10.1016/j.eja.2016.05.005
Telwala, Y., Brook, B. W., Manish, K., & Pandit, M. K. (2013). Climate-Induced Elevational Range Shifts and Increase in Plant Species Richness in a Himalayan Biodiversity Epicentre. *PLOS ONE*, *8*(2), e57103. Retrieved from https://doi.org/10.1371/journal.pone.0057103
Teo, D. H. L., Tan, H. T. W., Corlett, R. T., Wong, C. M., & Lum, S. K. Y. (2003). Continental rain forest fragments in Singapore resist invasion by exotic plants. *Journal of Biogeography*, *30*(2), 305–310. https://doi.org/10.1046/j.1365-2699.2003.00813.x
Terra Global Capital. (n.d.). Katingan Peatland Restoration and Conservation Project, Central Kalimantan, Indonesia. Retrieved from http://www.terraglobalcapital.com/katingan-peatland-restoration-and-conservation-redd-project-indonesia
Tett, S. F. B., Betts, R., Crowley, T. J., Gregory, J., Johns, T. C., Jones, A., Osborn, T. J., Öström, E., Roberts, D. L., & Woodage, M. J. (2007). The impact of natural and anthropogenic forcings on climate and hydrology since 1550. *Climate Dynamics*, *28*(1), 3–34. https://doi.org/10.1007/s00382-006-0165-1
Thaman, R. (2008). A matter of survival: Pacific Islands vital biodiversity, agricultural biodiversity and ethno-biodiversity heritage. *Pacific Ecologist*.
Thaman, R. (2014). Agrodeforestation and the loss of agrobiodiversity in the Pacific Islands: A call for conservation. Pacific Conservation Biology. *Pacific Conservation Biology*, *20*(2), 180–192.
Thaman, R. R. (2011). The silent invasion of our islands. *Mai Life*, *55*, 64–65.
Thaman, R. R. (2013). Silent alien invasion of our islands and seas: A call for action against invasive alien species (IAS). In H.-M. Tsai (Ed.), *2013 Proceedings of the IGU Commission on Islands International Conference on Island Development: Local Economy, Culture, Innovation and Sustainability October 1 - 5* (pp. 2–6). National Penghu University, Makong, Penghu Archipelago,Taiwan.
Thaman, R. R., & O'Brien, K. (2011). Caterpillar devastates kanava and undermines resilience to climate change in Tuvalu. *Mai Life*, *50*, 56–57.
The BIP Secretariat. (n.d.). Legislation for prevention and control of invasive alien species (IAS), encompassing "Trends in policy responses, legislation and management plans to control and prevent spread of invasive alien species" and "Proportion of countries adopting relevant nati.
Theuerkauf, J., Jourdan, H., Rouys, S., Gula, R., Gajewska, M., Unrug-Bielawska, K., & Kuehn, R. (2010). *Inventory of alien birds and mammals in the Wallis and Futuna Archipelago*. *Biological Invasions* (Vol. 12). https://doi.org/10.1007/s10530-010-9706-y
Thompson, L. M. C., & Schlacher, T. A. (2008). Physical damage to coastal dunes and ecological impacts caused by vehicle tracks associated with beach camping on sandy shores: A case study from Fraser Island, Australia. *Journal of Coastal Conservation*, *12*(2), 67–82. https://doi.org/10.1007/s11852-008-0032-9
Thomsen, M. S., Byers, J. E., Schiel, D. R., Bruno, J. F., Olden, J. D., Wernberg, T., & Silliman, B. R. (2014). Impacts of marine invaders on biodiversity depend on trophic position and functional similarity. *Marine Ecology Progress Series*, *495*, 39–47. https://doi.org/10.3354/meps10566
Thornton, P. K. (2010). Livestock production: recent trends, future prospects. *Philos Trans R Soc Lond B Biol Sci*, *365*(1554), 2853–2867. https://doi.org/10.1098/rstb.2010.0134

Thuiller, W., Albert, C., Araújo, M. B., Berry, P. M., Cabeza, M., Guisan, A., Hickler, T., Midgley, G. F., Paterson, J., Schurr, F. M., Sykes, M. T., & Zimmermann, N. E. (2008). Predicting global change impacts on plant species' distributions: Future challenges. *Perspectives in Plant Ecology, Evolution and Systematics*, *9*(3–4), 137–152. https://doi.org/10.1016/j.ppees.2007.09.004

Tilman, D., & Clark, M. (2014). Global diets link environmental sustainability and human health. *Nature*, *515*(7528), 518–522. https://doi.org/10.1038/nature13959

Tippler, C., Wright, I., & Hanlon, A. (2012). Is Catchment Imperviousness a Keystone Factor Degrading Urban Waterways? A Case Study from a Partly Urbanised Catchment (Georges River, South-Eastern Australia). *Water, Air, & Soil Pollution*, *223*(8), 5331–5344. https://doi.org/10.1007/s11270-012-1283-5

Tiwari, S., Siwakoti, M., Adhakari, B., & Subedi, K. (2005). *An Inventory and Assessment of Invasive Alien Plant Species of Nepal*. *Iucn*. Nepal.

Toba, M., Kobayashi, Y., Kakino, J., Yamakaw, H., Ishii, R., & Okamoto, R. (2016). Stocks and fisheries of asari in Japan. *Bulletin of Japan Fisheries Research and Education Agency*, *42*, 9–21. Retrieved from http://www.fra.affrc.go.jp/bulletin/bull/bull42/42-05.pdf

Todd, P. A., Ong, X., & Chou, L. M. (2010). Impacts of pollution on marine life in Southeast Asia. *Biodiversity and Conservation*, *19*(4), 1063–1082. https://doi.org/10.1007/s10531-010-9778-0

Tonkin, J. D., De'ath, R. G., & Joy, M. K. (2009). Invertebrate Drift Patterns in a Regulated River: Dams, Periphyton Biomass or Longitudinal Patterns? *River Research and Applications*, *25*, 1219–1231.

Tourism New Zealand. (2017). Visitor Experience. Retrieved December 28, 2017, from http://www.tourismnewzealand.com/markets-stats/research/infographics/visitor-experience/

Tourism Research Australia. (2015). POSITIVE GROWTH LEADS TO RECORD INTERNATIONAL, p. 6968.

Towns, D. R., & Ballantine, W. J. (1993). Conservation and restoration of New Zealand Island ecosystems. *Trends in Ecology and Evolution*, *8*(12), 452–457. https://doi.org/10.1016/0169-5347(93)90009-E

Trathan, P. N., Forcada, J., & Murphy, E. J. (2007). Environmental forcing and Southern Ocean marine predator populations : effects of climate change and variability Environmental forcing and Southern Ocean marine predator populations : effects of climate change and variability. *Society*, (May), 2351–2365. https://doi.org/10.1098/rstb.2006.1953

Trincsi, K., Pham, T.-T.-H., & Turner, S. (2014). Mapping mountain diversity: Ethnic minorities and land use land cover change in Vietnam's borderlands. *Land Use Policy*, *41*, 484–497. Retrieved from http://www.sciencedirect.com/science/article/pii/S0264837714001422

Tripathi, R. S., Khan, M. L., & Yadav, A. S. (2012). Biology of Mikania micrantha H.B.K: A review. In and K. R. K. Bhatt J R, Singh J S, Singh S P, Tripathi R S (Ed.), *Invasive alien plants: An ecological appraisal for the Indian subcontinent* (pp. 99–107). Wallingford, Oxon, UK: CAB International Publishing.

Tripathi, R. S., Yadav, A. S., & Kushwaha, S. P. S. (2012). Biology of Chromolaena odorata, Ageratina adenophora and Ageratina riparia: a review. In *Invasive alien plants: an ecological appraisal for the Indian subcontinent* (pp. 43–56). Wallingford: CABI. https://doi.org/10.1079/9781845939076.0043

Tripathi, V., Dubey, R. K., Edrisi, S. A., Narain, K., Singh, H. B., Singh, N., & Abhilash, P. C. (2014). Towards the ecological profiling of a pesticide contaminated soil site for remediation and management. *Ecological Engineering*, *71*, 318–325. https://doi.org/10.1016/j.ecoleng.2014.07.059

Tripathi, V., Fraceto, L. F., & Abhilash, P. C. (2015). Sustainable clean-up technologies for soils contaminated with multiple pollutants: Plant-microbe-pollutant and climate nexus. *Ecological Engineering*, *82*, 330–335. https://doi.org/10.1016/j.ecoleng.2015.05.027

Tsai, C. F., Lee, Y. F., Chen, Y. H., Chen, W. M., & Kuo, Y. M. (2015). Species turnover in tropical montane forest avifauna links to climatic correlates. *Global Ecology and Conservation*. https://doi.org/10.1016/j.gecco.2015.01.008

Tse-ring, K., Sharma, E., Chettri, N., & Shrestha, A. (2010). *Climate change vulnerability of mountain ecosystems in the Eastern Himalayas; Climate change impact an vulnerability in the Eastern Himalayas – Synthesis report*. Kathmandu: ICIMOD.

Tulachan, P. M. (2001). Mountain Agriculture in the Hindu Kush–Himalaya. *Mountain Research and Development*, *21*(3), 260–267. https://doi.org/10.1659/0276-4741(2001)021[0260:MAITHK]2.0.CO;2

Turbelin, A. J., Malamud, B. D., & Francis, R. A. (2017). Mapping the global state of invasive alien species: patterns of invasion and policy responses. *Global Ecology and Biogeography*, *26*(1), 78–92. https://doi.org/10.1111/geb.12517

Turner, K. G., Anderson, S., Gonzales-Chang, M., Costanza, R., Courville, S., Dalgaard, T., Dominati, E., Kubiszewski, I., Ogilvy, S., Porfirio, L., Ratna, N., Sandhu, H., Sutton, P. C., Svenning, J. C., Turner, G. M., Varennes, Y. D., Voinov, A., & Wratten, S. (2015). A review of methods, data, and models to assess changes in the value of ecosystem services from land degradation and restoration. *Ecological Modelling*, *319*, 190–207. https://doi.org/10.1016/j.ecolmodel.2015.07.017

Turney, C., Fogwill, C., Palmer, J., van Sebille, E., Thomas, Z., McGlone, M., Richardson, S., Wilmshurst, J., Fenwick, P., Zunz, V., Goosse, H., Wilson, K.-J., Carter, L., Lipson, M., Jones, R., Harsch, M., Clark, G., Marzinelli, E., Rogers, T., Rainsley, E., Ciasto, L., & Waterman, S. (n.d.). Increased climate variability in the Southern Ocean during the late Twentieth Century. *Science Advances*.

Turok, I., & McGranahan, G. (2013). Urbanization and economic growth: the arguments and evidence for Africa and Asia. *Environment and Urbanization*, *25*(2), 465–482. https://doi.org/10.1177/0956247813490908

U.S. Geological Survey. (2017). *Mineral commodity summaries 2017*. Retrieved from https://doi.org/10.3133/70180197

Uddin, K., Chaudhary, S., Chettri, N., Kotru, R., Murthy, M., Chaudhary, R. P., Ning, W., Shrestha, S. M., & Gautam, S. K. (2015). The changing land cover and fragmenting forest on the Roof of the World: A case study in Nepal's Kailash Sacred Landscape. *Landscape and Urban Planning*, *141*, 1–10.

UNDESA. (2012). *Changing Levels and Trends in Mortality: the Role of Patterns of Death by Cause*. United Nations Publication.

UNDESA. (2015a). *The Millennium Development Goals Report 2015*.

UNDESA. (2015b). *World Population Prospects: The 2015 Revision, custom data acquired via website*. Retrieved from http://esa.un.org/unpd/wpp/DataQuery/

UNDESA. (2015c). *World Population Prospects: The 2015 Revision, Key Findings and Advance Table*.

UNDESA. (2015d). *World Urbanization Prospects: The 2014 Revision*.

UNDP. (2013). *United Nations Development Programme Asia-Pacific Regional Centre Achieving Sustainable Energy for All in the Asia-Pacific*.

UNDP. (2015). *Human Development Report 2015 Work for Human Development*. New York: United Nation Publication. Retrieved from www.undp.org

UNEP-WCMC. (2016). *The State of Biodiversity in Asia and the Pacific: A mid-term review of progress towards the Aichi Biodiversity Targets*. Cambridge, UK. Retrieved from http://www.unep.org/delc/Portals/119/regional brief for Asia and Pacific.pdf

UNEP. (n.d.). Restoring Clean Air in Asia Pacific. Retrieved December 18, 2017, from http://web.unep.org/asiapacific/regional-initiatives/air-quality

UNEP. (2006). *Global Deserts Outlook*. Nairobi.

UNEP. (2010). *Environment Outlook for the Arab Region: Environment for Development and Human Well-being*.

UNEP. (2011a). *Freshwater under threat pacific islands*.

UNEP. (2011b). *Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication*. Retrieved from www.unep.org/greeneconomy

UNEP. (2012a). *Global Environment Outlook 5 – Summary for Asia and the Pacific Region*. UNEP.

UNEP. (2012b). Water. In *Global Environment Outlook 5* (pp. 97–132).

UNEP. (2016a). *GEO-6 Regional Assessment for Asia and the Pacific*. Nairobi, Kenya.

UNEP. (2016b). *GEO-6 Regional Assessment for West Asia*. Nairobi, Kenya.

UNESCAP. (2006). *State of the Environment in Asia and the Pacific 2005*.

UNESCAP. (2014). *Pacific Perspectives 2014, Pacific Perspectives on Fisheries and Sustainable*

Development. (R. Gillet, Ed.). Fiji: United Nations Economic and Social Commission for Asia and the Pacific. Retrieved from http://www.unescap.org/sites/default/files/Pacific_Perspectives_2014_0.pdf

UNESCAP. (2015a). *ECONOMIC AND SOCIAL SURVEY OF ASIA AND THE PACIFIC 2015 MAKING GROWTH MORE INCLUSIVE FOR SUSTAINABLE DEVELOPMENT*. New York: United Nation Publication.

UNESCAP. (2015b). *Statistical Yearbook for Asia and the Pacific 2014*.

UNESCAP, ADB, & UNDP. (2015). *Making It Happen: Asia-Pacific Regional MDGs Report 2014/15*.

UNFPA. (2014). *The State of World Population 2014: The Power of 1.8 Billion*. UNFPA.

UNHCR. (2015). *Global trends forced displacement in 2015*.

Union of Concerned Scientists. (2011). Wood for fuel. In *The root of the problem – What's driving tropical deforestation today?* Retrieved from http://www.ucsusa.org/sites/default/files/legacy/assets/documents/global_warming/UCS_DriversofDeforestation_Chap8_Woodfuel.pdf

United Nations. (1992). *Assessment of the environmental impact of port development. A guidebook for EIA of port development.* New York.

United Nations. (2009). *State of the World's Indigenous Peoples*. New York, USA.

United Nations. (2014). *World Urbanization Prospects: The 2014 Revision, Highlights (ST/ESA/SER.A/352)*. New York, USA.

United Nations Integrated Water Task Force for Iraq. (2011). *Managing Change in the Marshlands: Iraq's Critical Challenge*. United Nations white paper. http://iq.one.un.org/documents/Marshlands%20Paper%20-%20published%20final.pdf.

Unsworth, R. K. F., & Cullen-Unsworth, L. C. (2013). Biodiversity, ecosystem services, and the conservation of seagrass meadows. In B. Maslo & J. L. Lockwood (Eds.), *Coastal Conservation* (pp. 95–130). Cambridge: Cambridge University Press. https://doi.org/10.1017/CBO9781139137089.005

UNWTO. (2012). *Sustainable Development of Tourism in Deserts*.

Uprety, Y., Poudel, R. C., Gurung, J., Chettri, N., & Chaudhary, R. P. (2016a). Traditional use and management of NTFPs in Kangchenjunga Landscape: implications for conservation and livelihoods. *Journal of Ethnobiology and Ethnomedicine*, *12*(19), 1–58. https://doi.org/10.1186/s13002-016-0089-8

Uprety, Y., Poudel, R. C., Gurung, J., Chettri, N., & Chaudhary, R. P. (2016b). Traditional use and management of NTFPs in Kangchenjunga Landscape: implications for conservation and livelihoods. *Journal of Ethnobiology and Ethnomedicine*. https://doi.org/10.1186/s13002-016-0089-8

VanDerWal, J., Murphy, H. T., Kutt, A. S., Perkins, G. C., Bateman, B. L., Perry, J. J., & Reside, A. E. (2013). Focus on poleward shifts in species' distribution underestimates the fingerprint of climate change. *Nature Climate Change*, *3*, 239–243. https://doi.org/10.1038/nclimate1688

Vedeld, P., Angelsen, A., Sjaastad, E., & Berg, G. K. (2004). Counting on the Environment - Forest Incomes and the Rural Poor. *World Bank Environmental Economics Series.*, (98).

Venn, S., Pickering, C., & Green, K. (2014). Spatial and temporal functional changes in alpine summit vegetation are driven by increases in shrubs and graminoids. *AoB PLANTS*, *6*(0). https://doi.org/10.1093/aobpla/plu008

Verdon-Kidd, D. C., & Kiem, A. S. (2009). Nature and causes of protracted droughts in southeast Australia: Comparison between the Federation, WWII, and Big Dry droughts. *Geophysical Research Letters*, *36*(22), 1–6. https://doi.org/10.1029/2009GL041067

Verschuuren, B., Wild, R., McNeely, J., Oviedo, G., & Washington, B. (2010). *Sacred Natural Sites Conserving Nature and Culture publishing for a sustainable future*.

Vijgen, J., Abhilash, P. C., Li, Y. F., Lal, R., Forter, M., Torres, J., Singh, N., Yunus, M., Tian, C., Schaffer, A., & Weber, R. (2011). Hexachlorocyclohexane (HCH) as new Stockholm Convention POPs-a global perspective on the management of Lindane and its waste isomers. *Environmental Science and Pollution Research*, *18*(2), 152–162. https://doi.org/10.1007/s11356-010-0417-9

Vincelli, M. (2015). *The impacts of shrimp farming on mangrove forests*.

Vinke, K., Martin, M. A., Adams, S., Baarsch, F., Bondeau, A., Coumou, D., Donner, R. V, Menon, A., Perrette, M., Rehfeld, K., Robinson, A., Rocha, M., Schaeffer, M., Schwan, S., Serdeczny, O., & Svirejeva-Hopkins, A. (2017). Climatic risks and impacts in South Asia: extremes of water scarcity and excess. *Regional Environmental Change*, *17*(6), 1569–1583. https://doi.org/10.1007/s10113-015-0924-9

Vörösmarty, C. J. (2010). Global threats to human water security and river biodiversity. *Nature*, *467*, 555–561. https://doi.org/doi:10.1038/nature09440

Walston, J., Robinson, J. G., Bennett, E. L., Breitenmoser, U., da Fonseca, G. A. B., Goodrich, J., Gumal, M., Hunter, L., Johnson, A., Ullas Karanth, K., Leader-Williams, N., MacKinnon, K., Miquelle, D., Pattanavibool, A., Poole, C., Rabinowitz, A., Smith, J. L. D., Stokes, E. J., Stuart, S. N., Vongkhamheng, C., & Wibisono, H. (2010). Bringing the tiger back from the brink-the six percent solution. *PLoS Biology*. https://doi.org/10.1371/journal.pbio.1000485

Wang, H., Chen, Y., & Chen, Z. (2013). Spatial distribution and temporal trends of mean precipitation and extremes in the arid region, northwest of China, during 1960-2010. *Hydrological Processes*, *27*(12), 1807–1818. https://doi.org/10.1002/hyp.9339

Wang, L., Kong, W., Yang, M., Han, J., & Chen, S. (2015). Safety issues and new rapid detection methods in traditional Chinese medicinal materials. *Acta Pharmaceutica Sinica B*. https://doi.org/10.1016/j.apsb.2014.12.005

Wang, T., Wang, G., Innes, J., Nitschke, C., & Kang, H. (2016). Climatic niche models and their consensus projections for future climates for four major forest tree species in the Asia-Pacific region. *Forest Ecology and Management*, *360*(March), 357–366. https://doi.org/10.1016/j.foreco.2015.08.004

Wang, X., Liu, H., Gu, M.-B., Boucek, R., Wu, Z.-M., & Zhou, G.-Y. (2016). Greater impacts from an extreme cold spell on tropical than temperate butterflies in southern China. *Ecosphere*, *7*(5). https://doi.org/DOI: 10.1002/ecs2.1315

Wang, Z. M., Song, K. S., Liu, D. W., Zhang, S. Q., Li, F., Ren, C. Y., Jin, C., Yang, T., & Zhang, C. H. (2009). Land Conversion from Marsh into Cropland in the Sanjiang Plain during 1954 -2005. *Wetland Science*, *7*(3), 208–217.

Ward, D. F. (2007). Modelling the potential geographic distribution of invasive ant species in New Zealand. *Biological Invasions*, *9*(6), 723–735. https://doi.org/10.1007/s10530-006-9072-y

Ward, P. J., Jongman, B., Kummu, M., Dettinger, M. D., Sperna Weiland, F. C., & Winsemius, H. C. (2014). Strong influence of El Niño Southern Oscillation on flood risk around the world. *Proceedings of the National Academy of Sciences* , *111*(44), 15659–15664. https://doi.org/10.1073/pnas.1409822111

Watson, R. A., Cheung, W. W. L., Anticamara, J. A., Sumaila, R. U., Zeller, D., & Pauly, D. (2013). Global marine yield halved as fishing intensity redoubles. *Fish and Fisheries*, *14*(4), 493–503. https://doi.org/10.1111/j.1467-2979.2012.00483.x

Watts, C. H., & Larivière, M.-C. (2004). The importance of urban reserves for conserving beetle communities: a case study from New Zealand. *Journal of Insect Conservation*, *8*(1), 47–58. https://doi.org/10.1023/B:JICO.0000027504.92727.ab

Weber, E. (2017). *Invasive plant species of the world: a reference guide to environmental weeds*. CABI.

Weeks ES, Walker S, Dymond JR, Shepherd JD, & Clarkson BD. (2013). Patterns of past and recent conversion of indigenous grasslands in the South Island, New Zealand. *New Zealand Journal of Ecology*, *37*(127–138).

WEF. (2009). *Thirsty energy – Water and energy in the 21st Century*.

WEF. (2013). *Energy Vision 2013 Energy transitions: Past and Future Industry Vision Prepared in Partnership with IHS CERA*.

WEF. (2016). *Inspiting future cities and urban services*. Geneve: World Economic Forum.

WEF. (2017). *Internet for all – An investment framework for digital adoption*. (White Paper). Geneva, World Economic Forum.

Weimerskirch, H., Inchausti, P., Guinet, C., & Barbraud, C. (2003). Trends in bird and seal populations as indicators of a system shift in the Southern Ocean. *Antarctic Science*, *15*(2), 249–256. https://doi.org/10.1017/S0954102003001202

Welcomme, R. L., Baird, I. G., Dudgeon, D., Halls, A., Lamberts, D., & Mustafa, M. G. (2015).

Fisheries of the rivers of Southeast Asia. In *Freshwater Fisheries Ecology* (pp. 363–376). https://doi.org/10.1002/9781118394380.ch29
Welcomme, R., & Vidthayanom, C. (2003). *The impacts of introductions and stocking of exotic species in the Mekong Basin and policies for their control*. MRC Technical Paper No. 9, Mekong River Commission, Phnom Penh. 38 pp. ISSN: 1683-1489.
Wertz-Kanounnikoff, S., & Kongphan-apirak, M. (2008). *Reducing forest emissions in Southeast Asia: A review of drivers of land-use change and how payments for environmental services (PES) schemes can affect them*. *CIFOR Working Paper no. 41*. Center for International Forestry Research (CIFOR), Bogor, Indonesia. https://doi.org/10.17528/cifor/002604
Westbrooks, R. G., Manning, S. T., & Waugh, J. D. (2014). Early detection and rapid response: a cost-effective strategy for minimizing the establishment and spread of new and emerging invasive plants by global trade, travel and climate change. In *Invasive species and global climate change* (pp. 305–325). Wallingford: CABI. https://doi.org/10.1079/9781780641645.0305
Whalley, R. D. B., Price, J. N., Macdonald, M. J., & Berney, P. J. (2011). Drivers of change in the Social-Ecological Systems of the Gwydir Wetlands and Macquarie Marshes in northern New South Wales, Australia. *The Rangeland Journal*, *33*(2), 109–119. https://doi.org/http://dx.doi.org/10.1071/RJ11002
Wheeler, K., & Nauright, J. (2006). A Global Perspective on the Environmental Impact of Golf. *Sport in Society*, *9*(3), 427–443. https://doi.org/10.1080/17430430600673449
Whelan, C. J., Wenny, D. G., & Marquis, R. J. (2008). Ecosystem Services Provided by Birds. *Annals of the New York Academy of Sciences*, *1134*(1), 25–60. https://doi.org/10.1196/annals.1439.003
White, R., Murray, S., & Rohweder, M. (2000). *Pilot Analysis of Global Ecosystems: Grassland Ecosystems*. Washington D.C. Retrieved from http://www.wri.org/sites/default/files/pdf/page_grasslands.pdf
WHO. (2014). *A global brief on vector-borne diseases*. Retrieved from www.who.int/about/licensing/copyright_form/en/
WHO. (2016). *Ambient air pollution: A global assessment of exposure and burden of disease*. Geneva, Switzerland.
Wicke, B., Sikkema, R., Dornburg, V., & Faaij, A. (2011). Exploring land use changes and the role of palm oil production in Indonesia and Malaysia. *Land Use Policy*, *28*(1), 193–206. https://doi.org/10.1016/j.landusepol.2010.06.001
Wilhelmsson, D. (2010). *Greening Blue Energy: Identifying and managing the biodiversity risks and opportunities of off shore renewable energy*.
Williams, J. W., & Jackson, S. T. (2007). Novel climates, no-analog communities, and ecological surprises Novel climates, no-analog communities, and ecological surprises Frontiers in Ecology and the Environment 2007 5:9, 475-482 Frontiers in Ecology and the Environment 2007 5:9, 475-482. *Frontiers in Ecology and the Environment*, *5*(9), 475–482. https://doi.org/10.1890/1540-9295(2007)5[475:NCNCAE]2.0.CO;2
Williams, R. J., Wahren, C. -H., Stott, K. A. J., Camac, J. S., White, M., Burns, E., Harris, S., Nash, M., Morgan, J. W., Venn, S., Papst, W. A., & Hoffmann, A. A. (2015). *An International Union for the Conservation of Nature Red List ecosystems risk assessment for alpine snow patch herbfields, South-Eastern Australia: Risk Assessment in Alpine Herbfields*. *Austral Ecology* (Vol. 40). https://doi.org/10.1111/aec.12266
Williams, S. L., & Smith, J. E. (2007). A Global Review of the Distribution, Taxonomy, and Impacts of Introduced Seaweeds. *Annual Review of Ecology, Evolution, and Systematics*, *38*(1), 327–359. https://doi.org/10.1146/annurev.ecolsys.38.091206.095543
Wilson, J. R. U., Gairifo, C., Gibson, M. R., Arianoutsou, M., Bakar, B. B., Baret, S., Celesti-Grapow, L., Ditomaso, J. M., Dufour-Dror, J. M., Kueffer, C., Kull, C. A., Hoffmann, J. H., Impson, F. A. C., Loope, L. L., Marchante, E., Marchante, H., Moore, J. L., Murphy, D. J., Tassin, J., Witt, A., Zenni, R. D., & Richardson, D. M. (2011). Risk assessment, eradication, and biological control: Global efforts to limit Australian acacia invasions. *Diversity and Distributions*, *17*(5), 1030–1046. https://doi.org/10.1111/j.1472-4642.2011.00815.x
Woodroffe, C. D., Rogers, K., McKee, K. L., Lovelock, C. E., Mendelssohn, I. A., & Saintilan, N. (2016). Mangrove Sedimentation and Response to Relative Sea-Level Rise. *Annual Review of Marine Science*, *8*(1), 243–266. https://doi.org/10.1146/annurev-marine-122414-034025

Wookey, P. A., Aerts, R., Bardgett, R. D., Baptist, F., Bråthen, K., Cornelissen, J. H. C., Gough, L., Hartley, I. P., Hopkins, D. W., Lavorel, S., & Shaver, G. R. (2009). Ecosystem feedbacks and cascade processes: Understanding their role in the responses of Arctic and alpine ecosystems to environmental change. *Global Change Biology*, *15*(5), 1153–1172. https://doi.org/10.1111/j.1365-2486.2008.01801.x

World Bank. (2010). *Cities and climate change: An urgent agenda*.

World Bank. (2013). *Fish to 2030 – Prospects for fisheries and aquaculture* (Agriculture and Environmental Services Discussion Paper 03 No. World Bank Report Number 83177-GLB). Washington: The World Bank. Retrieved from www.worldbank.org

World Bank. (2017a). Poverty headcount ratio at $1.90 a day (2011 PPP) (% of population). Retrieved from http://data.worldbank.org/topic/poverty

World Bank. (2017b). World Bank In China. Retrieved December 28, 2017, from www.worldbank.org/en/country/china/

World Bank. (2018). Agriculture, value added. Retrieved January 2, 2018, from https://data.worldbank.org/indicator/NV.AGR.TOTL.ZS

World Energy Council. (2016). *World Energy Resources 2016*. World Energy Council . Retrieved from https://www.worldenergy.org/wp-content/uploads/2016/10/World-Energy-Resources_FullReport_2016.pdf

Wu, N & Yan, Z. (2002). Climate variability and social vulnerability on the Tibetan Plateau: Dilemma on the road of pastoral reform. *Erdkunde, 56*.

Wu, N., Ismail, M., Yi, S., Joshi, S., Qamer, F. M., & Bisht, N. (2016). Coping with Borders: Yak raising in transboundary landscapes of the Hindu Kush Himalayan region. In N. Wu, N; Yi, S; Joshi, S; Bisht (Ed.), *Yak on the Move - Transboundary Challenges and Opportunities for Yak Raising in a Changing Hindu Kush Himalayan Region* (pp. 3–22). Kathmandu: ICIMOD.

Wu, N., & Liu, Z. (1998). Probing into the causes of geographical pattern of subalpine vegetation on the eastern Qinghai-Tibetan Plateau. *Journal of Applied Environmental and Biological Sciences*, *4*(3), 290–297.

Wu, N., Yan, Z. L., & Lu, T. (2012). Enclosure and Resettlement in the Eastern Tibetan Plateau: Dilemma of Pastoral Development During the Last Three Decades (Chapter 16). In H. Kreutzmann (Ed.), *Pastoral practices in High Asia - Agency of "development" effected by modernisation, resettlement and transformation*. Springer Verlag. Retrieved from http://www.springerlink.com/index/10.1007/978-94-007-3846-1

WWF. (2014). *Living Planet Report 2014. Species, places people and places*. Switzerland. https://doi.org//

Wymann von Dach, S., Bachman, F., Borsdorf, A., Kohler, T., Jurek, M., & Sharma, E. (Eds.). (2016). *Investing in sustainable mountain development: Opportunities, resources and benefits*. Bern, Switzerland, Centre for Development and Environment (CDE), University of Bern, with Bern Open Publishing (BOP).

Xie, P., & Chen, Y. (1999). Threats to Biodiversity in Chinese Inland Waters. *Ambio*, *28*(8), 674–681. https://doi.org/10.2307/4314981

Xu, H., Ding, H., Li, M., Qiang, S., Guo, J., Han, Z., Huang, Z., Sun, H., He, S., Wu, H., & Wan, F. (2006). The distribution and economic losses of alien species invasion to China. *Biological Invasions*, *8*(7), 1495–1500. https://doi.org/10.1007/s10530-005-5841-2

Xu, J., & Grumbine, R. E. (2014). Building ecosystem resilience for climate change adaptation in the Asian highlands. *Wiley Interdisciplinary Reviews: Climate Change*. https://doi.org/10.1002/wcc.302

Xu, J., Grumbine, R. E., Shrestha, A., Eriksson, M., Yang, X., Wang, Y., & Wilkes, A. (2009). The melting Himalayas: Cascading effects of climate change on water, biodiversity, and livelihoods. *Conservation Biology, 23*(3), 520–530. https://doi.org/10.1111/j.1523-1739.2009.01237.x

Xu, M., He, C., Liu, Z., & Dou, Y. (2016). How Did Urban Land Expand in China between 1992 and 2015? A Multi-Scale Landscape Analysis. *PloS One*. https://doi.org/10.1371/journal.pone.0154839

Yang, S. L., Zhang, J., Zhu, J., Smith, J. P., Dai, S. B., Gao, A., & Li, P. (2005). Impact of dams on Yangtze River sediment supply to the sea and delta intertidal wetland response. *Journal of Geophysical Research: Earth Surface*, *110*(F3), n/a-n/a. https://doi.org/10.1029/2004jf000271

Yang, Y. Y., Xu, Y. S., Shen, S. L., Yuan, Y., & Yin, Z. Y. (2014). Mining-induced geo-hazards with environmental protection measures in Yunnan, China: an overview. *Bulletin of Engineering Geology and the Environment*, *74*, 1–10.
Yang, Z. Q., Wang, X. Y., & Zhang, Y. N. (2014). Recent advances in biological control of important native and invasive forest pests in China. *Biological Control*, *68*(1), 117–128. https://doi.org/10.1016/j.biocontrol.2013.06.010
Yao, T., Pu, J., Lu, A., Wang, Y., & Yu, W. (2007). Recent Glacial Retreat and Its Impact on Hydrological Processes on the Tibetan Plateau, China, and Surrounding Regions. *Arctic, Antarctic, and Alpine Research*, *39*(4), 642–650. https://doi.org/10.1657/1523-0430(07-510)[yao]2.0.co;2
Yao, T., Thompson, L., Yang, W., Yu, W., Gao, Y., Guo, X., Yang, X., Duan, K., Zhao, H., Xu, B., Pu, J., Lu, A., Xiang, Y., Kattel, D. B., & Joswiak, D. (2012). Different glacier status with atmospheric circulations in Tibetan Plateau and surroundings. *Nature Clim. Change*, *2*(9), 663–667. Retrieved from http://dx.doi.org/10.1038/nclimate1580
Yasunari, T. J., Bonasoni, P., Laj, P., Fujita, K., Vuillermoz, E., Marinoni, A., Cristofanelli, P., Duchi, R., Tartari, G., & Lau, K.-M. (2010). Estimated impact of black carbon deposition during pre-monsoon season from Nepal Climate Observatory – Pyramid data and snow albedo changes over Himalayan glaciers. *Atmospheric Chemistry and Physics*, *10*(14), 6603–6615. https://doi.org/10.5194/acp-10-6603-2010
Ye, Y., Barange, M., Beveridge, M., Garibaldi, L., Gutierrez, N., Anganuzzi, A., & Taconet, M. (2017). FAO's statistic data and sustainability of fisheries and aquaculture: Comments on Pauly and Zeller (2017). *Marine Policy*, *81*, 401–405. https://doi.org/https://doi.org/10.1016/j.marpol.2017.03.012
Yokohari, M., Takeuchi, K., Watanabe, T., & Yokota, S. (2000). Beyond greenbelts and zoning: A new planning concept for the environment of Asian mega-cities. *Landscape and Urban Planning*, *47*(3–4), 159–171. https://doi.org/10.1016/S0169-2046(99)00084-5
Yonezaki, S., Kiyota, M., & Okamura, H. (2015). Long-term ecosystem change in the western North Pacific inferred from commercial fisheries and top predator diet. *Deep Sea Research Part II: Topical Studies in Oceanography*, *113*, 91–101. https://doi.org/10.1016/J.DSR2.2014.10.027
Yoo, J. (2014). The Characterization of Environmental Problem and the Development of Korean Environmental Law. *CHONBUK LAW REVIEW*, *43*, 187–221.
Zeller, D., Harper, S., Zylich, K., & Pauly, D. (2015). Synthesis of underreported small-scale fisheries catch in Pacific island waters. *Coral Reefs*, *34*(1), 25–39. https://doi.org/10.1007/s00338-014-1219-1
Zhai, D. L., Xu, J. C., Dai, Z. C., Cannon, C. H., & Grumbine, R. E. (2014). Increasing tree cover while losing diverse natural forests in tropical Hainan, China. *Regional Environmental Change*, *14*(2), 611–621. https://doi.org/10.1007/s10113-013-0512-9
Zhang, P., Tang, J., Sun, W., Yu, Y., & Zhang, W. (2015). Differential effects of conservational management on SOC accumulation in the grasslands of China. *PLoS ONE*, *10*(9), 1–15. https://doi.org/10.1371/journal.pone.0137280
Zhang, T. (2000). Land market forces and government's role in sprawl. The case of China. *Cities*, *17*(2), 123–135. https://doi.org/10.1016/S0264-2751(00)00007-X
Zhang, Y., Liu, S., Xu, J., & Shangguan, D. (2008). Glacier change and glacier runoff variation in the Tuotuo River basin, the source region of Yangtze River in western China. *Environmental Geology*, *56*(1), 59–68. https://doi.org/10.1007/s00254-007-1139-2
Zhang, Y. Q., & Welker, J. M. (2014). Global Warming Impacts on Alpine Vegetation Dynamic in Qinghai-Tibet Plateau of China. *Journal of Geoscience and Environment Protection*, *2*(June), 54–59. https://doi.org/10.4236/gep.2014.23007
Zhao, P., Jones, P., Cao, L., Yan, Z., Zha, S., Zhu, Y., Yu, Y., & Tang, G. (2014). Trend of surface air temperature in Eastern China and associated large-scale climate variability over the last 100 years. *Journal of Climate*, *27*(12), 4693–4703. https://doi.org/10.1175/JCLI-D-13-00397.1
Zhao, Q., He, K., Rahn, K. A., Ma, Y., Jia, Y., Yang, F., Duan, F., Lei, Y., Chen, G., Cheng, Y., Liu, H., & Wang, S. (2010). Dust storms come to Central and Southwestern China, too: implications from a major dust event in Chongqing. *Atmospheric Chemistry and Physics*, *10*(6), 2615–2630. https://doi.org/10.5194/acp-10-2615-2010

Zhao, S., Peng, C., Jiang, H., Tian, D., Lei, X., & Zhou, X. (2006). Land use change in Asia and the ecological consequences. *Ecological Research*, *21*(6), 890–896. https://doi.org/10.1007/s11284-006-0048-2

Zhao, Y., Zhang, L., Pan, Y., Wang, Y., Paulot, F., & Henze, D. K. (2015). Atmospheric nitrogen deposition to the northwestern Pacific: Seasonal variation and source attribution. *Atmospheric Chemistry and Physics*. https://doi.org/10.5194/acp-15-10905-2015

Zhaoli, Y., Ning, W., Dorji, Y., & Jia, R. (2005). A review of rangeland privatization and its implications in the Tibetan Plateau, China. *Nomadic Peoples*, *9*, 31–51. https://doi.org/10.3167/082279405781826155

Ziv, G., Baran, E., Nam, S., Rodríguez-Iturbe, I., & Levin, S. A. (2011). Trading-offfish biodiversity, food security, and hydropower in the Mekong River Basin. *Proceedings of the National Academy of Sciences*, *109*(15), 5609–5614. https://doi.org/10.1073/pnas.1201423109

Zuskin, E., Mustajbegović, J., Doko Jelinić, J., Pucarin-Cvetković, J., & Milosević, M. (2007). Effects of volcanic eruptions on environment and health. *Arhiv Za Higijenu Rada i Toksikologiju*, *58*(4), 479–486. https://doi.org/10.2478/v10004-007-0041-3

Chapter 5. Current and future interactions between Nature and Society

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Table of Contents

Executive summary

A: INTERACTIVE ANALYSIS OF HUMAN-NATURE RELATIONSHIP

Future scenarios of Biodiversity and Ecosystem Services (BES) and implications to human well-being in the Asia-Pacific region need to account for the unique regional characteristics and national policymaking practices within the subregions (*well established*). The Asia-Pacific region is unique among regions, owing primarily to its high natural and cultural diversity, but also to the fast rates of social, economic and political changes, human population growth and the threats to both biodiversity and human well-being from natural disasters, especially climate driven extreme events {5.2.3.3}. Improving our understanding of the rapidly changing influence of drivers across the multiple dimensions of biodiversity and nature's contributions to people (NCP) is a key urgency to provide better decision-making support tools to policymakers in an increasingly uncertain future {5.1.2.2, 5.2.3.5}. This is challenging because from the policy perspective since both BES and human well-being can be spatially defined by political boundaries such as countries or regional cooperation platforms {5.2.3.2}. However, the actual and natural interactions of BES and human well-being processes may not necessarily be confined to such political definitions {5.1.4.1} (Table 5).

The future scenario of biodiversity being likely to depend more on underlying drivers than direct drivers such as climate change, further scenarios and models for Asia-Pacific region need to align more closely with the commonly used dimensions and scales (e.g. subregional or national) by policymakers in the Asia-Pacific region (*established, but incomplete*) {5.2.3.3, 5.2.3.4, 5.2.4 and 5.2.3.5}. A small group of scenarios and models have limitations to address necessary and relevant scales and themes of BES so a variety of tools and approaches are required to understand plausible future of biodiversity in the Asia-Pacific region {5.1.4.1, 5.3.2 and 5.3.3}. In assessing the best available scenarios and models, notwithstanding the shortcomings, the confidence gained from the critical evaluations of factors and pressures across multiple dimension of BES need to be considered {5.2.2.2.1}. Identifying and focusing upon key underlying drivers and themes needs to be given more emphasis {5.2.3.4}. For example, the majority of models and scenarios exploring BES trends focus on climate change (e.g. Figure 5.11). However, a key driver cutting across different types of ecosystems contributing to the threats is found to be forest and pasture land conversion to agriculture to feed increasing population, accommodate urbanization and meet increasing demand for natural resources in the Asia-Pacific *(established but incomplete)* {5.1.2.2 and 5.3.4}.

With rapid expansion of population, increasing standard of living, expanding hydro-power sector and expansion of plantation crops in the Asia-Pacific region, future food, water and ecological security will face a severe challenge in some of the subregions unless effective policy and governance reforms in BES management are introduced (*established but Incomplete*).
The Asia-Pacific region especially, the South and Western Asia subregions are particularly water scarce with limited surface water supply and over-reliance on groundwater leading to salinity-related problems {5.2.2., 5.3.2.1; Table 5.2}. All the major rivers in the Asia-Pacific region are anticipated to suffer declines in water flow under different climate change scenarios, affecting freshwater availability and water quality {5.2.2; Box 5.3}. The combined and synergistic impacts of drivers will lead the impact on all habitats, at least in the near future, with varied extent across the subregions {5.3.3}. Because of increasing demand for urban and agriculture land, aquaculture, and tourism infrastructure mangrove habitats remain particularly susceptible to future changes and are prone to local extinction {5.2.3}. Available scenarios for NCP from mangroves and coral alone anticipate losses worth billions of dollars per year, due to sea-level rise and costal land encroachment {5.2.3}. Coral reefs are projected to experience increasing frequency of bleaching, death, disease, and degradation, mostly due to ocean warming and acidification attributed to climate change. Even under conservative scenarios with global mean temperature increase of 2°C by the end of the century, about 90 per cent of corals are expected to suffer severe degradation by 2050 (*established but incomplete*). {5.2.3; Figure 5.13; Box 5.5}.

There is variation in the coverage, distribution and relative influence of different drivers on the human-nature interactions across the Asia-Pacific region (*established but incomplete*) {5.3.2.1, Figure 5.17}.
Most studies on influence of drivers focus on social and economic drivers, but lack integration of ecological drivers, such as the invasive alien species or new breeds of species, which underpin existing research gaps {5.2.1, 5.2.2.2.1}. In Oceania and North-East Asia, economic and policy drivers are somewhat less integrated, in South and South-East Asia, economic drivers, particularly changing lifestyles and consumption patterns, expansion of biofuels, and governance reforms were found to have strong influence {5.3.2.2, 5.3.3.3}. Similarly, climate change-related drivers such as sea level rise and rise in sea surface temperature have been relatively well captured in Oceania including Pacific islands compared to other subregions, in part because of the well-known climate vulnerability of small islands and low lying coastal areas in the Pacific {5.2.3.3}. However, most studies significantly focus on social and economic drivers, but lack incorporation of ecological drivers, such as possible introduction of invasive species or new crop or animal breeds, which underpin existing research gaps {5.2.3.4, 5.2.4}. Scenario archetypes depicting plausible futures under Business As Usual conditions, which are predominantly influenced by Market Forces, or scenarios with increased focus on national-level securities, all present narratives that show declines in both BES and human well-being across the Asia-Pacific region {5.2.4.1}.

B: SCENARIOS AND MODELS AS DECISION SUPPORT TOOLS

From available scenarios and models projecting future human-natureinteractions in the Asia-Pacific region, there is a clear indication of substantial future declines that will impact human well-being or good quality of life (*established but incomplete*) {5.2 and 5.3}.
Assessment of projections from 63 recent publications on human-nature interactions in the Asia-Pacific region clearly indicate decreasing trends over time (regardless of spatio-temporal scales), except for mitigation and adaptive/anticipative scenarios {5.3.2.7}. Despite an overall increase in forest and protected area coverage {4.1.2.1, 4.2.5} (Table 4.1), the flow of ecosystem goods and services from most of the ecosystems in the Asia-Pacific region is projected to decline although in some subregions (e.g. North-East Asia) the production trend shown an increase {5.2.2.2, 5.2.3.4}. For example, since the increased demand for forest products, especially timber will be catered by both planted and natural forests mostly outside the countries of consumption; overall, natural forest area loss is likely to reach 75 per cent by 2100, with up to 42 per cent of forest biodiversity lost {5.2.1.1}. Afforestation and reforestation efforts are increasing in the region and may lead to lower rates of forest area decline, but the biodiversity decline is expected to continue with potential loss of ecosystem function leading to negative impacts on human well-being {5.2.1.1}. Increasing demands for biofuel, palm oil and agriculture products due to expanding urban population is likely to intensify competition for land, especially in South and South-East Asia (*established but incomplete*) (5.2.1). Based on single quantitative estimates available, Business-As-Usual scenarios suggest BES declines valued at up to $5 trillion per year across the Asia-Pacific region, which under scenarios depicting policy for futures with positive and sustainable options for nature conservation, can be drastically reduced (*unresolved*) {5.2.1.2}.

It is difficult to ascertain the exact magnitude of change and future trends of nature's contribution to people in the entire Asia-Pacific region as the studies of interactions between BES and human well-being and good quality of life are typically carried out at national and local levels indicating the need for systematic regional assessment (*well established*) {5.2, 5.3}
The existing scientific literature outlining future trends in BES for the entire Asia-Pacific region or its subregions are predominantly climate-centric, providing long-term projections of 2050 and beyond (*well established*) {5.3.3, 5.4}. Scenario exercises that focus on a specific component of biodiversity and/or ecosystem services for the entire region are extremely limited {5.3.4}. Based on the limited evidence available, it is difficult to indicate likely changes with significant confidence as well as to synthesize the information into one set of plausible futures for the entire Asia-Pacific region, since the studies are spatially based, and utilize dissimilar models, data, and assumptions {5.2.3.2}. For example, scientific studies showing better community participation in ecosystem management,

coupled with systematic incorporation of traditional and indigenous knowledge into natural resource management plans and policies pointing toward better future for BES, are available from some subregions only {5.2.3.4}. Similarly, only a handful of studies actually deployed multi-stakeholder-based scenario development, therefore these components are assessed as inconclusive {5.2.3.5}.

C: FUTURE OF BIODIVERSITY AND HUMAN WELL-BEING IN THE ASIA-PACIFIC

The most significant drivers influencing biodiversity and ecosystem futures are economic, demographic, and anthropogenic climate change, thus scenarios that are based on application of new technology and management improvements that reduce their impacts are likely to improve the future of BES in the Asia-Pacific region *(inconclusive)* {5.3.3, 5.4.3}.
Among the results of the assessed scenarios, biodiversity loss would be lowest under the 'Global Technology' scenario in North-East Asia and Oceania, under the 'Consumption change' scenario in South-East Asia, and under the 'Decentralized Solution' scenario in Western Asia and South Asia {5.2.2.2.1} (Figure 5.15). In order to reduce the impact of climate change on biodiversity in Western Asia and Oceania, and crop production in South-East Asia, North-East Asia, and South Asia {Figure 5.16, left side}, appropriate technological and management interventions are likely to yield positive results {4.2.4 in Chapter 4, 5.1.2.2}. In terms of plausible future land use, all subregions would expect increases in natural areas under the three alternative pathways, compared to the 'Baseline' scenario {5.2.2.2}. The greatest increases in natural area are anticipated under the 'Consumption Change' scenario in Western Asia and South-East Asia, under the 'Global Technology' scenario in North-East Asia and Oceania, and the 'Decentralized Solution' scenario in South Asia {5.2.2.2.1, Figure 5.10}. A decrease in natural area, in comparison with Business-As-Usual, is expected only in North-East Asia under the 'Consumption Change' pathway {5.2.3.3, Figures 5.1, 5.10, right side}.

Despite declines predicted in both BES and human well-being in the Asia-Pacific region, scenarios under new policy reforms and behaviour change and their effective implementation that encapsulate sustainability and on-going protection of nature indicate either slowing down of declines in BES, or even improvements in some subregions (*established but incomplete*) {5.2, 5.3.2, 5.3.3}.
Scenario exercises that focus on a specific component of biodiversity and/or ecosystem services for the entire region being rare, hence, based on the available literature evidence; it is difficult to indicate likely changes with significant confidence {5.2.3, 5.3}. It is difficult to synthesize this information into one set of plausible futures for the entire Asia-Pacific region, since the studies are not only spatially separated, but also utilize dissimilar models, data, and assumptions {5.3.4.1}. However, critical evaluation of alternative scenarios in the Asia-Pacific can help its population prepare for both climatic and non-climatic hazards and disasters and/or modify the course of events towards reduced negative impacts of expected future declines in NCP {5.3.4}. Nevertheless, scientific studies from the Asia-Pacific region suggest better community participation in ecosystem management, as a systematic incorporation of traditional and indigenous knowledge into natural resource management policies, which could be one of the pathways for sustainable futures {5.3, Box 5.6}.

Technological advances and progress in economic development ignoring consideration of biodiversity and ecosystem conservation is less likely to lead to improved human well-being and good quality of life (*well established*).
Ample evidence exists in the region that the countries have managed to increase the GDP at the expense of natural capital in the Asia-Pacific region {5.1.2.2, Figure 5.6}. Economic development is derived from diverse components of human, physical, social, economic and natural capitals in which the ecosystem services contribute significantly to enhance the good quality of life of the people {5.2.3.4}. However, in most of the Asia-Pacific countries as indicators of human well-being and good quality of life are predominantly of economic nature with significant negative implications on regions biodiversity and ecosystem services {5.1.4, Box 5.1}. This is because nature's contribution to people most often are not reflected with the purely economic indicators based accounting system since it undervalues the contribution of ecosystem services {5.2.1.1.1}. As a result, countries which are

unsustainably exploiting their natural capital are most likely to face decline in future well-being and good quality of life in the long run (*established but incomplete*) {Figure 5.7, 5.1.3, 5.3.4}

5.1 Introduction

This chapter aims to provide a comprehensive assessment of the available scenarios on current and future interactions between biodiversity and ecosystems services (BES) and human well-being within the Asia-Pacific region. In particular, this chapter evaluates the trends and trajectories of available scenarios for BES and human well-being interactions within the Asia-Pacific region. This goal is approached from two directions: In Section 5.2 we draw on published literature from the Asia-Pacific region, examining plausible futures within terrestrial, marine and freshwater ecotypes. In section 5.3, we assess the current evidence from a suite of sources that have employed scenario and modelling approaches at various spatial and temporal scales. However, it also important to emphasise the variability of BES and human well-being interactions among member countries in the Asia-Pacific region, even among the developed nations (c.f. Chapter 2). In section 5.4 we examine the limited number of supranational scenarios developed across the Asia-Pacific region and subregions. We also take a ‘global to local’ approach by applying well established and accepted global scenarios to the Asia-Pacific region to highlight plausible futures across the region and subregions. Our final section (5.5) sketches key themes leading to policy options to be explored in Chapter 6 and encapsulated in the Summary for Policymakers (SPM).

5.1.1 The context for Scenarios and Models in the Asia-Pacific region

The Asia-Pacific region is characterized by a remarkable heterogeneity of resources, societies and socio-cultural contexts, and is spread over four of the world’s major bio-geographical realms (Australian, Indo-Malayan, Oceanian, and Palearctic), including several archipelagic countries across the Indian and the Pacific Ocean. From the remote Pacific islands to Deserts of Western Asia, the region serves as a habitat for numbers of globally important endemic species, both terrestrial and marine, and has contributed to the well-being of the different ethnic and socio-cultural groups through provision of a range of valuable ecosystem services. This further translates to high bio-cultural diversity that exist under different political and social contexts, all of which have profound implications for the future of the region. Chapters 2, 3, and 4 have laid out the status, trends, changes, and reasons for changes to the biodiversity and ecosystem services in the region across various ecosystem types and subregions. By assessing and exploring scenarios and models, this chapter seeks to build on these trends to articulate plausible futures relating to biodiversity, ecosystem services and human well-being (notionally to 2050). Important findings from the preceding chapters of this assessment offer context to the benefits of using scenarios across broad themes pertinent to human well-being.

Food production and food security: Food security has been identified across all chapters as an important concern in the region. Whilst estimates indicate overall improvement in food security (2.2.4), this is not uniform across the subregions and even within countries in a subregion (4.2) owing to problems of poverty and insufficient access with consequent high rates of malnourishment in certain areas within the Asia-Pacific region (2.4). Being a basic need, increasing food supply for both domestic and export markets has been a priority for many national governments in the region, and thus policies are geared towards this direction. These range from positive policies promoting sustainable agriculture (6.2; 6.5), to perverse incentives for chemical inputs use and agricultural intensification (4.2). Market based instruments such as certification schemes for sustainably produced, organic, and local foods are gaining popularity (4.2).

Nonetheless, given the growth of population, urbanization, and changes in lifestyles of populations, especially those who had traditional lifestyles, the demand for food is increasing (4.2). Food crops are being increasingly cultivated as monocultures (3.2; 4.4), in conditions not naturally feasible for their cultivation (3.2). Crops are often used for purposes other than ‘food’ (e.g., industrial and biofuel use, and as animal feed) and produced using intensive agricultural techniques that use excessive chemical fertilizers and pesticides (3.2). This has resulted in loss of agro-biodiversity (3.2.1), ecosystem degradation (3.2.1) declines in soil fertility (3.2.1.5), large scale conversions of bio-diversity rich forest and fertile land (3.2) and the spread of invasive alien species (3.4, 4.1.4). Additionally, incidence of pollution of water and soils have increased (3.2.2) impacting human, plant and animal health (3.2, 4.1.3). In the case of the fisheries sector, over-exploitation of fish resources in response to rising market demand is facilitated by large trawlers that do not discriminate between species (3.2.4, 4.1, 4.4.5). The increase in the demand for meat in the region, has led to large scale forest land conversion for pasturelands, ranches with negative implications for biodiversity (3.2). Such changes also have made the region more vulnerable to extreme events and climate change as both the adaptive capacities and natural mitigation options are reduced (3.2, 4.4). Increased trade and globalization have facilitated quicker and larger movement of food products and have contributed to higher production at environmental costs (4.2.2). In some cases, it has been noticed that this has led some countries to under-utilize their resources (such as forestry resources) as they source cheaper options from other countries (4.2.2).

Health security: While not directly expressed, it is captured in aspects of access to clean air, water, ecosystem functioning, regulation of pests and vectors of diseases. Key themes considered across all chapters deal with high levels of air (4.1.3), water (4.1.3), and soil (4.1.3) pollution across the subregions. Influential factors included increasingly built up areas in urban centres with limited vegetation, and chemical run off in soil and water. Loss of natural ecosystems or their degradation also enables the spread of disease causing vectors and pests (4.1), in addition to threats to human life due to increasing vulnerability to extreme events. The uses of traditional medicine as well as medicinal plant diversity and abundance have also reduced, due to commercialization of products that is not always commensurate with sustainable regeneration capacities (2.3, 2.4). Technological solutions to ameliorate these impacts are available and are often successful where deployed (4.2.4).

Water security: Freshwater is required for consumption, irrigation, and energy-generation purposes. Trends indicate large scale water stress in different subregions in the Asia-Pacific region arising from over exploitation of water resources and high pollution from agricultural, fishery and other industrial activities (2.4, 3.2). Efforts at managing water resources have resulted in some innovative mechanisms of transboundary co-operation between countries and co-management between different stakeholders in an ecosystem (2.3).

Energy security: Given the large population and extensive urbanization in the region, the demand for energy is also high. This is met heavily through coal, firewood, oil and biofuels (2.4, 4.1). The region is the highest consumer and supplier of coal and (4.1), with resultant loss of species through deforestation, land clearing, and mining activities (4.1). Emphasis on producing cleaner coal and clean energy is increasing across the region (4.1, 4.2) and is likely to be a key driver of future change.

Income and Livelihoods: Rising commoditization of food and biofuels resources, and increasing availability of lifestyle products enabled by globalization have had both positive and negative impacts to biodiversity (4.2). On the one hand, tropical deforestation has seen unprecedented levels in the last decade due to activities like oil palm plantations and on the other end (3.2), commercialization has enabled a revitalization of local livelihoods and economies by creating niche markets for local products, and local ecosystems through activities like for instance, ecotourism (4.2.2).

Equity and Justice: Large scale transformations of traditionally occupied and managed ecosystems for various development purposes have had negative impacts on the livelihoods of local communities (2.2). These impacts have resulted in migration to urban centres and consequent unemployment, inadequate access to basic necessities of life, and the loss of sense of place and culture (2.3, 4.2). Policies focusing on changing existing production patterns and the management of ecosystems have exacerbated the problems, particularly in rural and nomadic communities (3.2), including exposure and sensitivity to extreme events, such as natural disasters (2.4).

Specific policies relating to rewarding local knowledge, practices on conservation are being developed, such as laws on equitable sharing of benefits from using resources and related knowledge from communities; or co-management of forests, watersheds and landscapes or coastal areas. Where these are implemented cooperatively between local communities, governments and private sector, they have been found to be mutually beneficial (2.3.2, 2.3.7, 2.5, 3.4.6). Similarly, policy support for niche markets also enable sustaining cultural practices and better address the needs of the poor (4.2). The combination of these factors in the Asia-Pacific and subregions lead to potentially divergent and unique future options. Despite the general appreciation of the major challenges faced by the Asia-Pacific region above and in **Chapter 1**, there is a lack of systematic or synthesized scenarios and modelling assessment of interactions between BES and human well-being in its widest sense for the region. Therefore, this chapter evaluates and presents an assessment of available scenarios of current and future interactions of BES and human well-being in the Asia-Pacific region, in particular, following the integrated assessment approaches of the Intergovernmental Platform for Biodiversity and Ecosystem Services (IPBES).

5.1.2 IPBES framework: Integrated assessments of multiple components of interactions between Biodiversity and Ecosystem Services and Human Well-being across multiple spatial and temporal scales

The assessment of current and future interactions between BES and human well-being in the Asia-Pacific region follows the integrated conceptual framework of IPBES (see Chapter 1). In particular, it takes into consideration the multiple components of BES and human well-being relationships such as the multiple direct and indirect drivers (see Chapter 4 for detailed assessment and discussion of drivers) impacting BES (see Chapter 3 for detailed assessment of BES status and trends in the Asia-Pacific region), and thereby subsequently impacting human well-being and good quality of life (see Chapter 2 for detailed assessment of nature’s benefits to people in the Asia-Pacific region). The multiple components of BES and human well-being, and their interactions can be expressed in terms of plausible scenario narratives for BES and human well-being at various spatial and temporal scales (Figure 5.1; IPBES Deliverable 3c.).

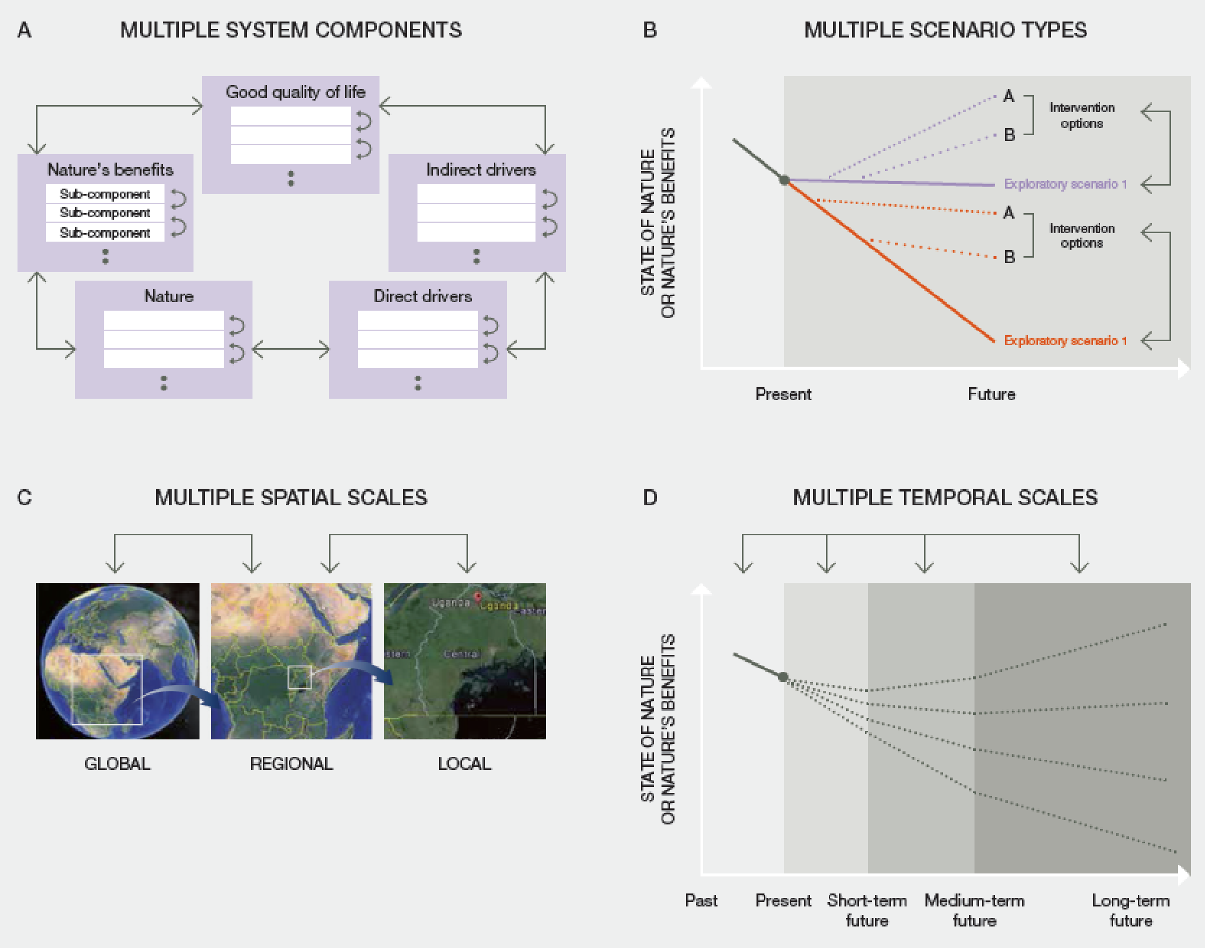


Figure 5.1 Illustrations of multiple components (A), scenarios (B), and spatio-temporal scales of Biodiversity and Ecosystem Services and Human Well-Being. Source: IPBES (2016).

5.1.3 Current understanding of interactions between Biodiversity and Ecosystem Services and Human Well-being in the Asia-Pacific region and its gaps

One of the main characteristics of the Asia-Pacific region is its great diversity – from natural ecosystems, socio-cultural and political systems, and status of economic development – thus integrated assessment of BES and human well-being interactions within this region can be very challenging, especially without coordinated effort or shared database and methodologies. Up to 65 per cent of countries in the Asia-Pacific region could be considered as 'developing', and as few as 20 per cent considered as 'developed' according to economic measures (UNESCAP, 2016). However, all are dependent on BES for their well-being, be it through provision of clean water or soil function for agriculture and food security. For example, a significant proportion of the Asia-Pacific region population is reliant on solid biofuel, especially within lower income countries (Figure 5.2). The concept of well-being has already been discussed in the earlier chapters but it can manifest in the form of service provision impacting other forms of capital (see Box 5.1)

However, the countries comprising the Asia-Pacific region also share many regional characteristics, such as (1) the degradation of many BES due to rapid deforestation and conversion of land to agricultural (figure 5.3), industrial and urban areas, (2) the high population and population growth rates in many countries (3) the high biodiversity within the region (from genetic resources to ecosystems), (4) the exposure and vulnerability of many countries to natural calamities and disasters; (5) the depletion of coastal marine ecosystems within the Asia-Pacific region and the continuous overcapacity in fishing sectors of the region (figure 5.4); (6) the intensive eutrophication and modification of many aquatic and inland water ecosystems within the region to support energy production (hydrothermal energy), irrigation of agricultural lands, and heavy pollution of many aquatic ecosystems within the region coming from industries, urban sewage, and agricultural run-off (figure 5.5).

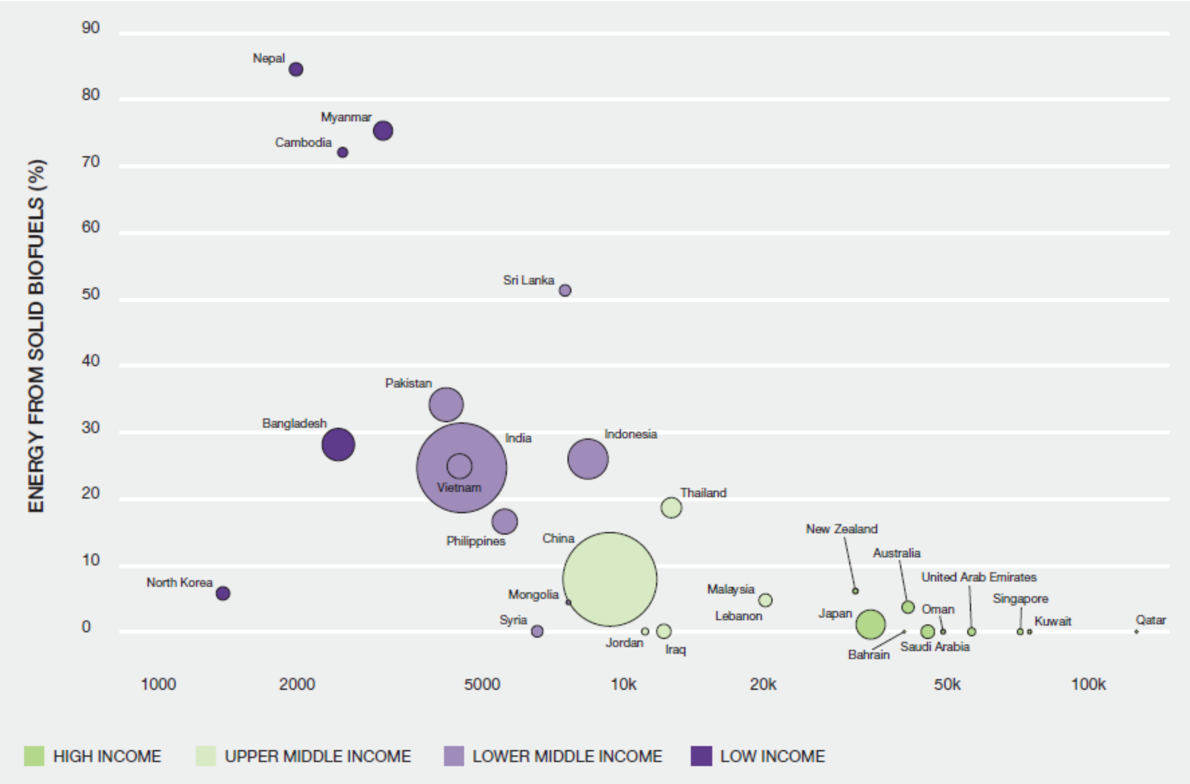


Figure 5.2 Proportional energy derived from solid biofuels from latest available data in 2010, including traditional energy sources (firewood) by country within the Asia-Pacific region
Note: Colours indicate income levels, based on per capita GDP, and circle sizes are proportional to population size. Source: Energy supply from primary solid biofuel and total energy supply is from the International Energy Agency data (2013) (Link to EIA data: http://data.iea.org/IEASTORE/DEFAULT.ASP). Data presented using Gapminder World software, a free vizualization from Gapminder.org, CC-By License.

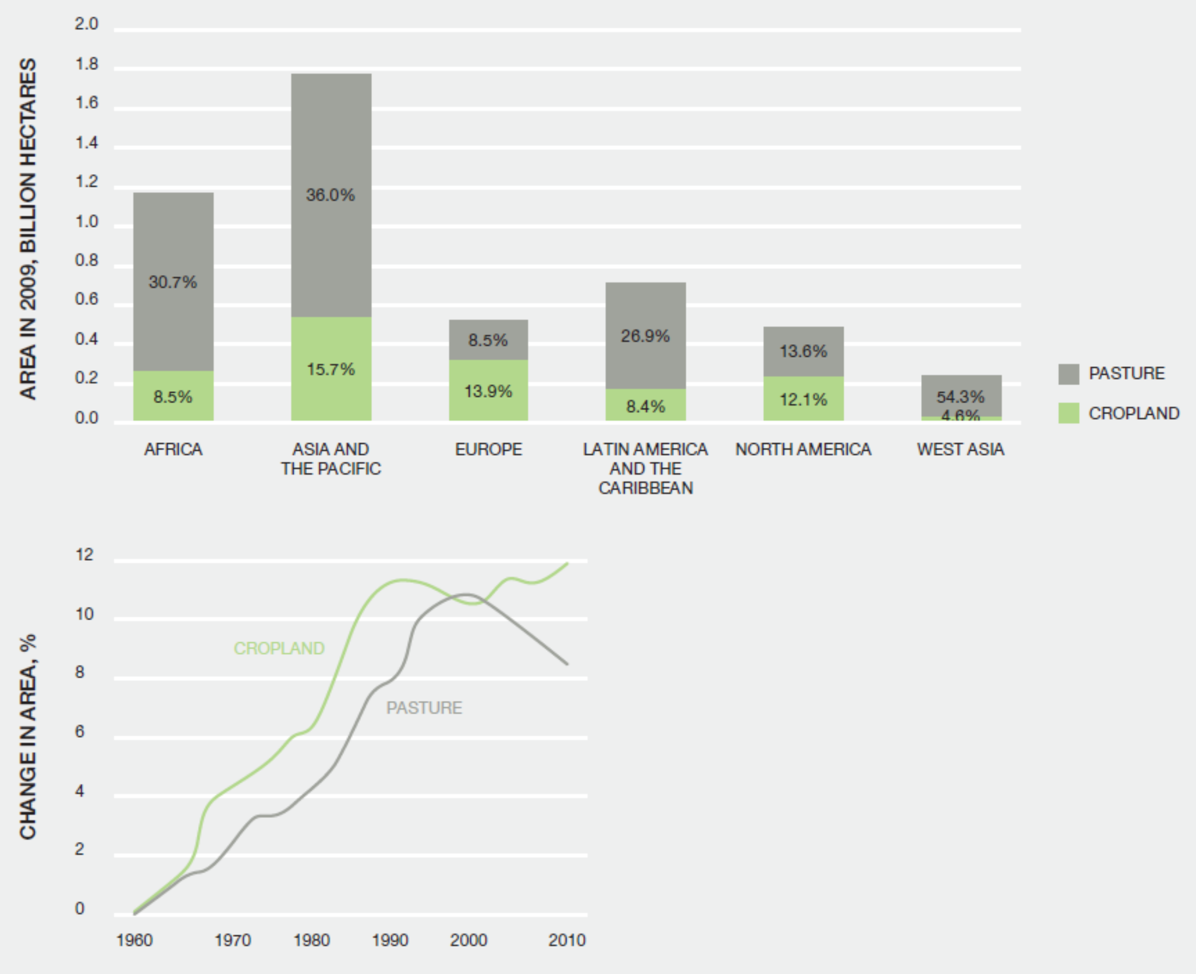


Figure 5.3 Proportion of land (forest and others) converted in the Asia-Pacific region for pasture and cropland. Source: GEO-5 (UNEP, 2012).

These disturbances to ecosystems, coupled with the growing demand for more resources to sustain the need for large and rapidly growing population within the region, pose a threat for calamitous collapse of BES productivity within the region. Hence, there emerges a need for this assessment to help guide policies aimed at recovering and maintaining the sustainability of BES and human well-being interactions of desired present and future BES and human well-being interactions within the region. Integrated scenario and modelling analysis of BES and human well-being interactions have been shown to be useful in providing guidance for policies that could provide clear pathways and options for sustainability (IPBES, 2016).

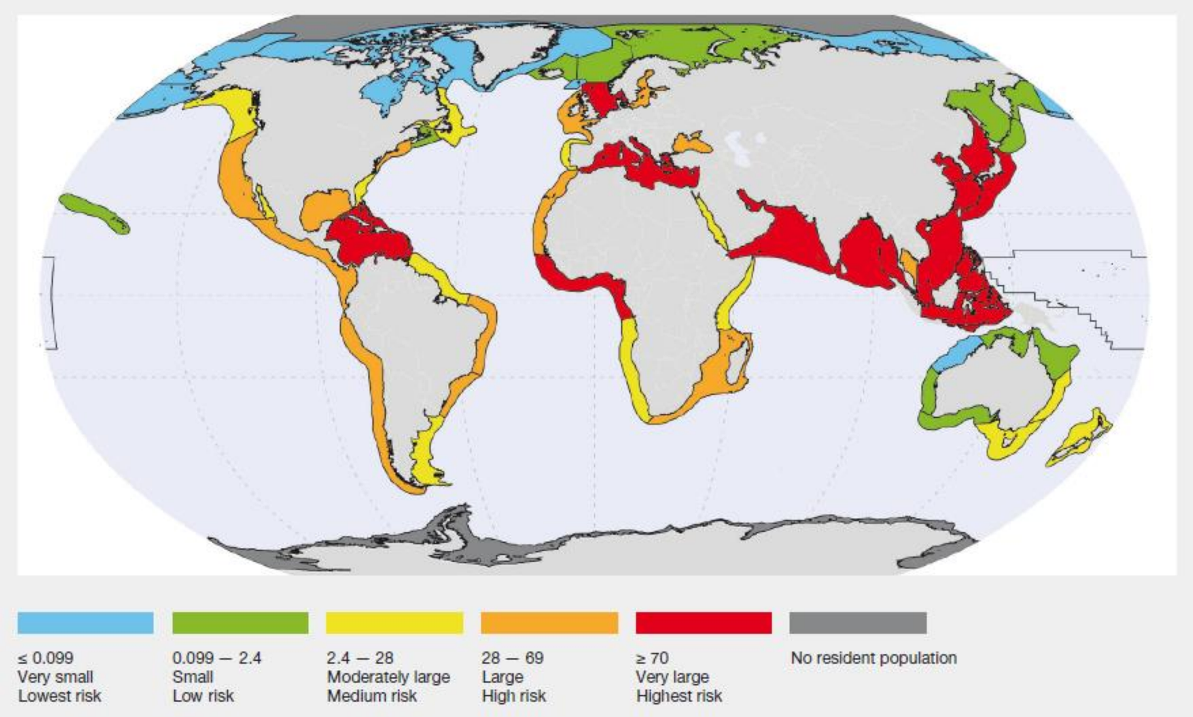


Figure 5.4 Populations along global coastal areas and the risk to the ecosystem (overcapacity or over-exploitation) with high values in the Asia-Pacific region. Source: IOC-UNESCO & UNEP (2016).

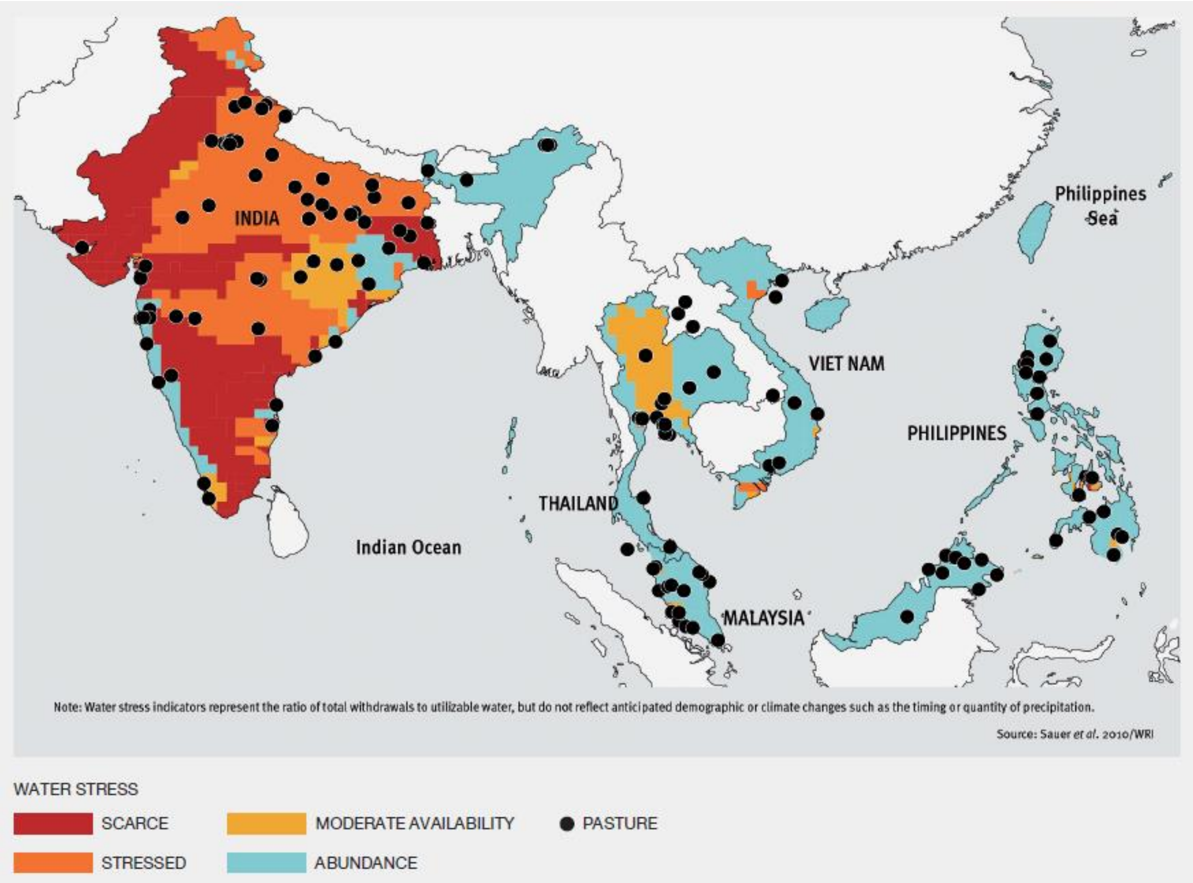


Figure 5.5 Thermal and hydro power plants in the Asia-Pacific region, and the stress on aquatic ecosystems in the region. Source: GEO-5 (UNEP, 2012).

5.1.4 Further considerations for an integrated assessment of scenarios of interactions between Biodiversity and Ecosystem Services and Human Well-being within the Asia-Pacific region

Given the vast diversity within the Asia-Pacific region, conducting an integrated regional assessment of scenarios for BES and human well-being interactions would require careful consideration in terms of relevance to policymaking conventions within the region. This is challenging because from the policy perspective BES and human well-being can be spatially defined by political boundaries such as countries or regional cooperation platforms, such as The Association of Southeast Asian Nations (ASEAN) or The South Asian Association for Regional Cooperation (SAARC). However, the actual and natural interactions of BES and human well-being processes may not necessarily be confined to such political definitions (e.g. connectivity among migrating species both on land and sea or the flow of freshwater and associated biodiversity across national boundaries). Thus, the assessment must seek to provide insights for BES and human well-being interactions that are relevant to national context and regional, or appropriate spatial context, when applicable or necessary. Similarly, temporal scales must be provided to reflect the appropriate interactions between BES and human well-being that would require long time (e.g. forest or coral reef restoration) vs. those that operate at relative shorter temporal scales (e.g. seasonal agricultural production or seasonal tourism activities).

Box 5.1 What constitutes Well-being?

The Millennium ecosystem assessment defined human well-being to be derived from five components: basic materials, health, security, good social relations, and freedom of choice and actions, where freedom of choice and actions is expected to emerge from the other components of well-being. The Millennium Ecosystem Assessment highlighted the important contribution of ecosystem services to the human well-being. Ample evidence exists at the micro-level in different countries highlighting the dependence of communities on different ecosystems for their livelihoods, providing a source of income, employment, and economic safety-net among other things.

At the national level, countries often rely in Gross Domestic Product as a measure of well-being (a reflection of the capacity of the country to produce goods and services) and improving the quality of life (as measured by the Human Development Index). However, more emphasis on GDP as a measure of well-being would have significant negative impacts on ecosystem services. Ecosystem services can decline but the GDP can go up. Gundimeda and Atkinson (2014) notes that Natural capital (ecosystems) provides multiplicity of intermediate and final goods which are often invisible and thus are not measured by the national income indicators like the GDP. Some of the reasons include: (1) the contribution of natural capital as an input into the production process; (2) the broader values that the society places on these assets; 3) the benefits provided by ecosystems go beyond the production boundaries of the system of national accounts, which measure GDP; (4) failure to account for the impact of human activities on natural capital. There has been considerable advancement in practical assessment for this natural wealth (ONS, 2014; United Nations, 2012; UNU-IHDP & UNEP, 2012; World Bank, 2011)

Increased emphasis on expanding the economic opportunities has come at the expense of ecosystem health, biodiversity, air quality, and human resiliency. There are also other dimensions, other than GDP, which impact the well-being like the educational opportunities, health, natural landscapes and ecosystems, social networks, among others (see Figure 5.6). Thus, the concept of inclusive wealth takes into account all these dimensions of wealth. Inclusive wealth is defined as the Present Discounted Value of all capital assets, where the stocks are valued in terms of their shadow prices (Arrow *et al*., 2012), and through the changes in shadow prices, the society can get real signals on the impact of loss of ecosystem services. The shadow prices contain information on the impact of the future scarcities.

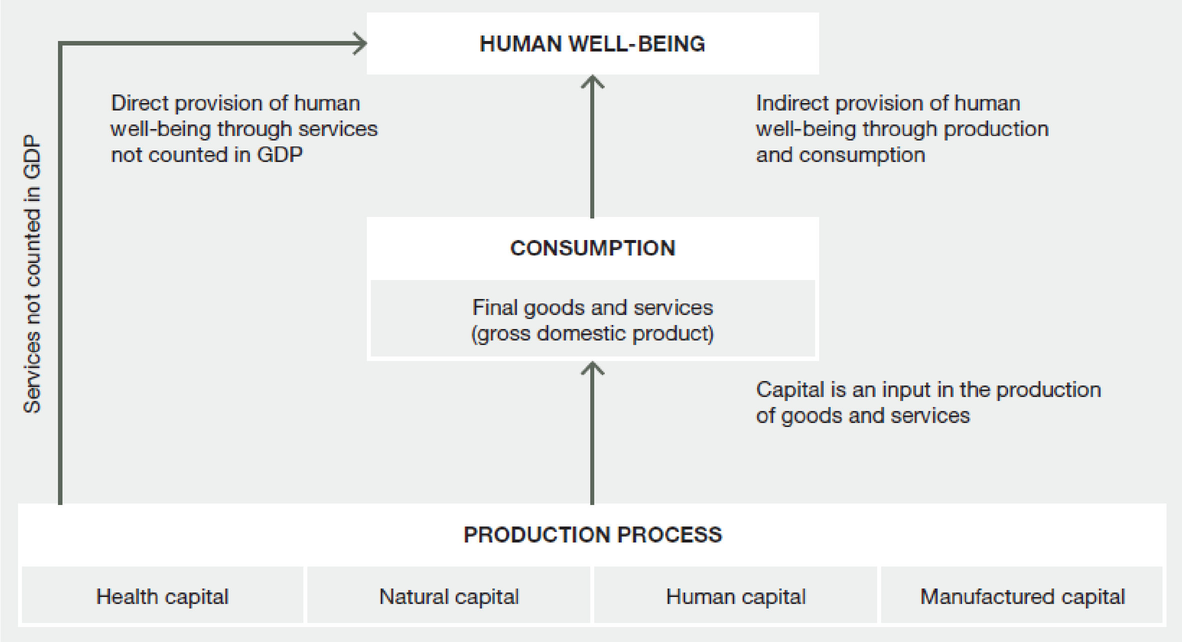


Figure 5.6 Relationships between produced capital, consumption, and human well-being. Source: UNESCO/UNU-IHDP and UNEP (2014).

It is often seen that the economies of countries that are exploiting their natural capital grow rapidly. Raudsepp-Hearne *et al*. (2010) break this paradox by arguing that the critical dimensions of human well-being have not been adequately captured. With the increase in production per capita, and important provisioning services, human well-being would increase regardless of the decline in other services. Due to the technology and social innovation, human well-being appears to be less dependent on ecosystem services. In addition, due to the time lag between ecosystem service degradation and the negative impacts on human well-being, these negative impacts may take some time before being felt to a measurable extent.

Despite a general increase in awareness of these issues in recent years, the current state of BES (and subsequent human well-being) in the Asia-Pacific region has vastly deteriorated from the previous decade (established in chapter 3), while future projections are no exception either (UNEP-WCMC, 2016) (see section 3.4). As per the GBO-4 assessment report, the state of biodiversity in the Asia-Pacific region will continue to decline at least until 2020 (CBD, 2014).

5.2 Observed and projected impacts on Biodiversity and Ecosystem Services in the Asia-Pacific region

Human well-being and sustainable futures are linked to the steady flow of goods and services from nature (c.f. Chapter 1 and 2). Building from Chapter 3 (Status, trends, and future dynamics of biodiversity and ecosystems underpinning nature's contributions to people) and Chapter 4, here we highlight key features of observed and projected impacts in nature-society interaction, particularly portraying plausible future states under the existing Business-As-Usual (non-interventionist) scenarios and the links to the human well-being. The projections of such interactions highlight the future risks of changes in various drivers on the ecosystems and enable proactive policies to mitigate the impacts. In this section we explore the impact of various drivers on different ecosystems and its consequent impact on well-being in the Asia-Pacific region based on the synthesis of literature.

However, given the diverse demographic and structural variation across the region, and the multiplicity of the approaches used, it is difficult to synthesize and single-out the observed trends and projected impacts with specific reference to the entire region or any of the subregions. The available scientific evidence of an observed and future trend in nature-society interaction from the region (or at the subregion) are particularly scanty, and only handful number of studies considered the entire region (or subregions) as their projection scale, thus adding complexity to project plausible future of nature-society interactions in the Asia-Pacific region.

These complexities in synthesizing the available scientific evidence on the projected impacts on future biodiversity and well-being arise from the following reasons: (1) Majority of the publications did not have future projections of nature-society interactions, nor used comparable scenarios or models, and thus are of very limited use in the context of the IPBES integrated assessment framework; (2) The scientific literature that met the criteria had very limited information in terms of the spatio-temporal scales, scenarios used, models employed or nature's contribution to people or society; (3) Nature's contribution to people has been captured through diverse indicators (e.g. area changes, species richness, and species abundance)[73] and the studies also varied in terms of the number and nature of well-being indicators (in line with the MEA), limiting the comparisons on a common ground; (4) The spatial coverage of the studies differed from sub-national (local), national, subregional (sub-sections of the Asia-Pacific region) and global studies with subregional components; (5) The temporal scale of the nature-society interactions also varied, with ambiguity in the time-period of projections ; (6) the nature of models used for projections often differed[74] and (7) as the plausible future depends on the scenarios considered (see section 5.3), the scientific studies used different set of local scenarios (see Appendix 2 for illustration of a set of studies); (8) the studies were taxonomically limited as only very few species were considered and they form very small percentage of the actual diversity. Moreover, existing scientific literature outlining future trends in BES for the entire Asia-Pacific region or its subregions are predominantly climate-centric, providing long-term projections of 2050 and beyond. The ecosystem services are dynamic and are influenced by social, ecological, and climatic systems and non-climatic factors and constraints (Bennett *et al.*, 2015). For instance, while globally, climate change may cause 10-15 per cent reduction of mangrove habitats in distant future, the imminent threat for the next 25 years comes from urban development, aquaculture, mining and overexploitation, with insignificant impacts from 'alteration of hydrology' or 'global warming' (Alongi, 2002, 2008). At the same time, mangrove future beyond 2025 will rest upon social, technological and ecological advances, and given the ongoing restoration efforts, the future might not be entirely bleak as often projected (Alongi, 2002).

Despite these ambiguities, it remains imperative to understand the future of BES in the Asia-Pacific region, as it provides a rough depiction of the likely state (or the baseline) of availability of key ecosystem services in the absence of any corrective policies (under the Business-As-Usual scenario). The section is designed to share the understanding of observed and projected impacts of BES in the Asia-Pacific region. By the term 'projected impacts,' we broadly refer to the IPCC's definition, which defines 'projection' as a model-based estimation of future (IPCC, 1995). The section is divided into three sub-sections, each catering to projected outcomes in nature-society interaction for terrestrial, freshwater, and coastal-marine ecosystems.

[73] For example, the contribution of aquatic ecosystems is captured through quantity and quality of water supply provision but had limited information on aquatic biodiversity indicators, for coastal-marine ecosystems, the commonly projected indicators of NCP were coral reefs, coral reef habitat and fisheries. For terrestrial ecosystems, the most commonly projected NBP indicators were agricultural food production, forest area or habitat, biodiversity, and carbon storage

[74] For example, for aquatic ecosystems, hydrological or ensemble models (e.g. climate projections models CMIP3 and CMIP5, or bioclimate models) were most commonly used, but were often specific to the study. For coastal-marine ecosystems, most studies used ensemble models (e.g. climate projections models CMIP3 and CMIP5, or bioclimate models). For terrestrial studies, most used various versions of land-use (e.g. CLUE-S) or forest production and dynamics models

5.2.1 Terrestrial Ecosystems

5.2.1.1 Forest ecosystems

Forests are significant pools of BES and offer a number of valued ecosystem services, therefore changes in forest cover are often considered as a proxy for the state of terrestrial BES. However, there is a rapid loss of tropical lowland forests, threatening biodiversity and ecosystems in the Asia-Pacific region (***see section 3.3.1***). During 2000-2013, forest cover in the Asia-Pacific region has roughly decreased by 6 per cent. Particularly, degradation of forest remains severe in South-East Asia (Figure 5.7) (Hansen *et al.*, 2013; UNEP-WCMC, 2016). Although historically, demand for timber resulted in the loss of forests, in recent years, human-induced land-use changes, predominantly, for agriculture, habitation (Fox *et al*., 2012; Kubiszewski *et al*., 2016; Lal, 2011), expansion of biofuel and oil palm cultivation have contributed to the bulk of the loss in the Asia-Pacific region (CBD, 2014).

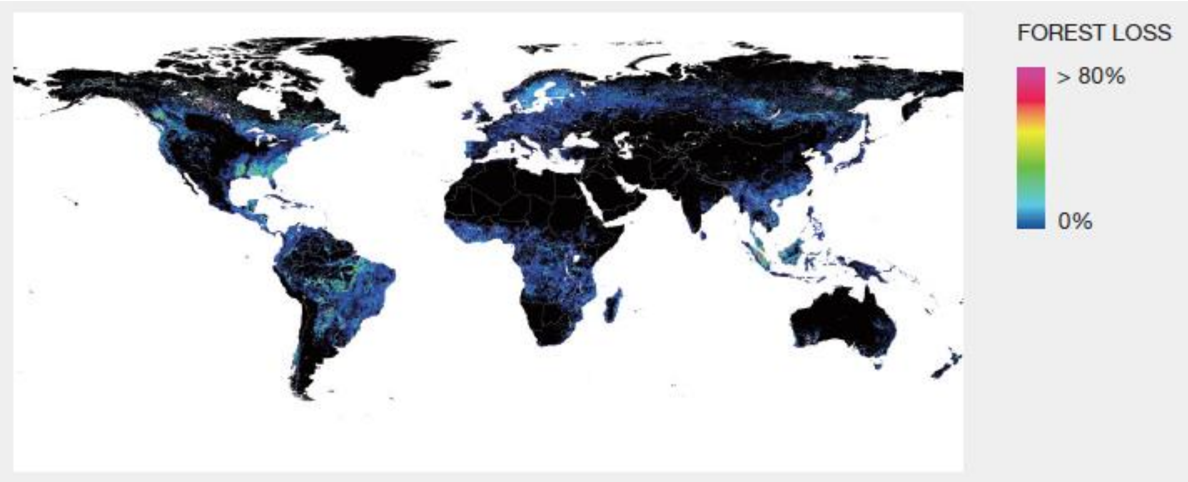


Figure 5.7 Loss in Global forest cover from 2000-2013. Source: Hansen *et al*. (2013).

In general, further reduction of forested area, mostly in South and South-East Asia, are expected. Given the current trend, South-East Asia may lose the greatest extent of forest in future – i.e., nearly three-quarters of its original extent by the end of this century and 13 - 42 per cent of its original biodiversity (Sodhi *et al*., 2004). Human intervention in forested areas, especially for biofuel expansion, will continue to dominate future conversion of forested areas, particularly in South-East Asia. For instance, a study by Raunikar *et al*. (2010) estimated annual growth rate of 1.04-1.94 per cent per year for biofuel sector in Asia (up to 2060). Some projections, nonetheless, also show that the loss of forest might slow down slightly by 2030, due to the expansion of planted forests and commercial forestry (d'Annunzio *et al*., 2015; Rutten *et al*., 2014). Although this might partially cater to an increasing wood-demand, especially from region's growing economies, this will not necessarily make sufficient positive impact in the future state of biodiversity (d'Annunzio *et al.*, 2015).

Significant species loss is, thus, expected in major biodiversity hotspots across the Asia-Pacific region (see Box 5.2). However, in the future, the region's protected areas, currently about 13.7 per cent of the total land area, will continue to possess much of the remaining biodiversity and, in general, will remain unaltered (CBD, 2014).

Among material contribution from forest ecosystems, wood-demand and production will increase across the region. However, much of the demand will be catered by planted forests. As figure 5.8 suggests, share of planted forests are consistently rising in the Asia-Pacific region (FAO, 2010). Public and private investments in planted forests, particularly in South and East Asia, may lead to some improvement in forest cover as well as cater to about 83 and 96 per cent of future wood demand respectively (2050) (d'Annunzio *et al.*, 2015). In addition, international support for forestry schemes such as REDD/REDD-plus will also offer improvement in forest cover, particularly in the developing countries. Degraded grasslands and heavily degraded forests in the region may, thus, become economically lucrative for plantation development. In addition, abandoned farmland in East Asia would enable some degree of 'passive restoration'. As a consequence of this passive restoration, forest cover is likely to increase. For example d'Annunzio *et al*. (2015) estimated that forest cover in Asia is expected to increase marginally, from 593 million ha to 604 million ha by 2030. However, despite some projection in forest cover and timber production, there is a significant lack of future projections concerning Non-Timber Forest Products (NTFPs), which includes a broad range of commodities, including honey, wax, and medicine. These are equally important for the well-being for a vast section of communities, particularly in poverty reduction for forest-dependent communities. Moreover, loss of traditional species (mostly flowering plants) might lead to a reduction of traditional health benefits for the indigenous people and local communities (Millennium Ecosystem Assessment, 2005).

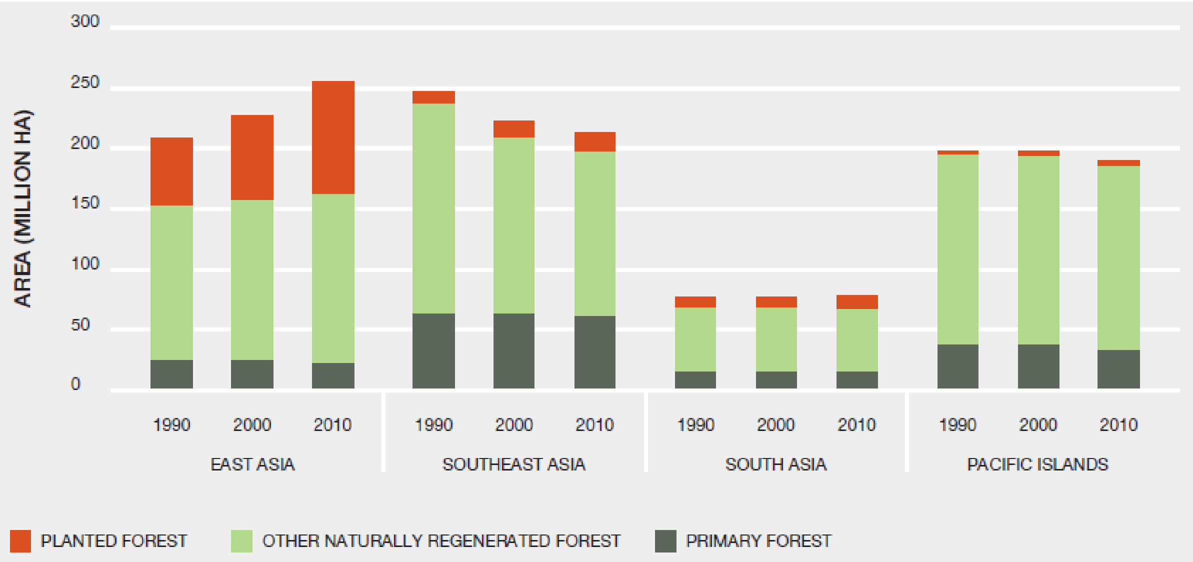


Figure 5.8 Observed trend in forest category shows a growing inclination to planted forest, both by public and private sector, to meet industrial and commercial demand. Source: FAO (2010).

Box 5.2. Reconciling Oil Palm and Rubber cultivation with agriculture/forest conservation

Palm oil is the world's most important vegetable oil regarding production quantity. Indonesia, the world's largest palm oil producer, plans to double its production by 2020, which may have implications for other national priorities of rice production, forest and biodiversity protection, and carbon conservation. Koh *et al*. (2010) modeled the outcomes of alternative development plans and found that a *hybrid approach* wherein oil palm expansion targeted degraded and agricultural lands were most suited. This approach avoided any loss in forest or biodiversity and substantially ameliorated the impacts of oil-palm expansion on carbon stocks (limiting net loss to 191.6 million tons) and annual food production capacity (loss of 1.9 million tons). Similarly, strong international demand for natural rubber is driving the expansion of industrial-scale and smallholder monoculture plantations, with >2 million ha established during the last decade. Mainland South-East Asia and Southwest China represent the epicenter of rapid rubber expansion (Warren-Thomas *et al*., 2015). Their study indicates that 4.3–8.5 million ha of additional rubber plantations are required to meet projected demand by 2024, threatening significant areas of Asian forest, including many protected areas with negative impacts on negatively impacts bird, bat and invertebrate biodiversity. However, rubber agroforests in some areas of South-East Asia support a subset of forest biodiversity in landscapes that are again degraded or retain little natural forest.

What are the implications of these changes to the Asia-Pacific region in terms of magnitudes? The resulting changes in forest ecosystem services for example can increase the income in these countries (e.g. oil palm and timber exports are a huge foreign exchange earner, which increase GDP) but decreases the value of the forest capital. The distribution of these impacts will be different across different strata of the society. A study by Gundimeda and Atkinson (2014) illustrated these trade-offs between the growth in income and changes in forest capital in different countries in the Asia-Pacific region classified by the income groups for the period 1990-2010. The study has illustrated the trade-offs between population growth, income growth and forest wealth (Figure 5.9). Table 5.1 shows the trade-offs in some countries of the Asia-Pacific region covered by each ecosystems and the changes in the unit values, of these ecosystems. The global GDP has also increased as well as the loss in ecosystem services. For instance, Costanza *et al*. (2014) showed that between 1997 and 2011, the global value of ecosystem services decreased by an estimated $20 trillion per year due to land use change, a loss approximating around one-third of the global GDP.

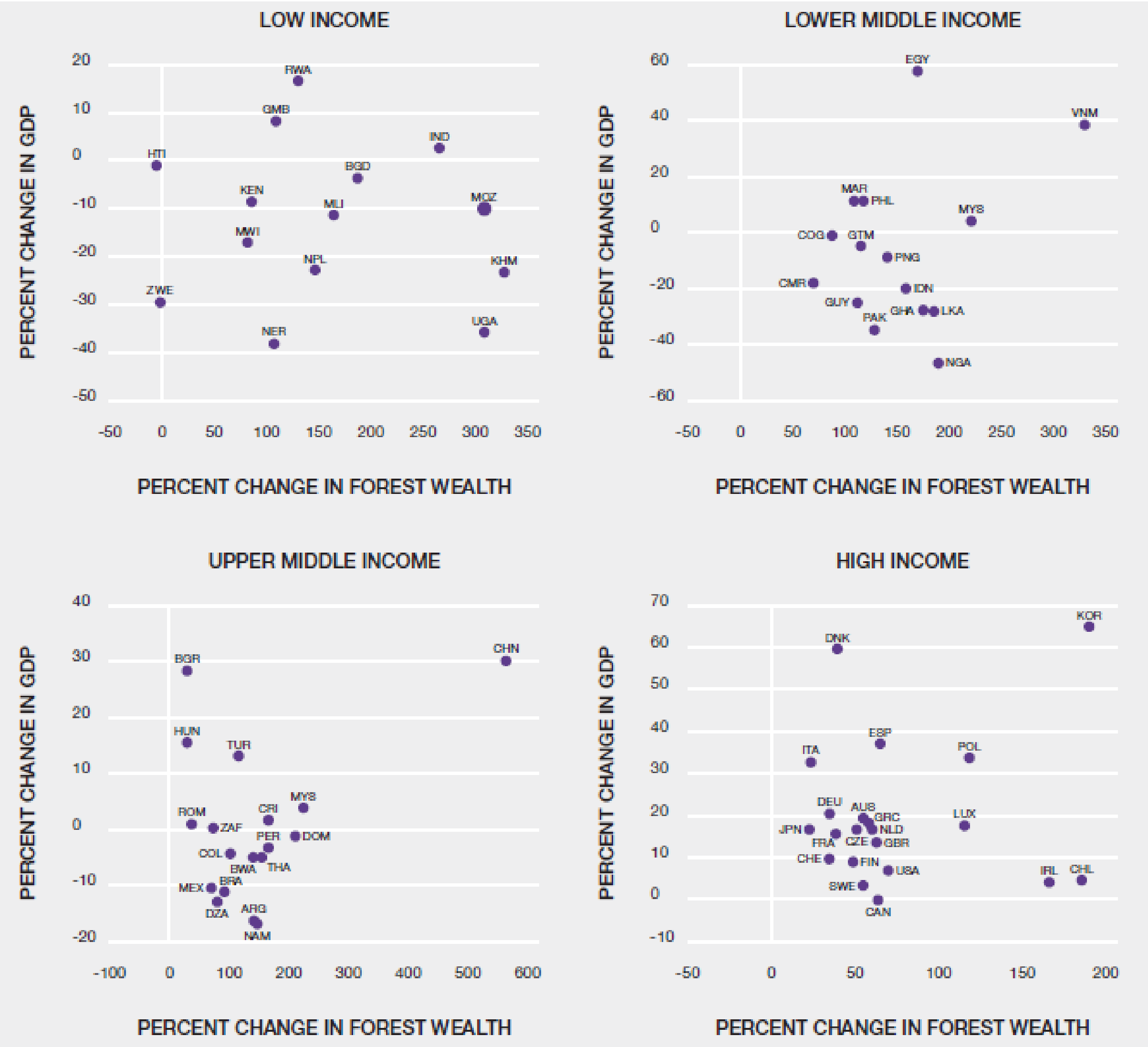


Figure 5.9 Trade-offs between economic growth (GDP) and forest wealth. Source: Gundimeda and Atkinson (2014).

Table 5.1. Changes in forest wealth and per capita forest wealth vis-a-vis GDP for some countries in the Asia-Pacific region. Source: Gundimeda and Atkinson (2014).

	Changes in absolute forest wealth, 1990-2010	Per capita changes in forest wealth
Growth in GDP while investing in forest capital	China, India, Japan, Vietnam, Malaysia, Philippines	China, Vietnam, Japan
Growth in GDP while depleting forest capital	Indonesia, Myanmar, Thailand, PNG, Nepal, Pakistan, Bangladesh	Indonesia, Myanmar, Thailand, PNG, Nepal, Pakistan, Bangladesh, Malaysia, Philippines
Decline in GDP while declining forest capital	--	--
Decline in GDP while increasing forest capital	--	--

5.2.1.2 Agriculture and cultivated land

Agriculture and cultivated land are among the other important terrestrial ecosystems that have significant implication in human well-being for the Asia-Pacific region, particularly considering the rapid economic and population growth of the region. In general, there is a consensus that an increase in food demand from a wealthier population as well as changing consumption patterns (particularly increasing meat consumption) will expand cropland in the Asia-Pacific region, wherever it is still possible (UNEP, 2007) (also established in 3.2.1.5). For instance, the global availability of calories for consumption as food, i.e., calories per capita per day, will increase by 818 calories between 2000 and 2050. The steepest increases will be in Asia, followed by sub-Saharan Africa, and Latin America, and the number of children suffering from malnutrition will decrease significantly by 2050 (Hubert *et al.*, 2010). Nonetheless, increasing demands for biofuels and alternative use of cropland will intensify competition, especially in South and South-East Asia (Koh & Ghazoul, 2010) (established but incomplete). For example, Indonesia plans to double palm oil production by 2020. However, these may need the further diversion of forested areas or existing cultivated land, which may well compromise social goals of food security unless appropriate management is enforced (see Box 5.2). Technological improvement such as cultivation of high yielding varieties and improvement in the irrigated crop will contribute to enhanced food production system, however, may lead to rural unemployment in the agricultural sector (Rutten *et al.*, 2014). With growing middle-class, meat consumption is also projected to rise. For instance, Machovina *et al*. (2015) estimated that by 2050, meat demand will rise by the following percentages: India (1 per cent), Indonesia (5 per cent), and Malaysia (12 per cent). China (35 per cent), and Philippines (50 per cent), which will be met by further land conversation or importation.

Although the existing evidence is still incomplete, a growing number of studies highlight a poor outlook for the future state of agriculture in the Asia-Pacific region due to the possible negative consequences of climate change; particularly the semi-arid areas, which remain highly sensitive to climate change. In most cases, a gradual decline in crop production is projected under even the minimum possible climate impacts. For instance, Lal (2011) estimated that due to climate change, rain-fed rice and wheat cultivation will decrease in South Asia. In India, Soora *et al*. (2013) projected that climate change is likely to reduce irrigated rice yields by approximately 4 per cent in 2020 (2010–2039), approximately7 per cent in 2050 (2040–2069), and by approximately10 per cent in 2080 (2070–2099). However, climate change may also result in an increase of crop yield in some areas. For example, cereal production in North-East Asia may rise. IPCC's Fifth assessment report also suggested a likely northward shift of crop production which will benefit the temperate region, while crop production in the tropical region may suffer from a paucity of rain and heat stress unless proper management techniques are enforced (Hijioka *et al.,* 2014).

Future pathways studies on the importance of terrestrial ecosystems for human well-being are mostly qualitative and very few studies have quantified their impacts at the AP regional level. The only study which addressed the impact of changes in terrestrial ecosystems value is by Kubiszewski *et al*. (2016). They estimated the current value of benefits from ecosystem services for terrestrial ecosystems in 47 countries in the Asia-Pacific region at $US14 trillion/yr, most of which are non-marketed and not reflected in GDP (Figure 5.10). The study calculated the changes in terrestrial ecosystem service value for the scenarios to the year 2050, under four archetypes: Market Forces, Fortress World, Policy Reform and Great Transition (see the next section for a more detailed description of archetypes). Change in value occurred due to two factors: (1) the change in area covered by each ecosystems, and (2) the changes in the unit values, which are dependent on the management policies of land and water. Under the Market Forces and the Fortress World scenarios, the ecosystem service value in the region continues to decline from $14 trillion/yr in 2011 to $11 and $9 trillion/yr in 2050 respectively. In the Policy Reform scenario, the value tends to remain at $14 trillion/yr and increased to $17 trillion/yr in the Great Transition scenario.

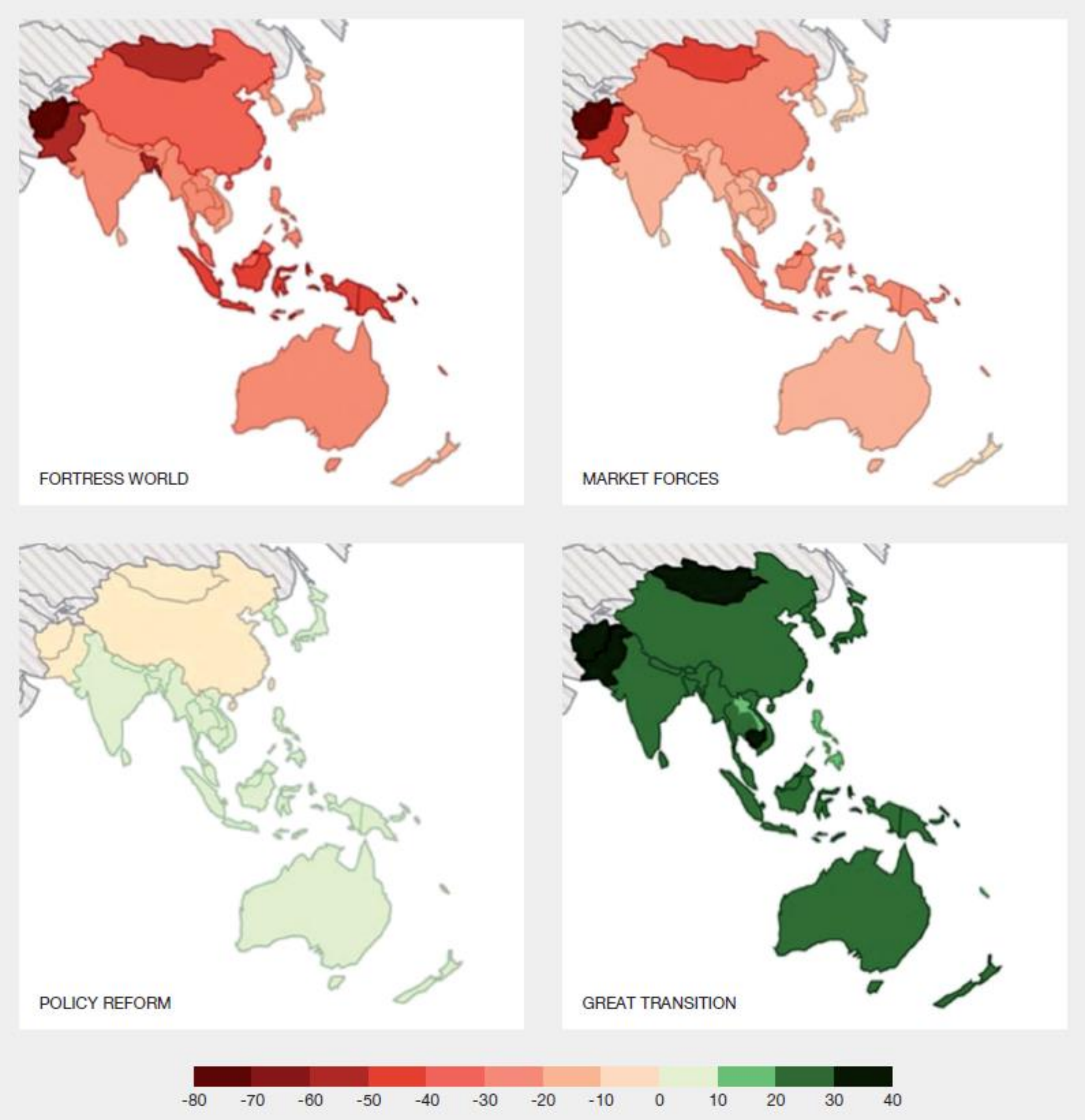


Figure 5.10 Per cent change from the 2011 base map of ecosystem service value for each country under each of the four scenarios. Source: Kubiszewski *et al*. (2016).

5.2.2 Freshwater Ecosystems

Although the Asia-Pacific region is home to 60 per cent of the world's population, it has access to only 36 per cent of its water resources, making the per capita water availability lowest compared to any other region (APWF, 2009). The freshwater ecosystems, consisting of rivers, streams, ponds, lakes and inland wetlands (Ramsar Convention Secretariat, 2012), are rich in biodiversity and ecosystem services (***see section 3.2.2.***), and at the same time, form an indispensable component of current and future human well-being in the Asia-Pacific region. Chapter 3 (***section 3.2.2)*** provided a detailed assessment of observed changes in the freshwater biodiversity and concluded a sharply declining trend of freshwater biodiversity, owing to numerous anthropogenic disturbances, including the disappearance of wetlands throughout the region. This section focuses on water availability and their implications for the human well-being.

Contribution from the freshwater systems is pivotal for sustaining life and to support other activities, including agriculture, fisheries, and industry. Services from freshwater ecosystems are also seen as an integral component of a larger Water-Energy-Food nexus that remains critical for achieving several Sustainable Development Goal (SDG) targets in the Asia-Pacific region. With rapid expansion of population, increasing standard of living and expanding hydro-power sector in the Asia-Pacific region, future availability of fresh water, both in acceptable quality and quantity, remains a significant challenge for the region (*established*).

The current distribution of freshwater availability varies extensively within the Asia-Pacific region and differs widely among the subregions, as well as substantial seasonal variations. The Western Asia and the Pacific low islands are particularly water scarce with limited surface water sources and over-reliance on groundwater. However, in the tropical region of South and South-East Asia, monsoon plays a pivotal role for replenishing the freshwater systems, especially the large river systems of the region. The mighty rivers of Asia, namely the Indus, Ganges, Brahmaputra, Yangtze, and Yellow Rivers, with sources in the high mountains and Qinghai-Tibetan Plateau, serve as the primary sources of water and supports over a billion of the population living in their highly productive river-basins. However, there is a consensus that due to intense agricultural activity and massive water withdrawal, demand for water outstrips the natural replenishment capacity. The observed trend in rainfall, despite extensive variation, remain mostly unaltered or inconclusive of any specific pattern. While in some cases, rainfall increased over the decades, some also registered downward trend. For instance, IPCC's fifth assessment report stated that, in South Asia, a frequent deficit monsoon has been prevalent in recent years, however, with an increase in extreme weather events (Hijioka *et al.*, 2014). Similar consequences are also observed in Western Asia, with a non-significant downward trend in mean precipitation over the recent years. In general, Hijioka *et al*. (2014) pointed out that due to lack of historical observation in many parts of the region, it is difficult to draw any conclusive evidence of rainfall variability.

Water availability in the major Asian rivers, nonetheless, has been decreasing, often due to wide-spread diversion for irrigation purposes (Biemans *et al.*, 2011; Syvitski *et al.*, 2009). For instance, water-intensive crops, such as cotton are being produced in water-stressed regions or even water-scarce areas, sharply promoting diversion of fresh water from natural streams. The immediate ecological consequence of lack of freshwater reaching the ocean is a loss of sediment accumulation in large river deltas, damaging nutrient supply for aquatic ecosystems and potentially endangering faster submergence under the rising sea level (Syvitski *et al.*, 2009). In Indus delta, for example, 50 per cent decline in fish catch has been reported since 1993, while high salinity (because of reduction of freshwater flow) virtually turned previously diverse mangrove forest into a mono-specific mangrove forest (Memon, 2005). The future projections in perennial water flow in the big rivers basins within the Asia-Pacific region is most likely to decline, especially during the summer (Alam *et al*., 2016; Elliott *et al*., 2014; Immerzeel *et al*., 2013) (see Box 5.3).

In addition, there are some trends suggesting shifts in monsoon regimes, rainfall or precipitations, and seasonality of dry and wet season, which may vary across subregions and countries (Hasson *et al*., 2016; Trang *et al*., 2017; Wang *et al*., 2017). These climate change-related reductions and modifications of river flow and water supply will have large adverse consequences for the biodiversity, livelihood, food production, and water availability to the millions of people in the Asia-Pacific who are dependent on the major rivers for their water and food supply (Elliott *et al*., 2014; Ferraro *et al*., 2013; Hejazi *et al*., 2014; Quinn *et al*., 2013).

Box 5.3 Projected changes in water flow and supply across four major Asian river basins
(From Immerzeel, Beeks, and Bierkens (2010))

The Indus, Ganges, Brahmaputra, Yangtze, and Yellow rivers are the significant sources of water for over 1.4 billion people in the Asia-Pacific region. Below is a set of figures showing the simulated mean upstream discharge for the present (2000-2007) and projected future (2046-2065) under SRES A1B scenario, for the five major rivers (see inset map). The model outputs show that all rivers are susceptible to flow reductions under climate change scenario, but the flow reductions are greater for Indus and Brahmaputra, threatening water and food security of over 60 million people dependent on those two rivers (Immerzeel *et al.*, 2010).

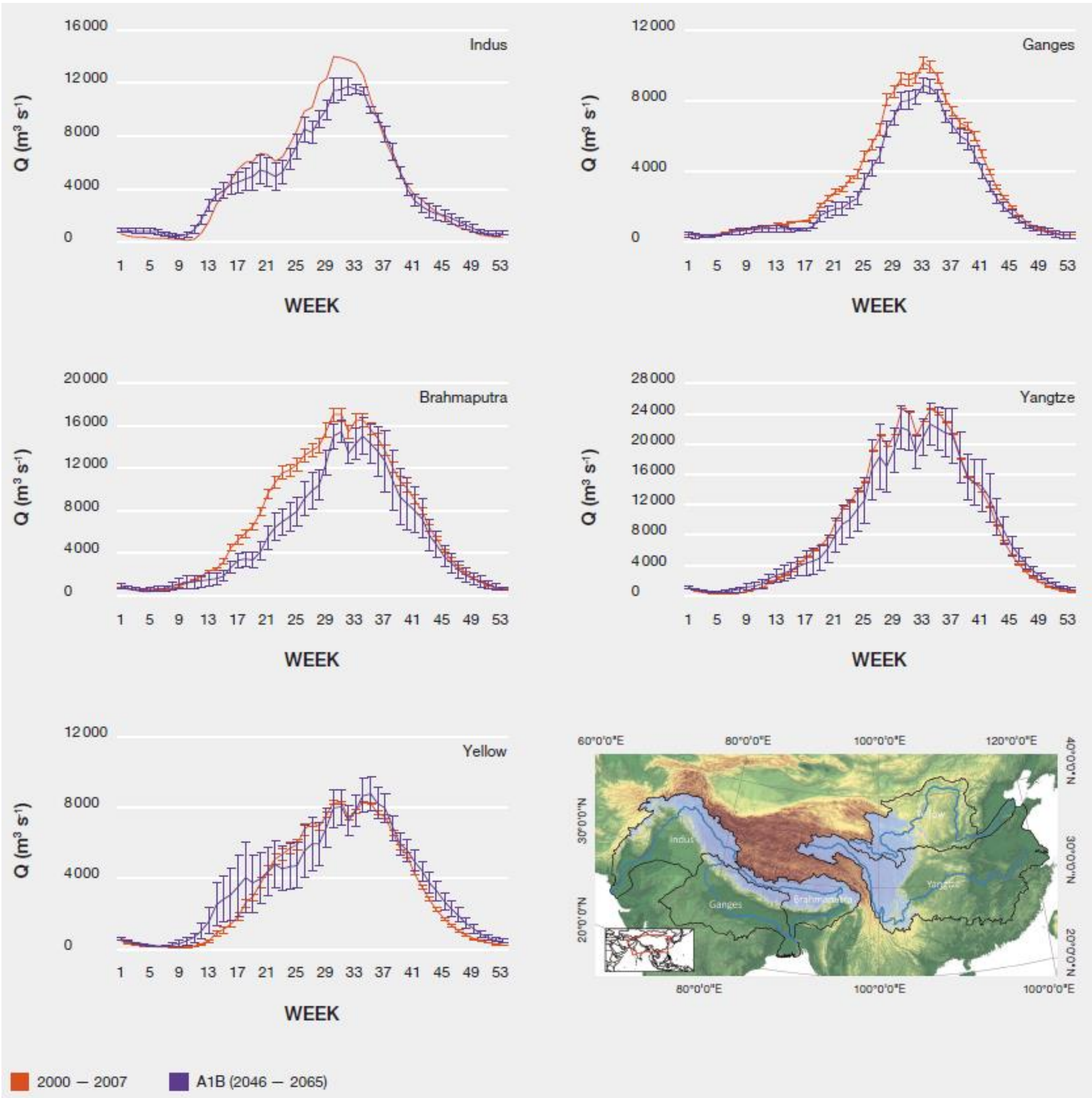


Figure 5.11 Simulated mean upstream discharge for the present (2000-2007) and projected future (2046-2065) under SRES A1B scenario, for the five major rivers of the Asia-Pacific region (Indus, Ganges, Brahmaputra, Yangtze, and Yellow rivers). Source: Immerzeel, Beeks & Bierkens (2010).

Future projections also suggest that construction of dams and blocking of tributaries would vastly reduce freshwater availability in downstream of major rivers, impacting biodiversity and nutrient transportation (c.f. 5.4.4). Lack of freshwater flow may reduce further flora and fauna diversity, including mangroves and several freshwater fish species, particularly in the ecologically fragile delta areas, and indirectly impacting livelihood and security from natural disasters. For instance, a study by Ziv *et al*. (2012) modeled a potential catastrophic consequence of aquatic biodiversity and loss of commercially important fish species, if the planned dam constructions are executed across the Mekong River Basin - currently the most prominent inland fishery area of the world. Moreover, the quality of water would also deteriorate across the major river basins in Asia, particularly in South and South-East Asia, impacting freshwater biodiversity. A study conducted by CSIRO suggested that water quality in the major river basin would largely deteriorate unless strict management action is enforced (Figure 5.12)

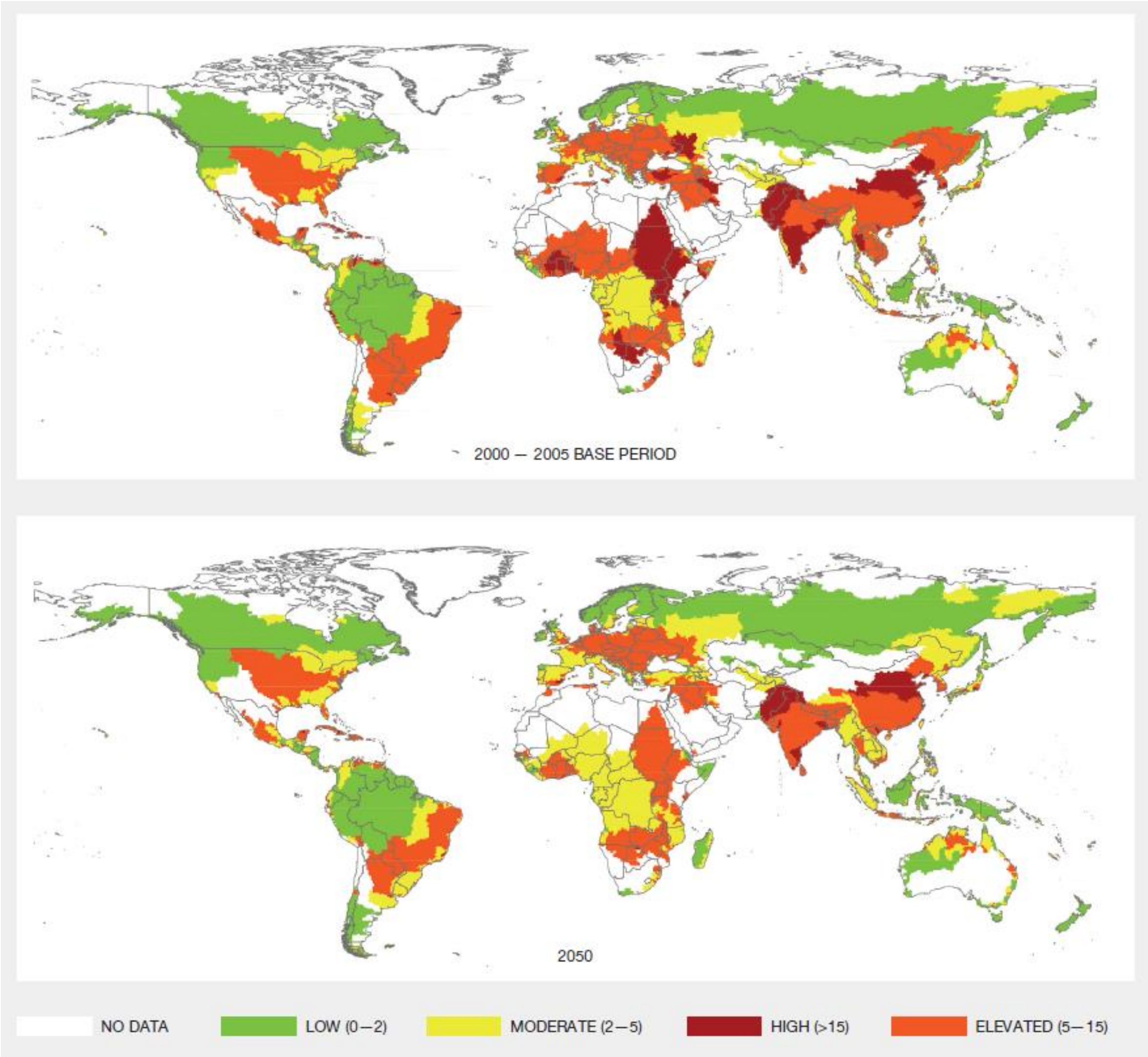


Figure 5.12 Water quality risk indices for major river basins during base period (2000-2005) compared to 2050. Source: Veolia and IFPRI (2015, Fig. 3, p. 9).

5.2.3 Coastal/Marine Ecosystems

Coastal/marine ecosystems, comprised of mangroves, coral reefs, seagrass beds and salt marshes, provide essential ecosystem services for vast section of the region's population living in the densely populated low lying coastal areas, including large river-deltas and several Small Island Developing States. The Asia-Pacific region, particularly, South-East Asia accounts for exceptional marine and coastal biodiversity and hosts nearly 32 per cent of the world's coral reefs (Wilkinson, 2008) and over 30 per cent of global mangroves (Hamilton & Casey, 2016). Several of the member states enjoy a relatively high share of mangroves, which include Indonesia (28.40 per cent), Malaysia (5.76 per cent), Papua New Guinea (5.12 per cent), and Myanmar (3 per cent) (Hamilton & Casey, 2016). The significant extent of mangroves is also found in South Asia and Oceania. On the other hand, the Coral Triangle in the western Pacific Ocean, which extends over the waters of Indonesia, Malaysia, the Philippines, Papua New Guinea, Timor Leste, and Solomon Islands, is a unique habitat for nearly 600 distinct species of reef-building corals that support more than 2000 species of reef fishes; while the Great Barrier Reef in Australia, stretching for over 2,300 kilometres, remain the world's largest reef system (Bohensky *et al.*, 2011; Wilkinson, 2008). However, over the years, the tropical coastline in the Asia-Pacific region underwent massive human-induced changes, with severe reported losses in mangroves, coral reefs, and a number of other important marine species. Spalding *et al*. (2010) reported that since 1980, South and South-East Asia had lost over 1.9 million ha of mangroves. Globally, mangroves are disappearing at an alarming rate of 1 to 2 per cent per year (Duke *et al.*, 2007), yet, the rate is particularly disturbing for South-East Asia. Hamilton & Casey (2016) reported that despite a growing awareness and recent slow-down in global mangrove deforestation, South-East Asia continues to lose mangrove with deforestation rates varying between 3.58 per cent and 8.08 per cent every year. Agricultural expansion into existing mangrove habitat accounted for the bulk of the mangrove loss in the Asia-Pacific region, particularly in South-East Asia, followed by an exponential rise in brackish water aquaculture. Approximately 75 per cent of the global commercial shrimps are produced in Asia, which is also known as an important economic activity for revenue generation, and is expected to rise in the near future. Globally, about 82 per cent of the reported loss of mangroves during 1975–2005 has been triggered by agricultural expansion (C. Giri *et al.*, 2008), and it continues to be an influential future driver. For instance, a study by Webb *et al*. (2014) projected that mangroves in the Ayeyarwady (Irrawaddy) Delta of Myanmar might disappear by 2030 with the current rate of agricultural expansion unless an optimum balance is achieved locally. However, countries like India and Bangladesh have been largely successful in maintaining a steady mangrove extent. For instance, a study by Giri *et al*. (2007) reported a negligible loss in the Sundarban mangroves, the largest contiguous mangrove forests stretching across India and Bangladesh, since the late seventies. In both the countries, an extended network of protected areas, have played a significant role in mangrove conservation, despite tremendous population pressure in the vicinity.

The future of mangroves in the region, nonetheless, will be dominated by both climatic and non-climatic direct drivers. Of which, non-climatic drivers, such as human-induced land use changes, urbanization, agriculture and aquaculture expansion, will lead the primary changes for mangrove habitats, at least for the near and short-term future, although with varied extent across the subregions. Because of increasing demand for land, small island mangrove habitats remain particularly susceptible to future changes and are prone to local extinction. Climate change, on the other hand, may result in 10-15 per cent decline in mangrove habitats for long-term future (Alongi, 2008). Sea level rise could threaten mangroves especially in Bangladesh, New Zealand, Viet Nam, and China (see section 3.2.1). With rising sea-level, mangrove extent would probably decline first, and, subject to land availability, will migrate inwards. Some studies also suggest that rising temperature would result in poleward migration of mangroves, with anticipated changes in species composition (e.g. Gilman *et al*. (2008)). There is a strong consensus among the existing literature that loss of mangroves will lead to discontinuation of several primary benefits, such as shoreline stabilization, sediment accumulation, coastal protection, particularly for the low-lying coastal areas and thus, make communities more vulnerable to natural disasters and climate change (Gilman *et al.*, 2008). The projected monetary value of these foregone ecosystem services due to losses in mangrove area (2000-2050) in South East Asia has been given by Brander *et al.* (2012). Using the results of the IMAGE

GLOBIO integrated assessment models for 1230 mangrove patches in South-East Asia (Brunei, Cambodia, Indonesia, Malaysia, Myanmar, Philippines, Thailand, and Vietnam), they produced aggregated values (losses) at the country level for foregone mangrove ecosystem services. The annual value of lost ecosystem services from mangroves in South-East Asia is estimated to be approximately $2.16 billion in 2050 (2007 prices), with a 95 per cent prediction interval of $1.58–2.76 billion. Assuming a linear time profile of these losses between 2000 and 2050, the present value of the stream of lost ecosystem services has been estimated between $17 billion - $40 billion expected to occur each year over the period 2010–2050.

Coral reefs also remain vulnerable to climate change and other environmental factors, predominantly from ocean warming, measured as rising sea surface temperature (SST) and ocean acidification. However, fishing and harbour activities, together with natural disasters such as cyclones and tsunamis have also played a key role in reef destruction in the past. Within the existing literature, there is a significant attribution of coral bleaching due to a rise in sea surface temperature, notably in 1998 and 2002, as well as during 2005, 2014 and 2016 (Donner *et al*., 2005; Wilkinson, 2008). Although corals can recover from mild bleaching, the persistent rise in sea surface temperature continues to threaten coral reefs almost across the globe. For instance, a study by Yara *et al*. (2012) estimated that even with the best possible consequences, climate change would significantly reduce coral reefs in the Japan sea (see Box 5.4)

Box 5.4 CASE STUDY: Future of corals around Japan under climate emission scenarios. From Yara *et al*. (2012).

CO_2 emissions causes ocean acidification, and along with global warming, it is an imminent issue for future status of calcifying organisms such as corals, because dissolved CO_2 reduces the saturation state of the carbonate mineral aragonite (Ω_{arag}) in seawater (Hoegh-Guldberg *et al.*, 2007). Future coral habitats in the seas around Japan during this century were estimated based both on global warming and on ocean acidification, by using the results from the coupled global carbon cycle–climate model under the Intergovernmental Panel on Climate Change (IPCC) emission scenarios SRES A2 and B1 (Yara *et al.*, 2012, 2016). Under the business-as-usual emission scenario (SRES A2), coral habitats will be sandwiched and narrowed between the northern region, where Ω_{arag} decreases, and the southern region, where coral bleaching occurs. This resulted in disappearance of corals around Japan in the 2070s. Under the low-emission scenario SRES B1, however, the coral habitats will also shrink in the northern region due to the reduced Ω_{arag}, but to a lesser extent than under SRES A2, and in contrast to SRES A2, no bleaching will occur in the southern region. Therefore, coral habitats in the southern region are expected to be largely unaffected by ocean acidification or sea surface temperature warming under the low-emission scenario. Potential future coral habitats depend strongly on CO_2 emissions, and emphasize the importance of reducing CO_2 emissions to prevent negative impacts on coral habitats, which was also suggested for the world's corals and achieving the Paris Agreement is required (Magnan *et al.*, 2016).

Based on an extensive assessment of published literature, Wilkinson (2008) provided the likely future for 40 years, and categorized coral reefs as follows: (1) Reefs 'effectively lost' [with 90 per cent of the corals lost and unlikely to recover soon] (2) Reefs at a critical stage with 50 to 90 per cent loss of corals and likely to become 'effectively lost' in next 10 to 20 years; (3) Reefs threatened with moderate signs of damage: 20–50 per cent loss of corals in 20–40 years, and (4) Reefs under no immediate threat of significant losses. In figure 5.13, derived from Wilkinson's (2008) assessment, we summarize the current and future state of coral reef in the Asia-Pacific region. As such, the figure suggests that coral reefs in South and South-East Asia remain particularly in a perilous condition and unless appropriate management efforts are in place. This figure, however, does not fully account for the likely impact of climate change. However, it is estimated that 90 per cent of the existing reefs will experience the adverse impacts of the rise in sea surface temperature and ocean acidification by the end of the 21st century (Kwiatkowski *et al*., 2015) (see Box 5.5), with other impacts of climate change on coral reefs anticipated by 2050 unless climate change mitigation strategies are effectively implemented (Frieler *et al.*, 2012; Hoegh-Guldberg *et al.*, 2007; Munday *et al.*, 2008; Pandolfi *et al.*, 2011; Reyes-Nivia *et al.*, 2013; Yara *et al.*, 2014)

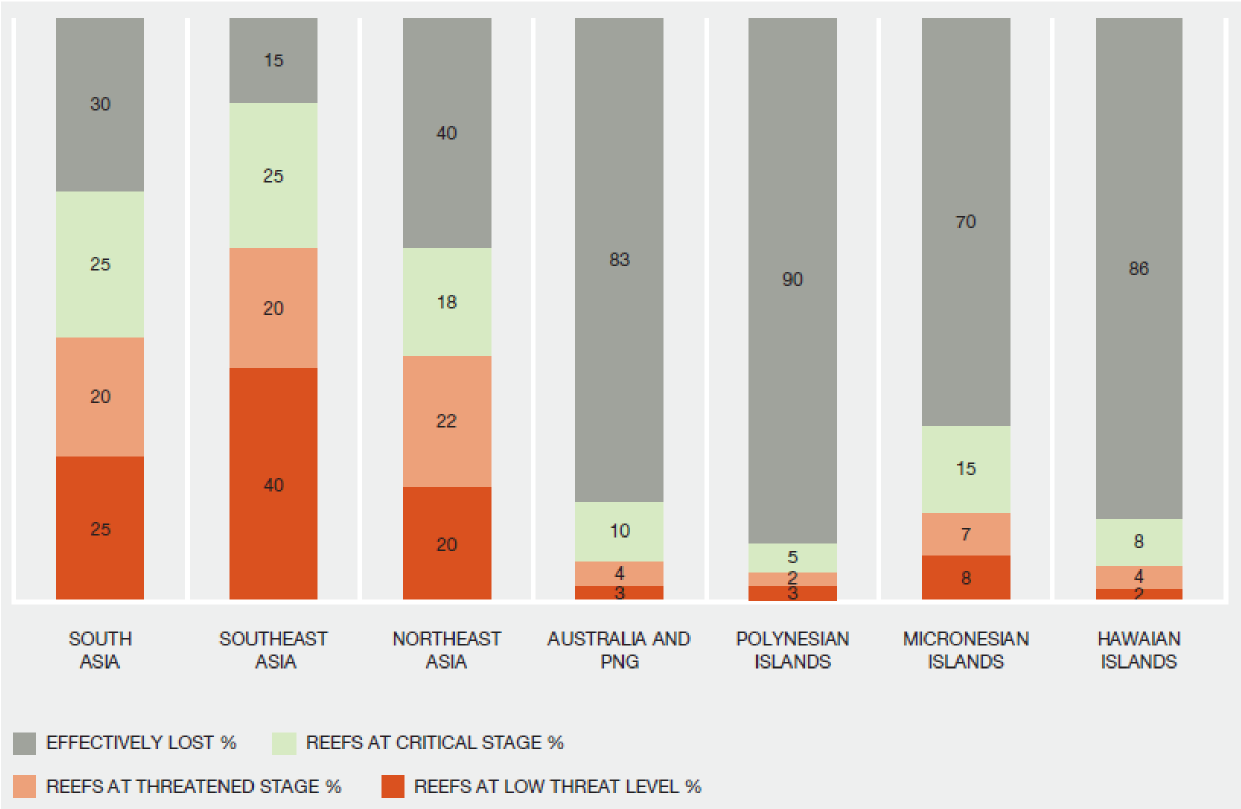


Figure 5.13 Status of Coral reefs in different coral habitats in the Asia-Pacific region. Data source: Wilkinson (2008).

Box 5.5 Delaying coral bleaching and degradation using mitigation technology (Kwiatkowski *et al.*, 2015)

Coral reefs from around the world, especially those in tropical latitudes, are projected to experience a high frequency of bleaching, death, diseases, and degradation, under the influence of climate change. Even under RCP2.6, that could achieve the increase of global mean temperature to 2°C, about 90 per cent of corals are expected to suffer severe degradation by 2050. However, analyses and simulations of geoengineering technology showed the potential to delay and ameliorate the effects of high Degree Heating Months (DHM>2) by 2035 and 2055, even under the medium emission and concentration pathway RCP 4.5 – Figures a and c below, compared to Figures b and d (RCP 2.6).

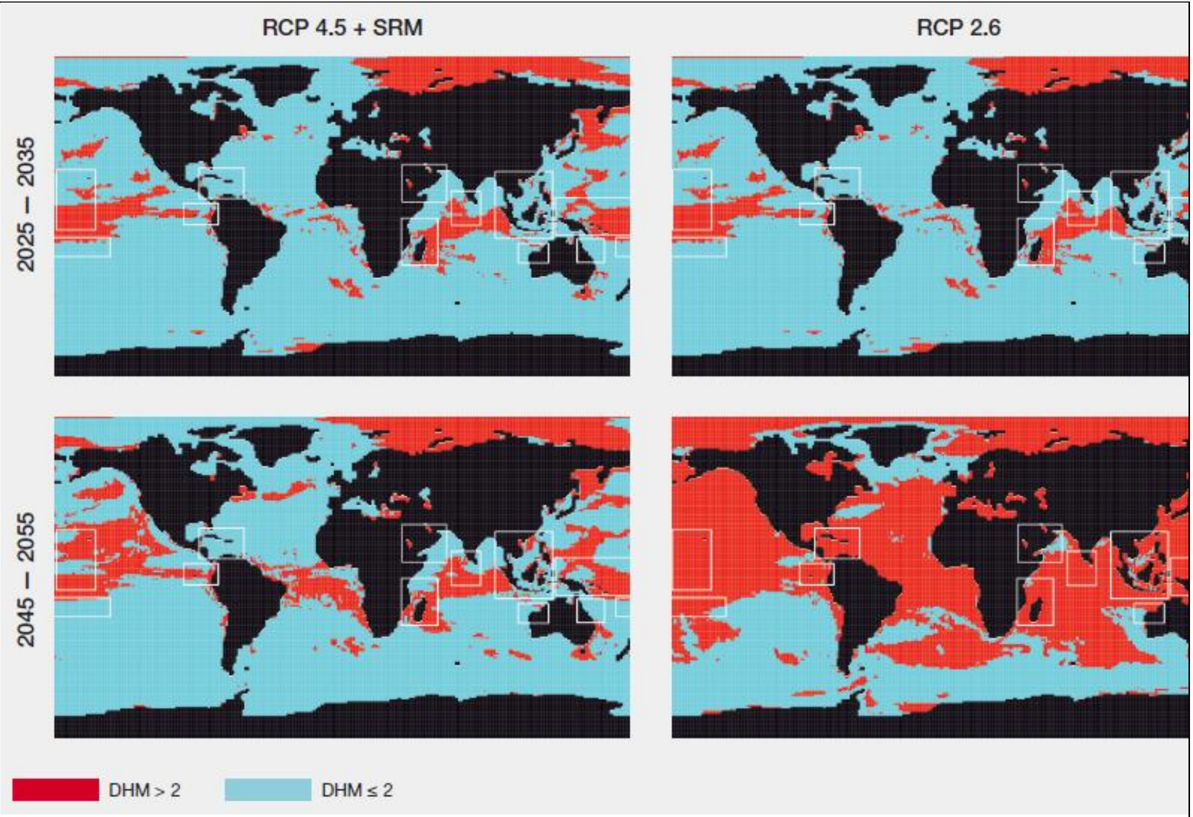


Figure 5.14 Degree Heating Months under RCP2.6 and RCP4.5 + solar radiation management. Source: Kwiatkowski *et al*. (2015).

In terms of the future trends in nature-society interactions that are dependent on coastal-marine ecosystems, a majority of the publications demonstrated that, most of the sensitive ecosystems (i.e., coral reefs, seagrass, mangroves, and their corresponding services such as fisheries) are adversely affected and will decline in productivity, albeit variably amongst subregions, also depending on latitudes (W. W. L. Cheung *et al.*, 2010; Gattuso *et al.*, 2015; Hoegh-Guldberg *et al.*, 2007; Lam *et al.*, 2016). However, the currently available literature that provides analyses of future pathways for Asia-Pacific fisheries and coastal habitats have been mostly limited to climate-related drivers (e.g., ocean warming and ocean acidification) (Gattuso *et al.*, 2015; Lam *et al.*, 2016) with no specific systematic and integrated assessments of plausible futures for Asia-Pacific fisheries. Global scale studies, which have included regional and subregional analyses, are in general agreement on the projected declines in the status of biodiversity and ecosystem services that many coastal-marine ecosystems provide across the Asia-Pacific region (Costello *et al.*, 2016; Worm, 2016; Worm *et al.*, 2009). Also, there is good evidence that such climate change-related declines are already taking effect (Blankespoor *et al.*, 2017; W. W. L. Cheung & Reygondeau, 2016; Kwiatkowski *et al.*, 2015; Schleussner *et al.*, 2016). Available evidence indicates that increased fisheries losses may occur to due to latitudinal shifts in species ranges, unless climate change mitigation is effectively implemented (W. W. L. Cheung *et al.*, 2010; W. W. L. Cheung & Reygondeau, 2016; Lam *et al.*, 2016). Of the limited national assessments carried out, indications also suggest future fisheries losses due to climate change (Bohensky *et al.*, 2011). Lam *et al.* (2016), using climate-living marine resources models, proposed that the global fisheries revenues could drop by 35 per cent by the 2050 under high CO_2 emission scenarios, with developing countries among the most severely affected. The numerous apparent drivers of fisheries decline and coastal habitat loss in the Asia-Pacific region (Section 3.2.4.6, Chapter 3, Chapter 4), indicate a plausible future where many of the fisheries and marine species in some regions of Asia-Pacific could decline considerably in the future under business-as-usual scenarios unless there is a substantial reduction in exploitation rates, perhaps as soon as 2048 (cf. Chapter 3; Chapter 4) (Costello *et al.*, 2016; Worm, 2016; Worm *et al.*, 2006, 2009). The heterogeneity of fisheries across the Asia-Pacific region and the variation in the rates of exploitation and effective implementation of policies suggest a mixture of approaches is required to avert collapse. Part of the reason for fishery decline in the Asia-Pacific region is due to acceleration in north-south redistribution of fisheries, where efforts to restore depleted fisheries in the developed world displaces fishery exploitation to the developing world, where there are weaker laws and enforcement capacity (FAO, 2016; Teh *et al.*, 2017; Worm *et al.*, 2009). A range of traditional approaches coupled with other regulatory approaches (such as strategic fishing closures, selective fishing gear, and ocean zoning) combined with economic incentives would therefore be required to prevent further depletion and steer fisheries towards a sustainable future (Costello *et al.*, 2012, 2016; FAO, 2016; Pascoe *et al.*, 2016; Worm, 2016; Worm *et al.*, 2009).

5.3 Assessment of scenarios and plausible alternative futures of the Asia-Pacific region

The previous section 5.2 identified possible projected futures, broadly portraying the interactions between nature and society under the current trend or without any significant policy/management intervention (the Business-As-Usual scenario). However, these impacts indicate the likely changes in the future biodiversity and ecosystem services but is uncertain due to multitude social, political, economic and environmental factors and responses. In such cases, scenarios are useful to depict the plausible alternative futures based on integrating qualitative story lines and quantitative models, based on likely developmental pathways. This complicated scientific exercise is translated into simple and easily understandable language for the policymaker using various story lines about the future (which can be in qualitative or quantitative). However, as scientific studies do not assume a common scenario or story line, comparisons across the regions can be very difficult and in such situations, archetypes can be used to streamline the information into a set of common compatible scenarios. The methods of scenario building and assessing future changes of BES revolve around depicting plausible futures, and as such, the assumptions for alternative developmental pathways are principally governed by multitude of Social, Technological, Economic Environmental and Political (STEEP) factors (Hunt *et al.*, 2012).

There are several approaches to scenario building, at local, regional or at global scales. While global scale scenarios essentially rely on broad-based assumptions on future trajectories, subregional or local scenarios depict specific assumptions related to their spatial scales. Local scale scenarios are particularly important because they are often scaled-up as the basis of the global or regional scale scenarios and outline multiple factors and constraints that decide the course of future trajectories. Sometimes, these scenarios are developed involving various stakeholders, which could reveal some qualitative information on the validity of depicted future pathways and these can be coupled with quantitative scenarios and models to reveal options for the future (see Box 5.6).

Thus, attempts have been made by different studies to harmonize these various regional and global scenarios to facilitate common understanding (e.g. IPCC SRES scenarios, SSPs, Global Outlook scenarios, GEO3/GEO4 scenarios, and Millennium Ecosystem Assessment scenarios). However, it is unlikely that a single set of scenarios (or scenario family) can explain all conventional and unconventional uncertainties. Researchers or institutions mostly contemplate one set of discrete alternative futures based on their purpose-driven storylines, pre-selected drivers and accumulated experiences in future studies (Boschetti *et al*., 2016). These storylines demarcate the area of precise interests within broad spectrum of uncertainties and thus, remain imperative to develop effective management and policy strategies.

This section attempts to explore the *plausible alternative futures* for the Asia-Pacific region, as represented in global, regional and subregional scenario exercises. In this section, we aim to understand the common threads and divergence of assumptions behind different scenarios, outlining the future socio-economic trajectories under multiple spatial and temporal scales as well as their implications for BES and human well-being.

Box 5.6 Role of Participatory Scenario building in delivering sustainable future

An assessment of the participatory scenarios and models in the Asia-Pacific region demonstrates positive results for BES and human well-being where local people and other stakeholders have been involved in the decision-making process. Regional studies have indicated that incorporating local knowledge and scientific knowledge is essential to support local planning and inclusive decision-making to achieve long-term sustainability (Castella *et al*., 2014; Nguyen *et al*., 2013). It was further observed that adequate governance structures and institution that ensure community participation in the decision-making process, women's empowerment and leadership play an important role in assuring sustainable future. The role of participatory modelling and scenario building exercises remain also critical elucidating information that supports key sustainability issues. Models developed through participatory involvement with research are particularly useful in this regard and remain imperative to enhance participation, empower stakeholders through knowledge-sharing and increase local-legitimacy and policy salience (Castella *et al*., 2014). For instance, using participatory models, Richards *et al*. (2017) demonstrated that providing people with a platform to share more information on ecosystem services should encourage them to consider a wider range of benefits that nature provides, and this in turn, may enable habitat management that better balances trade-offs between different services. Likewise, the application of the ADWIM (Asset Drivers Well-being Interaction Matrix) accounts for multiple stressors on multiple ecosystem goods and services and cross the conceptual boundary between ecosystem services modelling and adaptation planning (Skewes *et al*., 2016).

Scenario reviews and discussions could provide a focus for public consultations on park and other management strategies. It has proved to be a useful method for participants to focus on adaptation actions for high priority impacts on important ecosystem goods and services and to learn and reflect about the current and likely future importance of EGS to livelihoods. However, economic benefits from BES are crucial to maintain and sustain local people's interest in conservation (Purushothaman *et al*., 2013; Timothy, 1999). Despite their profound importance in local ecosystem management, current application of participatory scenario development and analysis are largely absent. In the Western Asia, for example, lack of efforts to address the socio-economic problems and a centralized control with limited public participation are identified as major weaknesses of the spontaneous participation of communities in decision-making process (Kolahi *et al*., 2012). Developing long term collaboration at various spatial scales is important to develop a common understanding and goal for sustainable use of BES (Amatya *et al*., 2010).

5.3.1 Methodology for screening of scenario narratives

For this assessment, we apply a 'Global to Local' hierarchical screening approach to analyse and identify alternative futures for the region and harmonize them into a set of common agreements. Firstly, we scrutinize the assumptions behind scenarios for the Asia-Pacific region from three global assessment reports: The Global Environmental Outlook (GEO-3) (UNEP, 2002); Global Environmental Outlook (GEO-4) (UNEP, 2007); and the Millennium Ecosystem Assessment (2005), from which we identify specific considerations for the Asia-Pacific region, as well as future states of influential drivers (see section 5.3.2.1). This is followed by region-specific scenario depiction from downscaled, back-casted pathways that would essentially meet the key sustainability targets, including energy, climate, food and biodiversity with different sustainability measures such as technology and consumption change (section 5.3.2.2.). These pathways are adopted from PBL (2012, 2014), based on Alkemade *et al*. (2009), and provide subregion-specific, quantitative estimation of future status of BES and influential drivers using the GLOBIO model (http://www.globio.info/home). Lastly, we conducted a systematic literature search and review of regional and subregional scenario studies, incorporating appropriate peer-reviewed literature and important grey-literature sources (section 5.3.3). The review principally aims to explore scenario assumptions, often portrayed as qualitative storylines, to improve understanding of scenario typology and attributes, subregional characteristics, drivers and, their orientation to the Aichi Targets and Sustainable Development Goals.

5.3.2 Assessment of scenarios from global and regional assessment reports

5.3.2.1 Implications of existing global assessments on the future of the Asia-Pacific region

Global assessments predominantly depict a set of exploratory scenarios (i.e., how the future might emerge) and outline broad-based assumptions on influential drivers.

The GEO-3 was among the first UNEP report to introduce scenarios to depict future uncertainties, utilizing four scenario archetypes and projecting changes up to 2032. These archetypes were derived from Global Scenario Group scenarios - a set of scenario narratives developed in 1995 by the Stockholm Environmental Institute (P. Raskin *et al.*, 2002). GEO-3 named four of its scenarios as ***'Markets First', 'Policy First', 'Security First' and 'Sustainability First'***, depending on the dominant drivers under which future emerges. For instance, in 'Markets First', market forces and free-trade dominate over social, political agendas and facilitates globalization with lesser consideration for environment. 'Policy First', on the other hand, outlines the emergence of appropriate policies, such as carbon taxes and investments in non-fossil-fuel energy sources, and in general, shows better consideration for environment. 'Security First' portrays a heavily fragmented world with high inequality as wealthier groups seek self-protection. Lastly, 'Sustainability First' relies on behavioural changes, supported by equitable values and institutions that drives environmental sustainability (UNEP, 2002). These pathways were retained in the later GEO-4, which were used for thematic modelling to depict the future status of BES (UNEP, 2007). GEO-4 provided specific and quantitative information of future for the Asia-Pacific region, up to 2050, although geographical boundaries differed slightly to this assessment. The future pathways of scenario analyses for the Asia-Pacific region under the four scenarios outlined in GEO-3 and GEO-4 reveal important distinctions and similarities between these plausible futures (Table 5.2).

Table 5.2. Plausible alternative futures and their regional consequences under the GEO scenarios.

Theme	Markets First Free-market Liberalism	Policy First Decisive initiatives	Sustainability First Pluralism and New Values	Security First Self-protection
Population (UNEP, 2007)	Expected regional population is over 4.5 billion by end of 2050.		Population growth is lowest under this scenario, expected population is close to 4.5 billion by 2050.	Population growth is highest under this scenario. Expected population of the Asia-Pacific region exceeds 5 billion by end of 2050.
GDP (UNEP,2007)	Highest increase in GDP, nearly five-fold increase in the entire region by 2050, with per-capita GDP increasing at a comparable rate.			Growth slows to about three-fold.
Freshwater (UNEP, 2002;2007)	In Asia, water withdrawals are expected to increase leading to an expansion of areas with severe water stress, especially in Western, South	Water demand decreases or is unchanged due to ameliorative policy arrangements.	Water demand decreases or is unchanged because of technological innovation and cooperation.	Water withdrawals increase with severe water shortage, particularly in Western Asia. Salinity due to excessive

	and South-East Asia. Salinity due to excessive irrigation may affect agriculture in Western and South Asia.			irrigation will affect agriculture in Western and South Asia.
Air Quality (UNEP2002;2007)	Coal continues to be the major energy source (driven by price). With concomitant decline in air quality.	Emission standards, clean fuel, better urban planning, improve air quality. Sulphur dioxide concentrations may decline, although economic growth contributes Nitrogen oxides increases from vehicle emissions, particularly in South Asia.	Emission standards, clean fuel, better urban planning, improve air quality. Energy efficiency contributes to improving air quality.	Coal continues to be the major energy source, air quality worsens. Low energy efficiency increases air pollution, particularly levels of Sulphur dioxide and Nitrogen oxides.
Biodiversity /Natural Capital (UNEP 2002;2007)	Greatest loss is projected under this scenario. Increases in trade and free-markets adversely impact biodiversity, especially in South and South-East Asia.	Regional cooperation to reduce illegal extraction and establish more protected areas. However, economic improvement still drives loss of biodiversity. Overall terrestrial protected area might increase.	Better technology enables monitoring and management of biodiversity and ecosystems. An environmentally aware community facilitate conservation. Terrestrial protected area might increase.	Reduction in trade and greater control over resources limit exploitation, however, in areas with no control, BES suffer greater loss.
Agricultural Land (UNEP2002;2007)	Increase in food demand (nearly two-fold) will lead to agricultural land expansion, where still possible. Technological improvements and free-trade might meet food demands and partly halt agricultural land conversion at later stage.	The potential for agricultural land conversion is highest since governments prioritize increased food production.	Crop land will perversely increase to meet the sustainability targets, modern bio-crop cultivation may prevail, particularly in South-Asia and South-East Asia.	Low economic growth will restrict expansion of agricultural land.
Forested Land (UNEP2002;2007)	Deforestation will increase and forest cover will decline.	Due to improved regulations (and restoration) for forest conservation, forest land is partly retained, although overall still decline in the Asia-Pacific region. Nevertheless, in Sustainability first, community based		Key forest areas are preserved as protected areas, whereas outside protection,

		conservation, participatory management of forest resources, incentives mechanism may improve forest cover.	deforestation exacerbates.

The Millennium Ecosystem Assessment (2005) adopted a different approach, introducing four scenario archetypes: ‘***Global Orchestration’; ‘Order from Strength’; ‘Techno-Garden’ and ‘Adapting-Mosaic***’. The ‘Global Orchestration’ scenario portrayed globally-connected societies with strong focus on economic expansion and trade-liberalization. This pathway, on one hand, envisaged better health and education, reduced poverty and inequality, however it suggested that reactive management of ecosystems might lead to reduced protection. ‘Order from Strength’ represents a regionalized and fragmented world, concerned with security and self-protection and similar to the GEO ‘security first’ scenario. The fate of ecosystems is largely compromised under this pathway, as governments are primarily concerned with economic and military security. ‘Techno-Garden’, on the other hand, represents sustainable global societies through technical innovation and collaboration among nations. In this pathway, technology provides ultimate solution to major global problems and artificial ecosystem services successfully cater to the future demands. Alternatively, ‘Adapting Mosaic’ outlines local institutions, equipped with global knowledge, leading local-scale ecosystem management and restoration. However, in time they form regional networks, creating a mosaic, to counter global problems. MEA scenarios were segregated between three-time intervals, i.e. 2000-2015, 2015-2030 and 2030-2050, of which we considered here the last two. Table 5.3 depicts key assumptions and their consequences for the Asia-Pacific region. Despite the Millennium Ecosystem Assessment (2005) providing some projections for Asia using these scenarios, due to cross-scale dissimilarities, it was not possible to synthesize precise regional projections under these scenarios.

Table 5.3. Important scenario assumptions and their consequences for the Asia-Pacific region (Synthesis from Millennium Ecosystem Assessment)

	Global Orchestration	Order from Strength	Adapting Mosaic	Techno-Garden
Year	Globally connected world	progressively compartmentalized	Local institutions-based ecosystem management	Artificial ecosystem services meet sustainability
2015-30	Technological developments, particularly in the field of agriculture, food production, and energy generation, became more rapid, leading to yield intensification. Increased wealth leads to dietary changes, meat consumption increases. Regional connectivity increases. As a result, environmental	Fundamental departure from trade-reforms. Increased conflict and global terrorism create barriers between nations. Local production suffers from risk, which might offer temporary environmental benefits. However, environmental issues deprioritized, as governments focus on economic and military security.	Despite trade barriers, improved communication technologies lead better information exchanges. The rate of biodiversity loss remains central to global political and scientific debate. Developing countries formulate adaptation policies. Civil societies spearhead local ecosystem management.	Massive investment in agriculture, use of bio-technology and ecological engineering to trigger another green revolution. Evolution of New-Asian urbanism, with, for example green building materials, lower energy and water use, and urban agriculture. Aging and shrinking cities

	issues are prioritized.	'Asian blocs' are created from dominant economic and military powers and some trade relationship established.	Greater protection of ecosystems and reduced organized ecological crime.	in developed countries. Reliability in ecological engineering increases private-sector involvement.
2030-50	Crop intensification due to increased irrigation (possibly leading to a fresh water crisis), better control of agricultural pests due to adoption of appropriate technologies. Growing unity within the Asia-Pacific region, regional unification and propagation of Asian culture. Many marine and coastal ecosystems may suffer from local extinction. As a result, coastal tourism might decrease in the region.	Lack of environmental awareness in developed wealthy countries due to limited international travel. Severe water crisis in some countries. Lack of capacity to develop cross-border agreements on water sharing, leads to widespread poverty and loss of ecosystems. Most governments recognize the problems, but too late to act.	More harmonized approach to integrate socioeconomic interests in ecological conservation. Further promotion of civil societies. Due to over fishing, fish catches decline to global low, meat consumption increases. Economic reform advocated, establishment of ecological networks.	Use of alternative fuels, such as solar power increases. Emergence of Biofuel economies in Asia and reduction of oil-wealth in Western Asia. Cheap, reliable eco-technologies will reduce income inequality between urban and rural areas. Innovation in auto-mobile technology and high level of fuel-efficiencies achieved, reducing pressure on natural resources.

5.3.2.2 Region-specific scenarios and future projections of Biodiversity in the Asia-Pacific region

The three global assessments (GBO3, GBO4 and MEA) were mostly exploratory, seeking to understand the plausible alternative futures for the Asia-Pacific region. However, they do not give an indication as to the possible future trajectories to achieving global sustainability targets. To address this, The PBL Netherlands Environmental Assessment Agency employed a back-casting approach to identify alternative development pathways that could meet the global sustainability targets by 2050 (PBL, 2012). Under the GLOBIO model, which considered five broad thematic drivers to depict biodiversity futures at global scale, namely: land use changes; atmospheric nitrogen deposition; infrastructure development; fragmentation; and climate change (Alkemade *et al.*, 2009). Using the same approach (PBL, 2012), plausible regional futures for the Asia-Pacific region up to 2050 were developed for this assessment. In line with the main report, a set of four scenarios were adopted; including a Baseline (BL) 'Business-As-Usual' scenario without any strong policy interventions and three alternative scenarios that would essentially fulfil global sustainability targets for energy, climate, food and biodiversity with different sustainability measures, such as technology and consumption change. Following PBL (2012), these alternative pathways were named: (1) Global Technology (GT), (2) Decentralized Solution (DS), and (3) Consumption Change (CC) (Box 5.7).

Box 5.7. Target seeking Scenarios depicting plausible futures (PBL, 2012)

Global Technology (GT): This scenario portrays a future with a focus on large-scale technology such as intensive agricultural production, and international coordination (e.g. trade liberalisation). Along Global Technology pathways, international organizations, national governments and multinational corporations jointly lead provision of large-scale, global solutions to emerging problems, including climate change and biodiversity loss (Top-down approach). Particularly, the characteristic assumptions for Global Technology pathways can be summarized as (a) significant increase in crop yield and livestock productions (b) food markets become more global with trade liberalisation (c) expansion of protected areas and (d) gradual shift to clean and renewable energy.

Decentralized Solutions (DS): The Decentralized Solutions pathway offers a focus local energy production, agricultural production with more consideration on environment, and policy interventions that support equitable access to food. Under this pathway, national governments and regional initiatives lead the way (bottom-up). Consequently, biodiversity protection becomes more diverse emanating from a variety of local/regional initiatives. The other important considerations and assumptions are (a) larger emphasis on renewable energy as local/regional and (b) lack of improvement in agricultural yields due to slowing rates of technological development.

Consumption Change (CC): This pathway depicts an environmentally-aware society with a focus on changing people's consumption patterns, most notably by limiting per capita meat consumption, especially in wealthier countries. The important considerations under this scenario are (1) meat consumption across regions are harmonized and as a result meat-demand falls in developed countries, (2) about 50 per cent reduction in food-waste, (3) equitable access to food and better fuel efficiency in developing world.

5.3.2.2.1 Plausible alternative futures for Biodiversity and influential drivers in the Asia-Pacific region

Global biodiversity loss is often reported in relative terms, such as the Mean Species Abundance (MSA) of originally occurring species (Alkemade *et al.*, 2009; van Vuuren *et al.*, 2015). Predictive modelling under the Business-As-Usual scenario suggest that the Asia-Pacific region will continue to lose habitats and species at a similar pace with the global rate of extinction, with a loss of approximately 45 per cent of the original species abundance anticipated by 2050 (PBL, 2014) (also established in 5.2). However, analyses under the three alternative scenarios (i.e., Global Technology, Decentralized Solutions, Consumption Change), suggested that MSA declines can be partly constrained if alternative trajectories are enforced, with the greatest potential along the '*Decentralized Solutions'* pathway (PBL, 2012, 2014). Subregional projections indicate dynamic variations in MSA declines, with some regions able to recover previous losses and others suffering increasing rates of decline (Figure 5.15). Irreversible biodiversity loss in terms of MSA is anticipated in both South Asia and South-East Asia under all scenarios. In contrast, Western, North-East Asia and Oceania may register a slowing in MSA decline along alternative pathways. In Western Asia, the *'Decentralized Solutions'* and *'Consumption Changes'* scenarios may lead to significant improvements, while the *'Global Technology'* pathway may offer improvements for biodiversity in Oceania and North-East Asia.

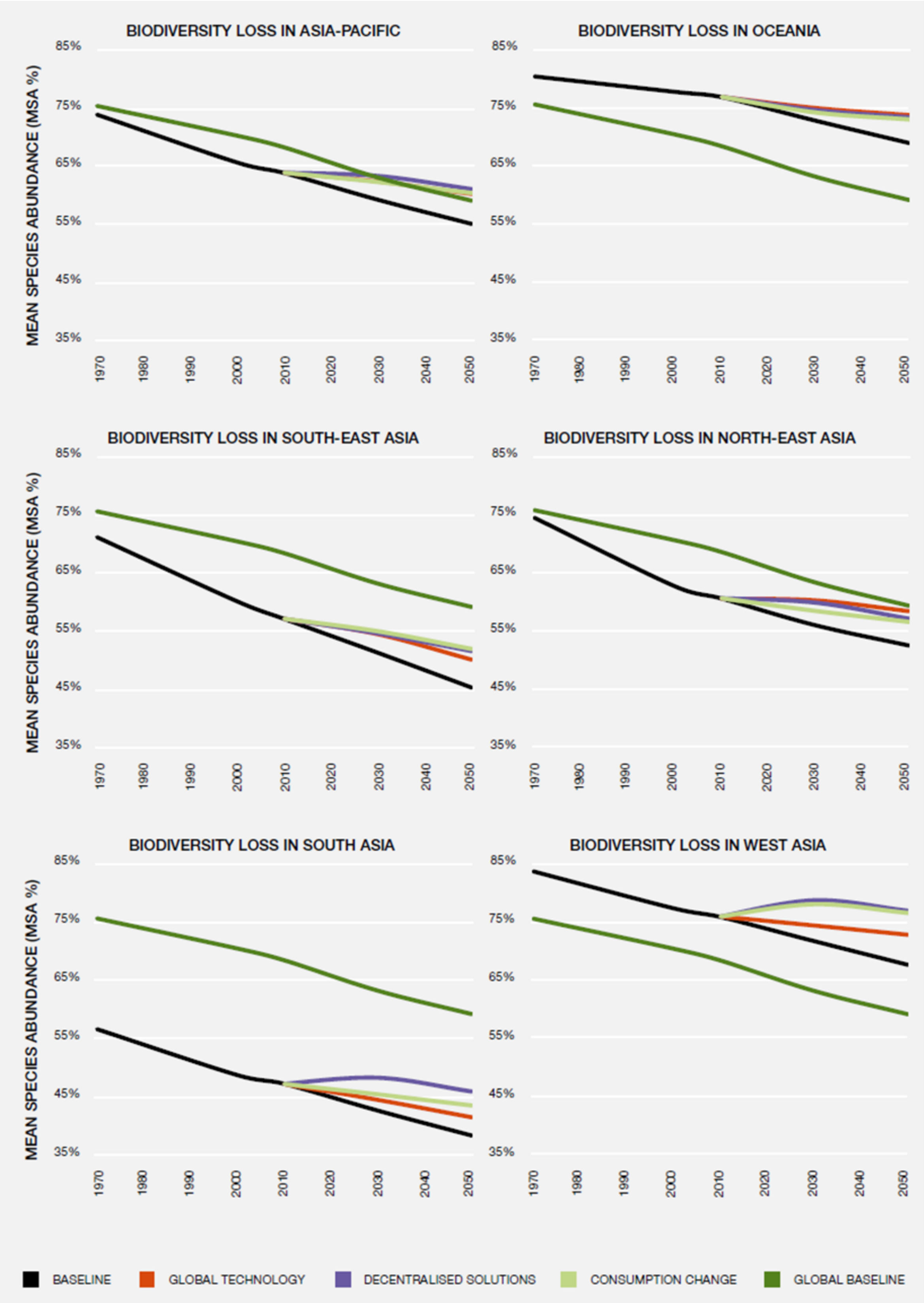


Figure 5.15 Biodiversity loss in the Asia-Pacific region in terms of Mean Species Abundance under different scenarios

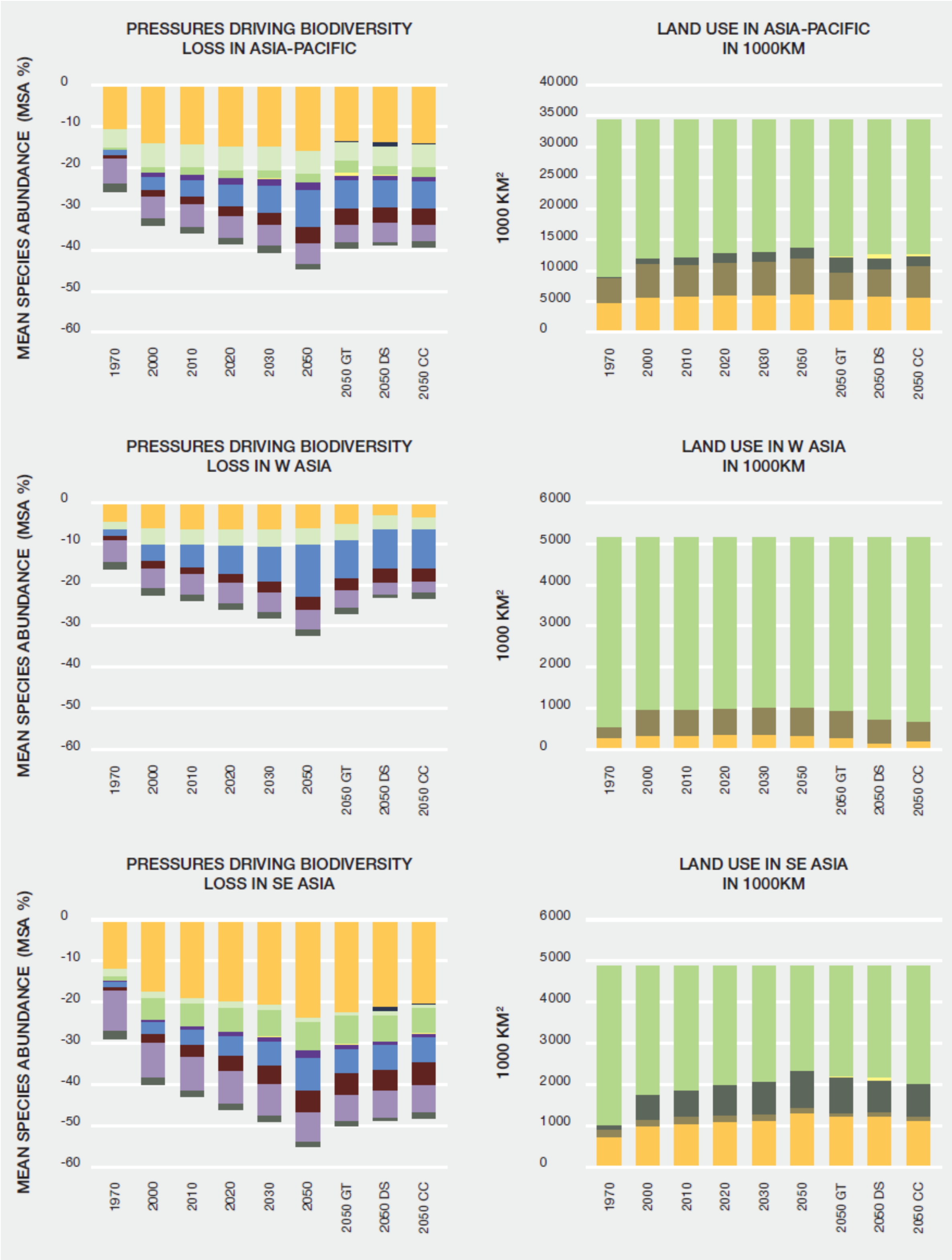
Note: Geographical boundaries differ slightly from IPBES and IMAGE region definition, which is used for modelling purposes. In these analyses Bahrain and Iran included in Western Asia; Papua New Guinea was included in South-East Asia. Data Source: PBL (2012, 2014)

- In the **global technology** scenario it is envisaged that large-scale technology will be developed (with resulting increases in crop yield and livestock production, expansion of global markets and trade liberalization) and global solutions will be found to emerging problems (through protected area expansion and a shift to clean and renewable energy, among others). Biodiversity loss would be lowest under this scenario in North-East Asia and Oceania.

- **Consumption change** entails an environmentally-aware society, changed consumption patterns, falling meat demand and food waste, equitable access to food and better fuel effi ciency in developing countries, with lowest biodiversity loss in South-East Asia.
- **Decentralized solutions** involve local and/or regional initiatives for biodiversity protection, energy, agriculture production with environmental consideration, policy interventions that support equitable access to food and slow technological development. Biodiversity loss is lowest in Western Asia and South Asia under this scenario.

In terms of drivers, cropland and pasture expansion will continue to trigger highest losses of MSA under all scenarios. On average, crop and pasture expansion will result in 10- 25 per cent reduction of MSA in the region, but with significant subregional variation (Figure 5. 13 (PBL, 2012, 2014)). For instance, in South and South-East Asia, expansion of croplands will lead to 22-35 per cent predicted loss of MSA in 2050, especially under the ‘Global Technology’ pathway. The other subregions will have comparatively lesser impacts but may still suffer from average reductions of 3-10 per cent of MSA in 2050. The growing energy demands will also drive biofuel cultivation, which will peak in a ‘Decentralised Solutions’. Under the Decentralized Solutions pathway, expansion of biofuels may facilitate enhanced regional bio-economies, driven by enhancement of rural areas. Although biofuel has strong potential to achieve energy security, mitigate some impacts of climate change, and reduce rural poverty (Yan & Lin, 2009); nonetheless, it will also increase conversion of natural areas to agricultural land in both South Asia and South-East Asia. Some countries in North-East Asia may also face negative consequences from abandoned agricultural land, especially along ‘Global Technology’ and ‘Decentralized Solution’ pathways. Among other important regional drivers, such as climate change, infrastructure development and nitrogen deposition, marginal subregional variation is anticipated. For instance, climate change would be a dominant pressure for species loss in Oceania (about 8 per cent of MSA by 2050) compared to South and South-East Asia (about 5-6 per cent of MSA by 2050), while, nitrogen deposition will have similar consequences across South, South-East, and North-East Asia.

In summary, biodiversity loss would be lowest under the ‘Global Technology’ scenario in North-East Asia and Oceania, under the ‘Consumption change’ scenario in South-East Asia, and under the ‘Decentralized Solution’ scenario in Western Asia and South Asia (Figure 5.15). The most significant pressure driving biodiversity loss is climate change in Western Asia and Oceania, and crop production in South-East Asia, North-East Asia, and South Asia (Figure 5.16, left side). In terms of plausible future land use, all subregions would expect increases in natural areas under the three alternative pathways, compared to the ‘Baseline’ scenario. The greatest increases in natural area are anticipated under the ‘Consumption Change’ scenario in Western Asia and South-East Asia, under the ‘Global Technology’ scenario in North-East Asia and Oceania, and the ‘Decentralized Solution’ scenario in South Asia. A decrease in natural area, in comparison with Business-As-Usual, is expected only in North-East Asia under the ‘Consumption Change’ pathway (Figure 5. 14, right side).


PRESSURES DRIVING BIODIVERSITY LOSS IN ASIA-PACIFIC
LAND USE IN ASIA-PACIFIC IN 1000KM
PRESSURES DRIVING BIODIVERSITY LOSS IN W ASIA
LAND USE IN W ASIA IN 1000KM
PRESSURES DRIVING BIODIVERSITY LOSS IN SE ASIA
LAND USE IN SE ASIA IN 1000KM
MEAN SPECIES ABUNDANCE (MSA %)
1000 KM²
0
-10
-20
-30
-40
-50
-60
40 000
35 000
30 000
25 000
20 000
15 000
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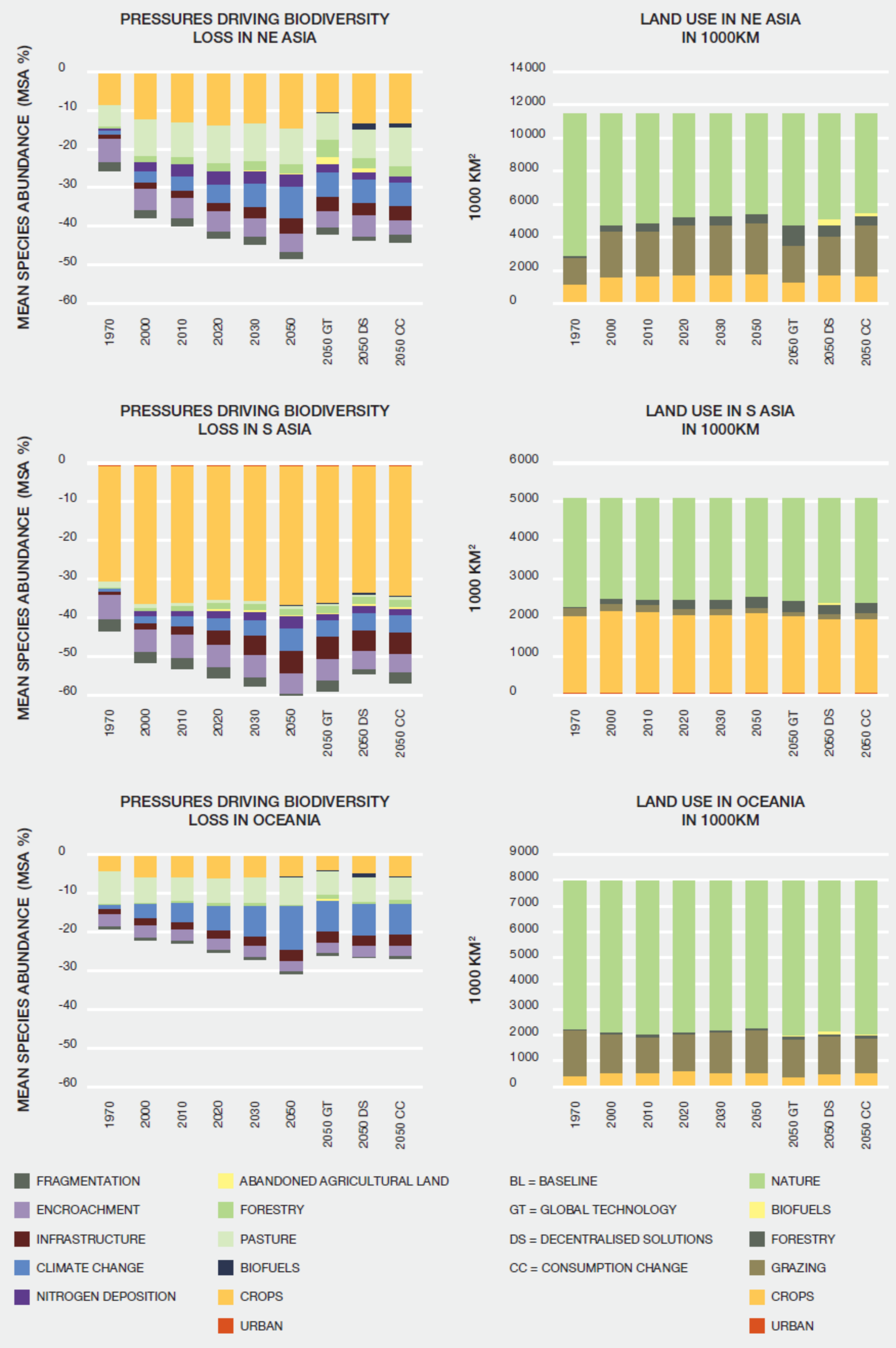

Figure 5.16 Pressure driving biodiversity loss (left side) and projected land use changes (right side) under alternative scenarios for the entire Asia-Pacific region and its five subregions. Source: PBL (2012, 2014).

5.3.3 Assessment of scenarios from regional and subregional literature

5.3.3.1 Systematic review of regional/subregional scenario exercises

To assess the findings from regional/subregional scenario analyses, we conducted a systematic review of peer-reviewed literature and appropriate grey literature deemed valuable to include in the assessment. We searched the Scopus database (https://www.scopus.com). Specific keywords such as *'scenario'* AND '*ecosystem AND/OR biodiversity'* were used as primary search criteria. Further, articles were screened based on their geographical origin and as such, search results yielded 2,454 articles for the Asia-Pacific region. The majority of literature identified from the Scopus search, however, were not directly relevant to the assessment of interactions between BES and human well-being in the Asia-Pacific region. For instance, the word 'scenario' has been inconsistently used for depiction of ecological states and/or biodiversity status reporting rather than depiction of 'plausible alternative futures'. Hence, after preliminary screening, we relied on snowball-sampling method and included only articles that have a relevant scenario depiction of alternative futures. The latter criteria yielded a total of 61 articles from 18 countries, including national assessment reports (e.g. JSSA (2010)). Out of the 61 studies, 60 studies are from different subregions and countries, while one study conducted scenario analysis for the entire Asia-Pacific region. Articles were further classified according to their subregional distribution, spatial and temporal scales, depiction of influential drivers, and the critical synergies and trade-offs considered in relation to BES. To capture the linkages between the regional and subregional scenario exercises for future sustainability, and the 17 UN Sustainable Development Goals (SDGs) and the 20 Convention on Biological Diversity (CBD) Aichi Targets, further screening criteria were employed. These data were used to evaluate trends and gaps of current and future interactions of BES and human well-being in the Asia-Pacific region under different scenarios.

5.3.3.2 Geographical distribution of regional/subregional scenario exercises

Overall, greatest number of published scenario exercises originated from North-East Asia (18 studies), followed by South-East Asia (16 studies), Oceania (13 studies), South Asia (12 studies) and Western Asia (1 study) (Figure 5.17), while one study used the entire region for scenario analysis. About 38 per cent of the literature had its geographical origin from either Australia or China.

Spatially-explicit, quantitative and exploratory scenarios dominated the regional/subregional scenario studies. Nearly 93 per cent of the selected studies explored plausible alternative futures, in comparison to five studies delivering 'policy-screening' scenarios (e.g. Cotter *et al*. (2014); Suwarno *et al*. (2016)). No studies could be retrieved which either provide 'target-seeking' or 'back-casting' scenarios - marking an outstanding research gap in development of normative scenarios in the region that would assist governments with policy development. Within spatially-explicit scenarios, nearly half of the studies utilized land-use transition pathways as proxies to determine competing claims over ecosystem goods and services. These delivered understanding of critical sustainability issues, such as food productivity, water availability, changing life-styles and energy consumption, and carbon sequestration. (e.g. Schaldach *et al*. (2011); Zhao & Wu (2014); Connor *et al*. (2015); Bryan *et al*. (2016)).

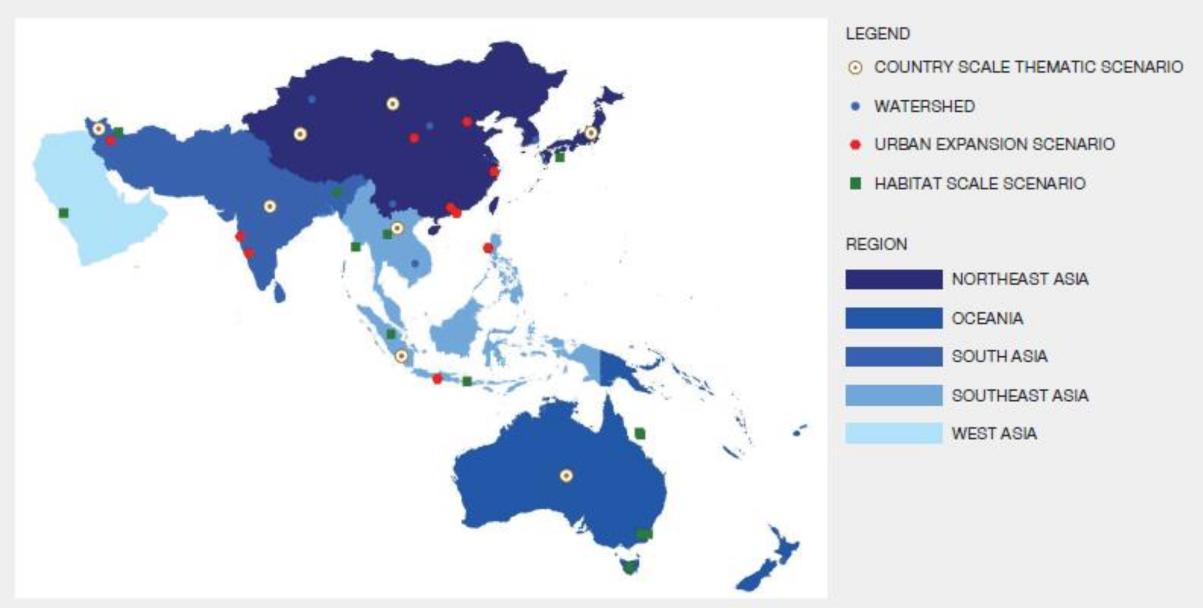

Figure 5.17 Map showing the distribution of regional/subregional scenarios studies

Regional and subregional scenarios covered a wide range of spatial scales. We segregated them into four representative spatial extents: national (or larger) scenarios, habitat-scale, urban-only scenarios, and watersheds. The first category depicts country or regional-scale scenarios which illustrate trade-offs of ecosystem services at a large spatial scale and are generally guided by national-level policies or international agreements. Habitat scale scenarios include terrestrial and aquatic conservation and/or management scenarios, limited to smaller geographic scales, including biodiversity hotspots such as national parks, biosphere reserves and world heritage sites. The third category describes distinctive urban expansion scenarios, focusing on the urbanization process and transformation of peri-urban production landscapes. Spatial extent of this category is limited to city boundaries and the peri-urban areas within the immediate vicinity. The fourth category represents watershed scale scenarios which address ecosystem services of large lakes, rivers, and wetlands, and utilizes the watershed boundary as their scale for scenario development. Watersheds are also considered as a focus of political and economic activity, for example under the MEA Adapting Mosaic scenario (Millennium Ecosystem Assessment, 2005).

Segregation based on spatial scales reveals that the greatest proportion of scenarios (35 per cent) are developed at country or even larger-scale regional levels, with habitat-scale scenarios (31.6 per cent) also featuring prominently. Watershed-scale scenarios (16.7 per cent) and urban/cityscape scenarios (16.7 per cent) occurred less frequently.

Among country-scale scenarios, land use transition pathways and their subsequent impacts on ecosystem services were developed for Australia (e.g. Bryan *et al*. (2016); Connor *et al*. (2015)), Japan (e.g. JSSA (2010)), China (e.g. Zhao & Wu (2014)), India (e.g. Schaldach *et al*. (2011)). Habitat scale scenarios, included a multitude of terrestrial and aquatic conservation/management pathways and involving biodiversity hotspots such as the following:(1) Ramsar sites and World Heritage sites, such as the Great Barrier Reef in Australia (Bohensky *et al*., 2011; Butler *et al*., 2013); (2) Deepor Beel, a Ramsar-designated wetland in North-East India (Mozumder & Tripathi, 2014), and (3) the mangroves of the Ayeyarwady (Irrawaddy) Delta in Myanmar (Webb *et al.*, 2014). Watershed-scale scenarios, considered ecosystem services of lakes and rivers, particularly future water availability across narratives. However, the majority of the scenario studies from the region focused on smaller river systems and watersheds (e.g. Herzig *et al*. (2016); Shooshtari & Gholamalifard (2015)). Lastly, urban expansion scenarios were dominant particularly from India and China, covering important cities such as Beijing (Han *et al*., 2015), Hong Kong (Zheng *et al*., 2015) and Pune, for example.

5.3.3.3 Consideration for influential drivers in regional/subregional scenarios

The review of regional/subregional scenarios identified a total of 11 conventional drivers, including both direct and indirect drivers, which would shape the future nature-society interactions. As such, many studies considered combinations of drivers, in line with section 4.3 in chapter 4. Accounting separately for individual drivers, 'population growth/demographic changes' was identified as the most influential regional driver (40.9 per cent), followed by climate change (32.3 per cent), agricultural expansion (20.2 per cent) and urbanization (20.9 per cent). The selection of dominant drivers, in general, aligns with existing global assessments such as the MEA (2005) and GEO-3/4 (UNEP, 2007); and the PBL (2012, 2014).

Subregional distribution of influential drivers shows moderate variation in their intensity (see Figure 5.18). For instance, in Oceania and North-East Asia, indirect drivers are less integrated in plausible scenarios, whereas in South Asia and South-East Asia, indirect drivers are explicitly considered, particularly changing lifestyle and consumption patterns (e.g. Hubacek *et al*. (2007)), expansion of biofuel use (Schaldach *et al*., 2011), governance reforms (e.g. Ornetsmüller *et al*. (2016); Webb *et al*. (2014)). Climatic direct drivers, such as sea level rise and rise in sea surface temperature have been captured more often in Oceania including the Pacific islands, compared to the other subregions, in part because of the well understood vulnerability of small islands and low-lying coastal areas of Pacific origin (c.f. IPCC). Several direct drivers are highlighted that have not been rigorously considered in scenario development and the articulation of plausible futures. Most notable are introductions of non-native species and threats from emerging zoonotic disease.

		West Asia (n=1)	South Asia (n=12)	South east Asia (n=16)	North east Asia (n=18)	Oceania (n=13)
DIRECT DRIVERS	Degradation of Land	**	8.3	31.3	22.2	23.1
	Natural disasters	**	0.0	6.3	16.7	7.7
	Climate Change and all related impacts	**	25.0	18.8	33.3	46.2
	Water related drivers (pollution etc.)	**	16.7	0.0	0.0	23.1
	Agricultural expansion	**	16.7	31.3	11.1	23.1
	Urbanization	**	25.0	25.0	27.8	7.7
	Others direct drivers (Invasive species, Fire, New Breeds etc.)	**	8.3	6.3	0.0	15.4
INDIRECT DRIVERS	Population Growth and demographic Changes	**	41.7	50.0	44.4	30.8
	Economic drivers	**	33.3	25.0	11.1	7.7
	Policy Drivers	**	8.3	31.3	16.7	15.4
	Other indirect drivers (Global development etc.)	**	0.0	6.3	0.0	7.7

Figure 5.18 Subregional distribution of drivers considered for scenario development.
Note: Cell values correspond to per cent share of literature from each subregion. One study covering the entire Asia-Pacific region was not included for this analysis. ** Denotes inconclusiveness due to lack of representative literature.

Crucially, the ***time-horizon*** and ***number of alternative futures*** considered in scenario developments are important to understand impacts of drivers in alternative pathways. Exploration of time horizons facilitates understanding of the trade-offs between BES and human well-being, whilst the number of alternative scenarios captures plausible socio-ecological pathways or trajectories. Accordingly, studies have tended to formulate intermediate scenarios to examine synergies and trade-offs more accurately, dividing longer time horizons into two or more periods, often in line with global assessments (e.g. MEA (2005)). While, in general, the sample set of literature captured broad time-horizon, however, nine studies did not specify any specific projection year.

It is inherently difficult to generalize the number of alternative futures, however, 40 out of the 61 selected studies used three or four alternative scenario archetypes to depict the uncertainties in various driver sets. A further ten studies portrayed more than four alternative scenarios and identified long-term, cross-scale relationships between influential drivers. Across the Asia-Pacific, 'indirect' drivers (mainly population growth, consumption changes, economic drivers) and integrated drivers (including non-climate direct drivers and other indirect drivers), were examined in three or four alternative scenarios over short-term frames (i.e. 2015-2045). Conversely, mid-term scenarios (i.e., 2045-2075) typically considered direct drivers and/or integrated drivers cutting across climate change and economic growth. Longer-term scenarios (i.e., 2075-2100) characteristically focus on climatic direct drivers alone and depicted larger numbers of (>4) alternative scenarios. Figure 5.19 depicts the cross-scale relationship between drivers, number of alternatives and final projection year.

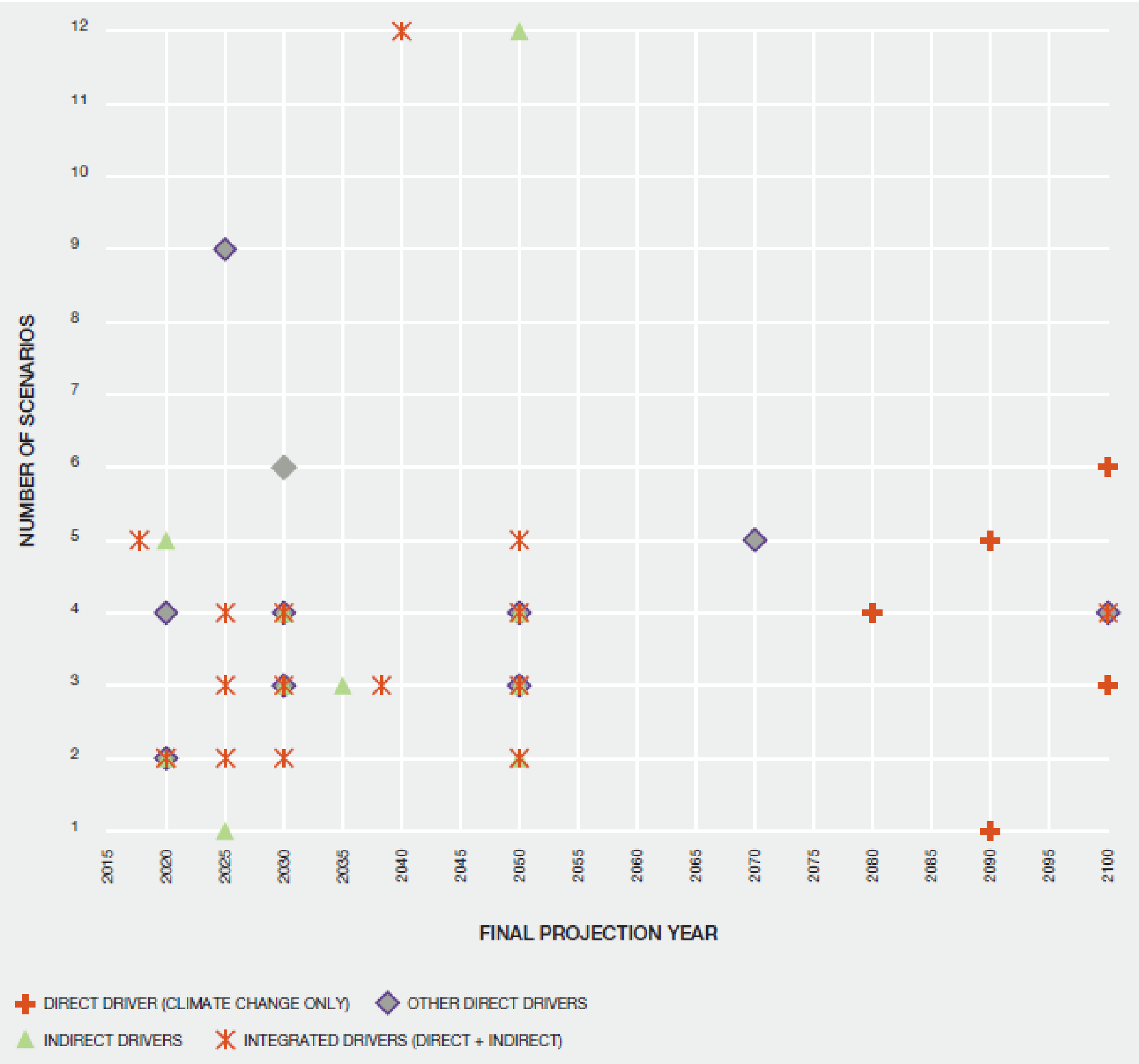

Figure 5.19 Segregation of regional scenario exercises based on number of alternative pathways (y-axis), type of drivers, and final year of projection (x-axis)
Note: since nine studies did not specify final projection year, the current analysis shows the result of 52 articles.

5.3.3.4 Consideration of Ecosystem Services and Nature's Contribution to People

In our review of regional and subregional scenarios, the greatest emphasis was on provisioning ecosystem services, followed by regulating and supporting ecosystem services (Figure 5.20). Even though we encountered variety of regulating (n=7), cultural and supporting ecosystem services, over 50 per cent of the scenario exercises examined plausible future trends in food provisioning services (e.g. Fox *et al*. (2012); Baral *et al*. (2014)). These in turn primarily focused on agricultural production landscapes (including expansion of biofuels and land-competition), as well as limited attention on productive marine and coastal areas. The trade-off between agricultural intensification and consequent loss of habitat quality was well established in almost all the spatially explicit scenarios (e.g. Fox *et al*.

(2012); Baral *et al*. (2014)). Furthermore, the impact on the food provisioning services of demographic and economic drivers including trade reforms, global and domestic policy changes, and urbanization were addressed in various policy-screening scenarios (e.g. Corner *et al*. (2015)). Water availability was also addressed by studies examining potential impacts of indirect drivers, such as changes in life styles and consumption, and the intensification of direct drivers such as climate change, land use alteration, crop intensification, and urbanization (e.g. Herzig *et al*. (2016); Yang *et al*. (2016)). In general, however, regional scenario exercises generally lacked assessments of cultural or non-material ecosystem services, probably due to lack of well-established models and methods, highlighting a significant research gap.

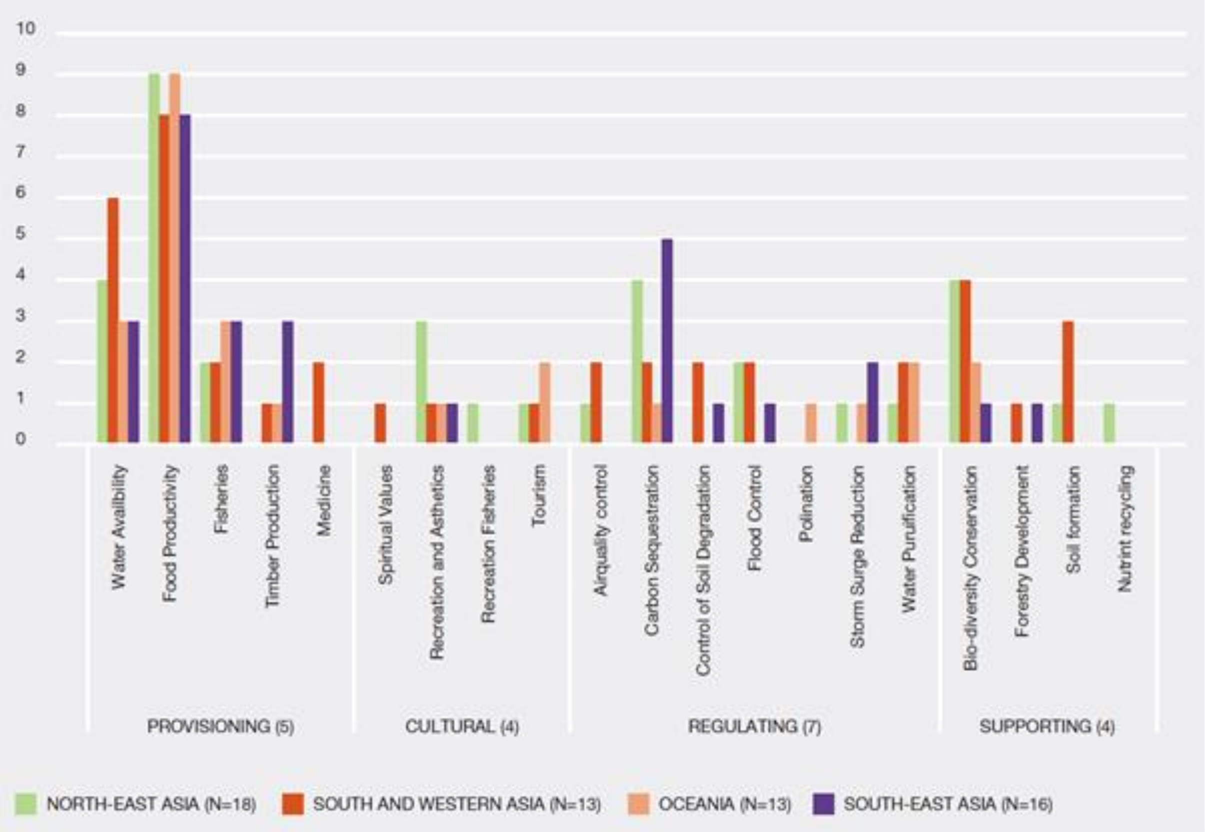

Figure 5.20 Proportion of ecosystem services addressed in scenario exercises for the Asia-Pacific region

Note: Bars represent the number of studies considering specific ecosystem services. (N=60)

5.3.4 Harmonizing global, regional and subregional scenarios

The section 5.3.2 synthesized the relevant assumptions and implications for BES in the Asia-Pacific region from the GEO-3/GEO-4 scenarios, Millennium Ecosystem Assessment scenarios, and the target-seeking scenarios developed by the PBL Netherlands. In the following section (section 5.3.3), the contingent of 61 regional/subregional scenario studies illustrated a total 224 plausible alternative futures, depicting multitude of possibilities involving conventional uncertainties (e.g. changes in social and technological systems, trade liberation, regional integration, and globalization). Particularly, the subregional scenarios provided place-specific, competing assumptions on local drivers and their likely implications. As such, within the reviewed regional and subregional studies, we observed four principle means of scenario development, including localization of global scenario narratives. Nearly 35 per cent of the existing studies utilized the assumptions of one or the other global scenario narratives. This includes the IPCC SRES scenarios (e.g. Khoi & Suetsugi (2014); Soora *et al*. (2013); Ty *et al*. (2012); Zhao & Wu (2014)), RCP (e.g. Dai *et al*. (2016); Wang *et al*. (2017)), the GEO scenarios (e.g. Connor *et al*. (2015)), and the Millennium Ecosystem Assessment scenarios (e.g. Schaldach *et al*. (2011)). Some studies further applied cross-selection of narratives, by integrating global scenarios with domestic policy provisions (e.g. Bryan *et al*. (2016)). However, the other three modes of scenario development, i.e. 'participatory scenario' approach (e.g. Mitchell *et al*. (2015; 2016)), 'policy review' approach (e.g. Cotter *et al*. (2014); Suwarno *et al*. (2016)) and 'trend manipulation' approach (e.g. Thapa *et al*. (2013); Mozumder & Tripathi (2014)), which collectively constitute about 65 per cent of the regional/subregional scenarios, provided distinctive and place-based assumptions of influential drivers; and unlike the global scenarios, sometimes indicated asymmetric manifestations of influential drivers. For instance, Feng and Liu (2016) introduced an 'eco-storm' scenario archetype for Lingang New City in China, which identifies 'intensification of storm surges' alongside 'rejuvenation of coastal ecosystem services'. With these diverse variety of scenarios, it is extremely difficult to assimilate the underlying core assumptions of dominant drivers for the region/subregions and to depict the plausible trajectories on how the regional future might emerge. To have a common agreement on plausible futures, an archetype-based harmonization, thus, remains imperative to synthesize vast selection scenarios, and to integrate the local scenario assumptions with their global counterparts.

5.3.4.1 Scenario Archetypes

All scenarios, irrespective of their scales, domain and development methods, are orchestrated around some common expectations of plausible eventualities, and thus it is essential to group them into small number of 'similar futures' according to the underlying assumptions, storylines, and logic (IPBES, 2016). The purpose of having an archetype is to describe a generalized set of compatible scenarios and to develop a collective logic from variety of scenario assumptions. This eases decision-making by comprehending similarities among diverse assumptions, allows mapping of plausible futures and facilitate comparison among and within the region. Some researchers suggest that 'archetypes' essentially depict plausible 'end-world' state - i.e., how the world would look in future (Hunt *et al.*, 2012), it can be equally understood from the driver perspective, i.e., having consensus on influential drivers that will impact future interactions between society and environment. Despite these differences, archetypes provide good approximation to depict the possible eventualities amidst wide interlaying uncertainties. The purpose of this section is, therefore, to provide archetypes that best explains the regional/subregional scenarios from the Asia-Pacific region and broadly interlink them to global scenario narratives.

Since the pioneering work of Global Scenario Group (GSG) group on Great Transitions (P. Raskin *et al.*, 2002), global scale environmental assessments have used scenarios for projecting plausible futures, and in doing so, they often used archetypes of predominantly four scenario variants. In particular, the IPCC's Special Report on Emissions Scenarios (SRES) (Nakicenovic *et al.*, 2000) paved the way for a generation of climate scientists to conceive, elaborate and analyse range of plausible futures (Alcamo & Henrichs, 2008; Wardropper *et al.*, 2016). In fact, from the third Global Environmental Outlook (GEO3) report, the first UNEP report to introduce scenarios, to the recently formulated Shared Socio-economic Pathways (SSPs) for IPCC's fifth assessment report (2014), there is no dearth of scenario families at the global scale, which are not only rich in vocabulary, but also cater to wide thematic purposes. The choice of scenario archetypes, however, differ considerably among researchers/institutions, based on the understanding of dominant drivers and pre-defined objectives (Boschetti *et al.*, 2016). Despite many such global-scale scenarios, there are a limited number of overviews that synthesize them into groups of plausible futures (e.g. Raskin (2005); Hunt *et al*. (2012) and Cheung *et al*., (2016)). Of these, Raskin (2005) was among the first to harmonize the global scenarios. The IPBES methodological assessment on scenarios and models have also grouped the global scenario families using six representative scenarios, adopted from an archetype proposed by Van Vuuren *et al*. (2012). The six pathways are: Global Sustainable Development, Business-As-Usual, Regional Competition, Economic Optimism, Reformed Markets, and Regional Sustainability. These studies provide an established method to group the popular global scenarios, including IPCC SRES, Millennium Ecosystem assessment, and GEO-3/4.

Focusing specifically on subregional and local scale scenarios, Hunt *et al*. (2012) provided archetypes based on the existing Global Scenario Group scenarios and synthesized a large number of global, regional and subregional scenarios. The three-world archetypes, i.e. '*Conventional World', 'Great Transitions' and 'Barbarization'* denotes the 'official future', 'the sustainable future' and 'what could go wrong' and follows the Bezold's (1999) argument on having thee-world scenario archetypes. Each of these three-world end-states was further categorized into two sub-scenarios, depicting an archetype of six alternative pathways (i*.e. 'Policy Reform', and 'Market Forces' under 'Conventional World', 'Eco-Communalism' and 'New Sustainability Paradigm 'under 'Great Transitions', 'Break Down' and 'Fortress World' under 'Barbarization'*). Supported by some broad selection criteria of likely changes in STEEP drivers, Hunt *et al*. (2012) used this archetype to classify an enormous number of available scenarios, including global, regional, country and local-scale scenarios. Despite certain approximations, we adopted the same archetypes to classify and map the reviewed global, regional/subregional scenarios. The specific reason behind the adoption of Hunt *et al*. (2012) archetypes is that we found that the underlying assumptions of the three-world archetypes better suits the subregional scenarios, particularly due to very site-specific information provided in the scenario literature. 224 subregional scenarios were mapped using these archetypes with the following broad criteria (Table 5.4).

Table 5.4: Screening criteria for regional/subregional scenarios as per Hunt *et al*. (2012)

Archetype	Scenario variants	Key assumptions	Underlying assumptions from regional/subregional scenario exercises
Conventional World	**Market Forces**	*Free market optimism*	Trade-liberalization, Continuing foreign investments, strong international co-operation, rapid urban growth, agricultural intensification, expansion in aquaculture, heavy water-withdrawal without any efforts for conservation of BES.
	Policy Reform	*Necessary regulatory mechanisms*	Although the above drivers continue to occur, zoning, incentives, regional policy targets, new conservation policies, new protected areas, technological intervention, and fuel efficiency are enforced to reduce the loss of BES.
Great transitions	**New Sustaina bility**	*societal values towards sustainability*	Restoration scenarios, the increment in social values, changes in dietary habits, eco-system based resilience planning for disaster risk reduction.
	Eco-commun alism	*Semi-isolated and self-reliant communities*	Local scale community mobilization, participatory resource management, Incentives for conservation, sustainable but isolated society
Barbarization	**Fortress world**	*Elites control an impoverished majority*	Widespread poverty and isolation, great disparities and inequality
	Break-down	Collapse of civil order, conflict all-over	Disintegration, war and political breakdown

Grouping based on the criteria mentioned above, under the six-scenario variants, indicated that the bulk of the scenarios utilized the 'Conventional World' pathway (see Figure 5.21). We observed that researchers generally considered 'Market Forces (MF)' as the most dominant scenario variant (32 per cent), followed by 'Policy Reform' (PR) (24 per cent)' and 'Eco-Communalism (22 per cent)' (EC). On the contrary, only a handful of studies could be identified that proposed revolutionary changes in institutional or human values leading to 'Great transition; or have outlined chaotic situations leading to complete 'Break-down'. The regional trend, by far, is indicative of the fact that globalization would be a dominant force in coming years and 'Market Force', would generally prevail over the entire region without any significant variation across subregions. Prominent narratives considered under MF scenario variants include a substantial number of exploratory scenarios depicting linear interpolation of current trends of urbanization, land-use changes, economic expansions, population growth and agricultural intensification and many other Business-As-Usual scenarios. Among the alternative scenarios, Policy Reform (PR) and Eco-Communalism (EC) are prevalent, as researchers believed that certain degree of sustainable practices would succeed through ameliorative policies and incorporation of 'green visions'. PR scenarios are mainly reflected in spatial considerations for protected areas, restrictive zoning, incentive-based conservation, whereas, the regional characterization of EC scenarios depict community-based forest management, development of agroforestry, facilitation of global incentive mechanisms (e.g. REDD-plus) and proliferation of carbon capture and storage schemes.

GLOBAL SCENARIOS						
GEO 3/4	Market First	Policy First	Sustainability First		Security First	
Millennium Ecosystem Assessment	Global Orchestration		Techno-Garden	Adaptation Mosaic		Order from Strength
IPCC SRES	A1F1		B1 (A1T)	B2	A2	
SSPs (RCPs)	SSP 5 (RCP8.5)		SSP1(RCP 4.5)	SSP2 (RCP 6.0)	SSP 3/ 4 (RCP 8.5)	
PBL, 2012	Baseline/BAU	Global Technology	Consumption Changes	Decentralized Solution		
REGIONAL SCENARIOS						
Hunt et al., 2012	Market forces	Policy reform	New Sustainability	Eco-communalism	Fortress world	Break down
Dominant Change Themes	Market	Policy	Social Values	Localized	Inequality	Collpase
	Current trend persists, free markets drive exploitation of natural resource, trade-libarization and strong integration	New policies related to wise use of biodiversity and ecosystem services, enforcement of protected areas, restrictions in land-use conservations.	Changes in energy consumptions, dietary consumptions, education for sustainable development etc.	Community mobilization, Participatory resource management, Incentives for conservation, strong copoeration between stakeholders	Widespread decgradation/ conversation of existing Biodiversity, Political isloation	Consideration for war, political breakdown
West Asia						
South Asia						
Southeast Asia						
Northeast Asia						
Oceania						
Changes in value of Ecosystem services (currently $ 14 trillion/year)*	$11 trillion/year	$14trillion/year	$17trillion/year	–	$9trillion/year	–

Figure 5.21 Archetype based mapping of regional/subregional scenarios
Note: Darker shade implies more number of scenarios are inclined towards the specific scenario variants, while lighter shade implies lack of data or inconclusive evidence.

5.4 Synopsis and Policy Implications

While addressing futures for the four subregions within the Asia-Pacific region: North-East Asia, South-East Asia, South Asia, and Western Asia, we acknowledge that while each face a specific set of challenges, there are commonalities across the region as a whole. GBO-4 identified five major challenges for business as usual scenarios leading up to 2050 (pp. 134-135): (1) Climate change is projected to become a major driver, of biodiversity loss and ecosystem change by 2050; (2) demand for fertile land is projected to increase, substantially; (3) many wild fisheries collapse and, increasing aquaculture for fish production; (4) water scarcity; and (5) combinations of drivers pushing some ecosystems, beyond recoverable tipping points at regional scales.

As we have shown, it is apparent that no single set of models and scenarios currently account for the myriad possible impacts on BES and human well-being across the Asia-Pacific region. We have shown how subsets of models and scenarios are addressing some issues pertinent to policy directives across the Asia-Pacific region and within subregions, both Aichi and SDG targets concerned with natural ecosystems. Despite these advances, approaches to date have largely failed to address targets and goals that encompass human economic and social development. The dependencies of human well-being on nature have been well articulated elsewhere in this assessment (e.g. Chapter 1) and beyond. Through our assessment, complex interactions have been demonstrated for a number of drivers of BES and the implications for human well-being are shown to be equally complex, although the outcomes are often depressingly simple. Lack of clean water, food insecurity and poor health, inequitable access to natural resources, to name but a few, are widespread throughout the Asia-Pacific region and declining BES are a common linking feature.

In an attempt to draw policy relevance from our assessment of futures within the Asia-Pacific region, in this section we explore regional orientation towards the 20 ‘Aichi Targets (2011-2020)’ and the 17 ‘Sustainable Development Goals (SDGs) (2015-2030)’ and then go on to briefly depict some of the pitfalls and counter-intuitive outcomes that can emerge from such explorations. As a first step, we thematically screen regional and subregional scenarios, particularly focusing on the ‘alternative scenarios outlining sustainability measures’ and capture specific sustainability components that contribute to both Aichi targets and SDGs, either fully or partially.

5.4.1 Synergies between the Aichi Biodiversity Targets and the Sustainable Development Goals (SDGs)

Both the “Strategic Plan for Biodiversity 2011-2020 (aka Aichi Biodiversity Targets)” and the “Sustainable Development Goals 2015-2030 (SDGs)” are important sustainability targets that have strong implications in sustainable development of the Asia-Pacific region. Despite being temporally disjointed, both have many similar and coherent targets. While ‘Aichi Targets’ are more technical, problem-specific and are essentially designed from in-depth understanding of underlying drivers and pressures, SDGs are thematic and broad-based, and oversee environmental sustainability from general developmental challenges. Nonetheless, the Convention on Biological Diversity (CBD) in 2015 listed 35 of 169 targets of SDGs which fully or partially corresponds to the 20 ‘Aichi Targets’. Of which, about 14 targets of SDGs have strong coherence with Aichi Targets (CBD, 2015). While environmental conservation, in general, remains a prominent theme of both the Aichi Targets and SDGs, unlike the Aichi Targets, SDGs have wider obligations in terms of social and economic goals. For instance, the first 7 SDGs (SDG 1 to 7) primarily include fundamental human needs, while SDG 8 to 10 mostly emphasize common drivers and cross-cutting developmental issues (Kumar *et al*., 2016). However, goals depicted in SDG 11 to 15, in principle, have direct implication in environmental sustainability, of which, SDG 14 and 15 specifically address biodiversity and ecosystem services. SDG 16 and 17 are more aspirational and recognizes the role of appropriate institutions, coordination and collaboration among stakeholders to accomplish the other goals and targets.

Many researchers/institutions further argued that the goals and targets mentioned under the SDGs have strong inter-linkages (UNEP, 2016); and therefore, provisioning of ecosystem services should not only be accounted against specific environmental goals/targets, rather, it is important to recognize the explicit role of BES across all the SDGs. For instance, achieving targets of SDG-1 (End poverty in all its forms everywhere) necessitates prudent management of biodiversity and ecosystems- to support livelihood, create new jobs and building resilience to climate change- which are also coherent with SDG 8, 10, 12 and 14. Nonetheless, despite strong synergies, some of the SDGs may also have significant trade-offs. For instance, fulfilling objectives of Goal 2 (End hunger and achieve food security), especially the targets mentioned in 2.3 (double agricultural productivity), may well lead to widespread conversion of natural ecosystems, in addition of putting considerable stress to the already depleted fresh water resources, thereby, putting other targets (e.g. 6.1, 6.3, 15.5) at risk. Section 6.8.3

in the following chapter highlights the major synergies and trade-offs in the Asia-Pacific region with respect to 17 Sustainable Development Goals.

Despite none of our reviewed articles explicitly mentioning SDGs or targets, there are significant consistencies among various scenario assumptions and objectives of the SDGs. These are primarily reflected in the alternate scenarios *'leading to more preferred futures'* or suggested '*sustainability pathways'* in exploratory and target-seeking scenarios respectively (See Box 5.8). These scenarios are depicted in specific consideration of future drivers, socio-political changes, trade-offs in ecosystem services and incorporation of global sustainability issues, such as climate targets. For example, scenario considerations for intensified food production, agricultural expansion, changes in agricultural land, open markets, and food prices can be considered as 'proxy' representatives of SDG-2 (zero hunger). Thus, to identify these linkages we first defined a set of qualitative demarcation criteria to interweave thematic matches between Aichi Targets and SDGs with appropriate scenario assumptions (Appendix 1). Scenarios were accordingly screened against their alignment towards specific sustainability goals. Scenario studies were allocated according to subregions, and incorporation of a specific SDG were assessed as simple 'yes/no' responses. Thereafter, we derived the total frequency (i.e. number of studies marked as 'yes') against specific targets for each of the subregion, and standardized the frequency data from 0 to 1 scale to harmonize varied sample size across subregions. The score obtained against each of the targets were classified into three intervals, namely 'strongly incorporated', moderately incorporated' and 'less integrated /lack of sufficient data'.

Box 5.8. Capturing sustainability targets from 'Alternative Scenarios with sustainability visions' and/or Suggested 'Sustainability Measures'

In scenario exercises, policy intentions are often reflected in consistent storylines that enunciate 'assumptions' for preferred futures, concurrent with regional priorities and targets (Hunt *et al*., 2012; Schmitt Olabisi *et al*., 2010; Volkery *et al*., 2008). In exploratory scenario studies, researchers principally depict three types of scenarios, broadly ranging from 'what may go wrong', 'official future' or 'trend depiction', and 'preferred futures' portraying transitions towards more sustainable future. Although, at times, these scenarios can be speculative, more often, they are shaped by regional priorities and policy intensions based on the understanding of critical demographic, economic and socio-political factors. Contrarily, normative scenarios (e.g. 'target-seeking' and/or 'back-casting' scenarios) primarily depict clear benchmarks and thereby, formulates pathways indicating specific '*sustainability pathways'*. Capturing this 'sustainability measures/pathways' provide critical information of regional priorities related to specific sustainability targets.

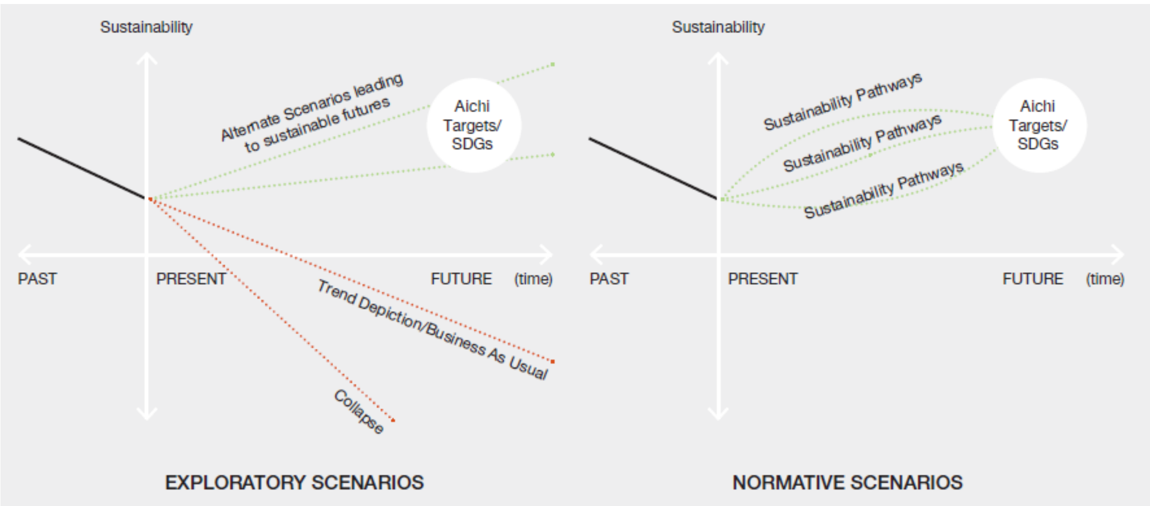

Figure 5.22 Visualisation of exploratory versus normative scenarios

5.4.2 Incorporation of Sustainability Targets in regional and subregional scenarios

SDGs 11 to 15, which principally correspond to environmental goals and align with prominent ‘Aichi targets’ encompassing the first two strategic components (i.e. Targets 1 to 10), were relatively well-articulated within the alternate scenarios leading to more sustainable futures (see Figure 5.23 & Figure 5.24) (*established, but incomplete*). Particularly, subregional scenario exercises have stronger implications for SDG 14 and 15, which fully or partly cater to at least 11 Aichi Targets (i.e. 2,3,5,6,10,11,12,14,15,16 and 17) (CBD, 2015). For instance, subregional studies incorporated multiple targets of SDG-15 (Protect, restore, and promote sustainable use of terrestrial ecosystems) (42 per cent); SDG-14 (Conserve and sustainably use of marine resources) (30 per cent); and specific targets of SDG-11 (32 per cent) (Sustainable cities and communities). Dominant examples of ameliorative scenarios in terrestrial ecosystem conservation include enforcement of protected areas (e.g. Estoque & Murayama (2012); Mozumder & Tripathi (2014)), policy reforms (e.g. Mitchell *et al*. (2015)), and favorable institutional changes, depicting participatory conservation, incentives and regime shifts. Likewise, scenario studies, predominantly from South-East Asia and Oceania, demonstrated analogous assumptions, while describing future occurrence, distribution, production, and consumption of marine ecosystems services (e.g. Webb *et al*. (2014); Takao *et al*. (2015); Bohensky *et al*. (2011)). Many of the studies characteristically considered protective zoning through enforcement of protected areas (e.g. Estoque & Murayama (2012); Mozumder & Tripathi (2014)) which, in principle, corresponds to the Aichi Target 11 and contributes partly to Aichi Target 12, 13 and 14. Similarly, some studies indicated improvement of provisioning and regulating services through ameliorative policy arrangements, such as participatory conservation, better incentives designs (through REDD +, or PES schemes).

Figure 5.23 Thematic Incorporation of the Sustainable Development Goals in subregional scenario exercises

Note: Darker shade implies strongly incorporated, while lighter shade implies less incorporated, or lack of sufficient data. The analysis is based on 60 subregional scenario studies, excluding one study depicting the alternative futures for the entire Asia-Pacific region.

In addition, close to half of the studies depicted thematic association with SDG-13 and its targets (combat climate change and its impacts). Demonstrative examples comprise multitude of climate mitigation and/or adaptation scenarios, including ‘carbon capture and storage’ (e.g. Yang *et al*., (2016)), ‘utilization of regulating ecosystem services for hazard mitigation’ (e.g. Feng & Liu (2016)), ‘assessing impacts and adaptation options for food productivity’ (e.g. Soora *et al*. (2013)) and ‘water availability’ (e.g. Van Ty (2012)). By sharing advanced knowledge on crop-yields, agricultural productivity, water and energy demands under different climate regimes, these studies also contribute in fulfilling allied developmental goals; such as SDG-2 (end hunger and achieve food security), 3 (Good health and human well-being), 6 (clean water and sanitation) and 12 (sustainable consumption and production). However, despite an abundance of urban-expansion scenarios, particularly from South Asia (e.g. Hosseinali *et al*. (2013); Mozumder & Tripathi (2014)) and North-East Asia (e.g. Pei *et al*. (2015); Zheng *et al*. (2015); Feng & Liu (2016)), underlying linkages between ameliorative scenarios and SDG-11 only correspond to a handful of specific targets (e.g. target 11A) and principally focus on controlling ecological impacts of existing urbanization process. While the environmental goals expectedly remain closely reflected in regional scenario studies, the SDG 4, 5, 6 and 7, on the other hand, are under-represented in regional context. In addition, within the cross cutting developmental goals, SDG 8, i.e. ‘decent work and economic growth’ is partially included under urban expansion scenarios, yet the other goals, particularly SDG 9 and 10 are also unrepresented.

Regional scenarios are further lacked in SDG 16 and 17, since only a handful of studies actually considered strong regional and stakeholder collaboration for enduring sustainable and responsible development (e.g. Mitchell *et al*. (2015)). Similarly, within the Aichi Targets, the last two strategic goals, i.e. ‘Enhance the benefits to all from biodiversity and ecosystem services’ and ‘enhance implementation through participatory planning, knowledge management and capacity building’, especially covering Targets 15 to 20 have not been properly reflected in the regional scenario exercises. This is in parts, due to very specific targets, such as implementation of Nagoya Protocol or formulation/revision of NBSAPs/LBSAPs, which are beyond the scope of reviewed scenario exercises. Nevertheless, apart from the current set of reviewed literature, a reasonable amount of allied scientific works from the Asia-Pacific region, particularly from South and South-East Asia, pointed towards better community participation in ecosystem management, as well as systematic incorporation of traditional and indigenous knowledge into natural resource management policies. While this contributes towards the partial fulfilment of target 18 and 19, within the set of reviewed scenario studies, only a handful studies (e.g. König *et al*. (2013); Mitchell *et al*. (2015)) deployed multi-stakeholder based scenario development, therefore these components are assessed as “***Inconclusive***”.

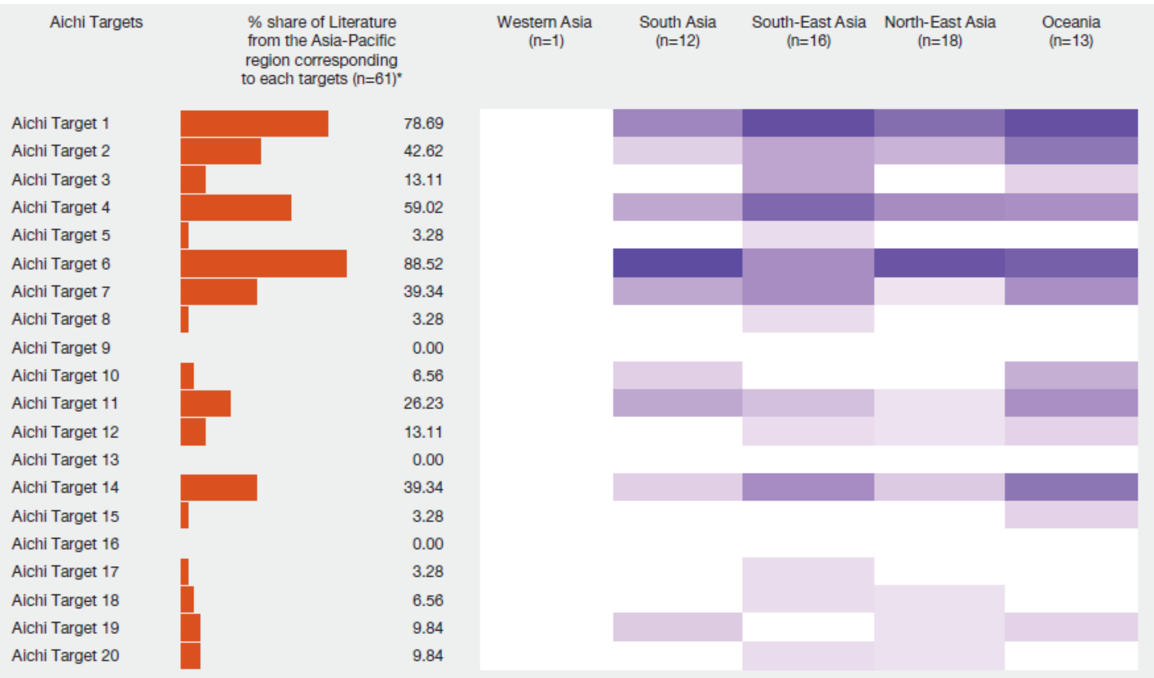

Figure 5.24 Thematic incorporation of the Aichi Biodiversity Targets in regional/subregional scenario exercises

Note: Darker shade implies strongly incorporated, while lighter shade implies less incorporated, or lack of sufficient data.

5.4.3 Regional future of Nature-Society interactions under Alternative Pathways

Archetype-based analysis of regional/ subregional scenarios depicts that most of the subregional scenarios tend to incline towards 'Market Forces', 'Policy Reform' and 'Eco-communalism', out of the six scenario variants under the Global Scenario Group archetype, albeit with some variations across the subregions. Moreover, there is also temporal variations, as studies tended to depict a wide range of alternative future spanning over the current century. It is also important to mention that although for many of these subregional scenarios, particularly from the region's developing countries, 'Market Forces' closely resemble with the Business-As-Usual scenarios, this is not uniformly applicable to the entire region. A similar variation of assumptions can also be attributed for other scenario variants, such as 'Policy Reform' and 'Eco-communalism,' given the broad socio-economic diversity across the Asia-Pacific region. Nonetheless, in this section, we portray the likely changes in major influential drivers (and nature-society interactions) under the three predominant scenario variants, i.e. *'Market Forces', 'Policy Reform' and 'Eco-communalism,'* relying on the local assumptions furnished in the subregional scenario exercises.

The general scenario assumptions for 'Market Forces' can be summarized in a continued population and economic growth for the Asia-Pacific region, regional integration, together with rising demand for resources, especially land and water. Globalization also plays a vital role in regional integration under 'market forces', with better integration and trading among the region/subregions, ensuring a gradual uplifting of the region's least developed economies. For instance, Ornetsmüller *et al*. (2016) developed a scenario for Lao PDR, named as 'ASEAN', outlining greater trade relations with neighbouring countries that propel a large expansion of cash-crop cultivation. Subregional scenarios further depict that due to increased global demand, more investments will focus onto the agro-based production sector (in comparison to the service sector) with a rise in virtual water consumption. Particularly, biofuel and palm oil cultivation may flourish uncontrollably in the Asia-Pacific region (Koh & Ghazoul, 2010). As such, many of the Asia-Pacific region countries will graduate from 'poverty' to 'adequate food and clothing' due to economic development, and India and China will remain at the forefront (Hubacek *et al*., 2007).

Under the Market Forces, cities will continue to expand at an increasing rate, driven by high economic growth, migration of work-forces and subsequent changes in consumption patterns, mostly disregarding environmental concerns. Significant trade-offs in terms of environmental quality, thus, remain inevitable. For instance, Rutten *et al*. (2014) identified that, there might be a sharp decline in natural forests in Vietnam, replaced by planted forests. Koh and Ghazoul (2010) also mentioned that unplanned expansion of oil palm cultivation in Indonesia will trigger the highest loss of forest cover. At the same time, many researchers identified a sustained growth in agricultural produce, mainly due to the adoption of technology, high yield crop varieties, and better management. In general, in the south and South-East Asia, high demand for timber will lead to an expansion of commercial forestry, and as a result, the natural forested area may be occupied for commercial plantation (*established, but incomplete*). Growing urbanization and migration towards cities will lead to significant deterioration of peri-urban production landscapes, with productive agricultural land/wetlands declining in the urban vicinity (*well established*). For example, several scenarios developed for Asian mega-cities cities outline a reduction of agriculture and natural land (open space) in existing peri-urban landscapes under the 'market force' (Han *et al*., 2015; Rutten *et al*., 2014). There is also a consensus that a lesser concern for the environment could intensify climate impacts under market forces, with a significant rise in extreme weather events, flooding and subsequent loss of agricultural productivity, particularly in low-lying coastal areas (Rutten *et al*., 2014).

Subregional scenario studies have portrayed positive ecological impacts under policy drivers, with broad assumptions on punitive and incentive measures. Policy Reform scenarios have particularly highlighted that, despite high population growth and economic development (mostly in line with market forces), policy-drivers can play a significant role towards achieving some degree of sustainability (*well established*). For instance, under the Urban Expansion scenarios, zonation has been widely referred as a measure of safeguarding future nature-society interactions in the built environment. Zheng *et al*. (2015), for instance, developed two scenarios with different policy interventions for Urban Expansion in Hong Kong, assuming that city-council will thrive to provide 'more open space for the benefits of urban communities' [open space scenario], currently capped at 3.39 m^2 per person. The other scenario being 'Protection Scenario', under which historical sites and parks are restricted for future conversion (Zheng *et al.*, 2015). Han *et al*. (2015), on the other hand, described an Urban Expansion scenario of Beijing, named as 'Protection Scenario,' where woodlands and water bodies are designated as 'nature reserves' and hence remain unaltered even under intense urban pressure. The idea of designation and expansion of protected areas, in general, results in conserving vital ecosystem services have been well established in subregional scenario literature. 'Policy Reform' also results in some degree of passive and active restoration, for example through compensatory forestry, or reclamation of degraded areas. In summary, both for the habitat-scale scenarios and urban expansion scenarios, proactive policies are expected to make significant changes to BES, even as the other drivers remain similar to Market Forces (*well established*).

With the subregional scenario literature, Eco-communalism is represented through specific sustainability measures, such as taking 'balanced approach' to economic development, integrating incentives, community-based management, changing lifestyles and perspectives. For example, a 'Go-Green' scenario developed for a watershed in Yunnan, Southwest China integrated three major assumptions into one plausible future - i.e., a stronger protection of the ecologically valuable land, reforestation of farmland on sloping terrain, introduction of community-based agroforestry systems with incentives (or compensation) for abandoning rubber cultivation practices, while developing agroforestry system for sustainable cultivation of Traditional Asian Medicine (Cotter *et al.*, 2014). There are also some evidence that adoption of international forestry conservation schemes such as REDD-plus lead to better conservation and management of protected areas (e.g. Thapa *et al*. (2013)). These scenarios are, however, highly site-specific and as such cannot be replicated as a core characteristic of the entire region. Nonetheless, it is also important to understand, that once scaled-up, this might hold significant implications for future sustainability for the Asia-Pacific region.

5.5 Synthesis of the Plausible Futures in the Asia-Pacific region – Where to next?

Reflecting on the remarkable heterogeneity of resources, societies and cultures in the Asia-Pacific region, the models and scenarios available in the literature were also diverse, as seen from the fact that there are several local story lines and models employed specifically to understand a particular decision-making context or the objective of the study. The synthesis of these studies on a common platform were marred by the fact that a very few studies looked at the whole range of nature's contribution to people using common sets of scenarios and models. Most of the scenarios considered were Business-as-Usual scenario and there is a dearth of 'target-seeking' and 'back-casting scenarios' that would assist governments with policy developments, constituting a significant research gap. The comparison across the models in the region has been difficult due to different set of temporal, spatial and units of analysis as well as socio-economic and cultural differences. Although the region is divided by boundaries, most often biodiversity does not know any administrative bounds, adding an extra layer of complexity (especially for transboundary resources).

Based on the systematic assessment of all the studies, and given the high diversity, subregional differences, and cross-scale variation, there is a worrying lack of systematic studies that comprehensively and consistently assess NCP future trends along plausible pathways in all subregions and countries within the Asia-Pacific region. The few regional and global scenarios and models that exist, are inadequate to fully address complex human-nature interactions, as all the possible and relevant pathways were not considered, such as socio-economic scenarios (population growth, consumption growth, trade, policies, technological interventions, etc.), but rather mostly focused on climate change scenarios (i.e., Business-as-Usual emissions or medium or strong mitigation emissions; RCPs and SRES). The multiple nature-society interactions (NCP) from each ecosystem were typically not explored exhaustively, being often limited to, for example forest area only, fisheries only, or coral reef cover only. These cannot, therefore, reflect the multiple NCP derived from an ecosystem and offer only limited analyses of trade-offs. As a result, our current understanding of projections of nature-society interactions within the Asia-Pacific must be considered largely fragmented and limited. Within the existing limitations, the predictive models under the Business-As-Usual scenario point out that biodiversity loss would continue and, if appropriate policy interventions are not initiated, the rate of species extinction would be similar to the global rate by 2050 (approximating 45 per cent). Appropriate proactive and regulatory policy interventions can help stabilize land/sea use changes, thereby improving nature's contributions to people and several such evidences of intervention exists in the region like that of adaptive multiple-use land management practices. The scenario analysis shows that a combination of old and new drivers such as human population growth, climate change, increasing urbanization, agricultural intensification are shaping the BES outcomes in the Asia-Pacific region at different spatial and temporal scales, which can impact the ecosystem health and thus further increase the disaster risk and risk of emergent zoonotic disease, with major implications for the poor. Under all scenarios, except those articulating major societal change (e.g. Great Transition, Eco-Communalism, or New Sustainability) greater disparity between social groups and entrenched poverty are anticipated, with Health Security worsening in poor communities as BES decline further.

Despite the implications of declining BES for the region, observations have also paradoxically shown increases in human well-being (Figure 5.9), and another example is seen in the Bangladesh delta (Hossain *et al*., 2016). Such improvements in human well-being are not necessarily linked to NCP and often result from new commercial activities or technologies, or donated foreign aid, masking fundamental BES and societal declines resulting in these interventions not persisting as viable future options. Scenarios such as '*Great Transition*' or '*Global Technologies*' often fail to incorporate changes, focusing instead in possibly short-term and/or small-scale outcomes. Other examples suggesting regional BES (and human well-being) in China may benefit from increasing urban industrialization (Hou *et al*., 2014), also appear to offer counterpoints to the scenarios depicted for the Asia-Pacific region and the environmentalism viewpoint. Therefore the scales and measures of human well-being examined are not necessarily the most appropriate (W. Yang *et al.*, 2013), and not linked to NCP – thus, offering insights to a relatively small subpopulation over limited time scales. As a result it is often seen that countries which are exploiting their natural capital are often growing rapidly. One can break this paradox by arguing that the critical dimensions of human well-being have not been adequately captured. With the increase in production per capita, an important provisioning service, human well-being would increase regardless of the decline in other services (Raudsepp-Hearne *et al.*, 2010; UNU-IHDP & UNEP, 2014). It is often misconstrued that, due to the technology and social innovation, human well-being is less dependent on ecosystem services. It should however, be understood that due to the time lag between ecosystem service degradation and the negative impacts on human well-being, the negative impacts on human well-being have not yet occurred to a measurable extent. This further points out to the need for more synergistic and cross-cutting policies across multiple domains, themes and across regions to capture the trade-offs better.

As policies overlap across multiple domains, these pathways needs to be aligned with wider policies and anticipated plausible futures. There exists some policy initiatives within social and economic spheres in the Asia-Pacific region that envisage and anticipate complex interactions with nature, such as the recent efforts to adopt One-Health (OH) policies offering possible means for addressing multiple impacts by directly targeting the outcome of improved health (Binot *et al.*, 2015). Such approaches integrate across numerous policy fronts, including: Health Security, Food production and food security, Income and Livelihoods, and Water security. Development synergies can thus be identified that prioritize and optimize health as the key outcome, leading to improved human well-being and ultimately alleviating poverty. Attempts to link OH approaches to international aid in SE Asia (Asakura *et al*., 2015) or provide more effective control for disease such as rabies (Aréchiga Ceballos *et al*., 2014), a disease that disproportionately affects children in poor communities, have identified clear links to BES, highlighting self-reinforcing policy options with clear co-benefits. No projections or future pathways are presented for OH options, but we must consider that outcomes will differ under the different scenario archetypes we present.

In addition we require more collaborative and coherent actions by all stakeholders to better harness the economic, cultural and regulatory contributions of Nature. Effective participatory governance is likely to emphasise the synergies between multiple drivers and can facilitating progress towards the Aichi Biodiversity Targets and Sustainable Development Goals. The plausible future pathways described are likely to shift with altered needs and depend on whose voices are having the greatest influence on policy directions. As an example, the Daly River catchment in North Australia illustrates common trade-offs between economic, environmental, cultural and social outcomes of management options and plausible futures. When asked, stakeholders ranked social and cultural outcomes as the most important, with commercial considerations being lowest (Adams *et al*., 2014). However, responses from indigenous communities differed to those from commercial farmers, the latter ranking economic concerned more prominently (Adams *et al.*, 2014). The way in which indigenous communities are engaged in these assessments is clearly important (Ens *et al*., 2016; Fuentes *et al*., 2015; Sangha *et al*., 2015; Satterfield *et al*., 2013) (c.f. Chapter 2), especially in countries where historical displacement by European settlers has created inequalities. Approaches that seek to identify the commonalities between stakeholders and build on consensus where it already exists are potentially more valuable than discussion of differences. This is illustrated in practise by water planning developments in New Zealand, where the hazards of purely top-down expert-driven policy framing are set against more inclusive participatory approaches (Tadaki *et al*., 2015). Where economic considerations are deemed to be priorities, issues surrounding compensation often prove to be complex and controversial (Kaplan & Leonard, 2012; Ruzicka *et al*., 2013; Wen, 2014; Xiao *et al*., 2015). These approaches often consider notions of social justice, seeking fairness between the individual and society. Where individuals from poor communities are not directly benefitting from commercial activities (judged to be desirable by society more widely), justice through compensation is a frequent approach. The effective and equitable delivery of such justice necessarily requires bottom-up, participatory approaches to fully understand the values and needs of these communities (Chapter 2) and develop scenario frameworks that fully incorporate these world views. As we have illustrated, participatory scenario development is rare in the Asia-Pacific region and consequently the multiple voices required to elucidate fully the range of plausible future are often absent. Under Business-As-Usual, economic priorities are set above all others, with alternatives having little traction because often there are not the societal mechanisms in place to accommodate diversity.

Energy security is clearly framed as an economic development priority and clear BES influences and outcomes are also apparent under various scenarios. Overall, the energy sector is a contributing drivers of BES decline (Chapter 4). It is worthwhile to explore the details in India, which is projected to be the largest coal consumer by 2050. However, numerous hydroelectric power schemes are proposed or are under development, with much focus in the Himalayan states, such as Uttarakhand. Here, “run-of-the-river” hydropower projects, that either eliminate or substantially reduce the need for water storage, are being developed to avoid costs to local communities through the creation of large dams. Stakeholders are diverse, with often diverging interests, resulting in governance challenges centred on trade-offs between local electricity to energy-insecure rural areas and revenue from the sale of hydropower, on the one hand, and the impacts on irrigation, riparian ecosystem services, and other natural resource-based livelihoods, on the other.

Using a social justice approach, strategies can be identified that safeguard or enhance livelihoods, especially of women and the young, while also maintaining critical ecosystem services (Buechler *et al*., 2016). Mitigation or compensation for loss of BES increasingly seek means of redressing ecological destruction and compensation schemes are often complex (e.g. Braun *et al*. (2015); Monjezi *et al*. (2009); Wen (2014)). Integration between adaptation responses to global change and human development are desirable in developing countries, ideally leading to no regrets, co-benefit strategies for the rural poor in alignment with Sustainable Development Goals (SDGs). The adaptation pathways approach provides a potentially useful decision-making framework because it aims to steer societies towards sustainable futures by accounting for complex systems, uncertainty and contested multi-stakeholder arenas, and by maintaining adaptation options.

A further example from Nusa Tenggara Barat Province, Indonesia, considered whether generic justifications for adaptation pathways are tenable in the local context of climate and global change, rural poverty and development. Although poverty is resilient, due to corruption, traditional institutions and fatalism, other trends around the erosion of traditional culture result in unpredictable futures. Tensions around formal and informal leadership, corruption, community participation in planning and female empowerment add further challenges to decision-making. Using an adaptation pathways approach, appropriate participatory processes and governance structures can be highlighted, including integrated livelihoods and multi-scale systems analysis, scenario planning, adaptive co-management and 'livelihood innovation niches' (Butler *et al.*, 2014). Under such circumstances, where governance structures are sufficiently flexible and responsive, we may divert off from the Business-As-Usual pathways and towards future scenarios that balances sustainable BES and human well-being both people and healthy and productive nature.

This points out to the need that the future efforts to develop more region-wide models needs to link the macro-economic conditions with more subregional or local conditions reflecting the diverse biodiversity and ecosystem services and the local knowledge, as well as ensuring spatial, sectoral and temporal consistency for a meaningful comparison of plausible futures across the region,including relevance for local contexts. We also recommend developing harmonized scenarios for the region, taking into account of multiple drivers and story lines that better reflect the attitudes, preferences, the biodiversity and ecosystem services as well as the overlapping and heterogeneous policy context of the region. Such scenarios can help policymakers make better decisions on the most plausible futures for biodiversity and NCP.

References

Adams, V. M., Pressey, R. L., & Stoeckl, N. (2014). Navigating trade-offs in land-use planning : integrating human well-being. *Ecology and Society*, *19*(4), 53. https://doi.org/10.5751/ES-07168-190453

Alam, S., Ali, M. M., & Islam, Z. (2016). Future Streamflow of Brahmaputra River Basin under Synthetic Climate Change Scenarios. *Http://Dx.Doi.Org/10.1061/(ASCE)HE.1943-5584.0001435*, *21*(11), 1–13. https://doi.org/10.1061/(ASCE)HE.1943-5584.0001435.

Alcamo, J., & Henrichs, T. (2008). Chapter Two Towards Guidelines for Environmental Scenario Analysis. *Developments in Integrated Environmental Assessment*, *2*, 13–35. https://doi.org/10.1016/S1574-101X(08)00402-X

Alkemade, R., van Oorschot, M., Miles, L., Nellemann, C., Bakkenes, M., & ten Brink, B. (2009). GLOBIO3: A Framework to Investigate Options for Reducing Global Terrestrial Biodiversity Loss. *Ecosystems*, *12*(3), 374–390. https://doi.org/10.1007/s10021-009-9229-5

Alongi, D. M. (2002). Present state and future of the world's mangrove forests. *Environmental Conservation*, *29*(03), 331–349. https://doi.org/10.1017/S0376892902000231

Alongi, D. M. (2008). Mangrove forests: Resilience, protection from tsunamis and responses to global climate change. *Estuarine, Coastal and Shelf Science*, *76*.

Amatya, L. K., Cuccillato, E., Haack, B., Shadie, P., Sattar, N., Bajracharya, B., Shrestha, B., Caroli, P., Panzeri, D., Basani, M., Schommer, B., Flury, B., Manfredi, E. C., & Salerno, F. (2010). Improving Communication for Management of Social-ecological Systems in High Mountain Areas. *Mountain Research and Development*, *30*(2), 69–79. https://doi.org/10.1659/MRD-JOURNAL-D-09-00084.1

APWF. (2009). *Regional Document (Asia Pacific). 5th World Water Forum*.

Aréchiga Ceballos, N., Karunaratna, D., & Aguilar Setién, A. (2014). Control of canine rabies in developing countries: key features and animal welfare implications. *Rev. Sci. Tech. Off. Int. Epiz*, *33*(1), 311–321.

Arrow, K. J., Dasgupta, P., Goulder, L. H., Mumford, K. J., & Oleson, K. (2012). Sustainability and the measurement of wealth. *Environment and Development Economics*, *17*(03), 317–353. https://doi.org/10.1017/S1355770X12000137

Asakura, T., Mallee, H., Tomokawa, S., Moji, K., & Kobayashi, J. (2015). The ecosystem approach to health is a promising strategy in international development: lessons from Japan and Laos. *Globalization and Health*, *11*(1), 3. https://doi.org/10.1186/s12992-015-0093-0

Baral, H., Keenan, R. J., Stork, N. E., & Kasel, S. (2014). Measuring and managing ecosystem goods and services in changing landscapes: a south-east Australian perspective. *Journal of Environmental Planning and Management*, *57*(7), 961–983. https://doi.org/10.1080/09640568.2013.824872

Bennett, E. M., Cramer, W., Begossi, A., Cundill, G., Díaz, S., Egoh, B. N., Geijzendorffer, I. R., Krug, C. B., Lavorel, S., Lazos, E., Lebel, L., Martín-López, B., Meyfroidt, P., Mooney, H. A., Nel, J. L., Pascual, U., Payet, K., Harguindeguy, N. P., Peterson, G. D., Prieur-Richard, A.-H., Reyers, B., Roebeling, P., Seppelt, R., Solan, M., Tschakert, P., Tscharntke, T., Turner, B. L., Verburg, P. H., Viglizzo, E. F., White, P. C. L., & Woodward, G. (2015). Linking biodiversity, ecosystem services, and human well-being: three challenges for designing research for sustainability. *Current Opinion in Environmental Sustainability*, *14*, 76–85. Retrieved from http://www.sciencedirect.com/science/article/pii/S1877343515000366

Bezold, C. (1999). Alternative futures for communities. *Futures*, *31*(5), 465–473. https://doi.org/10.1016/S0016-3287(99)00006-3

Biemans, H., Haddeland, I., Kabat, P., Ludwig, F., Hutjes, R. W. A., Heinke, J., von Bloh, W., & Gerten, D. (2011). Impact of reservoirs on river discharge and irrigation water supply during the 20th century. *Water Resources Research*, *47*(3). https://doi.org/10.1029/2009WR008929

Binot, A., Duboz, R., Promburom, P., Phimpraphai, W., Cappelle, J., Lajaunie, C., Goutard, F. L., Pinyopummintr, T., Figuié, M., & Roger, F. L. (2015). A framework to promote collective action within the One Health community of practice: Using participatory modelling to enable interdisciplinary, cross-sectoral and multi-level integration. *One Health*, *1*, 44–48.

https://doi.org/10.1016/j.onehlt.2015.09.001
Blankespoor, B., Dasgupta, S., & Lange, G. M. (2017). Mangroves as a protection from storm surges in a changing climate. *Ambio*, *46*(4), 478–491. https://doi.org/10.1007/s13280-016-0838-x
Bohensky, E., Butler, J. R. A., Costanza, R., Bohnet, I., Delisle, A., Fabricius, K., Gooch, M., Kubiszewski, I., Lukacs, G., Pert, P., & Wolanski, E. (2011). Future makers or future takers? A scenario analysis of climate change and the Great Barrier Reef. *Global Environmental Change*, *21*(3), 876–893. https://doi.org/10.1016/j.gloenvcha.2011.03.009
Boschetti, F., Price, J., & Walker, I. (2016). Myths of the future and scenario archetypes. *Technological Forecasting and Social Change*, *111*, 76–85. https://doi.org/10.1016/J.TECHFORE.2016.06.009
Brander, L. M., Wagtendonk, A. J., Hussain, S. S., McVittie, A., Verburg, P. H., de Groot, R. S., & van der Ploeg, S. (2012). Ecosystem service values for mangroves in Southeast Asia: A meta-analysis and value transfer application. *Ecosystem Services*, *1*(1), 62–69. https://doi.org/10.1016/j.ecoser.2012.06.003
Braun, A., Rosner, H. J., Hagensieker, R., & Dieball, S. (2015). Multi-method dynamical reconstruction of the ecological impact of copper mining on Chinese historical landscapes. *Ecological Modelling*, *303*, 42–54. https://doi.org/10.1016/j.ecolmodel.2015.02.013
Bryan, B. A., Nolan, M., McKellar, L., Connor, J. D., Newth, D., Harwood, T., King, D., Navarro, J., Cai, Y., Gao, L., Grundy, M., Graham, P., Ernst, A., Dunstall, S., Stock, F., Brinsmead, T., Harman, I., Grigg, N. J., Battaglia, M., Keating, B., Wonhas, A., & Hatfield-Dodds, S. (2016). Land-use and sustainability under intersecting global change and domestic policy scenarios: Trajectories for Australia to 2050. *Global Environmental Change*, *38*, 130–152. https://doi.org/10.1016/j.gloenvcha.2016.03.002
Buechler, S., Sen, D., Khandekar, N., & Scott, C. A. (2016). Re-linking governance of energy with livelihoods and irrigation in Uttarakhand, India. *Water (Switzerland)*, *8*(10), 1–22. https://doi.org/10.3390/w8100437
Butler, J. R. A., Suadnya, W., Puspadi, K., Sutaryono, Y., Wise, R. M., Skewes, T. D., Kirono, D., Bohensky, E. L., Handayani, T., Habibi, P., Kisman, M., Suharto, I., Hanartani, Supartarningsih, S., Ripaldi, A., Fachry, A., Yanuartati, Y., Abbas, G., Duggan, K., & Ash, A. (2014). Framing the application of adaptation pathways for rural livelihoods and global change in eastern Indonesian islands. *Global Environmental Change*, *28*, 368–382. https://doi.org/10.1016/j.gloenvcha.2013.12.004
Butler, J. R. A., Wong, G. Y., Metcalfe, D. J., Honzák, M., Pert, P. L., Rao, N., van Grieken, M. E., Lawson, T., Bruce, C., Kroon, F. J., & Brodie, J. E. (2013). An analysis of trade-offs between multiple ecosystem services and stakeholders linked to land use and water quality management in the Great Barrier Reef, Australia. *Agriculture, Ecosystems and Environment*, *180*, 176–191. https://doi.org/10.1016/j.agee.2011.08.017
Castella, J. C., Bourgoin, J., Lestrelin, G., & Bouahom, B. (2014). A model of the science-practice-policy interface in participatory land-use planning: Lessons from Laos. *Landscape Ecology*, *29*(6), 1095–1107. https://doi.org/10.1007/s10980-014-0043-x
CBD. (2014). *Global Biodiversity Outlook 4: A mid-term assessment of progress towards the implementation of the Strategic Plan for Biodiversity 2011-2020*. Montréal: Secretariat of the Convention on Biological Diversity. https://doi.org/10.1093/aje/kwq338
CBD. (2015). *Report of the ad hoc technical expert group on indicators for the Strategic plan for biodiversity 2011-2020*. Montreal, Canada. Retrieved from https://www.cbd.int/doc/meetings/ind/id-ahteg-2015-01/official/id-ahteg-2015-01-03-en.pdf
Cheung, W., Rondinini, C., Avtar, R., van den Belt, M., Hickler, T., Paul Metzger, J., Scharlemann, J., Vliendo, X., & Yue, T. (2016). Linking and harmonizing scenarios and models across scales and domains. In S. Ferrier, N. Ninan, P. Leadley, R. Alkemade, L. A. Acosta, H. R. Akç, L. Brotons, W. W. L. Cheung, V. Christensen, K. A. Harhash, J. Kabubo-Mariara, C. Lundquist, M. Obersteiner, H. M. Pereira, G. Peterson, R. Pichs-Madruga, N. Ravindranath, C. Rondinini, & B. A. Wintle (Eds.), *The Methodological Assessment Report on Scenarios and Models of Biodiversity and Ecosystem Services* (pp. 197–223). Bonn, Germany: Intergovernmental Platform on Biodiversity and Ecosystem Services.
Cheung, W. W. L., Lam, V. W. Y., Sarmiento, J. L., Kearney, K., Watson, R., Zeller, D., & Pauly, D.

(2010). Large-scale redistribution of maximum fisheries catch potential in the global ocean under climate change. *Global Change Biology*, *16*(1), 24–35. https://doi.org/10.1111/j.1365-2486.2009.01995.x

Cheung, W. W. L., & Reygondeau, G. (2016). Large benefits to marine fisheries of meeting the 1.5°C global warming target. *Science*, *354*(6319), 1–5. https://doi.org/10.1126/science.aag2331

Connor, J. D., Bryan, B. A., Nolan, M., Stock, F., Gao, L., Dunstall, S., Graham, P., Ernst, A., Newth, D., Grundy, M., & Hatfield-Dodds, S. (2015). Modelling Australian land use competition and ecosystem services with food price feedbacks at high spatial resolution. *Environmental Modelling and Software*, *69*, 141–154. https://doi.org/10.1016/j.envsoft.2015.03.015

Corner, A., Roberts, O., Chiari, S., Völler, S., Mayrhuber, E. S., Mandl, S., & Monson, K. (2015). How do young people engage with climate change? The role of knowledge, values, message framing, and trusted communicators. *Wiley Interdisciplinary Reviews: Climate Change*, *6*(5), 523–534. https://doi.org/10.1002/wcc.353

Costanza, R., de Groot, R., Sutton, P., van der Ploeg, S., Anderson, S. J., Kubiszewski, I., Farber, S., & Turner, R. K. (2014). Changes in the global value of ecosystem services. *Global Environmental Change*, *26*, 152–158. https://doi.org/10.1016/J.GLOENVCHA.2014.04.002

Costello, C., Ovando, D., Clavelle, T., Strauss, C. K., Hilborn, R., Melnychuk, M. C., Branch, T. A., Gaines, S. D., Szuwalski, C. S., Cabral, R. B., Rader, D. N., & Leland, A. (2016). Global fishery prospects under contrasting management regimes. *Proceedings of the National Academy of Sciences*, *113*(18), 5125–5129. https://doi.org/10.1073/pnas.1520420113

Costello, C., Ovando, D., Hilborn, R., Gaines, S. D., Deschenes, O., & Lester, S. E. (2012). Status and Solutions for the World’s Unassessed Fisheries. *Science*, *338*(october), 517–520. https://doi.org/10.1126/science.1229223

Cotter, M., Berkhoff, K., Gibreel, T., Ghorbani, A., Golbon, R., Nuppenau, E.-A., & Sauerborn, J. (2014). Designing a sustainable land use scenario based on a combination of ecological assessments and economic optimization. *Ecological Indicators*, *36*, 779–787. https://doi.org/10.1016/j.ecolind.2013.01.017

d’Annunzio, R., Sandker, M., Finegold, Y., & Min, Z. (2015). Projecting global forest area towards 2030. *Forest Ecology and Management*, *352*, 124–133. https://doi.org/10.1016/J.FORECO.2015.03.014

Dai, E., Wu, Z., Ge, Q., Xi, W., & Wang, X. (2016). Predicting the responses of forest distribution and aboveground biomass to climate change under RCP scenarios in southern China. *Global Change Biology*, *22*(11), 3642–3661. https://doi.org/10.1111/gcb.13307

Donner, S. D., Skirving, W. J., Little, C. M., Oppenheimer, M., & Hoegh-Guldberg, O. (2005). Global assessment of coral bleaching and required rates of adaptation under climate change. *Global Change Biology*, *11*(12), 2251–2265. https://doi.org/10.1111/j.1365-2486.2005.01073.x

Duke, N. C., Meynecke, J.-O., Dittmann, S., Ellison, A. M., Anger, K., Berger, U., Cannicci, S., Diele, K., Ewel, K. C., Field, C. D., Koedam, N., Lee, S. Y., Marchand, C., Nordhaus, I., & Dahdouh-Guebas, F. (2007). A world without mangroves? *Science (New York, N.Y.)*, *317*(5834), 41–42. https://doi.org/10.1126/science.317.5834.41b

Elliott, J., Deryng, D., Müller, C., Frieler, K., Konzmann, M., Gerten, D., Glotter, M., Flörke, M., Wada, Y., Best, N., Eisner, S., Fekete, B. M., Folberth, C., Foster, I., Gosling, S. N., Haddeland, I., Khabarov, N., Ludwig, F., Masaki, Y., Olin, S., Rosenzweig, C., Ruane, A. C., Satoh, Y., Schmid, E., Stacke, T., Tang, Q., & Wisser, D. (2014). Constraints and potentials of future irrigation water availability on agricultural production under climate change. *Proceedings of the National Academy of Sciences of the United States of America*, *111*(9), 3239–3244. https://doi.org/10.1073/pnas.1222474110

Ens, E., Scott, M. L., Rangers, Y. M., Moritz, C., & Pirzl, R. (2016). Putting indigenous conservation policy into practice delivers biodiversity and cultural benefits. *Biodiversity and Conservation*, *25*(14), 2889–2906. https://doi.org/10.1007/s10531-016-1207-6

Estoque, R. C., & Murayama, Y. (2012). Examining the potential impact of land use/cover changes on the ecosystem services of Baguio city, the Philippines: A scenario-based analysis. *Applied Geography*, *35*(1–2), 316–326. https://doi.org/10.1016/j.apgeog.2012.08.006

FAO. (2010). *Asia-Pacific forests and forestry to 2020. Forest Policy Brief 01 Asia-Pacific Forestry Commission*. Bangkok.

FAO. (2016). *The State of World Fisheries and Aquaculture 2016: Contributing to food security and nutrition for all*. Rome: Food and Agriculture Organization of the United Nations. Retrieved from http://www.fao.org/3/a-i5555e.pdf

Feng, Y., & Liu, Y. (2016). Scenario prediction of emerging coastal city using CA modeling under different environmental conditions: a case study of Lingang New City, China. *Environmental Monitoring and Assessment*, *188*(9). https://doi.org/10.1007/s10661-016-5558-y

Ferraro, P. J., Hanauer, M. M., Miteva, D. a, Canavire-Bacarreza, G. J., Pattanayak, S. K., & Sims, K. R. E. (2013). More strictly protected areas are not necessarily more protective: evidence from Bolivia, Costa Rica, Indonesia, and Thailand. *Environmental Research Letters*, *8*(2), 25011. https://doi.org/10.1088/1748-9326/8/2/025011

Fox, J., Vogler, J. B., Sen, O. L., Giambelluca, T. W., & Ziegler, A. D. (2012). Simulating Land-Cover Change in Montane Mainland Southeast Asia. *Environmental Management*, *49*(5), 968–979. https://doi.org/10.1007/s00267-012-9828-3

Frieler, K., Meinshausen, M., Golly, a., Mengel, M., Lebek, K., Donner, S. D., & Hoegh-Guldberg, O. (2012). Limiting global warming to 2 °C is unlikely to save most coral reefs. *Nature Climate Change*, *2*(9), 1–6. https://doi.org/10.1038/nclimate1674

Fuentes, M. M. P. B., Blackwood, J., Jones, B., Kim, M., Leis, B., Limpus, C. J., Marsh, H., Mitchell, J., Pouzols, F. M., Pressey, R. L., & Visconti, P. (2015). A decision framework for prioritizing multiple management actions for threatened marine megafauna. *Ecological Applications*, *25*(1), 200–214. https://doi.org/10.1890/13-1524.1

Gattuso, J.-P., Magnan, A., Bille, R., Cheung, W. W. L., Howes, E. L., Joos, F., Allemand, D., Bopp, L., Cooley, S. R., Eakin, C. M., Hoegh-Guldberg, O., Kelly, R. P., Portner, H.-O., Rogers, a. D., Baxter, J. M., Laffoley, D., Osborn, D., Rankovic, A., Rochette, J., Sumaila, U. R., Treyer, S., & Turley, C. (2015). Contrasting futures for ocean and society from different anthropogenic CO2 emissions scenarios. *Science*, *349*(6243), aac4722-1-aac4722-10. https://doi.org/10.1126/science.aac4722

Gilman, E. L., Ellison, J., Duke, N. C., & Field, C. (2008). Threats to mangroves from climate change and adaptation options: A review. *Aquatic Botany*, *89*(2), 237–250. https://doi.org/10.1016/J.AQUABOT.2007.12.009

Giri, C., Pengra, B., Zhu, Z., Singh, A., & Tieszen, L. L. (2007). Monitoring mangrove forest dynamics of the Sundarbans in Bangladesh and India using multi-temporal satellite data from 1973 to 2000. *Estuarine, Coastal and Shelf Science*, *73*(1–2), 91–100. https://doi.org/10.1016/J.ECSS.2006.12.019

Giri, C., Zhu, Z., Tieszen, L. L., Singh, A., Gillette, S., & Kelmelis, J. A. (2008). Mangrove forest distributions and dynamics (1975–2005) of the tsunami-affected region of Asia. *Journal of Biogeography*, *35*(3), 519–528. https://doi.org/10.1111/j.1365-2699.2007.01806.x

Gundimeda, H., & Atkinson, G. (2014). Forest wealth of Nations. In UNESCO/UNU-IHDP & UNEP (Eds.), *Inclusive Wealth Report 2014. Measuring progress toward sustainability.* Cambridge: Cambridge University Press.

Hamilton, S. E., & Casey, D. (2016). Creation of a high spatio-temporal resolution global database of continuous mangrove forest cover for the 21st century (CGMFC-21). *Global Ecology and Biogeography*, *25*(6), 729–738. https://doi.org/10.1111/geb.12449

Han, H., Yang, C., & Song, J. (2015). Scenario Simulation and the Prediction of Land Use and Land Cover Change in Beijing, China. *Sustainability*, *7*(4), 4260–4279. https://doi.org/10.3390/su7044260

Hansen, M. C., Potapov, P. V, Moore, R., Hancher, M., Turubanova, S. A., Tyukavina, A., Thau, D., Stehman, S. V, Goetz, S. J., Loveland, T. R., Kommareddy, A., Egorov, A., Chini, L., Justice, C. O., & Townshend, J. R. G. (2013). High-Resolution Global Maps of 21st-Century Forest Cover Change. *Science*, *342*(6160), 850 LP-853. Retrieved from http://science.sciencemag.org/content/342/6160/850.abstract

Hasson, S. ul, Pascale, S., Lucarini, V., & Böhner, J. (2016). Seasonal cycle of precipitation over major river basins in South and Southeast Asia: A review of the CMIP5 climate models data for present climate and future climate projections. *Atmospheric Research*, *180*, 42–63. https://doi.org/10.1016/j.atmosres.2016.05.008

Hejazi, M., Edmonds, J., Clarke, L., Kyle, P., Davies, E., Chaturvedi, V., Wise, M., Patel, P., Eom, J., Calvin, K., Moss, R., & Kim, S. (2014). Long-term global water projections using six socioeconomic scenarios in an integrated assessment modeling framework. *Technological Forecasting and Social Change*, *81*(1), 205–226. https://doi.org/10.1016/j.techfore.2013.05.006

Herzig, A., Dymond, J., & Ausseil, A.-G. (2016). Exploring limits and trade-offs of irrigation and agricultural intensification in the Ruamahanga catchment, New Zealand. *New Zealand Journal of Agricultural Research*, *59*(3), 216–234. https://doi.org/10.1080/00288233.2016.1183685

Hijioka, Y., Lin, E., Pereira, J. J., Corlett, R. T., Cui, X., Insarov, G. E., Lasco, R. D., Lindgren, E., & Surjan, A. (2014). Asia. In V. R. Barros, C. B. Field, D. J. Dokken, M. D. Mastrandrea, K. J. Mach, T. E. Bilir, M. Chatterjee, K. L. Ebi, Y. O. Estrada, R. C. Genova, B. Girma, E. S. Kissel, A. N. Levy, S. MacCracken, P. R. Mastrandrea, & L. L. White (Eds.), *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (pp. 1327–1370). Cambridge, United Kingdom and New York, USA: Cambridge University Press.

Hoegh-Guldberg, O., Mumby, P. J., Hooten, A. J., Steneck, R. S., Greenfield, P., Gomez, E., Harvell, C. D., Sale, P. F., Edwards, A. J., Caldeira, K., Knowlton, N., Eakin, C. M., Iglesias-Prieto, R., Muthiga, N., Bradbury, R. H., Dubi, A., & Hatziolos, M. E. (2007). Coral reefs under rapid climate change and ocean acidification. *Science (New York, N.Y.)*, *318*(5857), 1737–1742. https://doi.org/10.1126/science.1152509

Hossain, M. S., Eigenbrod, F., Amoako Johnson, F., & Dearing, J. A. (2016). Unravelling the interrelationships between ecosystem services and human wellbeing in the Bangladesh delta. *International Journal of Sustainable Development & World Ecology*, *24*(2), 1–15. https://doi.org/10.1080/13504509.2016.1182087

Hosseinali, F., Alesheikh, A. A., & Nourian, F. (2013). Agent-based modeling of urban land-use development, case study: Simulating future scenarios of Qazvin city. *Cities*, *31*(November 2015), 105–113. https://doi.org/10.1016/j.cities.2012.09.002

Hou, Y., Zhou, S., Burkhard, B., & Muller, F. (2014). Socioeconomic influences on biodiversity, ecosystem services and human well-being: A quantitative application of the DPSIR model in Jiangsu, China. *Science of the Total Environment*, *490*, 1012–1028. https://doi.org/10.1016/j.scitotenv.2014.05.071

Hubacek, K., Guan, D., & Barua, A. (2007). Changing lifestyles and consumption patterns in developing countries: A scenario analysis for China and India. *Futures*, *39*(9), 1084–1096. https://doi.org/10.1016/j.futures.2007.03.010

Hubert, B., Rosegrant, M., van Boekel, M. A. J. S., Ortiz, R., & Ortiz, R. (2010). The future of food: Scenarios for 2050. *Crop Science*, *50*(April), 33–50. https://doi.org/10.2135/cropsci2009.09.0530

Hunt, D. V. L., Lombardi, D. R., Atkinson, S., Barber, A. R. G., Barnes, M., Boyko, C. T., Brown, J., Bryson, J., Butler, D., Caputo, S., Caserio, M., Coles, R., Cooper, R. F. D., Farmani, R., Gaterell, M., Hale, J., Hales, C., Hewitt, C. N., Jankovic, L., Jefferson, I., Leach, J., MacKenzie, A. R., Memon, F. A., Sadler, J. P., Weingaertner, C., Whyatt, J. D., & Rogers, C. D. F. (2012). Scenario Archetypes: Converging Rather than Diverging Themes. *Sustainability*, *4*(12), 740–772. https://doi.org/10.3390/su4040740

Immerzeel, W. W., Pellicciotti, F., & Bierkens, M. F. P. (2013). Rising river flows throughout the twenty-first century in two Himalayan glacierized watersheds. *Nature Geoscience*, *6*(9), 742–745. https://doi.org/10.1038/ngeo1896

Immerzeel, W. W., van Beek, L. P. H., & Bierkens, M. F. P. (2010). Climate change will affect the Asian water towers. *Science*, *328*(5984), 1382–1385. https://doi.org/10.1126/science.1183188

IOC-UNESCO, & UNEP. (2016). *Large Marine Ecosystems: Status and Trends*. Nairobi, Kenya.

IPBES. (2016). *Summary for policymakers of the methodological assessment of scenarios and models of biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services*. (S. Ferrier, K. N. Ninan, P. Leadley, R. Alkemade, L. A. Acosta, H. R. Akçakaya, L. Brotons, W. Cheung, V. Christensen, K. H. Harhash, J. Kabubo-Mariara, C. Lundquist, M. Obersteiner, H. Pereira, G. Peterson, R. Pichs-Madruga, N. H. Ravindranath, C. Rondinini, & B. Wintle, Eds.). Bonn, Germany: Secretariat of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services.

IPCC. (1995). *IPCC Second Assessment: A Synthesis Report*. Geneva. Retrieved from https://www.ipcc.ch/pdf/climate-changes-1995/ipcc-2nd-assessment/2nd-assessment-en.pdf

IPCC. (2014). *Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. (O. Edenhofer, R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K. Seyboth, A. Adler, I. Baum, S. Brunner, P. Eickemeier, B. Kriemann, J. Savolainen, S. Schlömer, C. von Stechow, T. Zwickel, & J. C. Minx, Eds.). Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press.

Japan Satoyama Satoumi Assessment (JSSA). (2010). *Satoyama–Satoumi Ecosystems and Human Well-Being: Socio-ecological Production Landscapes of Japan - Summary for Decision Makers.* (A. K. Duraiappah, K. Nakamura, K. Takeuchi, M. Watanabe, & M. Nishi, Eds.). Tokyo.

Kaplan, I. C., & Leonard, J. (2012). From krill to convenience stores: Forecasting the economic and ecological effects of fisheries management on the US West Coast. *Marine Policy*, *36*(5), 947–954. https://doi.org/10.1016/j.marpol.2012.02.005

Khoi, D. N., & Suetsugi, T. (2014). Impact of climate and land-use changes on hydrological processes and sediment yield—a case study of the Be River catchment, Vietnam. *Hydrological Sciences Journal*, *59*(5), 1095–1108. https://doi.org/10.1080/02626667.2013.819433

Koh, L. P., & Ghazoul, J. (2010). Spatially explicit scenario analysis for reconciling agricultural expansion, forest protection, and carbon conservation in Indonesia. *Proceedings of the National Academy of Sciences of the United States of America*, *107*(24), 11140–11144. https://doi.org/10.1073/pnas.1012681107

Kolahi, M., Sakai, T., Moriya, K., & Makhdoum, M. F. (2012). Challenges to the future development of Iran's protected areas system. *Environmental Management*, *50*(4), 750–765. https://doi.org/10.1007/s00267-012-9895-5

König, H. J., Uthes, S., Schuler, J., Zhen, L., Purushothaman, S., Suarma, U., Sghaier, M., Makokha, S., Helming, K., Sieber, S., Chen, L., Brouwer, F., Morris, J., & Wiggering, H. (2013). Regional impact assessment of land use scenarios in developing countries using the FoPIA approach: Findings from five case studies. *Journal of Environmental Management*, *127*, S56–S64. https://doi.org/10.1016/j.jenvman.2012.10.021

Kubiszewski, I., Anderson, S. J., Costanza, R., & Sutton, P. C. (2016). The Future of Ecosystem Services in Asia and the Pacific. *Asia and the Pacific Policy Studies*, *3*(3), 389–404. https://doi.org/10.1002/app5.147

Kumar, N., Hammill, M., & Raihan, S. (2016). Strategies for Achieving the Sustainable Development Goals (SDGs) in South Asia : Lessons from Policy Simulations, (August).

Kwiatkowski, L., Cox, P., Halloran, P. R., Mumby, P. J., & Wiltshire, A. J. (2015). Coral bleaching under unconventional scenarios of climate warming and ocean acidification. *Nature Climate Change*, *5*(8), 777–781. https://doi.org/10.1038/nclimate2655

Lal, M. (2011). Implications of climate change in sustained agricultural productivity in South Asia. *Regional Environmental Change*, *11*(SUPPL. 1), 79–94. https://doi.org/10.1007/s10113-010-0166-9

Lam, V. W. Y., Cheung, W. W. L., Reygondeau, G., & Sumaila, U. R. (2016). Projected change in global fisheries revenues under climate change. *Scientific Reports*, *6*, 32607. https://doi.org/10.1038/srep32607

Machovina, B., Feeley, K. J., & Ripple, W. J. (2015). Biodiversity conservation: The key is reducing meat consumption. *Science of the Total Environment*, *536*, 419–431. https://doi.org/10.1016/j.scitotenv.2015.07.022

Magnan, A. K., Colombier, M., Billé, R., Joos, F., Hoegh-Guldberg, O., Pörtner, H.-O., Waisman, H., Spencer, T., & Gattuso, J.-P. (2016). Implications of the Paris agreement for the ocean. *Nature Climate Change*, *6*(8), 732–735. https://doi.org/10.1038/nclimate3038

Memon, A. A. (2005). Devastation of the Indus River Delta. In *Impacts of Global Climate Change* (pp. 1–12). Reston, VA: American Society of Civil Engineers. https://doi.org/10.1061/40792(173)500

Millennium Ecosystem Assessment. (2005). *Ecosystems and Human Well-being: Synthesis*. Washington, DC: Island Press. Retrieved from file:///C:/Users/okayasu/AppData/Local/Mendeley Ltd./Mendeley Desktop/Downloaded/Millennium Ecosystem Assessment - 2005 - Ecosystems and Human

Well-being Synthesis.pdf
Mitchell, M., Lockwood, M., Moore, S. A., & Clement, S. (2015). Scenario analysis for biodiversity conservation: A social–ecological system approach in the Australian Alps. *Journal of Environmental Management*, *150*, 69–80.
Mitchell, M., Lockwood, M., Moore, S. A., Clement, S., Gilfedder, L., & Anderson, G. (2016). Using scenario planning to assess governance reforms for enhancing biodiversity outcomes. *Land Use Policy*, *50*, 559–572. https://doi.org/10.1016/J.LANDUSEPOL.2015.10.020
Monjezi, M., Shahriar, K., Dehghani, H., & Samimi Namin, F. (2009). Environmental impact assessment of open pit mining in Iran. *Environmental Geology*, *58*(1), 205–216. https://doi.org/10.1007/s00254-008-1509-4
Mozumder, C., & Tripathi, N. K. (2014). Geospatial scenario based modelling of urban and agricultural intrusions in Ramsar wetland deepor beel in northeast India using a multi-layer perceptron neural network. *International Journal of Applied Earth Observation and Geoinformation*, *32*(1), 92–104. https://doi.org/10.1016/j.jag.2014.03.002
Munday, P. L., Jones, G. P., Pratchett, M. S., & Williams, A. J. (2008). Climate change and the future for coral reef fishes. *Fish and Fisheries*, *9*(3), 261–285. https://doi.org/10.1111/j.1467-2979.2008.00281.x
Nakicenovic, N., Alcamo, J., Grubler, A., Riahi, K., Roehrl, R. A., Rogner, H.-H., & Victor, N. (2000). *Special Report on Emissions Scenarios (SRES), A Special Report of Working Group III of the Intergovernmental Panel on Climate Change*. Cambridge University Press.
Nguyen, Q., Hoang, M. H., Öborn, I., & van Noordwijk, M. (2013). Multipurpose agroforestry as a climate change resiliency option for farmers: An example of local adaptation in Vietnam. *Climatic Change*, *117*(1–2), 241–257. https://doi.org/10.1007/s10584-012-0550-1
ONS. (2014). *UK Environmental Accounts*. London.
Ornetsmüller, C., Verburg, P. H., & Heinimann, A. (2016). Scenarios of land system change in the Lao PDR: Transitions in response to alternative demands on goods and services provided by the land. *Applied Geography*, *75*, 1–11. https://doi.org/10.1016/j.apgeog.2016.07.010
Pandolfi, J. M., Connolly, S. R., Marshall, D. J., & Cohen, A. L. (2011). Projecting Coral Reef Futures Under Global Warming and Ocean Acidification. *Science*, *333*(6041), 418–422. https://doi.org/10.1126/science.1204794
Pascoe, S., Kahui, V., Hutton, T., & Dichmont, C. (2016). Experiences with the use of bioeconomic models in the management of Australian and New Zealand fisheries. *Fisheries Research*, *183*, 539–548. https://doi.org/10.1016/j.fishres.2016.01.008
PBL. (2012). *Roads from Rio+20 Pathways to achieve global sustainability goals by 2050*. The Hague: PBL Netherlands Environmental Assessment Agency. Retrieved from http://www.pbl.nl/sites/default/files/cms/publicaties/PBL_2012_Roads from Rio_500062001.pdf
PBL. (2014). *How sectors can contribute to sustainable use and conservation of biodiversity*. (M. Kok & R. Alkemade, Eds.). Montreal: Secretariat of the Convention on Biological Diversity. Retrieved from http://www.pbl.nl/sites/default/files/cms/PBL_GBO4_Sectoral mainstreaming_low_res.pdf
Pei, F., Li, X., Liu, X., Lao, C., & Xia, G. (2015). Exploring the response of net primary productivity variations to urban expansion and climate change: A scenario analysis for Guangdong Province in China. *Journal of Environmental Management*, *150*, 92–102. https://doi.org/10.1016/j.jenvman.2014.11.002
Purushothaman, S., Patil, S., Francis, I., König, H. J., Reidsma, P., & Hegde, S. (2013). Participatory impact assessment of agricultural practices using the land use functions framework: case study from India. *International Journal of Biodiversity Science, Ecosystem Services & Management*, *9*(1), 2–12. https://doi.org/10.1080/21513732.2012.721005
Quinn, J. M., Monaghan, R. M., Bidwell, V. J., & Harris, S. R. (2013). A Bayesian Belief Network approach to evaluating complex effects of irrigation-driven agricultural intensification scenarios on future aquatic environmental and economic values in a New Zealand catchment. *Marine and Freshwater Research*, *64*(5), 460–474. https://doi.org/10.1071/MF12141
Ramsar Convention Secretariat. (2012). *Limits of acceptable change. The definition and operation of concepts and approaches for "limits of acceptable change" which may be applicable to the Ramsar context of defining and detecting change in the ecological character of wetlands.*

Ramsar COP11 DOC.
Raskin, P., Banuri, T., Gallopín, G., Gutman, P., Hammond, A., Kates, R., & Swart, R. (2002). *Great Transition: The promise and lure of the times ahead. A report of the Global Scenario Group.* Boston: Stockholm Environment Institute. Tellus Institute. Retrieved from http://greattransition.org/documents/Great_Transition.pdf
Raskin, P. D. (2005). Global Scenarios: Background Review for the Millennium Ecosystem Assessment. *Ecosystems*, *8*(2), 133–142. https://doi.org/10.1007/s10021-004-0074-2
Raudsepp-Hearne, C., Peterson, G. D., Tengö, M., Bennett, E. M., Holland, T., Benessaiah, K., MacDonald, G. K., & Pfeifer, L. (2010). Untangling the Environmentalist's Paradox: Why Is Human Well-being Increasing as Ecosystem Services Degrade? *BioScience*, *60*(8), 576–589. https://doi.org/10.1525/bio.2010.60.8.4
Raunikar, R., Buongiorno, J., Turner, J. A., & Zhu, S. (2010). Global outlook for wood and forests with the bioenergy demand implied by scenarios of the Intergovernmental Panel on Climate Change. *Forest Policy and Economics*, *12*(1), 48–56. https://doi.org/10.1016/j.forpol.2009.09.013
Reyes-Nivia, C., Diaz-Pulido, G., Kline, D., Guldberg, O. H., & Dove, S. (2013). Ocean acidification and warming scenarios increase microbioerosion of coral skeletons. *Global Change Biology*, *19*(6), 1919–1929. https://doi.org/10.1111/gcb.12158
Richards, D. R., Warren, P. H., Maltby, L., & Moggridge, H. L. (2017). Awareness of greater numbers of ecosystem services affects preferences for floodplain management. *Ecosystem Services*, *24*, 138–146. https://doi.org/10.1016/j.ecoser.2017.02.001
Rutten, M., Van Dijk, M., Van Rooij, W., & Hilderink, H. (2014). Land use dynamics, climate change, and food security in Vietnam: A global-to-local modeling approach. *World Development*, *59*, 29–46. https://doi.org/10.1016/j.worlddev.2014.01.020
Ruzicka, J. J., Steele, J. H., Ballerini, T., Gaichas, S. K., & Ainley, D. G. (2013). Dividing up the pie: Whales, fish, and humans as competitors. *Progress in Oceanography*, *116*, 207–219. https://doi.org/10.1016/j.pocean.2013.07.009
Sangha, K. K., Le Brocque, A., Costanza, R., & Cadet-James, Y. (2015). Application of capability approach to assess the role of ecosystem services in the well-being of Indigenous Australians. *Global Ecology and Conservation*, *4*, 445–458. https://doi.org/10.1016/j.gecco.2015.09.001
Satterfield, T., Gregory, R., Klain, S., Roberts, M., & Chan, K. M. (2013). Culture, Intangibles and metrics in environmental management. *Journal of Environmental Management*, *117*, 103–114. https://doi.org/10.1016/j.jenvman.2012.11.033
Schaldach, R., Priess, J. A., & Alcamo, J. (2011). Simulating the impact of biofuel development on country-wide land-use change in India. *Biomass and Bioenergy*, *35*(6), 2401–2410. https://doi.org/10.1016/j.biombioe.2010.08.048
Schleussner, C. F., Lissner, T. K., Fischer, E. M., Wohland, J., Perrette, M., Golly, A., Rogelj, J., Childers, K., Schewe, J., Frieler, K., Mengel, M., Hare, W., & Schaeffer, M. (2016). Differential climate impacts for policy-relevant limits to global warming: The case of 1.5 °c and 2 °c. *Earth System Dynamics*, *7*(2), 327–351. https://doi.org/10.5194/esd-7-327-2016
Schmitt Olabisi, L. K., Kapuscinski, A. R., Johnson, K. A., Reich, P. B., Stenquist, B., & Draeger, K. J. (2010). Using Scenario Visioning and Participatory System Dynamics Modeling to Investigate the Future: Lessons from Minnesota 2050. *Sustainability*, *2*(8), 2686–2706. https://doi.org/10.3390/su2082686
Shooshtari, S. J., & Gholamalifard, M. (2015). Scenario-based land cover change modeling and its implications for landscape pattern analysis in the Neka Watershed, Iran. *Remote Sensing Applications: Society and Environment*, *1*, 1–19. https://doi.org/10.1016/j.rsase.2015.05.001
Skewes, T. D., Hunter, C. M., Butler, J. R. A., Lyne, V. D., Suadnya, W., & Wise, R. M. (2016). The Asset Drivers, Well-being Interaction Matrix (ADWIM): A participatory tool for estimating future impacts on ecosystem services and livelihoods. *Climate Risk Management*, *12*, 69–82. https://doi.org/10.1016/j.crm.2015.08.001
Sodhi, N. S., Koh, L. P., Brook, B. W., & Ng, P. K. L. (2004). Southeast Asian biodiversity: an impending disaster. *Trends in Ecology & Evolution*, *19*(12), 654–660. https://doi.org/10.1016/J.TREE.2004.09.006
Soora, N. K., Aggarwal, P. K., Saxena, R., Rani, S., Jain, S., & Chauhan, N. (2013). An assessment of

regional vulnerability of rice to climate change in India. *Climatic Change*, *118*(3–4), 683–699. https://doi.org/10.1007/s10584-013-0698-3
Spalding, M., Kainuma, M., & Collins, L. (2010). *World Atlas of Mangroves*. *A collaborative project of ITTO, ISME, FAO, UNEP-WCMC, UNESCO-MAB, UNU-INWEH and TNC* (version 1.). London, UK: Earthscan, London. Retrieved from http://data.unep-wcmc.org/pdfs/5/WCMC-011-AtlasMangrove2010-Metadata.pdf?1479472733
Suwarno, A., van Noordwijk, M., Weikard, H. P., & Suyamto, D. (2016). Indonesia's forest conversion moratorium assessed with an agent-based model of Land-Use Change and Ecosystem Services (LUCES). *Mitigation and Adaptation Strategies for Global Change*, 1–19. https://doi.org/10.1007/s11027-016-9721-0
Syvitski, J. P. M., Kettner, A. J., Overeem, I., Hutton, E. W. H., Hannon, M. T., Brakenridge, G. R., Day, J., Vörösmarty, C., Saito, Y., Giosan, L., & Nicholls, R. J. (2009). Sinking deltas due to human activities. *Nature Geoscience*, *2*(10), 681–686. https://doi.org/10.1038/ngeo629
Tadaki, M., Allen, W., & Sinner, J. (2015). Revealing ecological processes or imposing social rationalities? The politics of bounding and measuring ecosystem services. *Ecological Economics*, *118*, 168–176. https://doi.org/10.1016/j.ecolecon.2015.07.015
Takao, S., Kumagai, N. H., Yamano, H., Fujii, M., & Yamanaka, Y. (2015). Projecting the impacts of rising seawater temperatures on the distribution of seaweeds around Japan under multiple climate change scenarios. *Ecology and Evolution*, *5*(1), 213–223. https://doi.org/10.1002/ece3.1358
Teh, L. S. L., Witter, A., Cheung, W. W. L., Sumaila, U. R., & Yin, X. (2017). What is at stake? Status and threats to South China Sea marine fisheries. *Ambio*, *46*(1), 57–72. https://doi.org/10.1007/s13280-016-0819-0
Thapa, R. B., Shimada, M., Watanabe, M., Motohka, T., & Shiraishi, T. (2013). The tropical forest in south east Asia: Monitoring and scenario modeling using synthetic aperture radar data. *Applied Geography*, *41*, 168–178. https://doi.org/10.1016/j.apgeog.2013.04.009
Timothy, D. J. (1999). Participatory planninga View of Tourism in Indonesia. *Annals of Tourism Research*, *26*(2), 371–391. https://doi.org/10.1016/S0160-7383(98)00104-2
Trang, N. T. T., Shrestha, S., Shrestha, M., Datta, A., & Kawasaki, A. (2017). Evaluating the impacts of climate and land-use change on the hydrology and nutrient yield in a transboundary river basin: A case study in the 3S River Basin (Sekong, Sesan, and Srepok). *Science of the Total Environment*, *576*, 586–598. https://doi.org/10.1016/j.scitotenv.2016.10.138
Ty, T. Van, Sunada, K., Ichikawa, Y., & Oishi, S. (2012). Scenario-based Impact Assessment of Land Use/Cover and Climate Changes on Water Resources and Demand: A Case Study in the Srepok River Basin, Vietnam-Cambodia. *Water Resources Management*, *26*(5), 1387–1407. https://doi.org/10.1007/s11269-011-9964-1
UNEP-WCMC. (2016). *The State of Biodiversity in Asia and the Pacific: a mid-term review of progress towards the Aichi Biodiversity Targets*. Cambridge, UK.
UNEP. (2002). *Global Environment Outlook 3 (GEO-3) - Past, present and future perspectives*. London: Earthscan Publications Ltd.
UNEP. (2007). *Global environmental outlook 4*. *Environment for development*. United Nations Environment Programme. https://doi.org/10.2307/2807995
UNEP. (2012). *Global Environment Outlook 5: Environment for the future we want*. Nairobi. Retrieved from http://www.unep.org/geo/geo5.asp
UNEP. (2016). *GEO-6 Regional Assessment for Asia and the Pacific*. Nairobi, Kenya. Retrieved from http://web.unep.org/geo-6-global-environment-outlook-regional-assessment-asia-and-pacific
UNESCAP. (2016). ESCAP Online Statistical Database. Retrieved April 20, 2017, from http://data.unescap.org/escap_stat/
United Nations. (2012). System of Environmental-Economic Accounting - Central Framework. New York.
UNU-IHDP, & UNEP. (2012). *Inclusive Wealth Report 2012. Measuring progress toward sustainability. Summary for Decision-Makers.* Bonn. Retrieved from http://www.ihdp.unu.edu/docs/Publications/Secretariat/Reports/SDMs/IWR SDM Low Resolution.pdf
UNU-IHDP, & UNEP. (2014). *Inclusive Wealth Report 2014. Measuring progress toward*

sustainability. Cambridge: Cambridge University Press.
van Vuuren, D. P., Kok, M., Lucas, P. L., Prins, A. G., Alkemade, R., van den Berg, M., Bouwman, L., van der Esch, S., Jeuken, M., Kram, T., & Stehfest, E. (2015). Pathways to achieve a set of ambitious global sustainability objectives by 2050: Explorations using the IMAGE integrated assessment model. *Technological Forecasting and Social Change*, *98*(March 2015), 303–323. https://doi.org/10.1016/j.techfore.2015.03.005
van Vuuren, D. P., Riahi, K., Moss, R., Edmonds, J., Thomson, A., Nakicenovic, N., Kram, T., Berkhout, F., Swart, R., Janetos, A., Rose, S. K., & Arnell, N. (2012). A proposal for a new scenario framework to support research and assessment in different climate research communities. *Global Environmental Change*, *22*(1), 21–35. https://doi.org/10.1016/j.gloenvcha.2011.08.002
Volkery, A., Ribeiro, T., Henrichs, T., & Hoogeveen, Y. (2008). Your Vision or My Model? Lessons from Participatory Land Use Scenario Development on a European Scale. *Systemic Practice and Action Research*, *21*(6), 459–477. https://doi.org/10.1007/s11213-008-9104-x
Wang, X., Yang, T., Li, X., Shi, P., & Zhou, X. (2017). Spatio-temporal changes of precipitation and temperature over the Pearl River basin based on CMIP5 multi-model ensemble. *Stochastic Environmental Research and Risk Assessment*, *31*(5), 1077–1089. https://doi.org/10.1007/s00477-016-1286-7
Wardropper, C. B., Gillon, S., Mase, A. S., Mckinney, E. A., Carpenter, S. R., & Rissman, A. R. (2016). Local perspectives and global archetypes in scenario development. *Ecology and Society*, *21*(2), 12. https://doi.org/10.5751/ES-08384-210212
Warren-Thomas, E., Dolman, P. M., & Edwards, D. P. (2015). Increasing Demand for Natural Rubber Necessitates a Robust Sustainability Initiative to Mitigate Impacts on Tropical Biodiversity. *Conservation Letters*, *8*(4), 230–241. https://doi.org/10.1111/conl.12170
Webb, E. L., Jachowski, N. R. A., Phelps, J., Friess, D. A., Than, M. M., & Ziegler, A. D. (2014). Deforestation in the Ayeyarwady Delta and the conservation implications of an internationally-engaged Myanmar. *Global Environmental Change*, *24*(1), 321–333. https://doi.org/10.1016/j.gloenvcha.2013.10.007
Wen, Q. (2014). Review of ecological compensation in China's mining exploitation regions. *Acta Ecologica Sinica*. Retrieved from http://www.ecologica.cn/stxb/ch/reader/view_abstract.aspx?doi=10.5846/stxb201312052898
Wilkinson, C. (2008). *Status of Coral Reefs of the World: 2008*. Townsville, Australia: Global Coral Reef Monitoring Network and Reef and Rainforest Research Centre. Retrieved from http://www.vliz.be/imisdocs/publications/213234.pdf
World Bank. (2011). *The Changing Wealth of Nations: Measuring Sustainable Development in the New Millennium*. Washington, DC: The World Bank. https://doi.org/10.1596/978-0-8213-8488-6
Worm, B. (2016). Averting a global fisheries disaster. *Proceedings of the National Academy of Sciences*, *113*(18), 4895–4897. https://doi.org/10.1073/pnas.1604008113
Worm, B., Barbier, E. B., Beaumont, N., Duffy, J. E., Folke, C., Halpern, B. S., Jackson, J. B. C., Lotze, H. K., Micheli, F., Palumbi, S. R., Sala, E., Selkoe, K. A., Stachowicz, J. J., & Watson, R. (2006). Impacts of biodiversity loss on ocean ecosystem services. *Science*, *314*(5800), 787–790. https://doi.org/10.1126/science.1132294
Worm, B., Hilborn, R., Baum, J. K., Branch, T. A., Collie, J. S., Costello, C., Fogarty, M. J., Fulton, E. A., Hutchings, J. A., Jennings, S., Jensen, O. P., Lotze, H. K., Mace, P. M., & Mcclanahan, T. R. (2009). Rebuilding Global Fisheries. *Science*, *578*(2009). https://doi.org/10.1126/science.1173146
Xiao, J., Wang, M., Yu, Q., & Liu, J. (2015). A study on the evaluation models of ecological compensation standard on the large-scale hydropower engineering construction based on the idea of ecological footprint: A case of Three Gorges Project. *Acta Ecologica Sinica*, *35*(8), 2726–2740. https://doi.org/10.5846/stxb201311182760
Yan, J., & Lin, T. (2009). Biofuels in Asia. *Applied Energy*. https://doi.org/10.1016/j.apenergy.2009.07.004
Yang, W., Dietz, T., Kramer, D. B., Chen, X., & Liu, J. (2013). Going Beyond the Millennium Ecosystem Assessment: An Index System of Human Well-Being. *PLoS ONE*, *8*(5).

https://doi.org/10.1371/journal.pone.0064582
Yang, X., Zhou, Z., Li, J., Fu, X., Mu, X., & Li, T. (2016). Trade-offs between carbon sequestration, soil retention and water yield in the Guanzhong-Tianshui Economic Region of China. *Journal of Geographical Sciences*, *26*(10), 1449–1462. https://doi.org/10.1007/s11442-016-1337-5
Yang, Y. C. E., Asce, A. M., Ringler, C., Brown, C., Asce, M., & Mondal, A. H. (2016). Modeling the Agricultural Water – Energy – Food Nexus in the Indus River Basin , Pakistan, *142*(1993), 1–13. https://doi.org/10.1061/(ASCE)WR.1943-5452.0000710.
Yara, Y., Fujii, M., Yamano, H., & Yamanaka, Y. (2014). Projected coral bleaching in response to future sea surface temperature rises and the uncertainties among climate models. *Hydrobiologia*, *733*(1), 19–29. https://doi.org/10.1007/s10750-014-1838-0
Yara, Y., Vogt, M., Fujii, M., Yamano, H., Hauri, C., Steinacher, M., Gruber, N., & Yamanaka, Y. (2012). Ocean acidification limits temperature-induced poleward expansion of coral habitats around Japan. *Biogeosciences*, *9*(12), 4955–4968. https://doi.org/10.5194/bg-9-4955-2012
Yara, Y., Yamano, H., Steinacher, M., Fujii, M., Vogt, M., Gruber, N., & Yamanaka, Y. (2016). Potential Future Coral Habitats Around Japan Depend Strongly on Anthropogenic CO2 Emissions (pp. 41–56). Springer, Singapore. https://doi.org/10.1007/978-981-10-0780-4_4
Zhao, D., & Wu, S. (2014). Vulnerability of natural ecosystem in China under regional climate scenarios: An analysis based on eco-geographical regions. *Journal of Geographical Sciences*, *24*(2), 237–248. https://doi.org/10.1007/s11442-014-1085-3
Zheng, H. W., Shen, G. Q., Wang, H., & Hong, J. (2015). Simulating land use change in urban renewal areas: A case study in Hong Kong. *Habitat International*, *46*, 23–34.
Ziv, G., Baran, E., Nam, S., Rodriguez-Iturbe, I., & Levin, S. A. (2012). Trading-off fish biodiversity, food security, and hydropower in the Mekong River Basin. *Proceedings of the National Academy of Sciences*, *109*(15), 5609–5614. https://doi.org/10.1073/pnas.1201423109

Appendix

Table 5.5 Selection criteria for identifying regional priorities against the 20 Aichi Biodiversity Targets

Aichi Targets	Theme	Components and/or assumptions within alternative scenario narratives that were presumed to have thematic linkages with the respective target or goal
Aichi Target 1	Understand Values	Synergies and Trade-offs assessment, enhancing knowledge and decision-making capacity as well as scientific novelty of the studies.
Aichi Target 2	Mainstream Biodiversity	Suggests policies to incorporate BES in future development.
Aichi Target 3	Address Incentives	Implementation of REDD/ REDD + mechanism, ameliorative conservation through incentives.
Aichi Target 4	Sustainable Production	Control of deforestation, techno-economic development and implementation of conservation plans.
Aichi Target 5	Halve the rate of Loss	Quantitative targets (in line with Aichi Target 5) for improvements in biodiversity and ecosystem services as well as conservation scenarios
Aichi Target 6	Sustainable Fisheries	Marine/Coastal ecosystem scenarios dealing with distribution, aquatic productivity, sustainable fisheries and aquaculture.
Aichi Target 7	Manage within the limits	Trade-offs in agricultural expansion scenarios, crop productivity, sustainable agriculture
Aichi Target 8	Reduce Pollution	Control of nitrate population in agricultural expansion scenarios
Aichi Target 9	Reduce Invasive Species	Control of invasive alien species
Aichi Target 10	Minimize reef loss	Scenarios depicting fate of coral reefs, provisions for sustainable management
Aichi Target 11	Protected Areas	Consideration for enforcement of protected areas.
Aichi Target 12	Prevent Extinctions	Scenarios depicting risk of annihilation of species or suggesting ameliorative management options
Aichi Target 13	Conserve Gene Pool	Specific mention of genetic pool in one of the scenarios
Aichi Target 14	Restore ecosystems	Alternative scenarios depicting restoration of specific ecosystems, such as forests.
Aichi Target 15	Enhance Resilience	Restoration of 15 per cent of degraded ecosystems, or any other quantitative targets
Aichi Target 16	Implement Nagoya Protocol	Specific mention about Nagoya Protocol in scenario depiction.
Aichi Target 17	Revise NBSAPs	Alternative scenarios outlining ameliorative conservation plan, including implementation of National biodiversity strategies and action plans (NBSAPs).
Aichi Target 18	Respect and Conserve TK	Integration of traditional knowledge and indigenous knowledge in development of one or more scenarios.
Aichi Target 19	Improve Knowledge	Alternative scenarios providing targeted recommendation for knowledge and capacity building
Aichi Target 20	Mobilize resources	Specific mention of mobilization of financial resources for meeting conservation targets

Table 5.6 Selection criteria for identifying regional priorities against the 17 Sustainable Development Goals

Goals	Theme	Components and/or assumptions within alternative scenario narratives that have thematic linkages with the respective target or goal.
SDG-1	End-Poverty	Livelihood and cross-cutting developmental issues, agricultural innovation, implementation of social security schemes, biofuel expansion and favorable techno-economic changes driving employment
SDG-2	Zero Hunger	Intensified food production, agricultural expansion, changes in agricultural land, open markets, food prices, and globalization
SDG-3	Good Health and Well-being	Changes in lifestyle and consumption patterns, Good quality of life (GQL), energy uses, water purification and control of soil pollution
SDG-4	Quality Education	Environmental education and Education for Sustainable Development (ESD)
SDG-5	Gender Equality	Women engagement in conservation and management of ecosystem services.
SDG-6	Clear Water and Sanitation	Water ecosystem Services of river, lakes and reservoirs including availability, quality and purification
SDG-7	Affordable and Clear Energy	Expansion of Biofuels, changing life-styles and consumption patterns, technological innovation
SDG-8	Decent Work and Economic Growth	Urban and economic expansion scenarios, International collaboration
SDG-9	Industry, Innovation and Infrastructure	Industrial and urban innovation, smart cities, environment friendly business
SDG-10	Reduce inequalities	Disproportionate economic growth, fragmented societies and social relations, regionalization
SDG-11	Sustainable Cities and Communities	Urban expansion including special economic zone, peri-urban landscapes, quality of urban life and urban ecosystems, including green spaces.
SDG-12	Responsible Consumption and Production	Land degradation scenarios, exploitation of forests and other natural resources
SDG-13	Climate Action	Scenarios where climate change is one of the main drivers including scenarios utilizing IPCC SRES and RCP narratives
SDG-14	Life below Water	Scenarios which depict future state of marine and coastal ecosystems, including mangroves and coral reefs.
SDG-15	Life on Land	Ecosystems, fragmentation and habitat quality.
SDG-16	Peace, justice and Strong Institutions	Empowerment of social institutions, decentralized management and governance reforms
SDG-17	Partnership for Goals	Participatory, multi-stakeholder based resource conservation, bottom-up/agent-based scenario modelling, issues of regional collaboration (e.g. ASEAN/SAARC) for transboundary ecosystem conservation and management

Chapter 6. Options for Governance and Decision-Making across Scales and Sectors

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Table of Contents

Executive Summary

Sustaining nature and nature's contributions to people (NCP) in the Asia-Pacific region is hinged on a multi-scale, multi-sectoral and multi-stakeholder governance regime (*well established*). The expert driven and centralised governance systems that still exist in varying intensities in almost all parts of the region, are insufficient for promoting a network-based governance linking sub-national and national political hierarchies to regional and global frameworks and adaptive co-management with various local stakeholders from communities, the private sector and civil society. Good environmental governance, which enables integration of regional and global BES frameworks to national sectoral policies and mainstreaming of BES policies into sub-national and local development plans, programs and actions, is crucial for achieving a positive future for BES. Moreover, mainstreaming will entail efforts from the government to enhance acceptance by and participation of various stakeholders. While some countries have responded to these needs, others, in particular Western Asia, have been slow to respond, mainly because of limited institutional capacity in formulating and implementing BES policies and devising innovative mechanisms for generating and mobilising finance. An important step towards this will be the assessment and, wherever necessary, restructuring policy instruments in light of the policy options {6.2.2, 6.2.2.1, 6.2.2.2, 6.4.1, 6.4.2}.

Strengthening instruments and modes for transboundary governance could greatly assist Asia-Pacific region in addressing the challenges of managing shared landscapes and seascapes (*well established*). Regional transboundary systems of environmental management complement the governance efforts at national and global levels. Subregional organizations such as ASEAN, SAARC, and SPREP play a significant role in the development and promotion of transboundary frameworks. However, improvements in transboundary governance mechanisms need to build on trust, crafting institutional frameworks for cross-scale action, inclusive stakeholder engagement, availability of information-base at multiple scales and across sectors and capacity development for holistic and multi-dimensional problem-solving. These could contribute to the success of important transboundary issues such as Asian haze, short lived climate pollutants such as black carbon. Establishing effective cross-border monitoring system based on credible criteria and indicators related to biodiversity and NCP would support information sharing and capacity development for reversing adverse trends in the region. Criteria and indicators need to be relevant and comprehensible to communities and the private sector so that they could effectively participate in mainstreaming BES in local planning and decision-making through their supportive efforts for accountability check on impacts of business operations on nature conservation in the region. For example, BES indicators need to capture interdependencies and synergies with ecosystem factors affecting livelihood, food security and quality of life {6.2.1, 6.2.2.1, 6.4.2.2, 6.4.3}.

Multiple partnerships across sectors could enhance financial and technical capacity for BES management and conservation at different governance scale (*established but incomplete*). There exist good potential for a new kind of public-private-civil society partnership development led by government agencies with an active participation of non-government organizations and private sector to engage corporations in allocating funds for BES conservation (e.g. Payments for Ecosystem Services (PES), Carbon Offsets) and increase commitments towards corporate social responsibility (e.g. voluntary sustainability standards) in the Asia-Pacific region. Innovative finance mechanisms through public-private partnership provide an opportunity for using market-based approach such as REDD-plus and other PES schemes to fund BES initiatives. Partnerships with the development partners (e.g. international non-governmental organizations, non-governmental organizations, multilateral development banks) not only increase BES finance, but also promote the transfer of technical knowledge for BES management to the local government and communities as in the case of participatory programmes (e.g. REDD-plus) {6.2.2.2, 6.2.3.1, 6.4.1.3, 6.4.1.5, 6.4.2.4}.

Well-designed partnership with the private sector can improve accountability in their business operations particularly in cases where environmental valuation of true benefits and costs of BES

provision and use is difficult (*established but incomplete*). Wider acceptance and more positive response is experienced in certifications and standards of BES goods and services that aim to achieve uniformity and consistency in environmental management systems. More and more private producers and firms are adopting Voluntary Sustainability Standards, Participatory Guarantee System and other certification schemes in North and South-East Asia as well as Oceania to meet export demand in the developed countries. Because VSS depends on private sector's voluntarism, it needs to be complemented with other policy instruments to promote its use and contribution to a more effective BES governance. Market-based instruments implemented through strict regulatory framework remain the status quo in the Asia-Pacific region because they have long been embedded in the governance system and provide an opportunity for raising revenues not only to address environmental but also other social and economic objectives. The use of appropriate regulatory instruments could create an enabling environment for adoption of universal standards and quality certifications {6.2.2.2, 6.4.1.1, 6.4.2.4, 6.4.2.7}.

Community-based management indicates a viable option for the governance of protected areas and shared natural areas and for mainstreaming BES in planning and decision-making, but the experience remains limited in some countries in the Asia-Pacific region (*well established*). Many countries in the region have long been promoting policies that support the implementation of community-based biodiversity conservation programs and projects. Moreover, indigenous and local knowledge of communities and their traditional organizations that support them are being increasingly acknowledged and effectively utilised in strengthening community-based management regimes. The strength of community-based management is better recognised as; these are built on indigenous and local practices and customary laws. Also, they build on the capacity of communities to learn and use innovative approaches that helps them adapt to global economic and climatic changes. The use of community-based management as a governance option needs to be up-scaled and where possible replicated within and outside countries to incentivise local people, private sector and civil society as a whole for conservation and combating environmental degradation in the Asia-Pacific region {6.2.3.1, 6.4.1.4, 6.4.1.5, 6.4.2.1, 6.4.2.4, 6.4.3.3}.

Rights based approaches and instruments can not only aim to protect land rights and indigenous knowledge, but also promote gender equality and social inclusion by promoting stewardship role of women and indigenous local communities in resource governance and management (*established but incomplete*). Given the high bio-cultural diversity, and the fact that a significant proportion of biodiversity of the region exists in areas outside the formal protected area network, the Asia-Pacific region is witnessing increased use of rights-based approaches and instruments in conservation policy and programming. Strengthening participatory and community based resource governance models, providing opportunities for producers and usufruct right holders to negotiate fair outcomes while also ensuring the protection of the rights of vulnerable communities and groups, can play an important role in furthering the adoption of rights based approaches in policies and programmes for securing access to biodiversity and ecosystem services in this region. Ensuring social and gender equity and equality, and promoting women's stewardship in conservation, needs to form an integral part of community-based governance process which will also address the existing asymmetry in participation and decision-making by women and marginalised groups due to elite dominance {6.2.3.1, 6.2.3.2, 6.2.3.3, 6.4.1.4}.

Synergies in policies across ecosystems and sectors are required to effectively address the adverse influence of drivers of change on biodiversity and NCP (*unresolved*). There has been an improvement in natural resources management policies and regulatory frameworks in the Asia-Pacific region for addressing environmental issues affecting human well-being largely due to the voice raised by civil society and enabling government legislations. Although indirect and direct drivers are synergistically impacting biodiversity and NCP. However, since due to archaic institutional arrangements in the natural resource management sector, there is limited consideration of multi-sectoral within these reformed policies (such as between policies related to biodiversity, energy, and food security). Policy synergies across ecosystems and sectors can be enhanced through integrative frameworks, partnership development, institutional innovations, inter-sectoral cooperation mechanism such as interdisciplinary committee, and use of smart policy instrument mixes {6.3.2, 6.2.2.1, 6.2.2.2}.

The diverse, multi-scalar and multi-sectoral drivers of change in nature and NCP can be best addressed with a smart and coherent policy instrument-mix (*established but incomplete*). The Asia-Pacific region is responding to the requirements of multi-scale (ecosystem and political) and multi-sectoral governance (transboundary, protected areas, community-based) and multiple-partnership (private interest on economic profit, community interest on rights and culture) by diversifying the instrument mix from conventional command and control approaches to increased use of incentivised economic, policy, regulatory and financial instruments in almost all the subregions of the Asia-Pacific region. Right based and human rights-based instruments (in Oceania, South and South East Asia), social and cultural instruments (in South Asia, South East Asia and Oceania), and management based instruments (South Asia, South East Asia and Oceania) are also prevailing. The role of formal institutions, in the form of laws, regulations, standards and planning requirements, would continue to be significant as a binding framework for the functioning of other policy instruments although informal institutions empowered by the indigenous and local knowledge systems also play critical roles in promoting community-based natural resources management. However, sectoral policy instrument design that inadequately addresses indigenous and local people's perspectives, needs, and aspirations for creating distributional consequences of policy interventions remains a challenge {6.4.1, 6.4.2, 6.4.4}.

Institutional, governance and policy frameworks have to create an enabling environment for effective participation and implementation of multiple partnership initiatives for BES (*well established*). A number of countries in the Asia-Pacific region have shifted from centralised to participatory mode of natural resource management and from regulatory to human-rights based approaches on resource governance to address the increasing societal pressure on the resources and citizen's demand for the democratic and transparent process in common property resources management. The emerging challenges from rapidly transforming society will need transformative governance systems that are responsive to these changes, but many countries in the region are yet to respond to these challenges. The business as usual approach to decision-making in natural resource management is not an option if adverse trends for each subregion's biodiversity and NCP are to be reversed. Governance options that match the socio-economic and institutional conditions in alternative pathways of development (e.g. green growth, low-carbon, etc.) will help to achieve globally set targets and goals. The commitment to achieve the Aichi Biodiversity Targets, Paris Agreement, and Sustainable Development Goals has been encouraging in some countries in the region who have undertaken the necessary governance transformation {6.2.2.2, 6.3.1, 6.3.4, 6.4.2, 6.4.3}.

Efforts for achieving the 2020 global biodiversity goals are accelerating at regional, national and sub-national levels, but are not sufficient enough to prevent trends of biodiversity loss, and cannot be met under current trajectories (*well established*). In response to the 2011-2020 Strategic Plan and global biodiversity goals, countries of the Asia-Pacific region have taken several affirmative actions (such as design and implementation of NBSAPs, inclusion of conservation objectives in overarching development framework, targeting policy instruments at addressing adverse land use, land-use change, and forestry, increase in protected area coverage (particular in NE Asia) inclusion of co-management and collaborative governance approaches, and formulation of green growth and low carbon development strategy. These measures are however not sufficient, as indicated by no progress on several targets (8 in Western Asia, 6 in South Asia and 5 each in rest of the regions) and changes in adverse direction often aggravated by climate change (in pollution-related targets in South Asia and North East Asia and reducing deforestation and habitat loss in South East Asia). Targets related to awareness rising on biodiversity, sustainable management of marine resources (except Oceania), reducing pressure on vulnerable ecosystems, and increase in financial resources from all sources have seen no significant overall progress in all the subregions. Realignment of incentives, use of smart policy mixes, building innovative partnerships with private sector to increase investment in green sector at various levels are viable options. Increased use of co-management and participatory governance mechanisms are the possible options in which bottlenecks limiting the achievement of biodiversity goals can be addressed {6.4.1, 6.4.2, 6.4.3, 6.5}.

Ecosystem-based integrative approaches that reinforce nature and NCP can support the Asia-Pacific region countries in realising sustainable development goals while securing the regions diverse natural capital (*established but incomplete*). Synergies as well as trade-offs exist, at multiple scales and sectors, between SDGs and BES management goals. Ecosystem-based integrative approaches are increasingly being adopted within the Asia-Pacific region as a mechanism for adapting to climate change (ecosystem based adaptation or EbA), reducing emissions from forest (REDD-plus) and incentivising community-based forest and water management (PES). However, scaling up of these community-based successes and increasing policy coherence will have to be done to achieve sustainable development goals. In particular, integrating biodiversity conservation in programmes related to SDGs will be necessary. Replication and upscaling of such approaches by considering ecosystems' ecological and socio-political contexts can help in ensuring that sustainable development pathways effectively complement, and to a large extent, internalise BES goals {6.4.3, 6.6}.

Given the developmental challenges in the Asia-Pacific region, an important policy imperative is to mainstream BES within developmental plans, programmes and actions, and simultaneously ensure explicit consideration of developmental outcomes within conservation policies and programmes (*established but incomplete*). Six major target sectors wherein biodiversity mainstreaming is urgently required, include, a) economic, trade and development policies; b) transport, energy and mining activities; c) agriculture, fisheries and forestry practices; d) corporate strategies and operations; e) development policies and planning at local, national and regional levels; and f) public procurement and private consumption. Placing biodiversity goals within sectoral decision-making systems within those ministries not directly concerned with biodiversity issues, such as the Ministries of Finance, Agriculture, Infrastructure, Planning, Tourism and Education and others remains a challenge. Use of diverse policy instrument mixes (such as coupling command and control instruments with economic and financial instruments) and integrative planning and implementation approaches (such as ecosystem-based adaptation and ecosystem based disaster risk reduction) can assist such mainstreaming efforts {6.2.2.1, 6.2.2.2, 6.3, 6.4.1, 6.4.4}.

Replication and upscaling of promising governance options across the Asia-Pacific will require building institutional and governance capacity of the national and local governments (*inconclusive*). The governments from national to local levels will need to support a cross-scale decentralised and devolved governance to ensure sustainable management of biodiversity and NCP. These entities have to develop their institutional capacity to adopt these pluralistic governance options and less regulated policy instruments. The support for such transition could come from development partners such as UN agencies, intergovernmental organizations, and private sectors. Best practices already available in the subregions can guide the governments on how to transform highly centralised and regulated system into a more collaborative form of governance. Sharing of national, regional and also global best practices using modern information and communication technologies will facilitate the efficient and effective transformation of decision-making system {6.4.2, 6.4.3, 6.7}.

6.1 Introduction

6.1.1 Rationale and context

The Asia-Pacific region encompasses some of the world's greatest ecological, cultural and economic diversity (see chapter 1). It covers 8.6 per cent of the Earth's total surface area and nearly 30 per cent of its land area (UNEP, 2010). Many different types of ecosystems including the spectacular Himalayan Mountains, forests of South East Asia, deserts of Central Asia and Arabia, the rainforests and arid plains of Australia and small island archipelagos of the Pacific, ranging from the tropics to the sub-arctic, have contributed to the richness of the biological and cultural diversity of the region. The forest resources of the region alone account for nearly 18 per cent of the global forest cover. Asia is home to the world's top 10 countries in terms of expanses of mangrove resources with exceptionally high biodiversity, as well as the world's most extensive and diverse reefs (about 28 per cent of the global total) in the Coral Triangle area of South East Asia. The Asia-Pacific region, which is home to around 60 per cent of the total world population, is also a very diverse region in terms of its social and economic environment. It includes, on the one hand, the smallest and some of the poorest countries and countries with very basic welfare systems, and on the other hand, seven of the world's 10 most populous countries, and some of the fastest growing and highly developed economies (International Social Work, 2014). With its diversity of human capital as an asset, the region has enjoyed remarkable economic growth in the last four decades. However, many parts of the society continue to live in impoverished and marginalised conditions. Moreover, current trends mean the region is likely to become less ecologically and culturally diverse, due to the rapid consumption of resources required for economic growth, as well as changes in human lifestyles as a result of globalisation and urbanization.

Today, most Asia-Pacific territories are facing economic and environmental challenges such as (i) increased demand for seafood for human consumption (demand is projected to increase by 50 per cent by 2030, which is well in excess of what coastal areas are currently able to produce without significant improvements in management and productivity) (Bell *et al.*, 2009; Bell *et al.*, 2011; Bryant *et al.*, 2011; Gillett, 2009; Kronen *et al.*, 2010), (ii) the rapid introduction of a market economy with its associated rural migration, loss of traditional knowledge and customs, and urban poverty (Aswani & Hamilton, 2004; Cinner & Aswani, 2007; Hughes *et al.*, 2012), (iii), limited economic options due to resource constraints (Hargreaves-Allen, 2004; van Beukering *et al.*, 2007), and (iv) climate change impacts on ecosystem services associated with coral reefs (Baker *et al.*, 2008; Bell *et al.*, 2011; Knowlton, 2001). These challenges are reinforced by the fact that national budgets to improve natural resource management are usually small and face considerable competition from other priorities for human development such as health, education and food production.

In view of these challenges, there is a need to improve policies and their implementation for the Biodiversity and Ecosystem Services (BES). Enabling recovery and restoration of degraded ecosystems while simultaneously meeting the growing demand for their services will require "significant changes in policies, institutions, and practices that are not currently underway" (Millennium Ecosystem Assessment, 2005). Three important features of effective policy options would include technical innovations (e.g. new or improved production techniques), policy reforms (e.g. modifying incentives and cost structures to reward sustainable practices), and building new institutions (e.g. multi-scale processes and governance mechanisms to reinforce local ecosystem-based management) (Cormier *et al.*, 2016; Haase *et al.*, 2014; Lubchenco *et al.*, 2016; OECD, 2008). More importantly, to address the issue of weak governance, which is a major driver for biodiversity loss and human poverty (Swiderska *et al.*, 2008), institutions that are responsible for managing resources at various scales need to be strengthened.

Given the critical role of policies and institutions on maintaining and enhancing nature's benefits to people, Chapter 6 assesses BES from a governance perspective. It aims to address the following questions:

(i) What are the current policies and institutions that support BES management and conservation at different ecosystem and political scales?
(ii) What are the role of various actors and organizations in the governance of BES, particularly in mainstreaming BES policies from national to local levels?
(iii) Given the emerging systems of governance, what are the policy instruments and options that could enhance BES management and conservation?
(iv) What are the opportunities and challenges for implementing governance options that cut across scales and sectors?
(v) What are the implications of the emerging governance systems on achieving the Aichi Biodiversity Targets and the Sustainable Development Goals?

6.1.2 Analytical approach

The contemporary concept for governance goes beyond the power and authority of the government, encompasses various stakeholders represented by public and private organizations, and recognises self-governing networks of autonomous actors (e.g. Roe, 2013; Stoker, 1998). The main governance elements are actors (taking roles), organizations (embodying roles) and institutions (accepted rules), which operate at multiple scales and evolve as a consequence of their interactions (Assche *et al.*, 2014). Decision-making is central to governance because it entails coordination of individual actors or actors embedded in organizations. Institutions play a central role in governance, facilitating coordination of actors and organizations (also referred to here as stakeholders). Within the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) Conceptual Framework, institutions and governance systems are indirect drivers, which have direct influence on anthropogenic (direct) drivers of Biodiversity and Ecosystems (see chapter 1). The IPBES defines institutions and governance systems and other indirect drivers as “the ways in which people and societies organize themselves and their interactions with nature at different scales” (Díaz *et al*., 2015, p.6).

> *Institutions encompass all formal and informal interactions among stakeholders and social structures that determine how decisions are taken and implemented, how power is exercised, and how responsibilities are distributed. Various collections of institutions come together to form governance systems, that include interactions between different centres of power in society (corporate, customary-law based, governmental, judicial) at different scales from local through to global. Institutions and governance systems determine, to various degrees, the access to, and the control, allocation and distribution of components of nature and anthropogenic assets and their benefits to people*. (Díaz *et al*., 2015, p.6).

Figure 6.1 presents the framework that was used in this chapter to assess governance, institutional arrangements and private and public decision-making in the Asia-Pacific region. In line with the IPBES Conceptual Framework, the assessment considers multiple governance scales across both the ecosystem and political boundaries. The ecosystems considered include agro-ecosystem, coastal and marine, inland freshwater and wetland, urban and semi-urban, grassland and savannah, forest and woodland, alpine, desert and semi-desert, island, and mountain. The sectors refer to economic resources (e.g. agriculture, fisheries, energy, forest, etc.) as well as administrative roles (e.g. public, private, development). This chapter is based on the assessment of both scientific and grey literature including peer-reviewed journals, academic books and documents, which are published among others by international organizations, non-government organizations and national governments.

Governance at the political scale corresponds to administrative boundaries including regional, subregional, national/sub-national, and local. The regional and subregional scales are important for assessing transboundary agreements and frameworks. The foci of the assessment is the subregional governance system that is shaped by the institutions and organizations/actors, which in turn define the policy options for the sustainable management of BES.

Formal interactions among actors and organizations, which determine how decisions are taken and implemented, how power is exercised, and how responsibilities are distributed, are embodied in institutions. The collections of institutions as well as interactions among actors and organizations, which influence or are influenced by the institutions, form governance systems at different scales (i.e. from local to global). On the one hand, the implementation of governance institutions such as multi-/bilateral agreements, national laws and policies, and customs and traditions is supported by policy instruments. On the other hand, the interaction among the actors and organizations from the government, non-government and private sectors defines the modes of governance. The governance systems influence access to and control of allocation and distribution of natural and human assets and their benefits to people. Ultimately, they influence global environmental change by interacting with nature through the anthropogenic direct drivers. In many Asia-Pacific countries, environmental governance is a shared responsibility with public, private and civil society organizations as well as indigenous and local communities.

The governance systems in the Asia-Pacific face the challenge of achieving the Aichi Biodiversity Targets and Sustainable Development Goals in order to reduce negative impacts on BES while achieving sustainable development. The governance systems relevant for the Asia-Pacific Regional Assessment can be posited at different political hierarchies, ranging from sub-national, national, to regional frameworks, as well as global cooperation frameworks influencing the former levels. For example, the United Nations Environment Programme (UNEP) enhances environmental governance in the Asia-Pacific region by working with various authorities, organizations and stakeholders (i.e. intergovernmental bodies, environment ministries and authorities, research organizations, international bodies, UN agencies and major groups and stakeholders) to identify and address common, transboundary and emerging environmental issues (http://web.unep.org/). A key consideration is to understand the issues that make institutions and linked governance arrangements adequate and effective for maintaining BES in the Asia-Pacific region.

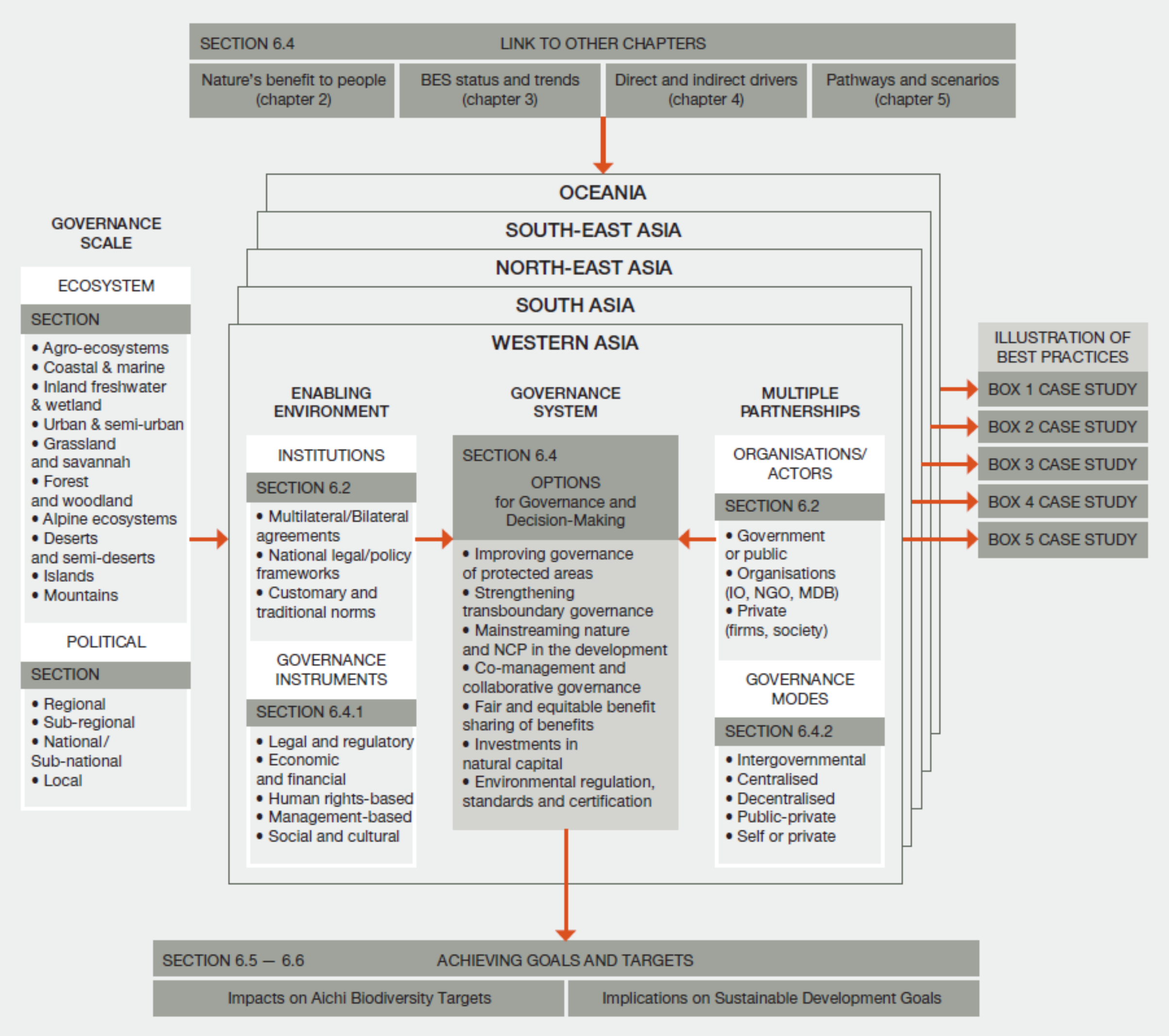


Figure 6.1 Analytical framework for BES governance and decision-making across scales and sectors in the Asia-Pacific region

In the Asia-Pacific assessment framework, the options for governance and decision-making are influenced by two components – the enabling environment and multiple partnerships (Figure 6.1). The former is defined according to five governance instruments (legal and regulatory, economic and financial, human rights-based, management-based, and social and cultural) that are formed through institutions at the international, national and local levels, while the latter refers to the five governance modes (i.e. intergovernmental, centralised, decentralised, public-private, self or private) arising from the partnerships between organizations or among actors within an organization (Figure 6.2). The instruments are described in details in section 6.4.1. Chapter 6 of the Europe and Central Asia Assessment Report described the governance modes as follows: centralised is considered hierarchical with central governmental as main actors; decentralised is described as subsidiarity with governments at lower administrative levels as main actors; public-private is the partnership between the central government and private sectors; and self/private is governance mainly by non-governmental organizations. In addition to these, the Asia-Pacific region assessment consider intergovernmental as relevant distinct governance mode due to the increasing role of intergovernmental organizations in addressing global challenges. Decision-making in intergovernmental governance occur at the supranational level (regional or global), with member states giving up some of their sovereignty when signing and ratifying agreements (Berg 2009; Bernstein, 2011).

The assessment of the policy environment in the Asia-Pacific region is aimed at defining features of the institutions and governance in which BES exist and future trends are projected (chapter 3). This chapter is thus linked to the earlier chapters (see 6.1.3). In addition to chapter 3, it links to chapter 2 on nature's benefits to people and quality of life status and chapter 4 on direct and indirect drivers of change. Moreover, an analysis of degree of fit between the elements of the governance systems and the trends in respective biomes can be used as a framework for assessing the likelihood of policy solutions in securing positive future for BES in the region. This chapter thus extends the scenarios described in chapter 5 to analyse alternative pathways for BES policy options and mixes. Within these various contexts, this chapter provides case studies of best practices for the different options of governance and decision-making. Finally, in assessing governance potential and constraints, this chapter outlines options available to reach the Aichi Biodiversity Targets and Sustainable Development Goals (Figure 6.1).

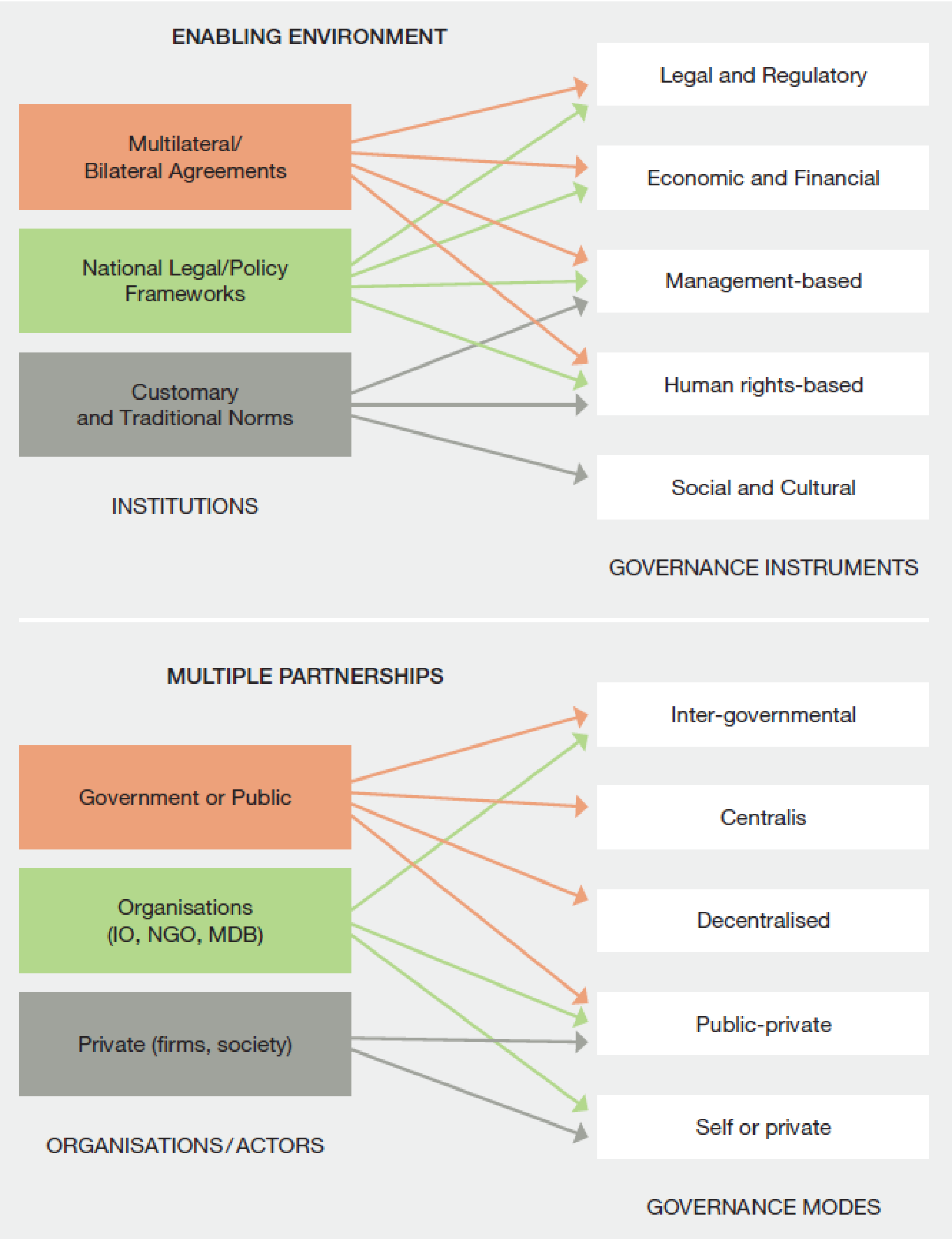


Figure 6.2 Various links between governance elements of enabling environment and multiple partnerships

6.1.3 Structure of the chapter

The overall structure of this chapter is guided by the analytical framework shown in Figure 6.1. First, the context of the assessment of options is introduced in section 6.2 by discussing governance systems and the institutional, political and social settings at various ecosystem and political scales. The section highlights the institutions, organizations and actors that are embedded in these governance systems and who have influence on BES. Section 6.2 provides answers to questions (i) and (ii) above. Second, the challenges for BES governance are discussed in Section 6.3 with particular emphasis on the ecosystem dynamics (status and trends), underlying drivers (direct and indirect) and potential pitfalls, and development pathways (scenarios) for the options. This section provides the links to the previous chapters. Section 6.3.1 discusses the need for good resource governance in view of the dilemma of preserving Nature's Contributions to People (NCP) in the face of increasingly negative BES status and trends as a result of unsustainable use of resources (chapters 2 and 3). Section 6.3.2 emphasises the potential governance pitfalls due to the impacts of direct and indirect drivers (chapter 4). Following from the discussion in section 6.2, section 6.3.3 presents the emerging governance options for alternative future scenarios or development pathways (chapter 5). Third, governance options that were introduced for the different development pathways are discussed in detail in Section 6.4, providing relevant policy instruments and mixes for these options at various governance scales. This section provides an assessment of the governance options for the different subregions in the Asia-Pacific region (section 6.4.2) and mixes of policy instruments for these options (sections 6.4.1 and 6.4.3) at various scales and sectors. Section 6.4 provides answers to questions (iii) and (iv) above. Finally, the global challenges with respect to global biodiversity targets and sustainable development goals facing institutions and governance systems in the Asia-Pacific region are analysed in Section 6.5 and 6.6, respectively. These two sections provide answers to question (v). The Asia-Pacific Regional Assessment is concluded in Section 6.7.

6.2 Governance Systems and the Institutional, Political and Social Settings

6.2.1 Subregional institutions and transboundary issues

To address environmental problems confronting Asia-Pacific region and its subregions, the countries in the Asia-Pacific region became parties to global, regional, subregional and bilateral environmental conventions and policy instruments (Table 6.1, Chapter 1). Subregional collaboration has been emphasised because of the huge geographical scope and diverse economic and political systems in the region (Takahashi, 2000). The legal instruments that cut across the region or with membership outside a subregion usually aim to foster transboundary collaboration to maximise benefits arising from or to reduce conflicts over common resources. The majority of instruments are however signed by countries within a subregion, but some involve agreements with countries outside the Region.

Table 6.1 Major subregional environmental legal instruments in the Asia-Pacific region

Subregion	Instruments

Oceania	• *Convention on Conservation of Nature in the South Pacific, 1976* (operation of this convention is suspended in 2006)
	• *Convention for the Protection of the Natural Resources and Environment of the South Pacific Region*, 1986
	    • *Protocol for the Prevention of Pollution of the South Pacific Region by Dumping*, 1990
	    • *Protocol Concerning Co-operation in Combating Pollution Emergencies in the South Pacific Region*, 1990
	    • Protocol on Oil Pollution preparedness, response and cooperation in the Pacific region, 2006

	◦ Protocol on hazardous and noxious substances pollution, preparedness, response and cooperation in the Pacific region, 2006 • *Convention to Ban the importation into Forum Island Countries of Hazardous and Radioactive Wastes and to Control the Transboundary Movement of Hazardous wastes within the South Pacific Region*, 2001 • *Convention for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean, 2000* • *Agreement Concerning Cooperation in the Management of Fisheries of Common Interest*, 1982
South East Asia	• *ASEAN Agreement on Transboundary Haze Pollution, 2002* • *ASEAN Agreement on the Conservation of Nature and Natural Resources, 1985 (not in force)* • *Agreement on the Cooperation for the Sustainable Development of the Mekong River Basin, 1995*
North East Asia	No legally binding subregional instrument.
South Asia	• *SAARC Convention on Cooperation on Environment, 2010* • *SAARC Agreement on Rapid Response to Natural Disasters, 2011*
Western Asia	The so called Regional Organization for the Protection Of Marine Environment (ROPME) and PERSGA protocols have been registered into the national legislation of the member states party to each convention so are legally binding domestically, as follows: • *Kuwait Regional Convention adopting i) the Kuwait Action Plan for the Protection and Development of the Marine Environment and coastal Areas, ii) Kuwait Regional Convention for Cooperation on the Protection of the Marine Environment from Pollution, and iii) Protocol for Regional Cooperation for Combatting Oil Pollution and other Harmful Substances in Cases of Emergency (1978)* • *Protocol concerning Marine Pollution resulting from Exploration and Exploitation of the Continental Shelf (1989)* • *Protocol for the Protection of the Marine Environment against Pollution from Land-Based Sources (1990)* • *Protocol on the Control of Marine Trans-boundary Movements and Disposal of Hazardous Wastes and Other Wastes (1998)* • *Regional Convention for the Conservation of the Red Sea and Gulf of Aden Environment, 1982* • *Protocol Concerning the Conservation of Biological Diversity and the Establishment of Network of Protected Areas in the Red Sea and Gulf of Aden, 2005* • *Protocol Concerning the Protection of the Marine Environment from Land-Based Activities in the Red Sea and Gulf of Aden, 2005* • *Protocol Concerning Technical Cooperation to Borrow and Transfer Experts, Technicians, Equipment and Materials in Cases of Emergency, 2009*

Some countries of the Oceania subregion adopted the Convention on Conservation of Nature in the South Pacific (Apia Convention) in 1976. The operation of this convention was suspended in 2006 until further notice. In 1986, the Convention for the Protection of the Natural Resources and Environment of the South Pacific Region (Noumea Convention) was adopted. This major convention is supported by a number of protocols. Countries of this subregion established the Secretariat of the Pacific Regional Environment Programme (SPREP) in 1993. Protection of biodiversity is one of the main areas of work of SPREP.

Another important legal instrument in the subregion is the Convention to Ban the importation into Forum Island Countries of Hazardous and Radioactive Wastes and to Control the Transboundary Movement of Hazardous wastes within the South Pacific Region, 2001 (Waigani Convention). Moreover, several legal instruments related to sustainable fisheries play an important role in solving the problems facing this region. The Convention for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean, 2000 (WCPF Convention) and the Nauru Agreement Concerning Cooperation in the Management of Fisheries of Common Interest (1982) result in a major contribution to the management of fish stocks in Pacific (Kinch *et al.*, 2010; Tarte, 2009; Techera, 2015) (Box 6.1).

Box 6.1 Migratory fish stock conservation in the Pacific Ocean

The tuna fishery in the western and central Pacific Ocean is one of the largest fisheries in the world and becomes the focus of attention as valuable fishing resources for both of Pacific Island coastal States and distant water fishing nations. The Pacific Islands Forum Fisheries Agency (FFA) — a regional fisheries agency established in 1979 in response to ocean governance tried to manage the fisheries in this area through conventions and agreements related to management of migratory fish stocks such as WCPF Convention, Nauru Agreement and Palau Arrangement (Tarte, 2009). Challenges such as concern regarding the increased levels of fish mortality for two species (yellowfin and bigeye tuna) and incompletion of effective management measures for long-term sustainability still remain (Langley *et al.*, 2009), and conflicts of interest between Pacific Island coastal States and distant water fishing nations are extremely complicated both politically and economically (Tarte, 2009). But tenacious negotiation by responsible committee through MEAs are essential for conservation of fishery stocks and recognised as good practice (Techera, 2015).

In South East Asia, the Association of Southeast Asian Nations (ASEAN), which was established in 1967 with the main goals of fostering economic cooperation and regional peace, play a significant role in promoting several legal and non-legally binding instruments including transboundary issues in the subregion (Koh & Karim, 2012, 2017). While some agreements were adopted, not all of them are in force as in the case of conservation of nature and natural resources. But even it came into force, the enforcement does not operate as envisioned such as in the control of transboundary haze pollution (Sunchindah, 2015; Varkkey, 2012). The areas of high biodiversity value are good target for transboundary collaboration. There are several conservation efforts across national boundaries such as the Coral Triangle Initiative on Coral Reefs, Fisheries and Food Security (1996), Sulu Sulawesi Marine Ecoregion Conservation Program (1999) and Heart of Borneo Initiative (2007). All Member States of the ASEAN have also ratified the ASEAN Agreement on Transboundary Haze Pollution. However, as discussed in the Box 6.2 below effectiveness of this Agreement is yet to be fully achieved.

Box 6.2 South-East Asian Haze

Extensive and persistent manmade forest fires have become an annual event in Indonesia. In 2015 an environmental disaster of global concern happened in Indonesia when the intensity and destruction of forest fire creating choking haze reached the highest level since the catastrophic haze pollution in 1997 (Chisholm *et al.*, 2016; Karim, 2008a; Koh & Karim, 2012; Sahani *et al.*, 2014; Varkkey, 2014). This is an anthropogenic transboundary environmental disaster affecting Indonesia, Singapore, Malaysia, Southern Thailand and the Philippines. The tropical forest destroyed by the fire is one of the most bio-diverse areas in the world hosting a number of critically endangered species including the orangutan and Sumatran tiger (Chisholm *et al.*, 2016). The outbreak added to the decades of peatland degradation in South East Asia, particularly in Indonesia primarily for palm oil production and to a limited extent for timber. Economic estimates of damages caused to the region's economy are believed to be over $45 billion. South-East Asian haze is an example of failure of environmental governance in regional, national and sub-national level (Chisholm *et al.*, 2016; Varkkey, 2014). The ASEAN member states have taken a number of initiatives to stop the transboundary haze problem since 1997, but most of these initiatives have been unsuccessful (Karim, 2008a). The ASEAN member states concluded the Agreement on Transboundary Haze Pollution in 2002, which came into force in 2003 after being ratified by Singapore, Malaysia, Myanmar, Brunei, Viet Nam, Thailand and the Lao People's Democratic Republic (Karim, 2008a). After more than a decade of adoption in the ASEAN region, Indonesia ratified the Agreement only in 2015. Like many other international environmental legal instruments, this convention failed to impose any stringent obligation on member states (Karim, 2008a). The future success of the agreement is doubtful despite recent ratification of Indonesia (Heilmann, 2015). Although there are laws addressing forest fires in Malaysia and Indonesia, these have not been a success, with 2015 seeing one of the most severe haze episodes in South East Asia to date, with more than 100,000 man-made fires burning 2.6 million hectares of Indonesian land (The World Bank, 2016). Despite significant economic and technological advancement of some countries, the region suffers from a lack of strong regional initiative for environmental and biodiversity conservation evident by the failure of the 1985 ASEAN Agreement on the Conservation of Nature and Natural Resources, which never came into force due to non-ratification of some member states. ASEAN Haze is a glaring example of reactive and ad-hoc environmental governance rather than proactive environmental governance.

In North East Asia, the diversity of governance systems prevented the establishment of a central political, economic or social force at the subregional level until the late 1980s (Takahashi, 2000). The 1990s show an onset in environmental agreements in the subregion but, unlike in the rest of the Asia-Pacific region, the agreements are largely based on bilateral arrangements. Japan and China were the main initiators of bilateral environmental agreements in North East Asia during this onset period. The North-East Asian Subregional Programme on Environmental Cooperation (1992) that was established at the subregional level with objectives to promote environmental cooperation and sustainable development through the support of the UNESCAP in the 1990s (Kato & Takahashi, 2000; Takahashi, 2000).

In South Asia, initiatives on environmental conservation and management are anchored on its subregional intergovernmental organizations including the South Asian Association for Regional Cooperation (SAARC), the South Asia Cooperative Environment Programme (SACEP) and the South Asia Regional Seas Programme (Kakakhel, 2012; UNEP, 2014a). Like the ASEAN, the SAARC was established in 1985 with the main goals of promoting welfare and economic growth in the subregion but the cooperation framework for environment is gradually evolving. The South Asia Cooperative Environment Programme was established in 1982 with the aim of promoting mutually beneficial cooperation in priority areas of environment. South Asian Seas Regional Program was established under the South Asia Cooperative Environment Programme. South Asian Seas Action Plan was adopted in March 1995 (www.sacep.org). However, development of subregional legal instruments for conservation of marine environment and prevention of marine pollution is yet to be achieved in this subregion (Karim, 2008b). The SAARC countries also adopted the SAARC Environment Action Plan (1997), SAARC Convention on Cooperation on Environment (2010) and SAARC Agreement on Rapid Response to Natural Disasters (2011). However, practical impact of these legal and policy instruments is yet to be fully achieved. Transboundary cooperation for conservation of biodiversity is yet to be fully successful in the subregion as discussed in the following Box 6.3 discussing on Sundarbans, a Ramsar and World Heritage site.

Box 6.3 Climate Change and Sundarbans

The Sundarbans is the largest single block of tidal halophytic mangrove forest ecosystem and UNESCO World Heritage Site in the world covering parts of Bangladesh and India, spanning to an area of 60172 km and sharing both land and a water body that forms ideal mangrove ecosystem (Hoq, 2007). It is also a wetland of international importance under Ramsar Convention. The Sundarbans eco-ecosystem supports a large number of valuable marine and coastal species, and hosts one of the richest natural gene pools for fauna and flora in the world (Islam & Gnauck, 2009). This mangrove is a habitat for a large number of species of mammals (42), birds (300), reptiles (35), and amphibian (8) including the largest population of the Bengal Tiger (Hoq, 2007). Its tangle forests protect the densely populated coastal communities in Bangladesh and West Bengal from destructive impacts of cyclones. But Sundarbans is now threatened by climate change, land reclamation, logging, shrimp farming, rising sea level and dwindling fresh water. Not only the biodiversity but also the very existence of the forest is under threat due to the climate change and associated sea level rise (Ahmad *et al.*, 2010; Rahaa *et al.*, 2014). Moreover, Sundarbans in Bangladesh is also facing serious problem due to the lack of freshwater supply from some transboundary rivers (Islam & Gnauck, 2009). Despite this vulnerability and a bilateral agreement between Bangladesh and India, there is a lack of significant joint initiatives at the ground level from these countries to protect Sundarbans. A bilateral, preferably regional, policy initiative is needed to save this forest from the impacts of climate change and economic activities. The regional, national and local level policy and institutional frameworks need to take into consideration the likely impacts on the Sundarbans forest. Without a joint and committed initiative of Bangladesh and India, this very important habitat for a number of endangered species cannot be saved.

As compared to other subregions in the Asia-Pacific region, Western Asia does not have a strong record of environmental cooperation. Countries in Western Asia lack a representative network that can effectively manage environmental concerns (IUCN-WAME, 2007). Most of Western Asia's cooperation initiatives are anchored on the League of Arab States which was established in 1945 to serve as a policy forum with the aim of fostering economic development and cultural preservation. The two regional sea initiatives upon which regional cooperation is enabled are the i) Regional Organization for the Protection of the Marine Environment (ROPME), whose geographical focus is 'the Gulf', the Gulf of Oman and a portion of the Arabian Sea (collectively known as the ROPME Sea Area, or RSA), and ii) Regional Organization for the Conservation of the Environment of the Red Sea and Gulf of Aden (PERSGA). Within this framework, the Gulf Cooperative Council (GCC) also has interest and capacity to foster cooperation between the six Arabian Gulf States of Kuwait, Saudi Arabia, Bahrain, Qatar, UAE and Oman, and the Regional office for West Asia (ROWA) of United Nations Environment Programme (UNEP) also facilitates and supports efforts to address environmental challenges in the Arab region, for example, through signing of agreement between UNEP and the Arab League in 2014 to "reinforce cooperation and coordination in the planning and implementation of global and regional environmental programmes." (UNEP, 2014b). Some of the environmental agreements in Western Asia, such as PERSGA, are with African countries such as Egypt and Sudan.

The interest of nations is growing in transboundary collaboration on protecting areas of high biodiversity conservation value areas, for example, the Greater Mekong Subregion, the Terai Arc landscape in India and Nepal, the Heart of Borneo initiative, the Sulu-Sulawesi marine areas and the Coral Triangle have become the focus of conservation efforts across national boundaries (UNEP-WCMC, 2016a). ROPME has also recently initiated a plan of action for Ecosystem Based Management (EBM) in the RSA, while the GCC Secretariat is currently in the process of conducting a transboundary diagnostic analysis for the Gulf Basin (GDBA) as part of its Gulf Environmental Partnership and Action Plan (GEPAP) program. Transboundary information sharing has also become the focus of effort for conservation and sustainable use of BES such as The Asia Biodiversity Conservation and Database Network (ABCDNet) of the Chinese Academy of Sciences and Asia-Pacific Biodiversity Observation Network (AP BON) (UNEP-WCMC, 2016a), ASEAN Clearing-House Mechanism of the ASEAN Centre for Biodiversity (http://aseanbiodiversity.org), and the Biodiversity Information Sharing Service of the ASEAN Regional Centre for Biodiversity Conservation (https://www.arcbc.org.ph).

Multilateral instruments have been developed in the Asia-Pacific area in the field of transboundary and highly-migratory fisheries resource management. The international organization for such fisheries resource conservation are called Regional Fisheries Management Organizations (RFMOs) (Pomeroy *et al.*, 2016). Examples include the Western & Central Pacific Fisheries Commission (WCPFC) for tunas, North Pacific Anadromous Fish Commission (NPAFC) for Pacific salmon, steelhead trout, etc., and North Pacific Fisheries Commission (NPFC) for chub mackerel, Pacific saury, and Regional Commission for Fisheries (RECOFI) in Western Asia to list a few. Other marine BES policies such as marine habitat protection, marine pollution or marine debris, climate change and acidification, invasive species, etc., are also regionally addressed in the Asia-Pacific region (Hu, 2012; IOC, 2007;

Manoa & Veitayaki, 2009; Rochette *et al.*, 2015). One example is the Pacific Island Regional Ocean Policy (PIROP) (Wright *et al.*, 2006). Partnerships in Environmental Management for the Seas of East Asia (PEMSEA) is promoting the integrated coastal management for the South-East Asian countries.

The Asia-Pacific Economic Cooperation (APEC) Sydney Declaration (2007) on Climate Change, Energy Security and Clean Development had APEC members agreeing to work to achieve a regional goal of increasing forest cover in the APEC region by at least 20 million hectares of all types of forests by 2020 (Asia-Pacific Economic Cooperation, 2007). Up to 2015, forests in the APEC region increased by 15.4 million hectares in 11 economies and declined in 9 economies in the APEC, although this included countries within the APEC community which are not included within the scope of this assessment report. It can also be noted that this includes “all types of forests” which include planted production forests. This could mean that planted production forest areas increase while natural forest areas decrease, so this may not be a good indicator of the level of biodiversity and ecosystem services (APFNet & FAO, 2015).

Finally, an important multilateral environmental agreement with global emphasis, but which would benefit from regional and subregional cooperation is the climate change convention. Many Asia-Pacific countries have ratified the Kyoto Protocol and Paris Agreement. Each country must, in accordance with their national circumstances, implement policies and measures to mitigate climate change and to facilitate adequate adaptation to climate change. A few of these measures contribute to the conservation of BES. Mitigation measures which positively affect conservation of BES include protection of forests, reforestation, and afforestation to protect and promote carbon sinks (e.g. India’s “Green India” initiative which aims to increase the forest/tree cover on five million hectares of forested and non-forested land, and improve the quality of forest cover on another five million hectares), and carbon trading programmes which recognise carbon credits (e.g. New Zealand’s Emissions Trading Scheme which includes a forestry component). Adaptation measures include protection of ecosystems to increase resilience against climate change impacts (e.g. China’s commitment to restore grasslands to increase agricultural resilience and afforest in mangrove forests to increase coastal protection) (Couzens & Honkonen, 2011; Institute for Global Environmental Strategies, 2008; Westphal *et al.*, 2013).

6.2.2 National, sub-national governments and civil society

6.2.2.1 National policies and local mainstreaming strategies

National policies and legislations to support these policies in the Asia-Pacific region cover broad issues such as environment, various sectors such as forestry, agriculture and marine, and specific environmental problems such as pollution. The region has experienced an expansion of environmental protection and conservation policies and legislation to control growing environmental issues that are impacting different parts of society and sectors of the economy. Several countries in the Asia-Pacific region have introduced innovative approaches to environmental governance, such as the precautionary principle (Indonesia), intergenerational equity and the writ of continuing mandamus (Philippines), and the public trust doctrine (Sri Lanka) (Mulqueeny & Bonifacio, 2012). Environmental courts and tribunals have been established in several countries in the region, including Bangladesh, China, India, Japan, Korea, Malaysia, Pakistan, the Philippines, and Thailand (Mulqueeny & Bonifacio, 2010). Moreover, except for the World Organization for Animal Health (OIE) with only about 20 per cent signatories, more than 80 per cent of Asia-Pacific countries are signatories to BES-related legal global conventions (i.e. IPPC, WHC, CITES, Ramsar, CMS, CBD, SPS, Cartegena, BWM) (figures computed from Biodiversity Indicators Partnership (BIP) data, https://www.bipindicators.net/), which all add weight to the call for mainstreaming environmental policies and improving governance.

Environment and Biodiversity

China and India have seen a rapid development in environmental policy in response to environmental problems caused by their rapidly growing economies and changing consumption patterns (UNEP, 2016). China introduced its first Law on Environmental Protection in 1979. Environmental policies were further strengthened with the formation of a government agency responsible for environmental protection in 1987, where policies changed their focus from enhancing administration to improving coordination (Chunmei & Zhaolan, 2010). All the South Asian counties have umbrella environmental protection or conservation laws that also include clauses on the conservation of biodiversity. India passed the Environment (Protection) Act in 1986, National Environment Policy in 2006 and more recently the National Green Tribunal Act in 2010 (UNEP, 2016). In 1983 Pakistan introduced Environment Protection Ordinance and Maldives introduced Environmental Protection and Preservation Act in 1993. Similarly, Sri Lanka, Nepal, Bangladesh and Bhutan introduced National Environment Act in 1980, Environment Protection Act in 1997, Environment Conservation Act in 1995 (replacing Environment Pollution Control Ordinance, 1977) and Environment Assessment Act in 2000, respectively (UNEP-SACEP, 2002). Iran's Constitution, Article 50 (1979) has particular relevance to the preservation of the Environment, and Oman introduced its first major piece of environmental legislation controlling pollution in 1982. Elsewhere in Western Asia, national laws relating to environmental protection and development were also developed, i.e. UAE in 1999, Saudi Arabia in 2001, Lebanon in 2006, Jordan in 1995 and 2006, Yemen in 1995, Bahrain in 1996, Oman in 2001, Syria in 2002, Qatar in 2000, and Iraq in 2009.

Most environmental policies and legislation in the Asia-Pacific region cover protection and conservation of biodiversity and ecosystem services. Australia's environmental legislation places emphasis on the issues of biodiversity through the Environment Protection and Biodiversity Conservation Act (1999). Some other countries enacted law that directly address biodiversity such as the 2008 Biodiversity Law in Vietnam, 2002 Biological Diversity Act in India, 2017 Biological Diversity Act in Bangladesh, etc. (Karim, 2017). Legislation on wildlife protection provide a basis for biodiversity conservation in many other Asian countries such as 1998 Law on Protection of Wildlife in China, 1973 National Parks and Wildlife Conservation Act in Nepal, 1972 Wildlife (Protection) Act in India, and the 2012 Wildlife (Conservation and Security) Act in Bangladesh. The formulation and implementation of National Biodiversity Strategies and Action Plan (NBSAP) in the late 1990s and early 2000's has become an important policy instrument for many countries, providing a framework for mainstreaming biodiversity conservation and sustainable utilisation in national development plans.

Many countries are mainstreaming climate policy through domestic climate institutions which serve as inter-agency coordination mechanisms. To strengthen the influence of these institutions, they are typically led by high-ranking officials, with some, such as Japan's Global Warming Prevention Headquarters and India's Prime Minister's Council on Climate Change, even headed by the Head of State (chaired by the Prime Ministers of Japan and India, respectively). Other stakeholders play roles in mainstreaming and implementing climate change actions and policies across sectors (horizontal integration) and levels of government (vertical integration). These differ from country to country, but may include ministers/ministries, local government (Korea), private sector (India), academia (Korea and India) and civil society (India and the Philippines). Indeed, some states have mandated responsibility for climate change to specific ministries, such as UAE (the Ministry of Climate Change and Environment (MOCCAE), and the Sultanate of Oman (the Ministry of Environment and Climate Affairs (MECA). Sectors which participate in these institutions may include mitigation-related sectors (e.g. transportation, electricity-supply and forestry) and adaptation-related sectors (e.g. environment, agriculture and water resources) (Institute for Global Environmental Strategies, 2008).

Climate policy is also being mainstreamed through integration into national sustainable development agendas. India, China and Malaysia are examples where climate change policies have been incorporated into the countries' national five year development plans (Institute for Global Environmental Strategies, 2008; Malaysia: Prime Minister's Department, 2015). In the Philippines, the Climate Change Commission (CCC) formulated a National Framework Strategy on Climate Change and National Climate Change Action Plan, which provides guidelines for mainstreaming national plans by the local governments into the Local Climate Change Action Plans. In the Pacific Islands, despite the relatively heavy involvement of the Pacific countries in climate change negotiations and the preparation of national adaptation programmes of action, little has been done with respect to including climate change considerations in national legislation. For example, despite the high public profile of climate change in Fiji, its Environmental Management Act 2005, which came into force on 1 January 2008, contains no specific reference to climate change impacts (Boer & Clarke, 2012). Compliance with multilateral environmental agreements and even their own national laws is a challenge for many Pacific countries. Whilst Pacific countries may have little to do with respect to the mitigation of greenhouse gas emissions, much focus is required in adaptation work by virtue of the climate change related threats to which this region is exposed.

There are existing opportunities within the national environmental law and policy framework of the Pacific countries to address climate change. Challenges with respect to implementation and compliance with laws at a national level can be attributed to a number of issues including lack of sufficiently robust environmental protection law in some countries; lack of capacity and resources of the relevant domestic executive, law enforcement and judicial institutions; and dilution of power to local authorities, communities and traditional owners with respect to environmental monitoring and enforcement (Boer & Clarke, 2012; Karim, 2009).

Unlike biodiversity and climate issues, there is very little in the way of coordinated mainstreaming of policies relating to forest fires in response to the ASEAN Agreement on Transboundary Haze Pollution in Indonesia and Malaysia (Abdullah, 2002). Although there are laws addressing forest fires in both Malaysia and Indonesia, these have not been a success, with 2015 seeing one of the most severe haze episodes in South East Asia to date with more than 100,000 man-made fires burning 2.6 million hectares of Indonesian land (The World Bank, 2016). An analysis of Indonesian laws related to forest and land fires found that implementation is lacking in many aspects - coordination at different administrative scales and single responsible authority, provisions for dealing with forest authorities, lacks mechanism for rewards or incentives to individuals to assist authorities, and regulations for peatland protection, restoration and management (Abdullah, 2002).

While laws and policies for environment cover many terrestrial (i.e. urban and semi-urban, agro-ecosystems, grassland and savannah, forest and woodland, alpine, deserts and semi-deserts) as well as inland freshwater and wetland ecosystems, many countries also have those related to specific sectors due their importance in the Asia-Pacific economies. These are discussed in details in the rest of this section.

Urban environment and green city

The increasing population density within urban area is a key cause of land conversion, and socio-economic factors (such as urban morphology, developmental history, income and education and management) affect the quality and quantum of urban green spaces through planning, construction or maintenance in direct or indirect ways (Tan *et al.*, 2013; Yang *et al.*, 2014). Green space is often lost to make way for housing, industrial areas and grey infrastructure (Haaland & Van Den Bosch, 2015). A number of cities in the region have gone beyond planning regulations by incorporating biodiversity into their structure plans, or by introducing environmental action plans and strategies that explicitly recognise NCP produced by the urban ecosystem and introduce policies to maintain and improve the ecosystems in question. Examples include Singapore’s Green Plan 2012 and Sydney’s Environmental Action Strategy and Action Plan for 2016-2021, both of which plan for restoring urban ecology through protecting existing and creating new habitat patches and wildlife habitat corridors to help plant and animal species move and spread throughout the cities (Chin, 2008; City of Sydney, 2017). Gandhinagar and Chandigarh in India have also integrated green areas in their City Master plans (Chaudhry *et al.*, 2011). Most cities in South and Western Asia, including Tehran in Iran have programmes to green their cities within their municipal boundaries (Åkerlund, 2006). Dubai adopted in 2016 the green building rating system called “Al Sa’fat” focusing on the life cycle of a building and aspects crucial to it such as increased energy and water efficiency, use of environment-friendly materials, renewable energy, alternative energy sources and more efficient construction techniques (Box 6.4).

Box 6.4 Dubai Green Building Evaluation System

In line with the commitment of Dubai to become a world leading 'green' city and to make Expo 2020 an environmentally sustainable event, in 2016 Dubai Municipality established a new rating system called “ALSA'FAT”, Dubai Green Building Evaluation System in the Emirate of Dubai. This initiative is designed to achieve high performance in buildings, to promote human and environmental health by strengthening the planning, design, implementation, and operational performance of buildings. The concept aims to achieve smart, sustainable city status for Dubai by 2021. Prior to this Dubai Municipality had issued many related regulations to promote the green building concept (such as the Green Building Regulations Circular No. 198 in 2011) which immediately became mandatory for government buildings and optional for private developers. This was followed in 2014 by another circular making the existing Green Building Regulations and Specifications (Green Building Regulations) mandatory for the private sector. These Green Building Regulations consist of the best international standards adapted to local conditions.
Al Sa’fat in Arabic means date palm fronds and refers to the traditional Arabic roofing system using palm fronds to keep the building interior cool. It was a symbol of sustainable construction and also represents resource efficiency since all parts of the palm tree were traditionally used for a range of purposes. The rating is split into four classifications: platinum, gold, silver and bronze (in descending order) and every building must achieve the minimum of bronze category. Higher ratings are optional. This will be applicable to all new buildings and those built since 2014. According to Dubai Municipality more than 90 per cent of buildings in Dubai constructed after 2001 already meet the necessary criteria to qualify for Al Sa’fat bronze certification. The launch of Al Sa’fat rating system complements the green building project perfectly, with its most prominent goals to reduce the consumption of electricity by 20 per cent, water consumption by 15 per cent, carbon dioxide emissions by 20 per cent, and waste by 50 per cent. Dubai Municipality has developed a smartphone application (green buildings) to explain the laws, terms and conditions of green buildings in non-technical language. It will also launch a website dedicated to green buildings to provide more information about the rating system, and a list of suppliers of green materials.
Sources: Government of Dubai (2013); Government of Dubai & Dubai Municipality (2016)

There are some cases where the objective of national policies is to expand and improve urban ecosystems. One example of a national regulation being applied for improving urban ecosystems is the Republic of Korea’s Act on Urban Parks and Green Spaces, which requires each city to develop a basic plan for expanding, managing and exploiting parks and green spaces (Park & Youn, 2013). In South and Western Asia, national programmes implementing international agreements, conventions and declarations such as Agenda 21, the Convention on Biological Diversity or the UN Convention to Combat Desertification in those Countries Experiencing Serious Drought and/or Desertification can contribute to increasing the quantity of urban green spaces (Knuth, 2006). Both national and local policies can also be used to incentivise the implementation and maintenance of green space by private landowners. For example, Japan offers tax incentives to citizens to carry out agricultural activities on land designated as “productive green space”, and the Japanese city of Nagoya has made an arrangement with regional banks to offer a discount 0.1-0.2 per cent discount on home loans for private properties that have achieved a certain level of green certification (Hayashi, 2010; Nikkei, 2017). Box 6.5 presents case studies on investing in urban ecosystems.

Box 6.5 Investment in urban ecosystem

In addition to incorporating greening into planning regulations, cities can also invest in major projects to restore degraded urban ecosystems to enhance the provision of NCP. There are few available examples in the Asia-Pacific region but perhaps the most well-known example is the Cheonggyecheon Stream Restoration in Seoul, where a steam that had been covered with an elevated motorway in 1972 was restored in 2005 as a public park/green corridor for pedestrians, cyclists and wildlife. As well as being an attraction for both the local population and tourists, the restored stream area also provides flood management control, increased air quality and temperature reduction to offset the urban heat island effect in Seoul. Another example is Singapore's Bishan-Ang Mo Kio Park, which restored the Kallang River – a concrete river canal running through a public park into a naturalized river and biodiversity corridor. The river provides recreational benefits to Singaporean residents as well as storm water management services (Gore *et al.*, 2013; Ibrahim, 2016; Lee & Anderson, 2013; National Parks Board Singapore, 2017). The award winning restoration of Wadi Hanifah that runs through the Saudi Arabian capital Riyadh is the Arabian region's highest profile example of the restoration of an urban ecosystem.

Forest and Agro-forestry

Many Asia-Pacific countries, particularly in South and South East Asia, have a long history of policies and legislation concerning the use and conservation of forests. In Japan, the Forest Act, which included the creation of the conservation forests scheme, was established in 1897. First forest law in India was enacted in 1865 when modern day India, Pakistan and Bangladesh were administered as one country under British colonial rule. After some amendments, this law was replaced by the Indian Forest Act in 1927, which has since been revised several times to adapt to new conservation challenges in all three countries. Other early forest legislation includes the 1941 Forest Act in Thailand, 1961 Forest Law in Korea, 1956 Forest Protection Act in Nepal and 1961 Forestry Law in Cambodia. Revisions in legislation and policies in Asia enabled the conservation of natural forests by completely or partially prohibiting logging activities (FAO, 2010). Several countries went one step further by initiating reforestation programs such as the 1998 Five Million Hectare Reforestation Programme in Vietnam, Conversion of Cropland for Forests and Grassland Programme in China, and the 2002 National Afforestation Programme in India. Policies in many countries in South and South East Asia support sustainable forest management, although success is rather mixed (FAO, 2010). Forest laws have also been revised in some countries with the objective of reducing environmental impacts and promote improved sustainability of logging concessions, e.g. Papua New Guinea's the Forestry Act 1991 (Scheyvens & Lopez-Casero, 2013). The important features of revised or new forest policies in the Asia-Pacific region has been the shift in the forest management authority from central to sub-national governments as well as participation of or partnership with civil society (Scheyvens, 2011). This policy shift has been enabled by the pursuit of decentralisation legislations (e.g. in Indonesia, Thailand, Philippines and Cambodia), existing federal systems of government (e.g. Australia, India, Malaysia and Pakistan) which allow for a degree of sub-national autonomy, and inherent local governance in countries with many islands (e.g. some Pacific Island States). In an effort to develop an effective institutional framework and mechanisms for greater involvement of local communities in the management of forest resources, several participatory forest management approaches have emerged in different countries in South Asia. These include community forestry, joint forest management, and forest user groups, which differ in their institutional, tenurial, decision-making, and benefit-sharing arrangements (Ramakrishnan *et al.*, 2012). Forest management in India, Nepal, Bangladesh, and Bhutan are moving from centralised to participatory forest management through these new institutional approaches, with the magnitude and pace of the movement being greater in Nepal and India. Aside from joint forest management, all participatory forest management mechanisms are supported by state legislation, although the degree of institutionalisation may vary (Rasool & Karki, 2007). Relative to the rest of the region, experience with forest legislations and policies is relatively scarce in countries in Western Asia. Forest legislation and policies in the many countries in the subregion are subsumed in the development policies for the agricultural (e.g. Jordan and Lebanon) and environment (e.g. Bahrain, Kuwait, Qatar) sectors so they are not comprehensive or systematic (Ma, 2008). Forest laws exist in Iraq and Yemen, but are not enforced in the former and not ratified in the latter.

One of the most important issues in the forestry sector in the Asia-Pacific region is illegal logging. Although only 5 per cent of the world's forests are located in South East Asia, the region contributed nearly 25 per cent of all global deforestation in the 1990s, with illegal logging being a major factor (Blaser, 2010). Both producer and consumer countries have implemented measures to mitigate illegal logging and trade, including bilateral trade agreements, private sector and civil society initiatives (Rosander, 2008). In September 2001, the East Asia Ministerial Conference on Forest Law Enforcement and Governance was held in Bali, Indonesia. The conference adopted the Bali Declaration through which the 20 participating countries committed themselves to intensifying national and international efforts to address the problem of illegal logging. Following the Bali Declaration, many countries, including China, the European Union, Japan and the United Kingdom developed bilateral agreements with Indonesia to address illegal logging and associated illegal trade (Centre for Forestry Planning and Statistics (CFPS), 2009).

Technical development as well as legislation in the forest sector is necessary in many Asia-Pacific countries in order to improve agricultural sustainability. In South and South-East Asian countries, REDD-plus (reducing emissions from deforestation and forest degradation in developing countries) is one mechanism to improve agricultural sustainability because agriculture has been identified as the most important driver of deforestation and forest degradation (Angelsen *et al.*, 2012; UNFCCC, 2011). The REDD-plus mechanism was negotiated under the United Nations Framework of Convention on Climate Change (UNFCCC) and has now been agreed and implemented in many Asia-Pacific countries. The framework of the mechanism has been fully accepted and no-carbon benefits as ecosystem services from forests have been recognised in the Paris Agreement of the UNFCCC/COP21 (UNFCCC, 2015). Because REDD-plus safeguards require promotion and support actions that are consistent with the conservation of natural forests and their biodiversity, and to incentivise the enhancement of social and environmental benefits (UNFCCC, 2011), the mechanism can be used as an incentive to halt logging that would otherwise convert forests to agricultural use such as oil palm plantations (Campbell, 2009; Ghazoul, 2001; Squires, 2014). As one method to reduce impacts of land conversion, agroforestry such as coffee and rubber plantations is included in a REDD-plus policy in a local Indonesian project (CCB & VCS, 2015; Government of Indonesia, 2012; John-O, 2007; UNREDD, 2010) (Box 6.6).

Box 6.6 Local REDD-plus projects in Indonesia

The Indonesian government has promoted conservation of forest biodiversity and carbon stock through REDD-plus projects by setting up national principles, criteria and indicators developed specifically for them (Government of Indonesia, 2012). In Indonesia, like many other South and South-East Asian countries, illegal and/or unsustainable logging which is often followed by land conversion to agriculture is caused by weak local governance, poverty and insecure land tenure in local communities. This chain of events directly threatens forest biodiversity and ecosystem services (Curran, 2004; Fitzherbert *et al*., 2008). In the tropical peatland swamp forest in Sebangau National Park in Central Kalimantan, for example, the REDD-plus project aims to strengthen the authority of the park office which will deliver improved sustainable management and ecosystem services – increase fish production, for instance because water logged peat land maintains high water levels while illegal logging often results in draining the exploited area (WWF-Indonesia, 2012). In the Rimba Raya biodiversity reserve, following damage to forest biodiversity arising from oil palm expansion, a REDD-plus was designed having objectives that i) suppressed illegal logging, ii) established a buffer zone between the protected area and the oil palm plantations, and iii) improved agricultural skills (CCB & VCS, 2015). The project also provided education to the community concerning food security and safety, and promoted agroforestry such as eco-friendly gum plantations (CCB & VCS, 2015).

Decentralisation of forest resources is another important trend in the development of forest policies and legislation in the Asia-Pacific region (Dung & Webb, 2008; Kijtewachakul *et al.*, 2008; Nagendra *et al.*, 2008; Webb & Dorji, 2008; Yonariza & Shivakoti, 2008). As previously described, many countries in the region have strong forestry laws and well-regulated forest resources. However, the centralisation of political authority over forest resources may lead to deforestation because of the loss of long-term community management and unregulated encroachment on state forests (Webb, 2008). Inconsistent forest policy and legal framework, insufficient enforcement capacity, and insufficient information about the condition of the forest resource contribute to insufficient legal compliance and governance in the sector (Blaser, 2010). Decentralisation is assumed to hold a great potential for local development and sustainable management of natural resources (Larson & Ribot, 2004; Moser *et al.*, 2001). However, recent studies on the impact of decentralisation reforms show mixed results (Balooni & Inoue, 2007; Baumann & Farrington, 2003; Bullinger & Haug, 2012; Ribot, 2002; Shackleton *et al.*, 2002). For example, in Nepal, decentralisation of forest management from fully centralised control of the resource towards community-based forest management had many positive impacts on the forest. Forest cover increased after the implementation of the community forestry policy and the trend in the biological condition of the community-managed forests was improving (Gautam & Shivakoti, 2008). On the other hand, in Indonesia, decentralised forest governance triggered a logging boom that increased inter- and intra-village conflicts, exacerbating inequality, and accelerating the rate of deforestation (Bullinger & Haug, 2012; Suwarno *et al.*, 2015).The issue of decentralisation is a central policy concern, but decentralisation should mean self-governance (Shivakoti & Ostrom, 2008). It will require a collective effort at all levels including local, regional, national, and international stakeholders to achieve effective decentralised forest management as we come to view conservation of forest resources from a global perspective (Balooni & Inoue, 2007).

Agriculture and bioenergy

The expansion and intensification of agriculture is a particular threat to native fauna and flora in many places including the Asia-Pacific region (McNeely, *et al.*, 2001; Matson, *et al.*, 1997; Tscharntke *et al.*, 2012). Landscape heterogeneity with diverse crops rather than a large scale mono-cultural plantations is fundamental to maintain biodiversity, and hence food security (Macfadyen *et al.*, 2015). Asian food production is characterised by smallholders (Bissonnette & De Koninck, 2015; FAO, 2017; Pingali, 2001), that requires governments to make appropriate policies to address their challenges, such as investment, technology improvement and information access for empowering small farmers (FAO, 2010). Since continuous growth of agricultural production in Asia is predicted for at least the next few decades (FAO, 2017) and commercialisation is being enhanced (Pingali, 2001), both macroeconomic and microeconomic policy reforms are necessary to anticipate further negative impacts on Asian Pacific biodiversity.

Large scale deforestation is another characteristic arising from the expansion of agricultural monocultural production such as palm which has significantly impacted South-East Asian biodiversity (Fitzherbert *et al.*, 2008; Koh & Wilcove, 2008), and which will continue if it is not satisfactorily addressed. A global multi-stakeholder initiative Roundtable on Sustainable Palm Oil (RSPO 2017) has been established to support advancing technology for sustainable production and market analysis of palm oil. The response at country level has been interesting. Malaysia decided to become certified (Palm Oil Health, 2017; The Star Online, 2017) by 2019, while Indonesia enacted some laws such as "Environmental Protection Law No. 3220" and "Ministry of Agriculture 14/2009 concerning peat land utilization" in 2009 (Handayani, 2010). Thailand, where most oil palm plantations were run by small holders, does not have specific environmental legislation controlling palm oil farmer (Termmahawong, 2014). In these countries the concerned environmental ministries may establish laws and policies without involvement of local government and/or other sectors, the increase of oil palm plantations still continues despite regional agreement (Shibao, 2015). Expansion and intensification of commercial agriculture is usually driven by poverty of local communities depending on forests and other natural ecosystems (Miyamoto *et al.*, 2014). Thus, without any alternative livelihoods and/or incentive to promote sustainable agriculture, protection of natural forests in one area may cause leakage of biodiversity in another (Koczberski & Curry, 2005; Rist *et al.*, 2010). There is another pitfall in this kind of conservation mechanism: weak national governance. In Malaysia, although local communities agree and enforce laws to protect the local environment, weak governance such as corruption and low levels of transparency sometimes makes them worthless (Lim, 2013).

Agricultural intensification threatens biodiversity by directly eliminating non-pest organisms through the use of excessive pesticides. It also degrades other ecosystem services such as provision of water quality and quantity as well as soil quality (Matson *et al.*, 1997; Tilman *et al.*, 2002; Tscharntke *et al.*, 2012). Examples of intensive agriculture can be seen, for example, in the western Australian wheat belt (Lambeck, 1999) and in New Zealand with pastoral farming (Moller *et al.*, 2008). Both countries have several laws controlling intensive agriculture with the purpose of protecting BES and increasing sustainability of agriculture based which have been driven by international agreements: for example, the 1972 Stockholm Conference on the Human Environment, the 1992 Rio Conference on Environment, CITES, CBD, UNFCCC, and Ramsar Convention (Australian Government, 2014, 2017; Craik, *et al.*, 2016; DAFF, 2013; Palmer, 2015; Preston & Hanson, 2013; Parliamentary Council Office, 2017). China, South Korea and Japan also established laws regarding intensive agriculture which are essentially adaptations of those mentioned above (Kim & Lim, 2015; MAFF, 2007; Yu, 2016). Although the number of organic farmers and the volume of their production have been increasing due to enabling policies, the market for organic products in Asia is small and even smaller in Oceania (Sahota, 2006). Farmers are improving organic farming technique which is lowering prices for products (Bellamy & Johnson, 2000; Garnett *et al.*, 2013; Vanclay, 2004). Since organic production is for export in most Asia-Pacific countries, national policies tend to encourage or require farmers to obtain international and/or to improve domestic certification to meet international standards (Wai, 2006; Wynen & Mason, 2006). Countries without good policies supporting sustainable agriculture, such as Bangladesh, have identified the benefits of enabling the sector to comply with international standards and expectations (Hossain, 2012).

Agriculture potentially plays two different roles in invasive alien species: pathway and prevention. The plant quarantine system based on the International Plant Protection Convention (IPPC) was established to protect native agriculture and biodiversity and was ratified by many countries in the Asia-Pacific region except for Kiribati, Marshall Islands, New Caledonia, Tokelau, Brunei Darussalam and Timor-Leste (FAO, 2013; International Plant Protection Convention, 2017). Another legal basis for countries to control invasive alien species is the Global Invasive Species Programme (GISP), coordinated by the Scientific Committee on Problems of the Environment (SCOPE), in collaboration with international organizations such as the World Conservation Union (IUCN), and Centre for Agriculture and Bioscience International (CABI) (McNeely *et al.*, 2001). Both Australia and New Zealand are known to have a strict system for introduction of exotic species based on the Environment Protection and Biodiversity Conservation Act 1999 and the Biosecurity Act 2015 in the former and Biosecurity Act 1993 in the latter, that enable quick actions for eradication once alien species are detected (Jay *et al.*, 2003; Mack *et al.*, 2000) (Australian Government 2017b; Ministry for Primary Industries 2017). Ever since exotic organisms were introduced both intentionally and unintentionally on agricultural products into Japan (Goka, 2010; Washitani, 2004), the Ministry of Agriculture, Forestry and Fisheries (MAFF) established Plant Protection Act in 1950 that requires the monitoring and scientific study of exotic species (MAFF, 2009). However, when the Act was renewed to a positive list system in 2011 (MAFF, 2011a), an increase in IAS that were not listed but suspensive caused concern amongst stakeholders. Japan has brought into law the Invasive Alien Act (MOE, 2004) but gaps in the regulated species are identified (Koichi Goka *et al.*, 2013). In many countries, disputes lead to unbalanced goals between consumer/environmental advocates and free-trade advisories have been issued (World Trade Organization, 2011a). For most other Asia-Pacific countries, legislation has not been enough and technical assistance is required for measures to be effective. In order to support such countries it is essential to build capacity to improve treatment techniques for packing materials and in other areas (e.g. FAO, 2013). The lack of sufficient capacity to inspect or control pest organisms in both exporting and importing countries also needs to be addressed with national and international interventions including the provision of scientific support (McNeely *et al.*, 2001; Shine *et al.*, 2000).

There are successful cases of organic agricultural food productions in many Asia-Pacific countries. Food retailers' demand as well as consumers' awareness enhance organic farming certified with local and international certification mechanisms when farmers have been incentivised with capacity building including technical training and market access supported by the government and the economic sector (International Fund for Agricultural Development, 2005; Salazar, 2005; Rogers & Morrison, 2010; World Trade Organization, 2011b; Nomura *et al.*, 2012; Beban, 2014). The financial support including action-based payment by the government is critical especially for smallholders, that are common in most AP countries (World Trade Organization, 2011b; Nomura *et al.*, 2012). Lack of awareness and experiences of organic farming in smallholders and uneven benefit sharing especially for marginalised groups may mislead an attempt of such farming (World Trade Organization, 2011b; Beban, 2014). Supermarkets and consumers' awareness and demand can make environmentally low-impact farming sustainable (Salazar, 2005). While food security policies such as intensive agriculture tend to fail both enhancement of food security and conservation of biodiversity, conservation of biodiversity considering food security may be a better approach to create synergy between them (Pretty *et al.*, 2006; Brussaard *et al.*, 2010)

The climate-smart agriculture is a new and innovative approach adopted in the region. It seeks to improve food security, increase agricultural productivity and income, and build resilience to climate change as well as reduce emissions and enhance carbon sinks where possible (Sawhney & Perkins, 2015). In addition to legal and regulatory instruments, economic incentives and financial support such as provision of technology, knowledge and subsidies in materials are being used to increase the uptake of climate-smart agriculture practices. However, due to financial, technological, institutional and other constraints, climate-smart agriculture has currently only been adopted on a limited scale and mostly in countries in South Asia, South East Asia, and North East Asia. Schemes are generally implemented in partnership with government, inter-governmental organizations, NGOs, development organizations and local communities. Implementation of climate-smart agriculture is mostly at local level, but few examples exist at the regional level including in South Asia and South East Asia (CCAFS, 2017; Sheinkman *et al.*, 2015). For example the Climate Change Agriculture and Food Security (CCAFS) has been implementing projects in six Climate-Smart Villages in Lao PDR, Vietnam and Cambodia since 2015. Another noteworthy initiative which has the aim of accelerating up take of climate technologies and increasing access to finance for environmentally friendly technologies in 16 countries in the Asia-Pacific region, UNEP and ADB are piloting a climate technology network and finance centre with financial support from Global Environment Facility (GEF).

Clearly, sustainable agriculture that supports and protects BES in the region requires multi-sector involvement, effective policies and governance, and adoption of farming methods that are based on sound science (Thompson *et al.*, 2011) (Box 6.7). Asia-Pacific countries need a policy environment that directly enhances ecosystem services such as native pollination, natural control of pests and nutrient cycling for soil (Dicks *et al.*, 2016).

Box 6.7 Satoyama Initiative - Multi-sectoral approach for agriculture sustainability

The Satoyama Initiative, a multi-sectoral approach to maintain a good agricultural and coastal landscape recognised during COP10 of CBD as a potentially useful tool for conservation of heterogeneous agricultural landscape (International Partnership for the Satoyama Initiative, 2010). The Globally Important Agricultural Heritage Systems (GIAHS) launched under an FAO initiative in 2002 is another mechanism that supports the implementation of the Satoyama Initiative (Department of Tourism Art & Culture, 2013). One resolution under the Ramsar Convention, "Enhancing biodiversity in rice paddies as wetland systems" can promote wetland and semi-aquatic organisms by promoting sustainable rice production (Convention on Wetland, 2008; Maeda & Yoshida, 2009) and good practice. As an example, national policy based on international engagement of CBD national strategy and national level laws encouraged Aichi Biodiversity Action Plan and the Aichi mitigation programme: Japanese laws including Law for the promotion of nature restoration (MOE, 2002), Basic Act on Biodiversity in 2008 and the law to promote local

cooperation expecting multi-sector participation at the landscape to prefecture level (Aichi, 1994, 2017; MAFF, 2011b).
Payments for Ecosystem Services (PES) is another direct incentive mechanism that may be able to improve sustainable agriculture (Squires, 2014). The District Development Committees (DDCs), municipalities and Village Development Committees (VDCs) provide a mechanism in Nepal for payment to community forest user groups for provision of irrigation water based on Local Self Governance Act 2055 (Nepal, 2013). The system was originally based on the principles that benefit receivers should pay for provision of services, and that those who provide environmental services should be compensated for doing so, is one of good practices to enhance multi-sectors involvement and to promote sustainable agriculture ceasing poverty (Pagiola, 2007).

Deserts and semi-deserts

Deserts and semi-deserts in the Asia-Pacific region are distributed over a wide area (Figure 3.2 in Chapter 3), and account for about 20 per cent of the total land area of the region. Although the percentage covered by protected areas has increased recently and now is more than 16 per cent of deserts and semi-deserts, Red List Index (RLI) and Species Habitat Index (SHI) for key vertebrate species indicate a decrease in biodiversity in almost all of the deserts and semi-deserts parts of the region (Figure 3.3 in Chapter 3). Species in this ecoregion show distinctive adaptation to extreme environments such as heat and drought, and are vulnerable to even slight environmental changes (see Chapter 4, section 4.4.4; (Hoekstra *et al.*, 2004). Deserts and semi-deserts have fewer species than other ecosystems which has led to the argument that biodiversity losses in arid regions is more significant than elsewhere (McNeely, 2003), and as such protected areas play an important role in conservation of these threatened species.

North Eastern Asia stands out in this regard as there are many endangered or threatened large mammals such as snow leopard (*Panthera uncia*), algari sheep (*Ovis ammon*), goitered gazelle (*Gazellus subgutturosa*) and wild Bactrian camel (*Camelus ferus*) (see Chapter 3, section 3.2.1.4; Reading, *et al.*, 2006), and conservation of these species becomes critical. In this context, Mongolia is proceeding with its plan to increase protected areas for biodiversity conservation. It is important not only to increase the number of protected area but also to improve protected areas management in a manner consistent with social circumstances (Reading *et al.*, 2006). Mongolia established two nature reserves in 1957 and six protected areas in 1965 including national conservation parks and strictly protected areas. After the great political transformation and economic conversion in 1990, Mongolia enacted the Mongolian Law on Protected Areas in 1994 and extended protected areas (Eagles *et al.*, 2001) most notably the Great Gobi Strictly Protected Area (GGSPA) which essentially acts as a refuge for large mammals (Box 6.8).

Box 6.8 Conservation of threatened large mammals in protected areas of Gobi Desert in Mongolia

Gobi Desert ecosystem provides a unique habitat for globally threatened or rare species of large mammals such as the Asiatic wild ass, goitered gazelle, wild Bactrian camel, Gobi bear and snow leopard, but human pressures (e.g. human population increase, overexploitation of the natural resources, infrastructure development) present a significant threat to those species (Buuveibaatar *et al.*, 2017; Reading *et al.*, 2001; Walzer & Kaczensky, 2005). A reserve was established in 1975 to maintain the ecological balance of the Gobi Desert ecosystems, which was designated as a man and Biosphere Reserve by the UNESCO in 1991. The GG”A” SPA, located in the southwest of Mongolia on the border with China, protects critical habitat for critically endangered species like the wild Bactrian camel and the Gobi bear (Tumendemberel *et al.*, 2015; Walzer & Kaczensky, 2005), and the GG”B” SPA, located west of GG”A”SPA, protects habitat for large ungulates like the Asiatic wild ass (khulan) and the goitered gazelle (Ransom *et al.*, 2012; Reading *et al.*, 2001).

Little was unknown about Mongolian wildlife and conservation status previously but recently nature conservation efforts on threatened large mammals in or around protected areas show steady progress. Although the Asian wild ass is categorised as Near Threatened and the goitered gazelle is categorised as Vulnerable on the IUCN Red List, population surveys of these animals were imprecise and not conducted in a standardised manner until recently until ground-based precise and reliable population survey methods were developed (Buuveibaatar *et al.*, 2017) and in the GG”B”SPA (Ransom *et al.*, 2012) that replaced expensive aerial survey. Especially in the GG”B”SPA, local people (pastoralists) participation in the scientific conservation program was successfully accomplished by conducting community-based large-scale survey in addition to the development of an improved method for population estimates. Pastoralists keep animals in the same areas as wild animals, so it is essential that conservation programs for threatened wild animals consider pasturalists as key stakeholders to promote proper resource management that is grounded in tradition knowledge of these ecosystems. This kind of collaboration provides a good model for integrating local people into scientific conservation projects (Ransom *et al.*, 2012).

In the GG”B”SPA, research was undertaken on the difference in resource selection between the Asian wild ass and the Przewalski’s horse (Equus ferus przewalskii) which became extinct in the wild before being re-introduced (Kaczensky *et al.*, 2008). In the GG”A”SPA, project for conservation of the Great Gobi ecosystem using the wild Bactrian camel as a flagship species was initiated and basic management techniques were developed (Walzer & Kaczensky, 2005).

Regarding the conservation of the Gobi bear in the GGSPA, it was believed that the number of bears was low but without evidence from data-based population surveys. But DNA-based population surveys established that the genetic diversity of the bear population in this area was low because of its isolation from other bear populations and the number was estimated to be fewer than 40 individuals. Efforts were initiated to reduce human-mediated mortality but also to improve the food supply and establish a second population were highly recommended as strategies for long-term conservation (Tumendemberel *et al.*, 2015).

Research on predator species has been conducted in the Gobi Desert. Non-invasive sampling for genetics and camera-trapping techniques were used to estimate the population of the endangered snow leopard (Panthera uncia) (Janečka *et al.*, 2011). The wolf (Canis lupus) is not a protected species under Mongolian hunting law and can be hunted even in protected areas, and consequently hunting is a threat for wolf conservation in the GG”B”SPA (Kaczensky *et al.*, 2008).

In Western Asia, the Sultanate of Oman took an early lead in reintroductions of Arabian Oryx (*Oryx leucoryx*) back into the wilds of the Jiddat Al Harasis desert from captive bred animals taken from the San Diego Wild Animal Park in 1982. Successful reintroductions of this species have since taken place in Saudi Arabia, UAE, Jordan and Israel, but pressure from poaching remains driven by private collectors. Other important populations of mammals are still found in the mountain ranges of Oman, Yemen, Iran and Saudi Arabia including those of the Arabian Leopard (*Panthera pardus nimr*), and the Arabian Tahr (*Arabitragus jayakari*). These habitats and those of the dry low-lands are also important for numerous species of endangered birds such as McQueen’s Bustard (*Chlamydotis macqueenii*), and a range of raptors including the endangered Egyptian Vulture (*Neophron percnopterus*). In many countries in Western Asia conservation and protection of desert habitats and key desert species is achieved through a combination of protected areas and legislation banning hunting. However, these measures alone are not sufficient to cause effective protection because a combination of traditional rights, sense of entitlement, and conflicting development pressures such as the oil and gas, mining and housing sectors continue to undermine conservation efforts. Two examples illustrate the point: i) hunting is still the major threat to the sociable lapwing, *Vanellus gregarious,* throughout most of its breeding range in Central Asia and migration routes through Turkey and Syria (Sheldon *et al.*, 2013); and ii) in 2007, in an unprecedented move the Arabian Oryx Sanctuary in Oman was removed from the UNESCO World Heritage Site list after the area protected under national legislation was reduced by 90 per cent to allow hydrocarbon exploration and production to proceed.

Coastal and marine

When compared to many terrestrial ecosystems, legislation and policies for protection and conservation of coastal and marine resources are more recent and fewer in number. Among the few early pioneers are the 1981 Coast Conservation Act in Sri Lanka, 1982 Ocean Policy Statement in India, 1982 Marine Environment Protection Law in China, and 1992 National Policy on Coastal Resources Management in Malaysia. Much earlier legislation and policies tended to address the fisheries sector in support of economic development. The archipelagic countries in South East Asia with extensive coastal areas responded to coastal conservation pressures only recently such as the 2001 Decree on Integrated Coastal Management and Sustainable Small Island Management in Indonesia and 2006 Integrated Coastal Management Policy in the Philippines. Although the Philippine Fisheries Code of 1998 amended in 2015 focused on fisheries, the legislation also encompasses conservation and management of coastal resources including marine sanctuary, fishers' settlement, disaster risk reduction and other coastal community concerns. The uptake of coastal management in the Pacific Islands has been even slower, with only few formally establishing national or state-level coastal zone management plans (SPREP, 1999). Not only in the Oceania subregion but also in the Asia-Pacific region, Australia has been the pioneer of integrated coastal management (Nasuchon, 2009). The concept of integrated coastal management has become widespread in North-East, South, and South-East Asian subregions with some countries implementing policies and legislation to support its implementation. Moreover, the participation of communities and funding from international organizations have been major drivers of integrated coastal management programmes. Community-based coastal management is only now starting to gain traction in Pacific Islands and Western Asia. Several coastal resource management arrangements in the Pacific island countries in the Oceania remain informal and ad hoc (SPREP, 1999), guided by statutory rather than legal laws.

Countries in the Asia-Pacific region have implemented variety of management measures for the protection of BES from the sea. The East Asia, South-East Asia and South Pacific countries are surrounded by sea and have large Exclusive Economic Zones. Fisheries production is one of the most important marine BES as a source of animal protein for the human consumption, and the demand for seafood is predicted to grow (Albert *et al.*, 2015; Fabinyi, 2016; Glaser *et al.*, 2015; Tran *et al.*, 2017). In order to protect the resource, most countries have national laws for the conservation and sustainable use of marine fisheries resources, such as the Fisheries law of the People's Republic of China in 1986, Fisheries Law No. 31/2004 in Indonesia, Fisheries Law of 1949 in Japan, etc. New Zealand is famous for their market-based approach for fisheries management, so-called the Individual Transferable Quota (ITQ) system (Harte, 2008). Recently, the trade of aquarium fish has been rapidly growing in tropical areas, and its impact to marine ecosystem is attracting increasing attention from global communities (Prakash *et al.*, 2017; Tripathi, 2014). In Western Asia and South Asia, some countries have also introduced marine BES conservation policies. For example, in UAE, Qatar, Iraq, Bangladesh, and India, fisheries sustainability is declared as a part of the National Targets in the NBSAPs. The UAE has a dedicated Marine and Coastal Sustainability national strategy that was developed in 2014. Moreover, Iran and UAE declared the development of their marine protected area networks as one of their National Targets. The UAE has a national target to designate 14 per cent of coastal and marine areas as marine protected areas (Ministry of Environment and Water, 2014).

At the highest level management of the marine and coastal environments in Western Asia are governed by regional seas conventions which in turn are facilitated by United Nations Convention on the Law of the Sea (UNCLOS). The Regional Organization for the Protection of the Marine Environment (ROPME) and the Regional Organization for the Conservation of the Environment of the Red Sea and Gulf of Aden (PERSGA) are the regional seas organizations responsible for Arabian Seas, while the Mediterranean falls under the Mediterranean Action Plan. Regional fisheries management organizations are also active, such as the Regional Commission for Fisheries (RECOFI). However, despite the regional and national organizations' efforts coastal habitat degradation and overfishing have been identified as key national and regional issues (ROPME, 2013; Medio & Wilson, in prep) that are urgently in need of effective action (also see Sheppard *et al*., 2010).

Multilateral Agreements have also been developed in the Asia-Pacific region in the field of transboundary and highly-migratory fisheries resource management. The international organization for such fisheries resource conservation are called Regional Fisheries Management Organizations (RFMOs) (Pomeroy *et al.*, 2016). Examples are the Western & Central Pacific Fisheries Commission (WCPFC) for tunas, North Pacific Anadromous Fish Commission (NPAFC) for Pacific salmon, steelhead trout, etc., and North Pacific Fisheries Commission (NPFC) for chub mackerel, Pacific saury, to list a few.

Other marine BES policies such as marine habitat protection, marine pollution or marine debris, climate change and acidification, invasive species, etc., are also regionally addressed in the Asia-Pacific (Hu, 2012; IOC, 2007; Manoa & Veitayaki, 2009; Rochette *et al.*, 2015). Perhaps the most advanced example in the region is the integrated and adaptive conservation framework of the Great Barrier Reef in Australia (Hedge *et al*., 2017; Schultz *et al*., 2015, see also Box 2.12 in chapter 2). Another example as an international framework is the Pacific Island Regional Ocean Policy (PIROP) (Wright *et al.*, 2006). Partnerships in Environmental Management for the Seas of East Asia (PEMSEA) is promoting the integrated coastal management for the South-East Asian countries.

Several important factors contribute to the success of marine and coastal BES conservation policies in the Asia-Pacific area. Firstly, a number of international projects and programs have facilitated effective coordination, information sharing and cooperation within and between government agencies. One example from South Asia is the Bay of Bengal Program, an inter-governmental organization composed of Bangladesh, India, Maldives, and Sri Lanka which works towards the sustainable use of coastal fishery resources in the Bay of Bengal (Hussain & Hoq, 2010). The Yellow Sea Large Marine Ecosystem (YSLME) Project, led by Korea and China is also a good example of international cooperation. The YSLME was based on an assessment of transboundary marine environmental issues such as fisheries, pollution, and biodiversity and then developed a Strategic Action Programme which made policy and institutional recommendations (Sherman, 2014). The North-West Pacific Action Plan is another example of regional framework for the sustainable development of the coastal area, as a part of the Regional Seas Programme of UNEP and participated by China, Japan, Korea and Russia. In such cases, continuous support from international organizations such as UNDP and GEF have been instrumental to their success.

Furthermore, conservation policy options must consider the natural ecosystem characteristics, capacity and local social context including the value system of Asia-Pacific people (Cinner & Aswani, 2007; Clifton & Majors, 2012; Ferse *et al*., 2010; Kittinger, 2013; Pascual *et al*., 2017). To achieve this, the involvement of local stakeholders particularly the use of their traditional knowledge are essential (Berkes, 2015; Christie *et al.*, 2014; Drew, 2005; Hashim *et al.*, 2017; McLeod *et al.*, 2009; Murshed-e-Jahan *et al.*, 2014). In South East Asia and Oceania such activities are not consistently integrated in regional organizations/frameworks such as PIROP, the University of South Pacific (USP), Southeast Asia Fisheries Development Centre (SEAFDEC), Partnerships in Environmental Management for the Seas of East Asia (PEMSEA), and others.

The role of local ecosystem service users and their communities are central to the effective and efficient implementation of conservation measures. For example, in the case of fisheries a management approach that shares responsibility and authority for management between local fishers group and government is known as co-management (Jentoft, 1989; Pomeroy & Berkes, 1997), and many successful cases of fisheries co-management have been documented (Deacon, 2012; Gutiérrez *et al*., 2011; Iwasaki, 2014; Townsend *et al.*, 2008). Furthermore, the role of local communities in the sustainable use of BES, which simultaneously conserves local ecosystems, are attracting greater attention (Garcia *et al*., 2014; Govan *et al*., 2006; Velasquez *et al.*, 2005). The concept of “Satoumi” (Village and Sea) is one such initiatives (Berque & Matsuda, 2013; Mizuta & Vlachopoulou, 2017; UNEP, 2010; Ishikawa & Kanazawa, 2011; Yanagi, 2013). The meaning of Satoumi is similar to the Sasi system in Indonesia, that is to say a sustainable and harmonised relationship between coastal people and marine ecosystem on which they depend. Also, according to a review of the successful cases studies in the Asia-Pacific area by the International Coral Reef Initiative (ICRI), good communication with local communities and integration of their needs, such as livelihoods, traditional practice, and religious requirements, into the management plan are identified as one of the key factors for success (Ministry of Environment *et al.*, 2015). There are other examples where the application of global standards has been successfully interpreted at a local scale (Box 6.9).

Box 6.9 A successful case of the customization/modification of global standard to the local context

In 2003, UN FAO published the global guideline for the ecosystem approach to fisheries (FAO, 2003). This guideline summarised the basic concepts and principles of how to achieve ecosystem conservation, and identified the action needed to operationalise them into real fisheries management institutions. In line with this, the guideline pointed out the difficulties in small-scale fisheries because of their size (in terms of the number of people involved), diversity of gear and practices, geographical dispersion, generally low level of education, low political influence, etc. Coastal fisheries in South-East Asian countries are generally fit this set of criteria. Under the leadership of the Southeast Asia Fisheries Development Center (SEAFDEC), South-East Asian countries adapted the FAO guideline to fit the region's fisheries context (Bennett & Dearden, 2014; FAO, 2015b; Makino & Matsuda, 2011; Sutton & Rudd, 2015). In so doing, the regional consultation meetings were consistently arranged to be held in real fishing communities in order to fully understand and reflect local conditions and context, and this approach truly enabled the global standard set by FAO to be customised to the South-East Asian style, which is of course more effective and easier to implement than the local policy. SEAFDEC then published the regional version of the guideline (SEAFDEC, 2006), which, for example, defined "Fisheries Refugias" as the South-East Asian version of the marine protected areas for sustainable fisheries. Now, each country implementing ecosystem-based fisheries management policies along these guidelines.

There are also issues and challenges that are specific to developing countries in the Asia-Pacific. In the case of PIROP, for example, Vince, *et al.*, (2017) identified the lack of funding, lack of capacity, vertical segmentation of national policy options, lack of responsibility arising from strong external technical support, among others. For example, GDP or per capita GDP is very low in several countries in Oceania, South East Asia and South Asia, which implies severe difficulties in securing appropriate project funding in these countries. International support is indispensable under these conditions. Vertical segmentation is a common phenomena all over the world, but integrated policy frameworks such as PIROP, NBSAP, etc., is suggested as a potential platform to overcome such barriers. When a considerable negative impact to local communities is expected, conservation activities, mitigation measures and alternative livelihoods such as eco-tourism etc. need to be considered (Atmodjo *et al.*, 2017; Novak Colwell & Axelrod, 2017; Wood *et al.*, 2013). In the field of fisheries management, eco-labelling is starting to attract attention globally. However, because of the large number of small-scale fishers and the large variety of fishing gear and target species, among other factors, this approach has not yet prevailed widely in the Asia-Pacific seafood market (Marschke & Wilkings, 2014; Wakamatsu & Wakamatsu, 2017). Because the Asia-Pacific generates more than half of the global marine capture fisheries (FAO, 2016), an effective eco-labelling scheme in this region would have significant impact. More appropriate and feasible scheme (e.g. multi-species certification or group/cooperative application) needs to be implemented (Marschke & Wilkings, 2014; Wakamatsu & Wakamatsu, 2017). Finally, the management of resources and biodiversity in the vast high sea areas i.e. beyond national jurisdiction, in the Asia-Pacific region is another issue that has yet to be addressed (Blasiak *et al.*, 2016; Agarwal, 2015).

Inland wetland

Asia has witnessed one of the most rapid decline in wetlands any where in the world (Davidson, 2014; Dixon *et al.*, 2016; Gardner, *et. al*, 2015; Hu *et al.*, 2017). The Ramsar Convention has played an important role in triggering national policymaking and transboundary actions for wetlands globally, including in the Asia-Pacific region (Ramsar Convention Secretariat, 2016, case study in Box 6.8). Most countries in the region have wetlands embedded within the existing environmental policy and regulatory framework, with a select few putting in place independent policies. In Oceania, only Australia and New Zealand have specific policies for wetlands. In response to the requirements of the Ramsar Convention, the Australian government developed a framework policy for the cooperative management of wetlands, as a part of the National Strategy for Ecologically Sustainable Development. Australia has also put in place Commonwealth environmental legislation, including the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) and the Water Act, which give effect to a number of international agreements. Policies of New South Wales, Western Australia, Queensland, South Australia and Northern Territory provide strategies for achieving wise use of wetlands within the jurisdiction of states/territories.

In 1986, New Zealand became the first Contracting Party to the Ramsar Convention to have put in place a National Wetland Policy. This non-statutory policy established objectives for preservation and protection, inventory and public awareness, and identified that immediate and continuing action was required to protect wetlands. The National Policy Statement for Freshwater Management (2011) sets out the objectives and policies for managing New Zealand's freshwater resources under the Resource Management Act 1991. Administration of water management in New Zealand is by 16 regional councils through the framework provided by the Resource Management Act. The National Policy statement requires councils to manage water in an integrated and sustainable way, while providing for economic growth within set water quantity and quality limits. Regional and district councils have responsibilities to implement legislation and develop policies and regulations to protect wetlands and prevent their damage and degradation. Most use a mix of regulatory mechanisms and voluntary incentives to encourage protection and restoration of wetlands. The strength of regulation for wetland protection varies across the country, with stronger more restrictive rules in more populated regions where the loss in extent has been most significant. The New Zealand Biodiversity Strategy (2000), released by the New Zealand Government in partial fulfillment of international obligations under the Convention on Biological Diversity, includes outcomes that enhance the ability to manage wetlands, through mechanisms such as Terrestrial and Freshwater Biodiversity Information System (TIFBIS). Funds were made available and has contributed to database development and enhanced access to published and unpublished information.

Fiji does not have a policy dedicated solely to wetlands, however, sections within environmental policies such as the NBSAP, Integrated Communication Strategy, Fiji Forest Policy, Agriculture Policy and others include sufficient measures to support the wise use of wetlands. The Kiribati integrated Environment Policy covers wetland issues and so does the Kiribati NBSAP.

However, many other countries in South East Asia have recently developed policies and plans for the management of their wetland resources. Indonesia’s national strategy and action plan for wetlands was formulated in 2004 but is currently still under review. A national strategy and action plan for Sustainable Management of Peatlands has also been developed in line with the ASEAN Peatland Management Initiative. Wetland issues also find a place in sectoral policies and plans related to poverty eradication, water resource management, national forest management, biodiversity, agriculture and sustainable development. In Malaysia, for example, the National Wetland Policy that was formulated in 2004 is currently being reviewed and strengthened to address the needs of wetlands conservation. In 2011, the Ministry of Natural Resources and Environment issued the National Action Plan for Peatlands. The action plan is aimed at haze free ASEAN region by contributing to four objectives namely i) enhanced awareness and capacity building, ii) addressing transboundary haze pollution, iii) promoting sustainable management of peatlands and iv) promoting regional cooperation. Wetland issues have been incorporated into other national strategies and planning processes.

The National Wetlands Action Plan (2011-16) for the Philippines provides a framework of strategies and actions for all concerned sectors of society including government agencies, NGOs, the private sector, small communities and indigenous people for the management and wise use of wetlands and their resources for the enjoyment of their benefits by the present and future generations. Also, plans for biodiversity, climate change, and coastal resources management also include wetland issues. Thailand has enacted cabinet resolutions regarding wetlands which call for measures for updating of wetland inventories and improved measures to cover wetland at all levels. Wetland issues have been incorporated within the NBSAP. Issues of conservation and wise use of wetlands have also been incorporated into plans or policy of relevant sectors such as land management, water resources, agriculture, and climate change. Elements of wetland policies of Vietnam and Cambodia are contained in regulations related to land, water and biodiversity. Wetland issues have been integrated into national strategies and planning processes related to poverty reduction, water resources management, marine resources, national forest, and agriculture.

As of 2015, the government of Lao PDR was revising its National Law on Water Management and including a substantial component on wetlands to make it compatible with the Ramsar Convention and the Department of Water Resources of the Ministry of Natural Resources and Environment is currently in the process of developing a National Wetland Policy. Myanmar has also come out with draft national wetland policy in 2017. In 2017, the countries of the Lower Mekong Region (Lao PDR, Cambodia, Myanmar, Vietnam, and Thailand) have come together to establish the Indo-Burma Ramsar Regional Initiative to strengthen conservation of wetlands within the region. Wetland conservation in Brunei Darussalam is delivered largely through the regulatory framework guided by the Environmental Protection and Management Order of 2015 and the Water Supply Act 12 of 1962.

In East Asia, policies for wetlands generally take the form of separate policies (as in China and South Korea), or as integrated biodiversity policies (as in Japan). In China, policies for wetland conservation have been taking shape since 1992 with the national government becoming a Contracting Party to the Ramsar Convention. The broad objectives of the policy environment are to form natural wetland conservation system through the biodiversity conservation, pollution control, and alignment of land use with the natural characteristics and essential functions of wetland ecosystems. In 2012, the State Council approved the Twelfth five-year national wetland conservation project implementation plan drawn up by the National Forestry Bureau. The country has designated many internationally important wetlands that have not yet been designated as Ramsar site as nature reserves, wetland parks, or other types of protected areas, and fulfils appropriate conservation in line with available laws, regulations, and policies. In Japan The National Biodiversity Strategy 2012-2020 approved by the Cabinet in September 2012 is regarded as a National Wetland Policy. The policy includes: a) conservation and restoration of the habitats of various forms of life at the watershed level, while also paying attention to the connection with the sea; b) establishing domestic and international ecological networks centering on river/wetland areas; c) improving water quality so that people can have contact with a variety of aquatic life and secure healthy hydrologic cycles including groundwater and spring water; and d) restoring rivers and lakes that characterise Japan where rich ecosystems and local history, culture and life are in good harmony.

Under the Wetland Conservation Act that states the implementation of the concept of conservation and wise use, Korea elaborates the 5-year Master Plan for Wetland Conservation (MPWC) that guides the national wetland policies and their detailed implementation strategies which reflect on the findings of the national surveys on inland and coastal wetlands. The 2nd MPWC (2013-2017) was created with the goal of facilitating ‘harmonious coexistence between human and wetlands’, and the three objectives; setting up a scientific framework for wetland surveys; facilitating conservation and restoration of wetlands; enhancing the sustainable use of wetlands.

In South Asia, almost all countries have formulated policies and plan for wetlands. The National Wetlands Conservation Strategy and Action Plan of Iran is built around five goals, namely prevention wetland loss by removing threats, sustainable economic use, linking within sectoral plans, ensuring national and international commitments, and adaptation of wetlands to climate change. Afghanistan as a part of its national strategy bestows protection to wetlands from a perspective of conservation of migratory waterbirds. In Sri Lanka, national wetland policy and strategies, issued in 2006, have its main objectives to protect and conserve these ecosystems, prevent illegal utilisation of wetlands, restore and maintain the biological diversity and productivity of wetlands, enhance ecosystem services from wetland habitats, assure sustainable use of wetlands and traditional practices by local communities, and to meet national commitments as a signatory to the Ramsar Convention on Wetlands. The wetland, which was designated as one of India's first internationally important site under Ramsar Convention in 1981 found a place in the Convention's Montreux Record (a list of degraded sites) in 1993. In line with Ramsar Convention's wise use commitment, the state government instituted the Chilika Development Authority (CDA) in 1991 as the nodal agency to undertake measure for ecological restoration (Box 6.10).

Box 6.10 Use of Wetland wise use approach to restore Chilika Lagoon, India

Chilika, a brackish water coastal lagoon on the Indian east coast supports livelihoods of 200,000 fishers, while also sustaining rich biodiversity including a resident population of globally vulnerable Irrawaddy Dolphin (*Orcaella brevirostris*) and one of the largest congregation sites of migratory waterbirds within Central Asian Flyway. Reduced connectivity of the lagoon to the Bay of Bengal during 1950 – 2000 led to rapid decline in fisheries (with annual average landing dropping from 8600 kg to 1702 kg between 1985/86 and 1998/99), spread of freshwater invasive species and reduced marine biodiversity. In 2000, a major hydrological intervention in the form of opening of new mouth to the sea was undertaken based on modelling and stakeholder consultations. An intensive awareness campaign on the values and functions of the wetland system, particularly amongst the villages in and around and school children was undertaken with the participation of civil society. To support systematic management, an intensive hydrological and ecological monitoring programme was put in place. These programmes are coordinated through the Wetland Research and Training Center constructed on the shorelines of Chilika in 2002. Over the years, CDA has also established collaborations with over fifty organizations of international and national repute to support scientific studies related to various dimensions.

Restoration of hydrological regimes and re-established salinity regimes has led to recovery of fisheries and biodiversity. The average fish landing has since increased from 1,747 MT in 2000 to an average of 13,000 MT during 2001-15, the number of Irrawaddy Dolphins increased from 89 to 144 individuals, sea grass beds have expanded from 20 km^2 to over 100 km^2 and freshwater invasive species significantly reduced. The improvement of Chilika habitat, in particular the increase in dolphins, has led to a resurgence of wetland tourism, which had dwindled due to degradation. Following an advisory mission in December 2001, the site was delisted and the intervention recognised with the Ramsar Wetland Conservation Award and Evian Special Prize for wetland conservation and management initiatives. Chilika has emerged as a role model for participatory and adaptive management of wetland ecosystems. As a proactive step towards addressing emerging drivers of change, particularly related to coastal zone and linked to changing climate, new research has been commissioned to assess the overall vulnerability of the wetland ecological character and identifying suitable management response options. The wetland monitoring system is also being continually upgraded and made more sophisticated through the use of better equipment, collaboration with expert institutions and training of research staff. A State Wetlands Authority has also been constituted to bring management of all wetlands of the state under the control of single management authority, and to benefit from the experiences of Chilika restoration.

Source: Pattnaik & Kumar (2016)

The National Environment Policy of India provide specific elements for wetlands, which include integration in river basin and coastal zone management, prudent use strategies and poverty eradication strategies. In 2017, a national regulatory framework for wetlands has been put in place in the form of Wetlands (Conservation and Management) Rules, which prohibits wetland conversion, and institute state-level wetland authorities as regulating and management agencies.

The national policy of Pakistan, drafted but not formally accepted, is built around the objectives of removing threats to wetlands, creating and implementing a regulatory framework, inter-agency collaboration, promoting research, capacity development, and securing financing. In line with sectoral policies on water and fisheries, a community-based management approach characterises wetland policy of Bangladesh. Nepal has specific national policy for wetlands, which emphasises science-based management of these ecosystems, while ensuring community participation. Bhutan's wetlands conservation programme is yet at a nascent stage. The Forest and Nature Conservation Rules and Regulations of Bhutan 2017 lays down the institutional and regulatory architecture of wetlands in the country.

Data analyzed for Western Asian countries indicate that independent national policies for wetlands are yet to be put in place for several countries. UAE has developed specific environment conservation strategies e.g. water resources management, biodiversity conservation and sustainability of marine and coastal areas. The wetland conservation was linked to these strategies. Most of the issues related to wetlands are covered in these strategies. Iraq has a national wetland policy under preparation. In Lebanon, a legal framework for environment, which includes actions related to precaution, prevention, biodiversity conservation, monitoring, economic incentives for encouraging compliance and pollution control has been put in place.

6.2.2.2 Role of development organizations and private sector

Many recent studies have confirmed that funding for protected areas and biodiversity conservation must increase significantly to achieve targets set at national or international levels (e.g. Aichi Biodiversity Targets). A recent global top-down assessment conducted by the CBD High Level Panel estimated the global investment required is equivalent to up to 5 times present budgets (CBD, 2013). Today, 80 per cent of biodiversity finance is generated from non-market mechanisms (Parker *et al.*, 2012) which, with the exception of philanthropy, are public sector mechanisms relying on regulation for their implementation. This includes domestic budget allocations, Official Development Assistance (ODA), debt-for-nature swaps and subsidies reform. The allocation of public finance is primarily a question of political will (and public opinion) and these mechanisms therefore tend to vary with political cycles (Credite Suisse *et al.*, 2014).

It has been estimated that market-based mechanisms could generate up to 50 per cent of biodiversity finance for coral reef in 2020 (Parker *et al.*, 2012), but long-term, reliable instruments need to be established and strengthened (Forest Trends & The Katoomba Group, 2010). Instruments for conservation finance are diverse and several classifications have been proposed (TEEB, 2010). Instruments might seek to internalise the damages and profits, based on the "polluter-pays" or "beneficiary pays". Environmental taxes, taxation of contamination and compensatory measures of impacts (avoid-reduce-compensate sequence) are potential public instruments focusing on damages. On the beneficiary side, instruments include Payments for Ecosystem Services (PES), Public Private Partnerships (e.g. concessions, easements) as well as product sustainability labels. Development organizations and business firms are increasingly engaging themselves in supporting environmental conservation initiatives using such instruments.

International organizations and development support

International and intergovernmental organizations operating at the regional and subregional levels are working, with varying degrees of success, on promoting environmental knowledge, awareness and providing policy support to national governments in the region. International development organizations including the multilateral development banks (e.g. World Bank (WB), Asian Development Bank (ADB), etc.) and development agencies (e.g. Danish International Development Assistance (DANIDA), Department for International Development (DFID), German Society for International Cooperation (GIZ), etc.) have been providing funding support for environmental conservation programs. For example, ADB provides technical and financial support to the Coral Triangle Initiative in South East Asia, GIZ initiated programs to increase application of Voluntary

Sustainability Standards (VSS) in the Philippines, etc. Moreover, the International Tropical Timber Organization (ITTO) with 12 Pacific Asian member countries and collaborative initiatives of the Montreal Process and Sustainable Management of Dry Forests in Asia with the International Union for Conservation of Nature and Natural Resources (IUCN) have supported the revision of criteria and indicators for sustainable tropical timber production forest including conservation of biodiversity as a criterion (ITTO, 2005). Other government-based organizations such as Montreal Process including Australia, China, Japan, New Zealand and Republic of Korea in the Pacific-Asia region, the Regional Initiative for the Development and Implementation of National Level Criteria and Indicators for the Sustainable Management of Dry Forests in Asia formed a network to promote conservation of forest. The IUCN has carried out several activities for training, capacity building and field projects related to biodiversity, climate change, environmental law education, community-based natural resource management and policy issues through its thematic programmes. For example, Thailand’s mangrove restoration activities was promoted through the support from IUCN Asia’s Regional Business and Biodiversity Programme, which was co-chaired by IUCN and UNDP (see www.iucn.org). It was a partnership-based initiative to promote investment in coastal ecosystems for sustainable development and conservation, with both private corporations and local communities as beneficiaries.

Non-government organizations (NGOs) play increasingly important roles in putting policy into actions by participating in, contributing to and initiating various resource conservation programs. There are several reasons for the shift in environmental governance from government-led to multi-stakeholder conservation management (Yasmi *et al.*, 2010). Governments have limited human and capital resources to implement policies, making support from communities and investment from private organizations very valuable. Many natural resources are common goods, requiring acceptance from stakeholders, including local and indigenous knowledge, to implement their management. More and more civil society movements are becoming closely involved in shaping many environmental policies, which help to promote the inclusion of civil society also in the policy implementation. Many NGOs mobilise communities to help in development and conservation activities. NGOs based in Asia and the Pacific have stepped up their environmental efforts at the local level. For instance, the Indonesian NGO WALHI (The Indonesian Forum for the Environment) has over 600 groups actively involved in a variety of work. WALHI publicised the name of the company that imported wastes into Indonesia and abandoned them in ports. Seven organizations are working together through the Responsible Asia Forestry and Trade (RAFT) to build capacity of Asia-Pacific countries, businesses and communities in their practice of legal and sustainable forest management and trade (http://www.responsibleasia.org/). The Philippine Federation for Environmental Concern is playing a pivotal role in the environment advocacy. Haribon Foundation for the Conservation of Natural Resources is the pioneer Filipino environmental NGO founded in 1972. It remains to this day a major contributor to the country's biodiversity conservation and human well-being including strengthening of protected area networks (terrestrial, marine, freshwater), promoting local conservation areas and critical habitat and threatened species protection and reconciling conservation with sustainable livelihoods, among others. In South Asia and the Pacific, Pacific Islands Association of Non-Governmental Organizations is a major regional NGO, which has served the Pacific through strengthening and building the capacity of the civil society sector. The most active international NGO operating in Western Asia is WWF which has registered offices in Pakistan and UAE (in partnership with the Emirates Wildlife Society). The Third World Network (TWN) is a network of organizations and individuals addressing issues relating to sustainable development. This NGO has been conducting research on environmental, social and economic issues in developing countries and made various proposals at international conferences from the perspective of developing countries. The NGOs are also leading forest certification initiatives such as The Programme for the Endorsement of Forest Certification (PEFC) and The Forest Stewardship Council (FSC) to promote SFM. These certifications successfully work on conservation of biodiversity and ecosystem functions in certified forests including in China, Japan, Australia and New Zealand (https://www.pefc.org/ ; https://www.fsc.org/). Inclusion of the supply chain into the certificate incentivise conservation of biodiversity. However, the certificate does not yet fully engage in rights and participation of local communities including indigenous people.

Private sector and multiple partnerships

The CBD and United Nations Environment Assembly (UNEA) recently recommended to explore new and innovative financial mechanisms at all levels with a view to increasing funding to support the three objectives of the Convention (CBD, 2013). Although private sector corporations or business were considered to mainly focus on their economic benefits, today a number of them engages in conservation of biodiversity through sustainable operations and/or corporate social responsibility (IUCN, 2014). Five areas of financial innovations have been set out for the private sector: schemes for payment for ecosystem services; biodiversity offset mechanisms; markets for green products; public-private partnerships and new forms of charity; development of new and innovative sources of international development finance. Public-private partnerships are presented as a type of arrangement that addresses the conservation financing gap in the government sector. At present, funds for protected areas managed by government departments depend almost entirely on allocations made by government from the national or subnational budget. This arrangement presents many uncertainties for several reasons: for example, the governments have a limited budget; the regulatory framework does not encourage protected areas to generate income; and budget or objectives for the protected area are affected by changes in government policy and priorities. The main advantages of public-private partnerships include: their flexibility to set fees and charges, establish funding mechanisms such as concessions, respond to customer needs, their ability to retain the money they earn (which gives a resulting incentive to generate funds through greater entrepreneurship), and their freedom to implement staffing policies based on efficiency and market salaries (The World Bank *et al*. 2014).

Public-private partnerships have taken a wide range of forms in the Pacific and South East Asia (Box 6.11), which vary in the degree of involvement of the private entity in a traditionally public infrastructure. The list below depicts the spectrum of public-private partnership agreements (classified from low to high level of private sector participation) (European Commission 2003):

- Utility Restructuring, Corporatisation and Decentralisation
- Civil Works and Service Contracts
- Parastatal agency
- Management and Operating Agreements
- Leases / Affermage
- Concessions, Build-Operate-Transfer (BOT), Design-Build-Operate (DBO)
- Joint Ventures and Partial Divestiture of Public Assets Full Divestiture
- Full Divestiture
- Contract Plans and Performance Contracts

Box 6.11 Public-Private Partnerships in South East Asia

El Nido-Taytay Protected Area, Philippines: El Nido-Taytay Managed Resources Protected Area demonstrates a good private-public sector partnership. Here, a developer built a series of exclusive island resorts over 20 years. Tourism services are combined with environmental management and community services at a municipality level. Activities are quite diverse and has been implemented and financed by a mix of user fees, private donations and grants. Activities include Monitoring Wildlife, Marine Ecosystems Preservation and Protection, Marine Turtle Conservation Program, Coastal Cleanups, Mooring Bouys, Protection of Giant Clams, Marine Monitoring Task Force, Employment and Livelihood Opportunities for the Local Community, Patronizing Local Products, Environmental Education, Educating Guests, state-of-the-art sewage treatment plant, Materials Recovery Facility, Water Conservation, Desalination Plant, Energy Conservation, Low Impact and Sustainable Guest Experiences. Overall, this is a good example of effective tourism-funded conservation.

Pemuteran, Indonesia: Pemuteran is a small fishing village in the North West of Bali, Indonesia's most popular island tourism destination. Illegal dynamite and cyanide fishing methods were (until recently) still being employed by local fishermen, so the private sector formed two informal semi-

voluntary agreements with fishermen and the community. A local ban on illegal fishing methods was declared and beach guards were appointed to enforce this. A No-Take Zone of 500m by 200m was also declared for which an entry fee was charged to tourists. Marine conservation institutions in Pemuteran are in place largely due to efforts of a few independently acting entrepreneurs. This entrepreneurial marine protected area comprises several informal institutions which work toward common goals, but appear to operate individually. The private sector gained legitimacy through financial and non-financial investments in the local community. Some dive shops pay fishermen for using their area, some supply the fishermen with fish aggregating devices. The private sector has also invested in cultural assets and activities such as funding restoration of temples, which has been important for building support amongst the local community. The reefs have largely remained common property as there has only been minimal enclosure. As a result, the private sector has been able to exercise marine conservation without marginalising original resource users. However, norms and rules established by the private sector have not been formalised into government regulation. Today, Pemuteran is designated as a Daerah Parawisata Laut (Sea Tourism Area) by provincial law. Regency law states that the area has to have some sort of conservation effort, but does not state how.
Source: Adapted from Pascal *et al*. (2014)

So far no study has produced a complete census of public-private partnership agreements for nature conservation in the Asia-Pacific region. By nature these agreements are private contracts and rarely shared publicly. The following discussion is thus based mainly on assessment of grey literature (technical reports, government gazetting) and illustrations extracted from published reports and articles (Gjersten, 2003; Teh *et al*., 2007; Svensson *et al*., 2009; IUCN & UNEP, 2014; The World Bank *et al*., 2014). Five main categories of agreements have been observed for nature conservation in the region: (i) parastatal agency, (ii) management contracts, (iii) leases, (iv) concessions, and (v) joint ventures. All these categories are described more precisely in a report of the European Commission (European Commission, 2003).

The setup of parastatal agencies for protected area management have been observed in Malaysia and Vietnam. They are essentially a public sector organization with some elements commonly found in private sector organizations (e.g. members of the Board of Directors experts in tourism, business and protected area management). However, parastatals lack the autonomy and flexibility of private sector organizations (Board members appointed by government, budgets of parastatals underwritten by governments reducing potentially the rigour to business decisions) (Jones & Yoo, 2011). A reduced number of management contracts and Operation and Maintenance (O&M) agreements have been reported in the Philippines for terrestrial area management (linked to forestry operations). Nonetheless, as explained before these contracts are confidential and we think many other may have been implemented in the region. They cover a range of agreements, from technical assistance contracts through to turn-key project and maintenance agreements. The operator is usually paid a fixed fee to cover its staff and expenses. There may also be a performance or penalty fee. These contracts can produce improvements in the management efficiency of protected areas when performance targets are clearly outlines and monitored. This kind of agreement can be useful in contexts of market and political uncertainties where the private sector would be unwilling to accept risk (European Commission, 2003).

Lease and concession contracts have been reported in Vietnam, Malaysia and Indonesia. Leases are public-private partnerships under which the private operator is in charge of the operations of the protected area, but not for financing the capital expenditures. The operator usually charges a user fee to visitors. The government remains responsible for financing and managing investment in the assets. The length is typically above eight years. Concessions give an operator the long-term right to use all the area, but property ownership remains with the government authority. In a concession revenues come directly from the visitors. A concession gives a private operator responsibility for operations and activities of the area but also for financing all required investment. Build Operate Transfer (BOT) and Design Build Operate (DBO) agreements are the most common forms of concessions and have been observed in the region for other goals different than nature conservation (The World Bank *et al.*, 2014). A concession is typically for a period of 25 to 30 years (i.e. long enough at least to fully amortie major initial investments). Concessions are usually focusing on outputs - i.e. the delivery of a service in accordance with performance standards.

Finally, for a joint venture, in the case of a new protected area, a special purpose entity shall be founded with a joint share ownership structure. Typically, the operation and maintenance functions would be delegated to the private operator through a management contract (European Commission, 2003). To our knowledge, no joint venture agreement has been signed so far in the region for protected areas.

All of the countries in the region have a regulatory context for public-private partnerships. In recent years, most of the countries have been receiving some kind of training about public-private partnership from development partners, including the World Bank Group, the Asian Development Bank (ADB), the Multilateral Investment Fund (MIF) and the European Union (EU), among others. This inclination reflects global trends and experience. Many countries have found that public-private partnerships—when selected, structured, and managed well—can help make the best use of the financial and technical resources of the public and private sectors to provide improved infrastructure assets and services (The World Bank *et al.*, 2014). General experiences with public-private partnerships in the region have been mixed. The World Bank, the Asian Development Bank and the Inter-American Development Bank have identified the following issues: (i) long delays in delivering projects due to the complexity of the project; (ii) questionable value or unexpected costs to governments or consumers due to mismanagement or structural agreement failure and, (iii) difficulty to take off for many projects because of complex processes with multiple actors and changing political priorities (The World Bank *et al.*, 2014). The needs of small-scale protected areas at the country level may also limit the extent of "bankable" public-private partnership projects. Moreover, public-private partnership project developers have to develop innovative business models. Inviting the impact investing industry to participate in this kind of public-private partnership with mixed finance could be part of the solution.

Public-private partnerships and other financial innovations through private sector involvement and/or multiple partnerships provide benefits in the form of additional resources including other types of fund (see for examples Box 6.11) and additional expertise, which may be more cost-effective than public sector provision (Bos *et al.*, 2015; Wescott, 2001; Pascal & Bos, 2015). Multi-partnerships bring shared decision-making and risks and a balance of rights and responsibilities between public conservation agencies and local private groups (Vermeulen & Sheil, 2007). Another complemental opportunity for private sector corporations regarding development is a biodiversity offset (see also 6.4.1.3), a way to result in no net loss or a net gain of biodiversity in an infrastructure project (refer to IUCN Policy on Biodiversity Offsets, WCC 2016 Res 059). Offsets are optional or mandatory in several states including Victoria and New South Wales in Australia and New Zealand. The Organization for Economic Co-operation and Development (OECD) recognises them as an effective tool for both biodiversity conservation and mitigation of developmental impacts (OECD, 2013). While the offset is a mechanism to cover an actual loss caused by development and anticipated to technically provide a funding opportunity for restoration (Miyazaki, 2011), it also has its controversies (Maron *et al.*, 2015).

6.2.3 Local socio-political and cultural scenes

6.2.3.1 Community participation

With the revival of community involvement in management and the policy issues, many public interest groups have become involved in community-based projects involving management of the environment and natural resources (DANIDA, 2007; IFAD, 2006). Community participation in local governance exists in the region. For example, India has promoted people's participatory institutions like Panchayati Raj, a system of governance where co-operatives and self-help groups contribute to solving problems at the local level. Agha Khan Rural Support Programme has helped in promoting sustainable agriculture in Pakistan. In Thailand, Phang Nga Bay programme has been addressing the overexploitation of fish and degradation of natural resources, which is causing reduction in the fish catches and incomes. Similarly, Indonesia recognises indigenous mutual help and community participation mechanisms such as the water user's associations Subak in Bali and MitraCai in West Java. Programs related to community forestry have been another way to recognise and support community user groups, such as the Joint Forest Management (JFM) in India (Box 6.12). Moreover, India's Eco-Development Program involves local communities in the maintenance of designated buffer regions surrounding protected areas. In Nepal about 30 per cent of the national forests are handed over to over 19 thousand community forests user groups that are willing and able to manage such forests (DoF, 2017). Similar policies promoting the active implementation of community or village forestry also exist in Thailand, the Philippines, and Sri Lanka (UNESCAP, n.d.) as well as in Indonesia (http://blog.worldagroforestry.org/).

Box 6.12 Role of Joint Forest Management Committees in conservation of forests in India

The Indian Forest Policy made a shift in forest management from near exclusion of people from use of forest resources to Joint Forest Management (JFM) by recognising customary rights and privileges of forest dwelling communities (MOEFCC, 1988). National policy guidelines issued in 1990 by the Indian Government paved the way for involvement of village communities and voluntary organizations in the regeneration of degraded forest lands. These guidelines emphasise the involvement of local communities through the formation of Joint Forest Management Committees (JFMCs) for the protection, afforestation, and development of degraded forest lands and benefit-sharing with communities. The JFMCs now cover 22 million hectares forests area spread over 28 states, i.e. about 18 per cent of the total forest cover of India. As a result of this approach around 45 per cent of open forests are brought under the JFM regime. The extent of support offered by the JFMCs is quite substantial. However, the nature of JFMCs varies between States with respect to their membership, the participation of women and other weak sections of society, and benefit sharing. Forests are important for socio-economic, ecological and environmental sustainability and in providing ecosystem services. Therefore, innovative and effective forest governance through the JFMCs is considered essential to deal with the challenges of sustainable forest management in India (Chavan, 2013).

Co-management with the communities is an optimal solution in specific cases (see chapter 2.5.2.2). For example, because most of the coastal fisheries sectors in the Asia-Pacific countries are small-scale operations by large number of coastal people (FAO, 2015b), the fisheries co-management, i.e. fisheries governance by the local communities or fishers' organizations, is widely facilitated as the realistic solution to avoid the overfishing (Gutiérrez *et al.*, 2011; Jentoft, 1989; Pomeroy & Berkes, 1997). As a specific policy instruments to facilitate the fisheries co-management, granting the exclusive fishing right (group user right) to the coastal people and the formation of the fishers' organizations at the coastal communities are encouraged (Southeast Asian Fisheries Development Center, 2006). In Malaysia, the Tagal system provides an evidence for successful co-management of inland fisheries between the government and local communities (chapter 2.5.1.3). Community-based management, which allows collaboration of local communities with government and/or non-government organization, is another form of community participation in the region. In the Western Desert of Western Australia, the Martu Living Deserts Project integrated traditional knowledge with scientific land management through collaboration of the Martu people (Kanyirninpa Jukurrpa) with The Nature Conservancy and BHP Billiton. The Martu people have tremendous traditional ecological knowledge, which contributes in keeping Martu lands one of the most intact deserts and providing habitats for Australia's threatened species. The project created employment opportunities for the Martu people as rangers, improved fire regimes, controlled feral herbivores and predators, maintained social and cultural benefits from inappropriate development and conserved threatened species such as the Greater Bilby and the Black-flanked Rock-wallaby (Jupp *et al.*, 2015).

Chapter 2 presented cases where co-managed institutions could be more successful than community-based institutions. Some community-based institutions are confronted with design-related and other challenges, resulting in less successful outcome in protecting and managing BES (chapter 2.5.1.4). But there are also many successful cases so that community-based management (also known as CBM approach) is now proposed as the main basis for securing the well-being of both reefs and communities in the Asia-Pacific region (Ban *et al.*, 2011; Jenkins *et al.*, 2007; Johannes, 2002; Johannes & Hickey, 2004; McClanahan *et al.*, 2006; Tawake & Aalbersberg, 2002; UNEP, 2004). There are many community-based and informal traditional institutions which are involved in the management of marine and coastal resources in Solomn Island, Fiji, Tuvalu, Samoa, Melanesia and Polynesia (chapter 2.5.1.3). Community managed protected areas, and especially those in the marine realm, have experienced an impressive development during the last decade (Aalbersberg *et al.*, 2005; Evans *et al.*, 2011; Mackay, 2001). They usually form a part of a larger management scheme (Govan, 2009). Management rules such as fishing closure, temporary bans, size restriction, gear controls can be very diverse and some of them are still based on traditional ecological knowledge (Cinner & Aswani, 2007; Johannes, 1998, 2002). In recognition of these characteristics a regional term Locally Managed Marine Area or LMMA has been adopted since 2000. First recognised in Fiji, LMMA's are being replicated across coastal communities world-wide (Box 6.13). The management is carried out primarily by the community through the relevant user groups and also involves local and national institutions and private stakeholders. More than 420 Indo-Pacific sites in the LMMA network involve around 600 villages and LMMAs cover more than 12,000 km2 in 15 Pacific Island States (Govan, 2015). An LMMA is defined as an area of nearshore waters and coastal resources that is largely or wholly managed at a local level by the coastal communities, land-owning groups, partner organizations, and/or collaborative government representatives who reside or are based in the immediate area (Govan, 2009; Ruddle, 1994). Community-based management starts from the basic premise that people have the innate capacity to understand and act on their own problems (Ruddle, 1994). It builds on what the community thinks and allows each community to develop a management strategy that meets its particular needs and conditions (Guzman, 2004; Teh *et al.*, 2009). Its approach is people centered and driven by consensus. The core of the community-based management is community organization, where empowerment is a primary concern.

Box 6.13 Fiji and Vanuatu Community Locally Managed Marine Area (LMMA)

Community-based marine protected areas are considered among the main fisheries and coastal management tools adapted to the context of many Pacific countries, where intervention of government agencies is minimal and where community participation remains important. Governments, multilateral agencies and NGOs have supported community-based marine protected areas in the last 15 years and their number was estimated at more than 500 in the Pacific in 2007. Nonetheless, this support must now be improved through provision of more stable funding and regulations, which are appropriate to this kind of management.

The Fiji Locally Managed Marine Area (FLMMA) Network has accomplished much in the past decade. According to regional studies (Govan, 2009), approximately 102 LMMAs (with a total of 175 sites) are being pursued and/or have been established. Each LMMA is focused on re-establishing traditional community management practices and participating in a larger effort to share lessons and data on the management of their marine resources across the network of LMMAs in Fiji – as well as across the Pacific-wide LMMA network.

The efforts and achievements of the FLMMA network have prompted the Fiji national government to formally adopt the LMMA approach and to potentially recognise some LMMA areas as designated marine protected areas in the proposed Fiji national protected area system. This has effectively broadened recognition of the usefulness of LMMAs and has served to accelerate their use and adoption throughout Fiji. A challenge, however, even for the existing LMMAs, is to secure the financial resources and other contributions necessary to cover the costs of the design, implementation and on-going and adaptive management of these marine areas – and to allow each to fully participate in the relevant learning efforts across the network. While most LMMAs currently do not receive outside assistance or funding (simply relying on community driven monitoring and adaptive management), many do rely on direct support and funding from

international NGO partners, the government of Fiji, multilateral or private foundations and sector funders.
An appraisal of the economic benefits of community-based marine protected areas has been conducted in 10 villages in Vanuatu and Fiji. A bottom line analysis of their impacts on local development, poverty reduction and on biodiversity as a public good was identified as a way to "inform & convince" decision makers, budget-makers, local stakeholders and donors. The marine protected areas have been shown to generate benefits mainly improving the nature tourism attractiveness and maintaining the service of coastal protection as well as fishery productivity. Tourism business owners are the main beneficiaries (>60 per cent of the total benefits in most of the cases) followed by village households.
Sources: Clements *et al.* (2012); Pascal (2011, 2013, 2014)

Based on several studies (Govan, 2009; Johannes & Hickey, 2004; UNEP, 2004), the community Managed Marine Areas (MMAs) for the marine protected areas in the Asia-Pacific present some specificity that apparently solves three issues of protected areas. First, the theory of marine protected areas states that they should produce benefits for fishery as well as a wide array of other benefits, including tourism, access to information, enhancing property rights, etc. (Angulo-Valdés & Hatcher, 2010; Gell & Roberts., 2003; Roberts & Hawkins, 2000). These benefits should be an incentive for permanency of the marine protected areas inside the MMAs. Second, their management through village committees respecting customary rights, and land tenure should improve the chances of acceptance by local communities (Chuenpagdee *et al.*, 2000; Johannes, 1984). Third, due to the size and remoteness of these small marine protected areas the distribution of benefits on fishery and tourism are more likely to be directed to local community stakeholders (Tacconi & Bennett, 1997; Veitayaki, 2000).

6.2.3.2 Local and indigenous people and their rights

Chapter 2 emphasised that symbiotic relationship between human beings and nature has strong cultural roots in many parts of the Asia-Pacific region. The Asia-Pacific region as a whole is home to many racial, cultural, ethnic, linguistic and religious groups. It has succeeded in nourishing cultures that fuse the indigenous with modern ones. This fusion has perhaps promoted the ideology of living in harmony with nature that has been a force for the region's rich natural environment still remaining relatively intact. Indigenous and local knowledge systems that have evolved in the Asia-Pacific region and its subregions over long periods of time have provided convincing and useful value support in shaping the practices that help communities to benefit from nature. These include, for example, the use of traditional and holistic seasonal calendars for managing BES (chapter 2.2.2.1) and various concepts of living in harmony with nature such as Feng-shui in China, Shizen tono Kyosei in Japan, Prakriti-Purus in India, Qanat system in Iran, Maori's Ki uta ki tai belief in New Zealand, Al-Hima system in the Arabian Peninsula, etc. (chapters 2.2.3 and 2.3.2). These knowledge systems have significantly contributed in not only protecting resources but also enhancing our understanding of the governance of biodiversity and ecosystems for improving the quality of life. The latter includes, for example, the Saguday forest governance system in the Philippines which consists of council of elders that serve as carriers of traditional knowledge (chapter 2, Box 2.6) and Van Panchayats traditional forestry institutions in India that have considerable autonomy in decision-making and control over the forest (chapter 2, Box 2.7).

Relationship to their traditional lands and territories shapes the identity, culture and spirituality of the indigenous and local people (Göcke, 2013; UN, 2007; Edwards *et al.*, 2014). Rights to own, use and access traditional lands are thus important for these people. Many countries in the Asia-Pacific region have significant share of land area designated for or owned by indigenous peoples and local communities. All land is held in the Cook Islands and Tuvalu under customary land tenure, while in other small islands Pacific nations (i.e. Fiji, Kiribati, Nauru, Niue, American Samoa, Samoa, Solomon Islands, Tokolau, and Vanuatu) constitutional provisions or legislation providing for land are in accordance with indigenous customs, usages, and traditions (McMurdo & Gardner, 2009). Recent

Study conducted by the Rights and Resources Initiative (2015) showed that 97 per cent of the total land area in Papua New Guinea are owned by indigenous peoples and local communities (Figure 6.3). In terms of hectares, China (over 465 million hectares) account for the largest area designated as autonomous regions.

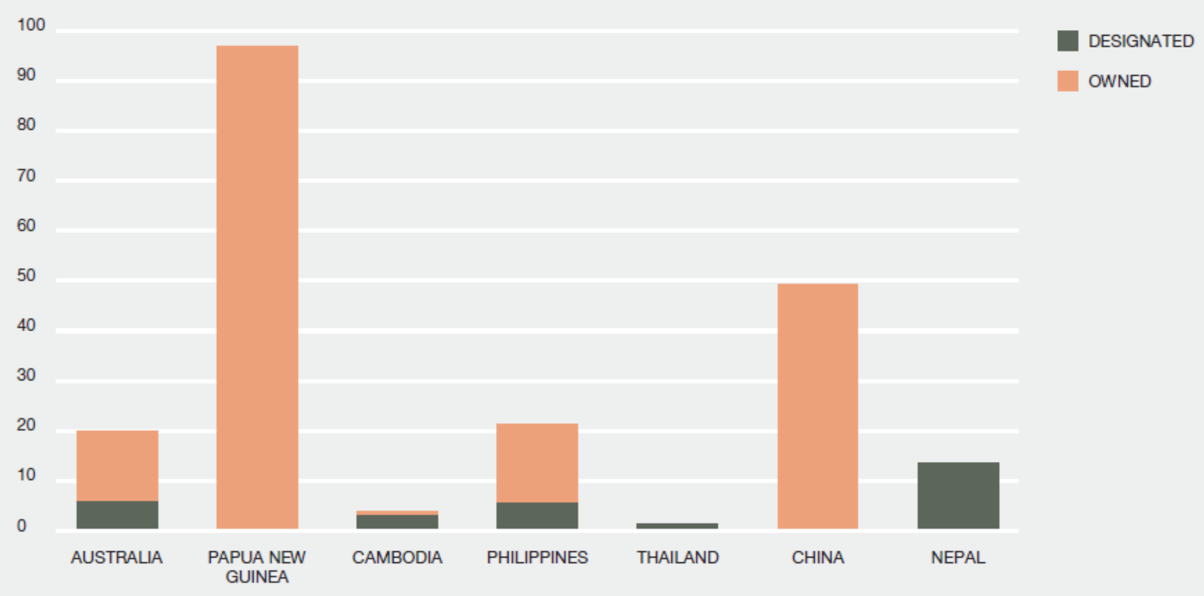


Figure 6.3 Land Designated for or Owned by Indigenous Peoples and Local Communities in Selected Countries in the Asia-Pacific Region (Per cent Country Area)
Data source: adapted from Rights and Resources Initiative (2015). Although similar breakdowns of country-specific data since 2015 could not be found, the overall figures of indigenous land titles may have changed significantly (e.g. Australia has exceeded 30 per cent as of March 2018 according to the National Native Title Tribunal (2018)). Moreover, there is data gap because indigenous people who are not formally recognised or are referred to using different terms (e.g. ethnic minorities) are not considered.

Norms, values, habits, practices and traditions, which are binding a society, passed down from generation to generation and strictly observed, become part of traditional customary law when they are recognised by the State or incorporated wholly within the State's predominant legal system (Davies, 2015). The legal reforms in the Philippines in the 1990s made its customary land rights amongst the strongest in the world and perhaps made it the only Asian country with clear recognition of indigenous peoples as 'indigenous' (Roy, 2005). In the Pacific, customary law in traditional indigenous contexts is more closely linked with morality and culture and incorporates many elements of sustainable development including equity, cooperation, responsibility for biodiversity and sustainable livelihoods (Techera, 2015). Similar system of customary law also exist in Asia such as the *tara bandu* in Timor-Leste (Miyazawa, 2013) and indigenous agroforest systems in the Philippines (Dulay, 2015), which practices provide protection for natural resources. In Australia's protected areas, habitation and land management by indigenous people were previously excluded to preserve wilderness areas, but recently the Indigenous Protected Area (IPA) program became a new initiative in protected area management. IPAs are established for the purpose of enhancing control of protected areas by indigenous people where traditional land management practices progress steadily and which provides cultural and biological benefits to the society (Muller, 2003). In the Middle East, the Al-Hima is the most widespread and longstanding indigenous and traditional institution for nature conservation. It is a traditional system of resource tenure that has been practiced for more than 1400 years in the Arabian Peninsula (chapter 2.3.2).

In many parts of the Asia-Pacific region, the management of coastal fisheries are based on traditional community-based systems, which are supported by property rights and associated regimes of rights and rules that closely reflect social organization and local power structure (Ruddle, 1997). In countries where “community land rights are respected and recognised in national law, communities can consider entering into partnerships with the private sector to establish responsible, secure, and sustainable investments” (Rights and Resources Initiative, 2015, p. 2). Moreover, international declarations and agreements (e.g. 1989 ILO Indigenous and Tribal Peoples Convention, 2007 UN Declaration on the Rights of Indigenous Peoples, etc.) provide indigenous people “rights of property over land and natural resources arising out of their own customary land tenure systems” (Anaya, 2005, p. 16).

6.2.3.3 Gender equity and women stewardships

Women in indigenous and local communities have important roles as stewards of natural resources and repositories of traditional knowledge and custodians of diverse culture (IFAD, 2004). These roles are anchored on their tasks to support the needs of their families such as food, water, livelihood, firewood, shelter and health care (AIPP, 2013). Development of human capital particularly among women is thus particularly important for sustainable land management. The gender development index (GDI) of the UNDP measures the disparities between women and men in human development including health, knowledge and living standards (UNDP, n.d.). The higher the index (highest global value is at the scale of 1), the lower is the gender disparity on these three human development dimensions. Figure 6.4 shows that GDI is highest in Australia and New Zealand, but many other subregions have experienced improvement in the index from 2005 and 2014. Women need to have equal access to not only human capital but also land. Rights over land is not a matter of possession but communal stewardship and spiritual relationship with the earth (Anaya, 2005). Gender equity in terms of access to land and security of tenure could thus also contribute to legal recognition of indigenous women’s role as responsible resource managers (IFAD, 2004).

Figure 6.4 Gender development and accessing institutions indices by subregion
Data sources: Gender Development Index from UNDP and data on Accessing Institutions from The World Bank. The index for accessing institutions was computed for this report.

Improving the role of women in the society will also improve their well-being. Women representation in community governance bodies and subordinate positions within the community can make women less vulnerable to the impacts of land commercialised or acquisition by investors (Salcedo-La Viña & Morarji, 2016). Based on a study of the International Union for Conservation of Nature (IUCN), gender equality particularly in terms of women's involvement "at the decision-making table leads to better environmental outcomes and actions" (Native Women's Association of Canada, 2014; p.9). However, in many countries, they only have limited access to basic services and resources, and are excluded from decision-making on management programmes (IFAD, 2004; Momse, 1996; Oviedo & Fincke, 2009; UN, 2010). Studies in Asia and Africa revealed that women take on more tasks and responsibilities in restoration of degraded drylands, but they remain excluded from decision-making process (Karmebäck *et al.*, 2015). Surveys conducted by the World Bank on women's access to institutions reveals that the indices have increased from 2010 and 2016, but they remain below 0.8 (Figure 6.4). The index, with a scale of 0-1 (highest global value is 1), measures women's legal ability to interact with public authorities and the private sector. The accessing institutions index was highest for Eastern Asia and lowest for Western Asia in 2016.

There are various initiatives and programs to enhance women's role in BES management. For example, the Women's Leadership Forum seeks to amongst others highlight women's contribution in marine conservation and to integrate gender principles at both the national and regional level of implementation of the plans of action (CTI-CFF, 2017b). By changing values and social structures, the Women in Business Samoa empowers women and equips rural families to cultivate sustainable businesses while respecting indigenous tradition (chapter 2.2.4.5). By providing control over management of the village forest, the Mahila Mangal Dals (women self-help groups) in Indian Himalaya offers an effective approach to manage forest ecosystem services under women's leadership (chapter 2, Box 2.7). Many of these are however scattered evidences. A more systematic research on the role of gender equity and women stewardships for BES in the region will be needed to guide policy on how to improve women's active role in BES governance.

6.3 Governance challenges and opportunities for viable options

6.3.1 Changing Governance Systems and need for good resource governance

Chapter 2 emphasised the immense contribution of BES at both the macro and micro levels: through contributions to national economies and by improving livelihoods and quality of life, and strengthening food security in the Asia-Pacific region. It also highlighted the importance of improvements in governance to reverse unsustainable use of natural resources and for achieving ecosystem-services-based ecological security, improving well-being and enabling economic progress in the Asia-Pacific region. A good governance system includes a stable set of formal and informal institutions and organizations; well-designed policy instruments; implementation of conventions and treaties; appropriate financing mechanisms; and rules, procedures and norms to arrest the degradation of ecosystems. Finally, demonstrated leadership, stakeholder support, enhanced institutional capacities and harmonisation of policies and inter-agency coordination among institutions are some of the enabling factors for effective and improved governance to shape individual and collective actions for the regional benefits. The emerging collaborative and participatory governance systems (section 6.2) show some progress towards good resource governance. However, adverse trends in BES show that the challenges for resource governance is increasing at a very fast rate.

Chapter 3 highlighted that biodiversity loss, both at the species and ecosystem levels, is at a critical state in many parts of the region due to multiple threats. In addition to logging and hunting, the growing practices of burning of forests and secondary vegetation to make space for industrial production of oil palm and pulpwood are destroying large areas of forest and woodlands, leading to extinction of bird species and mammals and increases in health problems from haze. In grasslands and savannahs, invasive alien plant species and climate change impacts are threatening the existence of herbaceous species and mammals. In desert and semi-desert environments, overgrazing due to increased livestock densities, increased mining and other developmental projects, and sedentarisation of herders are some of the causes of biodiversity degradation. The main threats to agro-ecosystems are farm intensification (i.e. South East Asia, South Asia) and abandonment (i.e. North East Asia), which cause resource degradation including soil depletion and pollution and pest outbreaks. Urban sprawl is a recent threat, resulting in the conversion of farmlands into built-up areas, intensifying heat effects of climate change in urban ecosystem. More than half of the world's biggest cities are in Asia, making urban ecosystems an important contributor to well-being in Asia. However, urban green space per capita is low and smog and heat negatively impact the urban population. Inland wetlands are also threatened by land-use conversion, with peat swamp forests in South East Asia being converted into banana and oil palm plantations. Continued land-use conversion is projected to cause extinction of fish species that are found only in peat swamp forests. In addition to aquaculture, which has already caused the destruction of large mangrove forests, the increasing conversion of mangrove areas to paddy cultivation and oil palm plantation are further degrading the coastal ecosystem. Finally, the combined impacts of overfishing and climate change have become a huge threat to marine biodiversity, including the coral reefs that provide fish habitat.

The persistence of adverse trends in BES in the Asia-Pacific region can be, amongst other things, attributed to institutions and governance systems which fail to respond to change effectively in order to secure sustained BES. The stability, self-reinforcing structure, and persistence (Hodgson, 1997; O'Connor, 1994) of institutions can often limit change and response to BES degradation (North, 1990; Shepsle & Weingast, 1981). This renders institutional change a gradual and incremental process, and is accomplished partly by the anchoring role of slowly-changing informal rules and complexity of formal rules, with each hierarchical level entailing more cost to change than the previous (North, 1997). The ability of institutions and broader governance systems to deal with environmental change is closely related to the degree of fit achieved between biophysical systems, resource regimes and governance systems (Victor *et al.*, 2008). BES in the Asia-Pacific region exist in a coupled human and biophysical system space, with impacts occurring at multiple scales, across time and space, and at different levels of biological and social organization and administration (Holling, 1986; Schneider & Root, 1996). A key prerequisite for sustaining BES in the region is to match attributes of institutions and governance systems with the biophysical dynamics underpinning BES. Misfits are known to occur across spatial scales (institutional jurisdictions are too small or large to affect the areal extent of ecosystems or linked ecosystem services domain), temporal scale (institutions formed too early or late to affect the desired effect on BES), thresholds (institutions are not capable of addressing abrupt shifts in biophysical systems, for example extensive bleaching and mortality of coral reefs in Indian Ocean), or cascading effect (institutions are not able to buffer, or trigger effects between biophysical, social or economic systems, for example, the inability of Roundtable on Sustainable Palm Oil to influence destruction of South-East Asian peat lands (Schrier-Uijl *et al*., 2013)). Increasing misfits also significantly increase governance challenges.

The effectiveness of institutions often depends not only on their own features, but also on interactions between institutions, often beyond their domains (Young, 2005; Young & Underdal, 2004). These interactions, however, can be synergistic or cause disruptions within the organizations. Interactions can be horizontal (occurring amongst institutions at the same level of social organization or at the same administrative scale) or vertical (influencing interactions at multiple administrative levels, for example the impact of the international Convention on Biological Diversity on the development of the National Biodiversity Strategy and Action Plans). Interaction through commitment is considered to be one of the causal mechanisms to influence the interplay between institutions (Gehring, 2006; Gehring & Oberthür, 2008). Assessing these interactions is important to understand the influence of different international or regional cooperation frameworks in the Asia-Pacific region with each other as well as the influence of frameworks such as the Sustainable Developmental Goals on governance pathways for BES.

6.3.2 Role of Drivers and potential policy pitfalls

Within the IPBES Conceptual framework, institutions and governance systems affect nature by influencing drivers of change, particularly anthropogenic direct drivers of change which are results of human action and choice. Chapter 4 discussed the direct drivers of change that can be reduced through institutions and enabling policy environment. Adverse impacts on BES due to changes in land cover and over-exploitation of natural resources as well as changes in the amount and patterns of consumption and infrastructure investment could be minimised through promotion of sustainable land management, consumption and investment. Much of the decline in traditional agroforestry and multi-cropping approaches resulting from the establishment of large scale monoculture plantations, associated deforestation and overexploitation of natural resources, have been caused by global trade and bioenergy policies. To minimise these adverse impacts, these policies need to be complemented with strategies that will ensure sustainable land use and reduce detrimental impacts on BES. For example, policies can help regulate leaching of pollutants from chemical fertilizer and pesticides in intensive agricultural systems, which cause eutrophication of freshwater and coastal water bodies, and kills beneficial microbes in these ecosystems. There is also a need to assess the impacts of the introduction of new technologies on biodiversity loss. One example of unintended impacts from the introduction of new technology is the case of the impacts of the introduction of genetic technologies on breeding and cross-breeding. Many stress tolerant and low external input agriculture crops and cropping practices have been lost with the introduction of new genetic technologies. Finally, socio-political issues like unclear land tenure, corruption, political unrest and local conflicts, which exacerbate illegal logging, mining, poaching, overgrazing, and over-exploitation, could be addressed by enhancing governance and improving policy enforcement.

Overall, however, market failure and weak governance are two fundamental challenges to achieving synergies between biodiversity and development outcomes. Market failure contributes to the decline in the state of BES because the value of BES is not reflected in market prices, and when considered they are often undervalued. As a result, integrating biodiversity-related considerations into decision- and policymaking processes has proven difficult (TEEB, 2010; United Nations Development Programme, 2012). Market failure can be corrected through good governance, which requires creating a 'match' and 'fit' between institutional and governance solutions and the underlying drivers of change in BES. A significant trend in this direction is embedding economic incentive policies, which create conditions for realigning private behaviour through consideration of full range of costs and benefits associated with BES provision and use. Weak governance is identified as a key barrier to creating synergies between ecological and economic development (Gardner *et al.*, 2013; Sayer *et al.*, 2013; United Nations Development Programme, 2012; Vaz & Agama, 2013). Governance challenges relate to ineffective or non-existent government institutions and rule of law, engendering other problems including a lack of clearly defined, secure and enforceable property rights/land tenure; a lack of clearly defined roles and responsibilities and of accountability; and elite capture and corruption (OECD, 2015). Governance needs to be improved to achieve global sustainability goals, which cut across all policy areas. Policies that cut across various scales and sectors are important for issues like poverty, food security and climate risks due to the interaction among direct and indirect drivers (chapter 4.3).

Poverty: In South East Asia, poverty is a common driver of natural ecosystem loss, demonstrated by the conversion of 62 per cent of forest area into plantation (Carnus *et al.*, 2006), particularly to oil palm which results in a significant loss of biodiversity (Koh & Wilcove, 2008; Miyamoto *et al.*, 2014). In cases where deforestation is due to large-scale plantation of bioenergy crops, biofuel policies contribute to exclusion and displacement of poor people (Acosta-Michlik *et al.*, 2011; Acosta *et al.*, 2016). The poorest resource users are typically marginalised, politically, as well as socially, even within their own communities (World Resources Institute, 2008; Sodhi *et al*., 2006), so measures that allow representation of marginalised social groups on decision-making bodies are critical. Community-based management programmes, which enable local stakeholders to participate in planning, researching, development and policymaking for protection of natural resources are one way of doing this, and innovative financing mechanisms, such as Payments for Ecosystem Services (PES) provide incentives for communities to remain engaged (UNEP, 2012). To ensure that the poorest benefit from improved ecosystem services, careful monitoring and targeting of pro-poor and pro-environmental interventions is essential, as well as high level policy support to ensure that local officials understand and are accountable for poverty reduction and ecosystem goods and services outcomes (Tyler, 2006). Although progress has been achieved in expanding protected area coverage, conserving species, and implementing community-based management, innovative financing mechanisms remain insufficient to address current biodiversity and habitat losses and some successful cases are yet to be replicated (UNEP, 2012).

Food security: With 490 million people, predominantly including the landless, indigenous people and ethnic minorities, still suffering from chronic hunger in the region (FAO, 2015a), one of the greatest priorities for countries in Asia and the Pacific is to reduce food insecurity and accelerate hunger eradication interventions. The challenge of eradicating hunger is largely compounded by growing shortages of land and water, increasing populations, and threats of climate change, which can significantly affect the availability and sustainability of agricultural and fisheries resources. For agricultural communities, well-directed policies and coherent strategies are needed to enhance productivity on smallholdings through R&D, crop diversification and smallholder market linkages. This includes a need for greater policy support to encourage innovations on farms and introduction of new technologies for revolutionising food production. Support is also needed for adopting 'save and grow' approaches, increasing water productivity to produce more food using less water, and promoting effective strategies and action plans for disaster risk reduction for food and nutrition security.

Climate risks: The Asia-Pacific region is highly vulnerable to climate-related disasters and could be among the hardest hit by a changing climate, especially small island developing states that are vulnerable to the risks associated with rising sea levels. As is so often the case the greatest impacts of climate change will be felt by the poor and vulnerable communities most intensely. The most immediate risks arising from climate change are from extreme weather events that will have direct impacts on BES, as well as food security in the Asia-Pacific region. Storms, floods and droughts will become more frequent and intense, resulting in landslides and siltation of dams, thus increasing the magnitude of asset losses, while decreasing agricultural production and purchasing power of low income consumers. Management of risks will require an enabling environment which includes: measures to improve infrastructure, access to information, access to credit and inputs, favourable prices for agricultural products, and security of land rights. These contribute to sustainable use of natural resources. Not only the Paris Agreement on climate change, but also the Sendai Framework for Disaster Risk Reduction 2015–2030 have recommend the use of ecosystem-based approaches to reduce risks including climate-related disasters. For many developing countries in the Asia-Pacific region, where insurance cover is limited, it is vital that climate risks are properly managed. This can be accomplished with comprehensive disaster risk reduction policy which includes hazard identification, risk assessment, risk communication, and risk management. Such a policy could also support the establishment of autonomous institutional mechanisms to effectively mitigate the impacts of natural disasters and environmental vulnerabilities. It is equally urgent to adapt to foreseeable shifts in agro-climatic zones, availability of water and related changes in species composition.

Another important issue that require cross-cutting policies is the adoption of REDD-plus. While REDD-plus is a highly anticipated international mechanism to reduce GHG emissions (IUFRO, 2012), there are increasing concerns about its trade-offs and/or negative effects on ecosystems (e.g. Ebeling & Yasue, 2008). For example, the conversion of high biodiversity but low carbon value land-uses to high carbon land-use, such as the conversion of low-carbon natural ecosystem to a fast-growing tree plantation, would lead to an overall loss of biodiversity and a local decline of ecosystem services (Secretariat of the Convention on Biological Diversity, 2010). REDD-plus also undermines the trend to decentralise forest governance and may even promote recentralisation. There was a shift to decentralisation of forest governance in the 1980's due to its expected benefits to local stakeholders (Colfer, 2011; Phelps *et al.*, 2010), for example, by reducing cost of environmental protection as assessed in the Himalayas of India (Somanathan *et al.*, 2009) and providing communities the opportunity to enhance local biodiversity (Chazdon, 2008). In recognition of the potential risks of REDD-plus activities, international society agreed to address and respect seven safeguards relating to: (i) national forest policy and international conventions, ii) national forest governance, iii) knowledge and rights of indigenous people and people of local communities, iv) full participation of stakeholders, v) conservation of biodiversity and enhancement of social/ environmental benefits from ecosystems, vi) prevention of reversal, and vii) prevention of displacement. Along with these safeguards are several requirements such as transparency, consistency and national sovereignty (UNFCCC, 2011). In the Asia-Pacific region, South-East Asian countries have developed or are developing principles, criteria and indicators, a roadmap and/or policy of safeguards at the national level such as those in Indonesia (Centre for Standardisation and Environment, 2013) and Viet Nam (Rey & Swan, 2014).

6.3.3 Development pathways for emerging options

Chapter 2 suggested that Asia-Pacific countries will have to explore new pathways to development that can improve their people's quality of life without liquidating their ecological wealth. Opportunities are emerging for networking among countries in the region with the creation of several regional global platforms for managing and protecting biodiversity, reducing climate-change-induced vulnerabilities, and promoting green and inclusive growth. Clear regional goals and commitments and mechanisms can support good governance and guide economic progress and societal well-being, which are linked to sustainable provisions and services from diverse ecosystems in the Asia-Pacific region. According to the Global Biodiversity Outlook (GBO4), significant progress has to be made to increase policy coherence with trade-related international instruments and to integrate biodiversity concerns into sectors outside of the biodiversity convention. There is so far a lack of commitment to integrating issues on ecosystem goods and services into international policy processes and only scant evidence exists for its proactive use in international policies (Malayang *et al.*, 2005; Ranganathan & Lucas, 2008; Swiderska *et al.*, 2008). This may be partly due to the novelty of the concepts, but also partly to the lack of understanding of the complex mechanisms linking local ecosystems to international policy. Sustainable delivery of ecosystem goods and services is directly linked to achieving the development goals, because most of the approximately two billion people targeted by the SDGs are farmers and subsist on immediately available ecosystem services. These development goals include among others SDG 1 on poverty eradication, SDG 2 on food security, SDG 3 on human well-being, SDG 6 on access to water, and SDG 13 on access to energy.

The development goals that directly address the sustainability of resources are SDGs 14 and 15. SDG 14 focuses on the conservation and sustainable use of the oceans, seas and marine resources for sustainable development. The goal aims to prevent and significantly reduce marine pollution of all kinds, sustainably manage and protect marine and coastal ecosystems, including restoring and building resilience to avoid significant adverse impacts, regulating harvesting, and increasing the economic benefits to Small Island Developing States and Least Developed Countries. The focus of SDG 15 is to protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss. The achievement of these goals will require integrating ecosystems and biodiversity values into national and local planning and development processes. This in turn will be influenced by system of governance, which embodies the processes of engagement, communication, learning and networking (Kok *et al.*, 2010).

Chapter 5 identified three development pathways that are relevant for assessing governance options that are relevant to both BES and SDGs. The pathways, which were developed by the PBL Netherlands Environmental Assessment Agency (2012, 2014), include Global Technology, Decentralised Solution, and Consumption Change. The PBL differentiates the pathways according to three dimensions – nature of economic activities (‘lifestyle’), availability and performance of technologies, and the interventions, regulations and policies that result in different associated effort levels, synergies and trade-offs to achieve sustainability goals. The pathways are relevant for assessing policy options because the dimensions represent the elements of governance systems including institutions (i.e. technologies, interventions, regulations and policies) as well as actors and organizations’ behaviour (i.e. lifestyle and societal changes) (refer to the governance framework in Figure 6.1). Moreover, the pathways allow for multi-level assessment, from global to local, and vice-versa, taking into account across-scale interactions and combining government actions with the civil and corporate initiatives. As such, the PBL emphasises that “governance and institutional developments in the various scenarios should be explicit on the nature of lifestyles, economic mechanisms and technology features” (PBL Netherlands Environmental Assessment Agency, 2012; p.103).

Figure 6.5 presents the schematic trajectories for achieving sustainable goals in the different development pathways between 2010 and 2050. In this chapter, the transformative actions and policy are represented by the instruments and options for sustainable BES governance. Table 6.2 describes these pathways and presents the options that are relevant for each. The governance options are discussed in detail in section 6.4.2. Many of the policy options represent the Global Technology pathways and only one option represents the Consumption Change pathway. There are however large options for incentive measures (or instruments) that influence consumption behaviour of the society. These measures are discussed in detail in section 6.4.1. The implications of the instruments and options on achieving sustainable development goals are discussed in section 6.6.

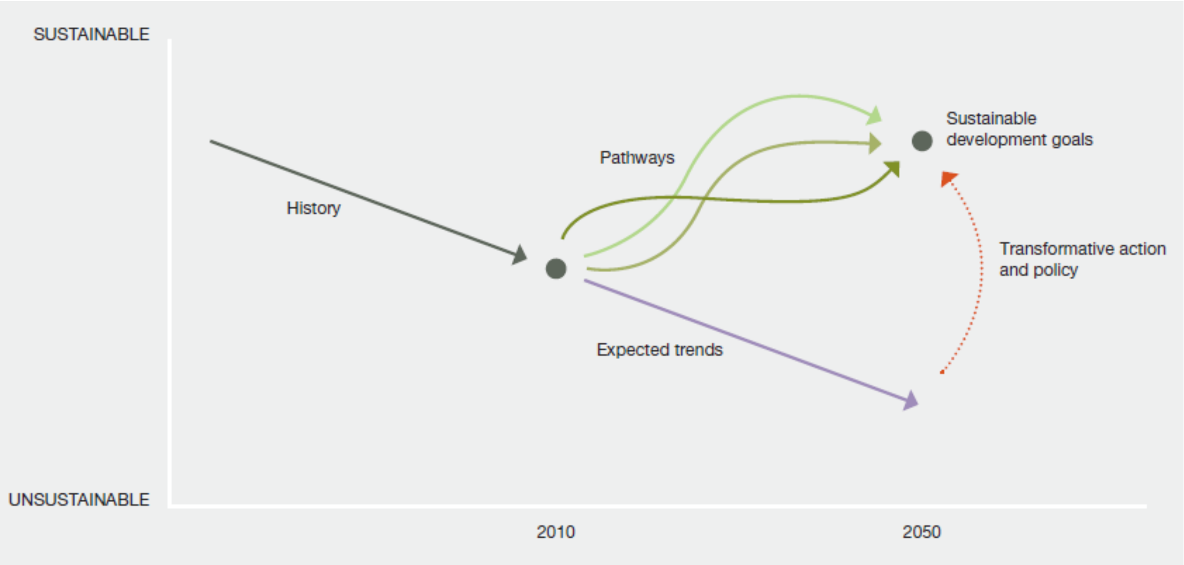


Figure 6.5 Pathways for meeting sustainable development goals
Note: The horizontal axis is time; the vertical axis represents an aggregate of indicators that cause unsustainable development. Source: PBL (2012).

Table 6.2 Development pathways and policy options for biodiversity and ecosystem services

Pathways	Description*	Governance options**
Global Technology	Top-down or global scale with international policymakers, multinational corporations as key actors Introduction of large-scale, global solutions to resolve global sustainability issues, particularly climate change and biodiversity loss Address large income and wealth inequalities that cause global insecurity, resource conflict and social and political turmoil	Improving governance of protected areas (section 6.4.2.1) Strengthening transboundary governance for shared natural areas (section 6.4.2.2) Mainstreaming biodiversity-related goals (section 6.4.2.3) Investments in natural capital (section 6.4.2.6) Environmental regulation, standards and certification (section 6.4.2.7) Strengthening indicators and accounting systems (section 6.4.2.8)
Decentralised Solution	Bottom-up or local scale with citizen groups and civil society, local and national policymakers as key actors Prioritise local or regional level to achieve sustainable quality of life Consider small-scale and decentralised technologies and organizational efforts as solutions to sustainability problems Use of ICT to ensure sufficient level of global coordination and disseminate smart and novel forms of technologies and institutions	Co-management and collaborative governance (section 6.4.2.4) Fair and equitable sharing of benefits (section 6.4.2.5)
Consumption Change	Activities in all scales with citizens and firms as key actors Increase awareness of sustainability issues results in sustainable lifestyle and transition towards less material- and energy-intensive activities Bridge targets that have not been achieved with additional existing technologies	Realigning incentives (section 6.4.2.8)

*Source: PBL (2012)
**These are emerging options identified from the assessment of governance systems – enabling environment and multiple partnerships in section 6.2.

6.4 Presentation of Options

6.4.1 Policy instruments

Delivery of policy objectives for conservation and sustainable management of nature and NCP in the Asia-Pacific region is through a diverse range of policy instruments, providing the crucial bridge between policy development, decision-making and policy implementation (Huppes & Simonis, 2009). This section presents an overview of policy instruments currently in use in the region, focusing on the opportunities and challenges associated with each, thus providing a prelude to policy options that follow in the next section. Based on available literature, instruments have been classified into five broad categories, namely legal and regulatory, economic and financial instruments, human rights based instruments, social and cultural instruments, and management instruments (Table 6.3). As can be discerned from the following sections, these instrument classes are not independent, and in practice have a high degree of interdependence. For example, human rights based instruments provide the basis of several social and cultural instruments, or the legal and regulatory instruments support the boundary conditions for operation of economic and financial instruments.

Table 6.3 An overview of policy instruments used in the Asia-Pacific region

Policy instrument categories	**Illustrative examples**	**Key findings**	
		Opportunities	**Constraints**
Legal and Regulatory	• Legislations • Standards • Supervision • Environment quality objectives • Liability rules • Technology requirements	• Can provide the regulatory basis for other instruments categories (such as economic and financial instruments)	• Often inflexible, can limit freedom of affected producers to choose their method of compliance • In weak governance situations, enforcement can be selective and lead to rent seeking behaviour
Economic and Financial Instruments	• Taxes • Subsidies • Charges and Fees • Offsets • Payments for Ecosystem Services	• Can assist in internalisation externalities • Provides flexible compliance mechanisms	• Markets cannot provide solutions under all circumstances • Can be controversial if not backed by adequate supportive ecological and socio-political measures
Rights based instrument and customary norms	• Heritage sites • Customary norms and institutions of local communities and indigenous people • Community conserved areas • Access and benefit sharing	• Securing participation of local communities and indigenous peoples in conservation of nature and sustainable management of NCP • Can augment formal protected area networks	• Underdeveloped local and national legal structures • Seeking balance between rights and responsibilities • Maintaining effectiveness of decision-making.
Social and cultural instruments	• Information • Biodiversity registers • Education and training • Corporate Social Responsibility • Self-regulation • Voluntary agreements	• Provide a space for indigenous and local knowledge to have a greater influence on planning and programming • Foster enhanced participation of diverse communities and sectors in conservation	• Decentralised approaches may not be necessarily aligned with traditional community institutions • Highly sensitive to local conditions • Being largely voluntary, there may be challenges in

		• Augment resources • Support behavioural change at local and sub-national scales	standardisation and upscaling
Management based instruments	• Landscape management • Sustainable forest management • Integrated coastal zone management • Integrated river basin management	• Foster systemic change in management of landscapes to secure long term conservation of nature and NCP	• Complex coordination and funding requirements across sectors and stakeholders

(Source: Authors' summary of assessment)

6.4.1.1 Legal and Regulatory Instruments

Legal and regulatory instruments, also alternately referred as command and control instruments have been the predominant approach for biodiversity conservation and addressing environmental issues in Asia and Pacific (Gunatilake & De Guzman, 2008; Miteva *et al.*, 2012). These instruments, which work in the form of setting standards, norms, technology requirements, threshold values, liability rules, or setting disincentives as means of conserving nature, or addressing threats to nature, have their positives in the form of clarity of objectives and outcomes and relative ease of compliance monitoring (Gunningham & Sinclair, 1999), and can set the boundaries for operation of other instruments classes such as economic and financial instruments (Vatn, 2015). An extensive assessment of policies for various ecosystems and for various subregions was presented in previous sections of this chapter. The assessment revealed that many instruments for these policies have been criticised for lacking flexibility, and adaptation to local conditions and intersectoral considerations. A review of environmental laws and institutions in South East Asia identify two major challenges, namely a) failure to coordinate developmental and environmental policies between the central and provincial governments, as well as between different sectoral interests at all levels, and b) sectorality, without adequate consideration for the deep inter-linkages that exist in various environmental issues (Tan, 2004). On similar lines, a review from the South Pacific concluded that command and control instruments could be used mostly as a last resort, with preference being given to social agreements to achieve a desired land use or change and undesired behaviour, with due consideration to sensitivities associated with customary land tenure, and traditional patterns of development (Farrier, 2003). Despite the mixed record of command and control approaches (Mukul *et al.*, 2014; Nagle, 2009), these instruments have an important role to play in providing the basis of operation of other instruments types, such as economic and financial instruments (Gunatilake & De Guzman, 2008; Mulongoy & Gidda, 2008a).

6.4.1.2 Social and cultural instruments

Social and cultural instruments build on the interdependence between ecosystems and sociocultural dynamics for meeting environmental management objectives. These include information related instruments such as environmental education, eco-labelling, certification, and awareness raising; self-regulation, voluntary agreements, corporate social responsibility: participation, and enhancement of collective action of indigenous peoples and local communities. There are several examples of community based nature conservation and sustainable management initiatives from the Asia-Pacific region centered on the conservation ethos of these communities (Box 6.14). In several cases, enabling local communities and indigenous people to take management decisions, and also providing options of livelihoods, have been key success elements.

Box 6.14 Community-based Trophy Hunting--a Powerful Tool for Maintaining Biodiversity

Pakistan is considered as a pioneer in successfully introducing community-based trophy hunting to conserve biodiversity, particularly mountain ungulates and their habitats. This is achieved through provision of direct and indirect economic incentives to local communities to conserve wildlife populations. Pakistan is rich in diversity of Caprinae species (mountain goats and sheep) like markhor (Capra falconeri), Himalayan ibex (Capra ibex), Sindh ibex (Capra aegagrus), Urial (Ovis vignei), and Blue Sheep (Pseudois nayaur). The trophy hunting of these species is allowed under a strict policy only in community-managed conservation areas. The revenue generated through this program is distributed at 20:80 ratios, meaning 20 per cent of the trophy permit fee is retained by the government, while 80 per cent of the revenue is shared with the participating community for use in species conservation and/or local economic development activities. These funds can provide an enormous increase in community's collateral savings and household income and act as a powerful incentive for managing biodiversity. For example, only 12 markhor permits are issued annually under the CITES quota, 4 each for Gilgit-Baltistan, 4 for Khyber Pakhtunkhwa, and 4 for Balochistan. These permits are issued through an open auction and can bring $50,000 to $110,000 on the international market for a single markhor trophy. Similarly, ibex trophy permits range from $3000 to $5,000, urial from $12,000 to $15,000, and blue sheep from $8,000 to $12,000 for foreign hunters. Ibex hunting permits are also offered to national hunters from PKR100,000 to 300,000 and for local hunters from PKR25,000 to 55,000. For 2016 hunting season, government of Gilgit-Baltistan has issued 4 markhor, 80 ibex, and 14 blue sheep permits through a bidding system. Community-based trophy hunting is taking place since 1996 and so far participating communities have generated considerable revenue from this scheme, which is contributing to biodiversity conservation and local socio-economic development. (IUCN SSC, 2012) recognises that trophy hunting can serve as conservation tool when it contributes to biological sustainability and provides net conservation and socio-economic benefits

There has been a remarkable impact on markhor, ibex and urial populations. Their numbers have increased many folds in the community conservation areas (biological sustainability). Trophy hunting fees brought many socio-economic benefits for the local communities in the form of developmental activities, scholarship schemes for talented poor student, especially girls, and community loans for micro enterprise. In addition, trophy hunting generates permanent employment as community rangers and seasonal employment as daily labours, rent for horses, porters, and selling local handicrafts (conservation and socio-economic benefits) (Ali *et al.*, 2015). These activities provided direct and indirect economic incentives to local communities, which changed their attitude and perceptions toward biodiversity and community-based biodiversity conservation, as a result poaching was controlled to large extent. Local people believe that the community-based trophy hunting has potential to contribute to biodiversity conservation and the cost of local development. It could be a powerful and effective conservation tool if applied correctly. It is low impact and low cost tool, but return from sustainable use of components of biodiversity is often very high (Shackleton, 2001; Virk, 1999).

Multi-stakeholders led initiatives described above are the outcomes of mainstreaming of biodiversity conservation into production sectors using the corporate social responsibility mechanism which paves way for achieving sustainable development goals by making conservation efforts beyond protected areas. Additionally, building capacity in developing and effective implementation of community managed business plans is equally important in generating sustainable financial mechanisms as an incentive for managing community conservation areas and protected areas. Further development of Trust Fund mechanism also enhances community involvement in protected area management. In Pakistan, Mountain Areas Conservancies Fund has been developed as a revolving fund for sponsoring small community-based biodiversity conservation projects. In addition, Protected Areas Fund has been created with seed money from the GEF to support the management and biodiversity conservation in buffer zones of important national parks (Hunnam *et al.*, 2003).

Consumer and producer market standards, product certification, sui generis protection systems, and sustainable supply chains are increasingly important, since large-scale threats, such as ranching, plantations, commercial fisheries, and products increasingly entering global supply chains, now supersede small-scale, rural marketing systems. Environmentally certified products have increasingly penetrated into mainstream product markets. Globally the area compliant with major Voluntary Sustainability Standards has expanded for more than three times from 2008 to 2013, where notable increase was seen for oil palm, sugar cane, and cocoa (Lernoud *et al.*, 2015). The adoption of VSS in Asia and the Pacific emerged slower than in other regions, but is now picking up, with 9 countries in the region are counted amongst the global “top-ten” countries regarding the area certified under major international certification schemes. Growing demand for environmentally certified products further led to the establishment of country initiatives, such as the Indonesian Ecolabelling Institute which developed Forest Certification Systems in Indonesia. The objectives and scope of certification substantially vary among different certification initiatives, whether it be very specific to conserve forest or agro-forest ecosystems, bird habitats or dolphin populations, or too general to be effective in delivering results for the conservation of BES.

Ecotourism can blend the goals of education and awareness as well as creation of positive economic incentives for nature. It can be combined with community conservation and protected area management, and when applicable, can be highly successful. Community-based ecotourism is one of the fastest growing industries in the world (Damania & Hatch, 2005). Protected areas are vital for safeguarding biodiversity and generating annual revenue through ecotourism. Ecotourism in and around protected areas in Thailand has increased average household income and lowered poverty rates (Ferraro *et al.*, 2013). Nepal uses a strategy of ecotourism built around tiger reserves, strongly emphasising benefit sharing, turning poachers into tour guides, and allowing the regeneration of degraded forests. g the local community and Non-Governmental Organizations. However its potential has not been fully tapped as there is limited involvement of the local community in the planning and implementation stages (Idajati *et al.*, 2016).

The rich cultural diversity of Asia and presence of local communities and indigenous peoples in key biodiversity areas in most parts of the region, make use of social and cultural instruments highly relevant. These tools also provide the possibility of augmenting public finance resources for nature conservation by mobilising resources from the private sector, yet their overall positive impact on conservation has only been limited (Robinson, 2012). Implementation of these instruments demands explicit consideration of local conditions, and thereby have replicability and scalability challenges. Schemes as certifications needs capturing substantial additional payments in the consumer market to cover certification cost and to incentivise environmentally sustainable production, which is, however, so far reported to be marginal and insufficient (Taylor, 2005). Effective certification systems require specific and meaningful criteria with legitimate validation mechanism, with markets settling upon broadly accepted industry-wide standards and means of raising consumers’ awareness (Ghazoul, 2001; Gullison, 2003; Laurance *et al*., 2010; Schouten & Glasbergen, 2011; Ward, 2008). ‘Information Strategies’ include education and training, corporate environmental reporting, community right to know (laws compelling firms to disclose their pollution and chemical hazard information, including pollution inventories and product certification. While information is an important tool for environmental protection both to correct asymmetry of information, e.g. between regulator and regulated or business and community, it is not sufficient by itself to produce results in environmental protection, and often needs to be paired with other policy instruments to achieve strong outcomes (Gunningham & Sinclair, 1999).

6.4.1.3 Economic and financial instruments

Economic and financial instruments form an important component of policymaker’s toolkit, aimed at altering the costs and benefits (or incentives or disincentives) associated with a policy option, to achieve the desired policy outcome. These instruments aim at internalising externalities generated through production and consumption processes, which are not recognised within the decision-making processes of those responsible for the processes. The CBD highlights absence of incentives as one of the leading causes for loss of biodiversity and associated ecosystem services. Article 11 of the CBD on incentive measure, creates an obligation for Contracting Parties to, “as far as possible and as appropriate, adopt economically and socially sound measures that act as incentives for the conservation and sustainable use of biological diversity” (CBD, 2011). The Aichi Biodiversity Target 3 stipulates for reformed incentives, and states that by 2020, incentives, including subsidies that are harmful to biodiversity are eliminated, phased out or reformed in order to minimise negative impacts on biodiversity (CBD, 2011). This target requires Parties to take actions to eliminate or phase out incentives that are harmful to biodiversity. Where elimination or phasing out is not possible, Parties are encouraged to reform such incentives so that their negative impact is minimised.

Once economic causes of biodiversity loss are identified and the need for economic incentives is felt, a range of financial and economic instruments can be introduced to change people’s economic behavior and promote biodiversity conservation (Emerton, 2000). Such instruments include voluntary approaches (voluntary certification/labelling/standards), charges (taxes, user fees, entrance fees, effluent charges, administrative fees,), fiscal instruments such as taxes and subsidies (direct taxes, tax relief, grants or low-interest loans, payments for ecosystem services), property rights approaches (special permits, tenure rights, licenses, concessions, biodiversity offsets, credit programs), liability rules, bonds and deposits (security deposits, restoration bonds, assurance bonds), conservation banking, biodiversity mitigation and indirect approaches of community-based and integrated development and conservation projects that includes eco-tourism. Box 6.15 illustrates use of economic incentives based approach for conserving mangroves along Indian east coast.

Box 6.15 Incentives for Mangroves Conservation

In Andhra Pradesh, India local institutions have been created to provide an incentive for the local communities for sound management of mangrove forests. Through these incentives an area of about 600 sq.km of mangroves in Godavari and Krishna estuarine areas has been brought under the community management regimes by constituting Forest Conservation Councils and Eco Development Committees. These village level institutions are allotted stipulated management areas for protection and conservation of mangrove forests. As an incentive they are allowed to harvest fishery resources from the wildlife sanctuary in a sustainable way (Ravishankar *et al.*, 2004). Such type of incentives are supported by the Biological Diversity Act 2002 of India, which calls for the constitution of Biodiversity Management Committees (BMCs) to empower people to conserve BES and provide access to resources and receive benefits as per the provisions of the Act.

Payments for Ecosystem Services (PES)

PES has attracted increasing interest as a mechanism for translating external, non-market values of the environment into real financial incentives for local actors for services provision (Engel *et al.,* 2008). An increasing gamut of PES and PES-like instruments has necessitated defining rigid characteristics for PES such as (Wunder, 2005), who have proposed to define PES as a voluntary transaction where; a well-defined environmental service (or a land use likely to secure the service), is being ‘bought’ by a (minimum one) service buyer, from a (minimum one) service provider, if and only if the service provider secures service provision (conditionality). PES has been used in the Asia-Pacific region for a range of purposes such as REDD-plus, payments to preserve watersheds, and payments to communities for specific projects for maintaining up-stream ecosystem services. Application as an incentive for maintain ecosystem services from the Asia-Pacific region include Woolong Nature Reserve for giant pandas in China; Afforestation CDM Pilot Project on Private Lands affected by shifting sand dunes in Sirsa, Haryana, India; Fair Deals for Watershed Services Project in Madhya Pradesh and Himachal Pradesh, India (Kissinger *et al.,* 2013). PES can be combined with other biodiversity conservation policies, such as community-based PES that preserves forests and controls sediment as seen in Kulekhani, Nepal (Ottaviani & Scialabba, 2011) (Box 6.16).

Box 6.16 PES in Kulekhani Watershed, Nepal

The Kulekhani watershed is located in Makwanpur district which is 50 km southwest of Kathmandu. Its 12,500 ha watershed area is the source of water for two hydropower plants. More than 46,000 people from eight villages live in the catchment area, most of them live in poverty. The villagers in the catchment area practice sloping land agriculture, rear livestock and use forests for fuel wood, fodder and litter. On the site of the Indra-Sarobar Lake, the Kulekhani reservoir was built in 1982 to collect monsoon rain and channel water from the reservoir to the hydropower plant. To promote proper management in the catchment area, the government initiated participatory watershed management programs which allow local communities to build sediment-trap dams and adopt measures to control gullies. Large pine trees on state forest, village lands and agricultural terraces were planted through the support of the government. In 2003, the Rewarding Upland Poor for Environmental Services program of World Agroforestry Center initiated work to establish a PES scheme between the upland communities in the Kulekhani watershed and hydropower plants. As per the law, all hydropower plants must pay royalties to the government which is channelled and used at various levels for development activities. Within the framework of the Local Self Governance Act 1999, the Makwanpur District Development Committee (DDC) receives 12 per cent of the revenue generated from the Kulekhani hydropower facility. Makwanpur DDC endorsed a directive known as Hydropower Royalty Distribution, which declares the DDC to spend half of this allotted revenue in the hydropower plant-affected area. The directive further specifies that of the 50 per cent allocation to the affected area, 20 per cent is for the upstream watershed area, 15 per cent for the surrounding area and the remaining 15 per cent for the downstream area. The money, which is deposited in the Environmental Management Special Fund (EMSF), can be used to support conservation and development activities proposed by the watershed communities. The EMSF is considered a payment to upland watershed communities for providing ecosystem services. Sources: Bhatta *et al.* (2014); Ottaviani & Scialabba (2011)

Setting new charges or rationalising existing charges, which incorporate all or part of the value of BES, can help pricing biodiversity, raise conservation revenue (and finance biodiversity conservation), and create incentives that align private behaviour more closely to economic-ecological objectives. Logging and grazing licenses and fees are often granted based on net revenues that are below market value and exclude the loss of biodiversity, downstream damage through erosion or hydrological impacts or foregone carbon sequestration capacity (Mackinnon, 2002). Consumer fees to finance upstream water catchment benefits can be cheaper than bottled water or paying for urban water treatment plants (Asquith *et al.*, 2008). Recycling charges with refunds for bottles, cans, and some paper products has proven to be feasible throughout Asia.

Bonds and deposits, product surcharges that shift the responsibility for biodiversity depletion to individual producers and consumers, require the resource user to pay against the possibility of damage. As advanced charges, the costs of any damage provide an incentive to avoid biodiversity damage and reclaim the depositor bond. Indonesia used performance bonds for forestry and allowed refunds through reforestation, although the fee was far lower than replanting costs, giving logging companies insufficient incentive to reforest the logged areas (O'Connor, 1994).

However, market-based instruments are not appropriate in all circumstances as they often cause high administrative and transaction costs because of the need to monitor compliance and apply prosecution rules. In some cases, these costs will already be needed to enforce regulatory policies, but in others, they may add up to a significant cost (TEEB, 2011, Chapter 10). Policy design will have to consider institutional preconditions necessary for implementation, such as the capacity for monitoring and enforcement, and weigh up additional costs of using a market-based instrument versus the added value compared to other policy instruments (TEEB, 2011).

Use of economic and financial instruments, preclude misaligned or misguided economic incentive as the central problem to be addressed. PES, for example, is vulnerable to unsustainable financing and changes in government policies. In an analysis of environmental and cost effectiveness of PES based on 41 case studies from Cambodia, China, India, Indonesia, Japan, and Nepal, concluded that challenges related to implementation of these schemes are often underestimated (OECD, 2011), and that the objectives proposed with these schemes can only be attained through wide participation of land users (Zanella *et al.*, 2014). Leimona *et al.* (2015) in their analysis of application of PES instruments in Asia highlight shifting perspectives, from legitimating cost-efficient and effective natural resource management to concerns about fairness in the design and benefit distribution of the scheme. Four major insights are drawn in the analyses, which are highly relevant for structuring an effective PES instrument for the Asia-Pacific region : a) co-investment in environmental stewardship as opposed to a strict and prescriptive PES definition; b) a shared understanding of multiple types of ecological knowledge in providing and managing ES to increase the efficiency and fairness of PES schemes; c) anti-poverty PES to adapt to local conditions in designing the types, forms and expected levels of payments; and d) a multidimensional approach to poverty and livelihoods to enable a broader analysis of local perspectives on PES.

The TEEB for National and International Policymakers Report (TEEB, 2009) recommends policy mixes that combine regulation with market-based instruments such as taxes, charges or tradeable permits. Regulation is important as it sets out clear rules and sets limits and boundaries to the legally allowed use of natural assets and resources through the issue of permits and prohibitions. Pollution control, resource use minimisation and land-use management can best be achieved on the basis of a strong regulatory framework. However, where regulation sets limits on resource use, the damage caused by use below these limits are borne by society, and there are no incentives to curb use below these limits (Gunatilake & De Guzman, 2008). Applying market-based instruments can address these issues by ensuring that resource users bear the full cost, thus changing economic incentives and the behaviour of private actors when deciding upon resource use. They are also crucial to keep the costs of action low. For example, through pricing, private actors are encouraged to develop and implement the cheapest abatement options. Market-based instruments, however, can only function well on top of a strict regulatory framework.

Biodiversity Offsets

Another complemental opportunity for private sector corporations regarding development is a biodiversity offset, a way to result in no net loss or a net gain of biodiversity in an infrastructure project. Offsets are optional or mandatory in several countries of the region. The Organization for Economic Co-operation and Development (OECD) recognises them as an effective tool for both biodiversity conservation and mitigation of developmental impacts (OECD 2012).While the offset is a mechanism to cover an actual loss caused by development, it is anticipated to technically provide a funding opportunity for restoration (Miyazaki, 2011). Forest certification provided by NGOs/ initiatives such as The Programme for the Endorsement of Forest Certification (PEFC) and The Forest Stewardship Council (FSC) to promote SFM successfully works on conservation of biodiversity and ecosystem functions in certified forests including in China, Japan, Australia and New Zealand (https://www.pefc.org , IIED n.d., https://ic.fsc.org/en, Romero *et al*., 2017). Inclusion of the supply chain into the certificate incentivise conservation of biodiversity. Certification costs can be high, while many markets are not prepared to offer price premiums for certified products (Scheyvens, *et al.*, 2010).

An example of biodiversity offset in forest conservation is that of Malaysia Malua BioBank, a joint venture between the Malua BioBank Company (Malua Wildlife Habitat Conservation Bank, Inc.) and the Sabah State Government. The initiative supports the Sabah Forestry Department (SFD) with the implementation of the Malua Conservation Management Plan. The BioBank is financed through sale of voluntary biodiversity conservation certificates (Brock, 2015).

In voluntary carbon market, roles of private sectors such as NGOs grew rapidly, with up to 90 per cent in offset purchases in 2012. Although the Verified Carbon Standard (VCS) targets the carbon credit, the partnership with The Climate, Community & Biodiversity Alliance (CCBA) enables inclusion of safeguards by development of standards on safeguards in REDD-plus and provision of various support such as making a project plan, monitoring and reporting results of project activities (CCBA, 2013). A number of carbon offset projects were certified with the VCS and CCBA including Gold Standard-certified offsets to clean cookstoves and water filtration devices (http://verra.org/, http://www.climate-standards.org/, Ecosystem Marketplace, 2013).

Mitigation hierarchy assists in evaluating all biodiversity losses and gains resulting from developmental interventions, and could help prioritise consideration of conservation goals and drive the empirical evaluation of conservation investments through the explicit consideration of counterfactual trends and ecosystem dynamics across scales (Arlidge *et al*., 2018, see also para 26 of the 2016 communique of the 67 Toyama Environment Ministers' Meeting (Vella 2016)). The mitigation hierarchy advocated in the International Finance Cooperation (IFC) Performance Standard 6 includes the concept biodiversity offsets as last resort where impacts arising from development can neither be avoided nor effectively mitigated through improved project design and management. IFC standards have been adopted as standard environmental and social risk management measures for many international development banks, including the Asian Development Bank, Import Export Credit Agencies and Equator Principle Financial Institutions, the latter being largely private organization having adopted IFC standards voluntarily.

In some Gulf countries whose economies have been hit hard by the low price of oil such as Oman, financing large infrastructure and industrial development projects is increasingly undertaken by international lenders applying IFC standards whereas previously such projects were financed domestically or regionally and only required national legislation and standards to be applied. This situation has led to more rigorous standards being applied to environmental and social risks, which in turn may improve outcomes in these domains. In some cases, such as downstream oil and gas projects in Duqm, Oman, IFC requirements are being assessed at a phase of the project cycle when avoidance options are not available and mitigation measures are limited. Under these circumstances biodiversity offsets will be adopted where feasible.

While biodiversity offsetting is an attractive option to developers, the approach is controversial because it rests on the need to accept ecological losses in return for uncertain gains (Bull *et al.*, 2013). Recognising the limits to biodiversity offsets, the IUCN published a framework to guide the design, implementation and governance of biodiversity offset schemes and projects (http://cmsdata.iucn.org/)

6.4.1.4 Human Rights-Based Approaches

There are increasing evidences of use of Human Rights Based Approaches and linked instruments in the Asia-Pacific region, which tend to integrate rights, norms, standards, and principles in policy, planning and implementation to ensure that conservation practices respect rights. The key underlying premise is the role of nature and NCP in providing the basis of human rights (such as those related to food and water security), and in turn, recognition of such rights fostering stronger action for conservation and sustainable use of nature.

In Oceania, human rights based approach for environmental conservation is recognised as a key issue, for instance in effective and equitable governance to develop relevant laws and policies but there are challenges such as awareness raising, capacity building, policy development and research and knowledge building (Campese *et al.*, 2009; IUCN, 2015; Polidoro *et al.*, 2011). Within Oceania and South and South East Asia, indigenous people and local communities tend to used traditional and local knowledge strategically for their territory claims (Berkes, 2004; Ford & Martinez, 2000). In Australia, the indigenous rights access and use of land and its resources have been called “native title” and the government of Victoria made an agreement between the native title holder for protected area where the holders live (National Native Title Tribunal, 2007; Strelein & Weir, 2009). The Australian courts consider environmental uses, regulation and the preservation of landscapes to support the right to native title, which prevented wholesale land tenure reform. The consent determinations, which was used to overcome limitations of native title, have been instrumental for indigenous people to demand for joint management arrangements in national parks or return of their rights over these lands (Campese *et al.*, 2009).

There are increased evidences of recognition of shared governance and governance by indigenous people within the governance frameworks for management of nature in the Asia-Pacific region (such in the form of a large network of locally managed marine areas in Oceania region (Rocliffe *et al.*, 2014), which serve as important instruments for recognition of human rights based approaches in conservation (Box 6.17). This trend align with the efforts of local and indigenous communities for maintaining or regaining decision-making rights over their customary territories and lands, along with their desire to conserve nature as a common patrimony and exercise their rights as citizens (Makagon *et al.*, 2014; Springer *et al.*, 2011). As a case in point, the Government of Japan assigns exclusive access to coastal fishery resources to Fishery Cooperative Associations, thus fostering establishment of over thousand fisheries regulated areas (locally referred to as sato-umi) under locally agreed rules (IUCN, 2015). In Philippines archipelago, the ICCAs complement the formal protected area network as an instrument of conserving the nation's key biodiversity areas (Mathur, n.d.). The value of such networks was evident in the aftermath of December 2011 cyclone, wherein in Mindanao, the watersheds protected by the heavily forested ancestral domains of the indigenous peoples in the Mount Kalatungan range received far less impact as compared with the developed watersheds which experienced huge mudslides, with villages destroyed and hundreds of deaths.

Box 6.17 Dhimurru Indigenous Protected Area (IPA) Management in Australia

IPAs in Australia provide an innovative approach to the management of protected areas that complements the system of government-declared and managed national parks and marine parks. Successful partnerships need to be mutually beneficial, and this is what Dhimurru can offer. For example, the Australian Government's support for the Dhimurru IPA contributed significantly to the national objective of building the National Reserve System (NRS) in a biogeographic region that was hitherto unrepresented in the NRS. Similarly, financial contributions from Alcan Gove enhanced its reputation as a responsible corporate citizen in a region where it is reaping big financial rewards from its mining activities (Smyth, 2007). Through the IPA Program, large areas of ecologically and culturally significant land, previously unrepresented or under-represented in the National Reserve System (NRS), have been brought under protected area management. This has been achieved without expending scarce conservation funding on the purchase of land—funds which instead can be devoted to protected area management through the IPA Program. It is found that the declaration and management of IPAs over the last 10 years has been very cost effective in contributing to the conservation aims of the NRS. There are considerable positive social and cultural outcomes from the IPA Program, including the transfer of traditional indigenous knowledge and engaging young indigenous people in positive educational experiences centered on the equitable exchange of western science and traditional knowledge (Gilligan, 2006). Dhimurru IPA provides an example of how the autonomy of indigenous sole management of a protected area can lead to partnerships that enhance rather than threaten Traditional Owner authority and that deliver tangible conservation, and social and cultural benefits. While IPAs lack the financial security that comes with jointly managed government-declared national parks, the Dhimurru example shows that it is possible to build a degree of security through multiple bilateral and multilateral partnerships, rather than single bilateral partnerships typical of joint management. The Dhimurru IPA, as with the other IPAs across Australia, demonstrates that, when given the freedom to choose how to take care of their Country, Traditional Owners willingly enter into collaborative partnerships that can assist them to manage their traditional estates sustainably.

Gaining comprehensive recognition of the rights and interests of indigenous peoples over the sea has, nevertheless, historically been far more difficult than over land. In marine title determined so far it has been clear that the marine rights of indigenous peoples must "yield" to all other legal rights and interests, even in areas where marine native title has been found to exist. In extending its interests into the sea - a logical and necessary step in achieving its founders' vision of looking after Country - Dhimurru is tackling one of its greatest challenges to date (Smyth, 2009).

The buffer zone community forests in Nepal present a promising potential for rights based approaches to conservation, the management and governance of buffer zones could be further improved and democratised. The rights-based agenda promoted within grassroots movements, campaigns and critical civil society groups in the lowland protected areas of Nepal has been key to advancing rights in the area. The successful experiences in community forestry and conservation in areas, such as the Annapurna Conservation Area, provide important examples of partnership between local people and conservation agencies (Campese *et al.*, 2009).

Indigenous community conserved areas (ICCA) in China include sacred natural sites, community forests and rangelands subject to customary governance. The size of sacred natural sites varies greatly (from individual compounds to entire regions). Some rangelands in the headwaters of the Yangtze River, restored and managed by the Tibetan communities with traditional grazing rights, have ICCA characteristics. Sacred natural sites can however be linked with mass pilgrimages, which can create stress of the ecosystem (such as the case of Otgontenger Mountains, Mongolia). The synergistic relationship between ICCAs and a government recognised protected area can often be seen, when the latter forms a part of the larger ICCA. In a wetland of international importance of Iran, Kushk-e Zar (Namdan), the voluntary conservation efforts of Kuhi communities, provides active protection to the site from vested interested who have attempted to drain the wetlands for agriculture (Borrini-Feyerabend & Hill, 2015). In Kufrdan Village of Palestine, a human rights based approach has enabled the farmers to access water for meeting their irrigation needs (Campese *et al.*, 2009).

There are increasing evidences of international instruments recognising human rights based approaches, thus influencing their national implementation. Five of the seven safeguards within REDD-plus relate with human rights: the agreement states consideration of national legislation and sovereignty, respect for the knowledge and rights of indigenous peoples and members of local communities, the full and effective participation, and rights to access social and environmental benefits (Angelsen *et al.*, 2012; Springer *et al.*, 2011; UNFCCC, 2011). Based on the agreement, Indonesia has established Principles, Criteria and Indicators, grievance mechanisms and FPIC (Free Prior Informed Consent) as instruments that can support implementation of REDD-plus . National laws of Cambodia and Philippines related to REDD-plus safeguard and respect and address the safeguards at the project level (REDD-plus Safeguard Research Consortium 2014). International organizations and NGOs play an important role for implementation providing multi-lateral programs such as by World Bank and FCPC, private certification schemes such as by VCS and CCBA and standards as financial guidelines by World Bank and Global Carbon Fund (GCF) (GCF, 2015; McDermott *et al*., 2012). Since its formal adoption in the IUCN in 2012, the application of Rights-Based Approach Policy has become mandatory to all its programmes (chapter 2.5.2).

Key challenges to implementation of human rights based approaches have been recorded in the form of underdeveloped local and national legal structures (Rocliffe *et al.*, 2014), seeking balance between rights and responsibilities, and maintaining effectiveness of decision-making (Borrini-Feyerabend & Hill, 2015).

6.4.1.5 Management based instruments

Instruments clustered under the category are aimed at providing the basis or articulating principles for management of nature, application of which is largely promoted as a best practice. Some examples, include use of sustainable forest management practices (Box 6.18), integrated coastal zone management practices (Krishnamurthy *et al.*, 2014; Wong, 2009) and integrated river basin management for freshwater ecosystems (Pittock *et al*., 2015). Several of these management tools address the needs of scale and cross-sectoral engagement in policy interventions. Experiences of water management in Murray Darling Basin highlights the importance of science-based adaptive management of water resources, within a basin scale governance framework (Banks & Docker, 2014). Contracting parties to the Ramsar Convention are encouraged to base management of wetlands on integrated management plans which incorporate full range of ecosystem services and biodiversity values within the developmental planning processes (Pittock *et al.*, 2015). The tools however often involve engagement with a range of landscape issues, sectors and stakeholders, and are contingent on complex information on ecosystems, landscape change and human-well-being interactions.

Box 6.18 Management of sustainable shifting cultivation in the Himalayas

Shifting cultivation, also known variously as rotational agroforestry, swidden cultivation, 'slash and burn' agriculture, jhum (India, Bangladesh), khoriya, bhasme (Nepal), tseri, pangzhing (Bhutan), lunxi di (China) is a complex farming system practiced not only across hilly regions of the Asia-Pacific region but also in other parts of the tropics globally (Grogan *et al.*, 2012; Kerkhoff & Sharma, 2006). Land use and/or forest policies have tended to identify shifting cultivation as an inefficient practice and a negative factor contributing to land/forest and biodiversity loss and degradation (Kerkhoff & Sharma, 2006; Rahman *et al.*, 2012; Raman, 2001; Upadhyay, 1995).This has led to the promotion of settled agriculture and plantations, which may in fact as monocultures or involving more intensive practices be more destructive. While retaining primary forest is crucial for biodiversity, shifting cultivation does not necessarily result in catastrophic declines in biodiversity and indeed reviews suggest that its negative environmental impacts may have been overestimated (Grogan *et al.*, 2012; Ramakrishnan, 1992; Raman, 2001; Raman, 1996). However, analyses by the International Centre for Integrated Mountain Development(ICIMOD) of shifting cultivation in five countries (i.e. Bangladesh, Bhutan, India, Nepal and Myanmar) across the Eastern Himalayan region pointed out that the policy has mainly been to replace shifting cultivation with settled or permanent forms of agriculture and plantation forestry (Kerkhoff & Sharma, 2006).

Over recent years, the debate on shifting cultivation has acquired renewed focus from policymakers and natural resource managers. It is increasingly being seen as a cultural and ecological practice that uses natural cycles to produce a variety of crops while allowing fallows to regenerate and continue to provide various resources. Policymakers need to recognise its benefits in terms of food security, cultural identity, income and employment. Policy options need to be explored to support sustainable shifting cultivation by identifying farmers' innovations in soil, water and biodiversity conservation, address issues of land tenure security, strengthen local and customary institutions that govern community regimes for shifting cultivation practices, and identify market opportunities and market development for products from shifting cultivation. To some extent, the shift in policy approach is becoming evident, for instance through regional efforts such as Regional Shifting Cultivation Policy Dialogue Workshop for the Eastern Himalayas organized by ICIMOD in 2004 and the policy recommendations arising thereof. In India, a task force on the Rehabilitation of Shifting Cultivation Areas was set up by the Government of India to allow a joint participatory approach for sustainable management of shifting cultivation lands (CBD, 2011). Similarly, initiatives have been taken up in Nepal and Bhutan to revisit policy approaches to shifting cultivation (Aryal & Kerkhoff, 2008; Kerkhoff, E & Sharma, 2006). Further efforts are required in the Asia-Pacific region involving policymakers, agriculture and ecology researchers and agricultural extension professionals to work jointly with farmers to address the challenges of ensuring sustainability in shifting cultivation.

6.4.2 Governance options for improving BES

Economic development in the Asia-Pacific region, while distinctly contributing to the significant reduction of poverty, education, and energy efficiency in the process; has also led to increasing demand for food, energy and materials, thereby significantly impacting nature and NCP within the region. Scenario assessments conducted in Chapter 5 indicate that under the baseline trend pathway, the Asia-Pacific region will continue to lose habitats and species at the similar pace with the global trend. The business as usual approach to policymaking is therefore not an option if the trends are to be reversed (Nicolai *et al.*, 2016). This section discusses the nine policy options that exist for the Asia-Pacific region, derived from a review of the literature on the topic which have been assessed in the context of scenarios and pathways described in Chapter 5. It is however stressed that that there is no single 'solution' for conserving nature and NCP in a rapidly changing the Asia-Pacific region, given that each country is different, each economy relies on nature and NCPs in different ways and each country starts with a different set of policies already in place. Expressing multiple values of nature and NCP can greatly assist in making informed policy choices in their integration development trajectories perused at various scales and within various sectors (Pascual *et al.*, 2017).

Figure 6.6 presents an assessment of different options for BES governance in the Asia-Pacific region. The information in the table is only indicative characteristics of the options for the subregions based on the most accessible and recent literature (i.e. see sections 6.2 – 6.4.1). The specific ecosystems are presented in order of importance for particular options, i.e. the first ecosystem in the list are most commonly targeted by the application of these options. The forest ecosystems are the most important targets of the options, followed by agriculture, marine and coastal (Figure 6.6). Among the different options, improving governance of protected areas and co-management/collaborative governance are widely applied options in the region and use various forms of governance instruments and modes. Details on the different options are discussed below.

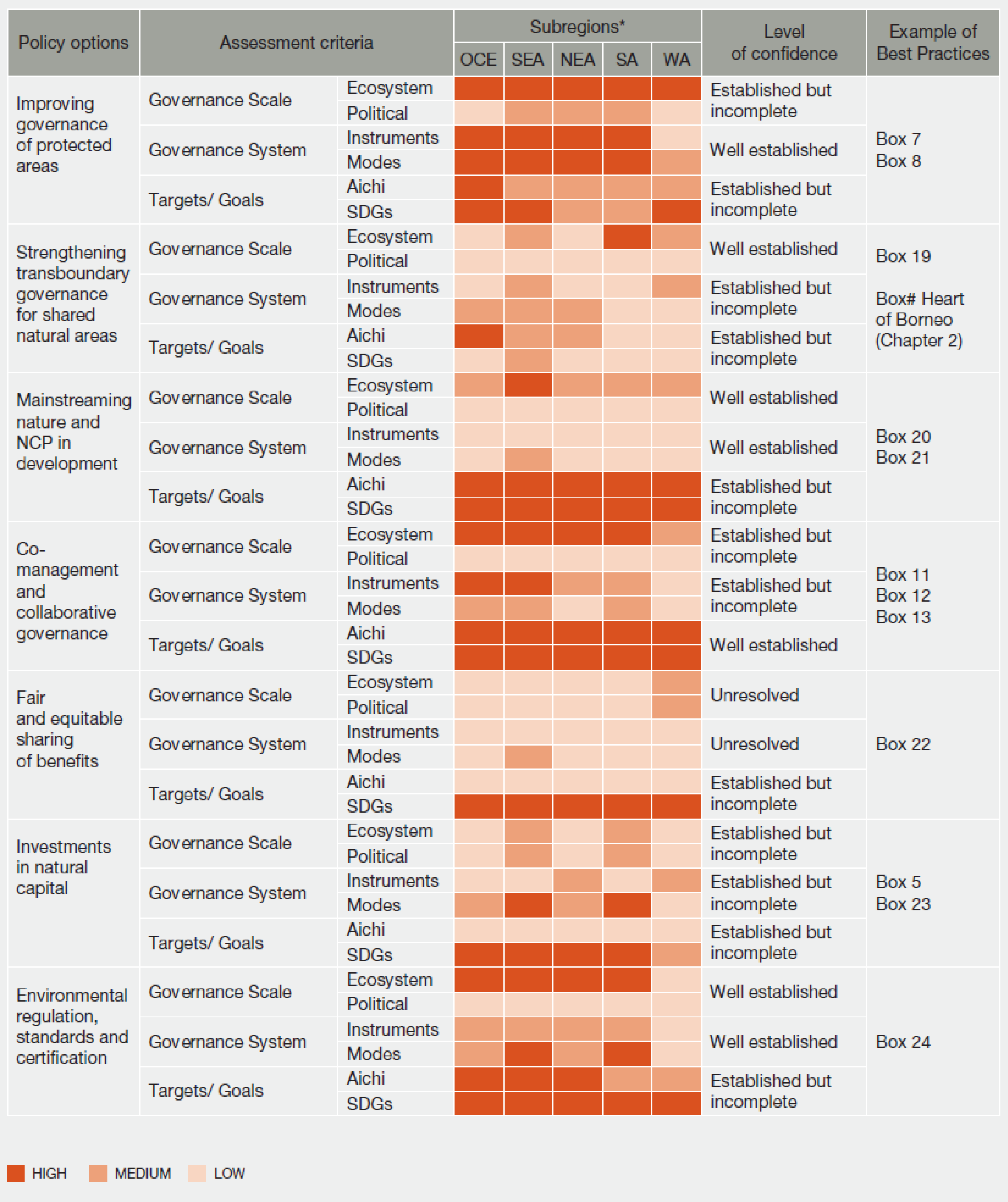


Figure 6.6 Subregional assessment of options for governance across scale and system and their links to the underlying drivers, Aichi Biodiversity Targets and SDGs

Notes: *Extent of application or evidence of use across scale and system, and the extent of the coverage of the Aichi Biodiversity Targets and SDGs.

Legend:

Extent	The colors on the figure refer to the following: High – 4 and above, Medium – 3, and Low – 2 and below number of scales, instruments, modes and targets/goals.
Ecosystem	1. Agro-ecosystems, 2. Coastal and marine, 3. Inland freshwater and wetland, 4. Urban and semi-urban, 5. Grassland and savannah, 6. Forest and woodland, 7. Alpine ecosystems, 8. Deserts and semi-deserts, 9. Islands, and 10. Mountains
Political	1. Regional, 2. Subregional, 3. National/Sub-national, and 4. Local

Instruments	1. Legal and Regulatory, 2. Economic and financial, 3. Human rights-based, 4. Management-based, and 5. Social and cultural instruments
Modes	1. Intergovernmental, 2. Centralised, 3. Decentralised, 4. Public-private, and 5. Self or private governance
Aichi Biodiversity Targets	1. Awareness of biodiversity increased, 2. Biodiversity values integrated, 3. Incentives reformed, 4. Sustainable production and consumption, 5. Habitat loss halved or reduced, 6. Sustainable management of marine living resources, 7. Sustainable agriculture, aquaculture and forestry, 8. Pollution reduced, 9. Invasive alien species prevented and controlled, 10. Pressures on vulnerable ecosystems reduced, 11. Protected areas increased and improved, 12. Extinction prevented, 13. Genetic diversity maintained, 14. Ecosystems and essential services safeguarded, 15. Ecosystems restored and resilience enhanced, 16. Nagoya Protocol in force and operational, 17. NBSAPs adopted as policy instruments, 18. Traditional knowledge respected, 19. Knowledge improved, shared and applied, and 20. Financial resources from all sources increased
Sustainable Development Goals	1. End poverty, 2. End hunger, achieve food security, 3. Ensure healthy lives and promote well-being for all at all ages, 4. Ensure inclusive and equitable quality education, 5. Achieve gender equality, 6. Ensure availability and sustainable management of water and sanitation, 7. Ensure access to affordable, reliable, sustainable and modern energy, 8. Promote sustained, inclusive and sustainable economic growth, 9. Build resilient infrastructure, 10. Reduce inequality within and among countries, 11. Make cities and human settlements inclusive, safe, resilient and sustainable, 12. Ensure sustainable consumption and production patterns, 13. Climate Action, 16. Promote just, peaceful and inclusive societies, and 17. Revitalise the global partnership

6.4.2.1 Expanding biodiversity coverage and improving governance of protected areas

Protected areas, terrestrial as well as marine, have been the dominant policy option for limiting human impacts on biodiversity in the Asia-Pacific region. Presently, 13.3 per cent of the terrestrial areas and inland waters, and 15.7 per cent of coastal and marine areas under national jurisdiction within the Asia-Pacific region are currently protected (UNEP-WCMC & IUCN, 2017). However, the existing prorected area network does not adequately cover areas of importance for biodiversity and are neither fully ecologically representative. For example, in 2013, only 16 per cent (326) of Important Bird and Biodiversity Areas (IBAs) and Alliance for Zero Extinction sites (AZEs) in Asia were completely covered by protected areas (Juffe-Bignoli *et al.*, 2014). Improving this coverage is essential, given the crucial importance of protected areas in safeguarding the biodiversity of important sites (Butchart *et al.*, 2012, 2015), as well as policy alignment given that this indicator is used to track progress towards SDG Targets 14.5.1, 15.1.2, 15.4.1 and Aichi Target 11.

The governance of protected areas is framed by the country's policies and plans (section 6.2.2) and often supported by subregional frameworks and agreements (section 6.2.1) as in the case South East Asia (ASEAN) and South Asia (SAARC). The option for improving governance of protected areas is increasingly using human rights-based instrument because of the need to consider the rights of indigenous people and local communities in the Asia-Pacific region (Figure 6.6). A review of assessments of the performance of protected areas in the Asia-Pacific region, however, indicates that their overall impact on containing human interference on biodiversity is highly variable (Ferraro *et al.*, 2011; Leverington *et al.*, 2010). In addition to the Satoyama Initiative (Box 6.7), positive impact cases include that of protected forests in Thailand, wherein about 15 per cent of these areas would have been deforested in the absence of protection (Ferraro *et al.*, 2011).

At the same time, Clark *et al.*, (2013) while assessing the impact of the South Asian protected area network on protecting species and outcomes, conclude that the trajectory of habitat conversion rates inside protected areas remained indistinguishable from those not covered under the protected area system. The assessment further indicates that the gazettement and current management of these protected areas did not lead to a reduction in human modification of these areas, and therefore called for substantially enhancing management, as well as developing systematic conservation outside formal protected area system (ibid). A national scale analysis of protected area systems in China, one of the most rapidly developing nations in the region, indicates that the protected area system worked moderately well for specific taxa but not for others, not for key regulating services, such as water retention, soil retention, sandstorm prevention and carbon sequestration (Xu *et al.*, 2017). Tang *et al.* (2010) in their assessment of transboundary protected areas in East Asia indicate continued degradation due to lack of synergistic policies and shifting policy focus.

The detractors of protected areas often critique their establishment and management for three main reasons (Mills *et al.*, 2011; Ruddle & Hickey, 2008; The World Bank, 2000; Wilkie *et al.*, 2006). First, they argue that only initiatives related to poverty alleviation will lead to successful biodiversity conservation because only these initiatives address the cause of environmental destruction (Leisher *et al.*, 2007; UNEP, 2004). Second, protected areas take away the property and rights of local people and can be an unjust drag on their present and future welfare (Dixon, 1993). Third, even if protected areas do generate economic value, the distribution of these benefits is so skewed against poor rural people that the role of such areas in local development is negligible, and they neither justly compensate for lost property and rights nor contribute to poverty alleviation (Garaway & Esteban, 2002; Pollnac & Crawford, 2000; WFC, 2008).

An important policy option for securing a positive future for nature and NCP in the Asia-Pacific region is to enhance management effectiveness of protected areas (Figure 6.7). For example, efforts put in by Republic of Korea in completing management effectiveness evaluation of its protected areas in line with WCPA management effectiveness assessment framework are model examples of government support for generating information on the status of protected area management (UNEP-WCMC & Korea National Park Service, 2016). The gazettement of protected areas provides the vital first step in this direction, but these areas can be rendered ineffective due to a lack of capacity and resources, weak political support, poor understanding of social interactions, and the absence of community consultations (TEEB, 2009). Castillo *et al.* (2015) in an analysis of protected area management capacity and financing gaps in South East Asia indicate a staffing gap between 200 per cent and more than 700 per cent. Fiscal gaps at the regional level were assessed to be as high as 900 per cent when compared to benchmarks (ibid). A review of marine protected areas of nine ASEAN member countries indicated that only a few (up to 20 per cent) were being effectively managed, thus reducing their impact on biodiversity and NCP values (ASEAN Centre for Biodiversity, 2010). Assessing management effectiveness is also an issue at the global level, and more assessments are needed to better understand the contribution of protected areas to biodiversity (UNEP-WCMC & IUCN, 2016).

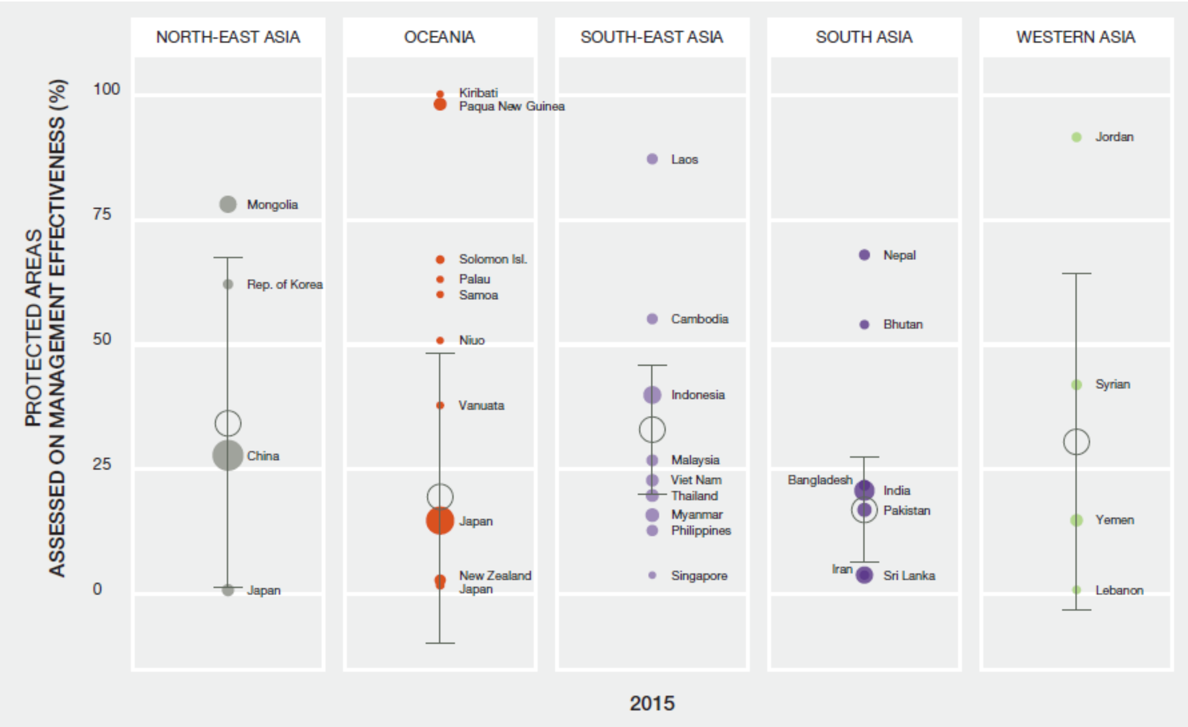


Figure 6.7 Proportion of protected areas in the Asia-Pacific region assessed for management effectiveness
Figure prepared by the IPBES Task Group on Indicators and Knowledge and Data Technical Support Unit. Indicator data source: UNEP-WCMC & IUCN (2016)

Policymakers can enhance the effectiveness of protected areas by creating enabling national frameworks (legislative basis, policy consistency, cooperation among stakeholders) and ensuring adequate financing stability for effective management (TEEB, 2010). Greater policy coherence, for example, by recognising the role of protected areas in climate change adaptation, or reducing disaster risk can significantly enhance effectiveness, as well as create synergistic conservation-development outcomes (TEEB, 2010).

While the definition of protected areas includes explicit reference to nature and associated ecosystem services, biodiversity conservation remains the dominant design, implementation and management objective. Given the role of protected areas in sustaining NCP, the protection of ecosystem services can also be integrated into design principles (Xu *et al.*, 2017). Regional trends (see chapter 5) can be used to identify such priorities, such as water scarcity in South Asia, or declining fish production. In Indonesia, flash flooding triggered by deforestation was a significant driver of creation of the 0.1 million hectare Batang Gaddis National Park (Mulongoy & Gidda, 2008b). Recognition of multiple values of nature and NCP associated with protected areas, especially in the context of diverse worldviews, can significantly assist in seeking the necessary policy attention to the needs of management effectiveness enhancement.

6.4.2.2 Strengthening transboundary governance for shared natural areas

The Asia-Pacific region has several shared nature areas and issues, addressing which requires proactive transboundary governance (as against reactive governance, see the case of responding to South-East Asian Haze and the Sunderbans in Box 6.2 and Box 6.3 of this chapter, Kailash Sacred Landscape and Rainforest Initiative (Heart of Borneo) in chapter 2). Transboundary governance is commonly connected to the protection of protected areas; hence like the latter option, the former is also widely applied in the region but covering fewer ecosystems and instruments (Figure 6.6). Regional transboundary systems of environmental management form an vital complement to governance efforts at national and global levels. (United Nations *et al.*, 2017) underline the need for regional cooperation in the Asia-Pacific region given that many of the SDGs deal with global and regional public goods. Such improvements need to build on trust, crafting institutional frameworks for cross-scale action, inclusive stakeholder engagement, availability of information-base at multiple scales and across sectors and capacity development for integrated problem-solving.

Dong *et al*. (2017), using Himalayan region as a case study, recommend six dimensions for consideration in setting up of a transboundary governance mechanism: a) technical and environmental (promoting protection of ecosystems, natural habitats, and maintenance of viable species in natural surroundings in nation as well as cross-national setting); social (networking the cooperation between different bodies and promoting equitable sharing of benefits); economic (promoting environmentally sound and sustainable development in areas adjoining the protected areas), ethical and cultural (call recognition for preserving and maintaining ILK) and political (developing transboundary conservation institutions to protect threatened species, populations, and habitats within the cross-nation region). Improvement of institutional arrangements, enhancement of regional governance practices, encompassing transparency and the provision of information, public involvement, and implementation of accountability mechanisms are identified as essential elements for enhancing transboundary biodiversity conservation.

Transboundary governance mechanism for water management in Lower Mekong also provide deep insights into policy prerequisites for such a mechanism. The Mekong River Commission enables a framework for transboundary water governance (involving Cambodia, Lao PDR, Thailand and Viet Nam) by recognising that development decisions by sector agencies in the sovereign riparian countries of the Mekong River Basin may have transboundary consequences and that the MRC as an inter-governmental river basin organization relies on Member Countries' endorsement of its orientations and initiatives (http://www.mrcmekong.org/about-mrc/mandate/; Bao *et al*., 2017). The role of trust building between and within participating countries as well as with upper basin countries to enable the transformation of environmental and social risks involved in transboundary water management into countries is highlighted (Grumbine *et al.*, 2012). Improved stakeholder participation, particularly of those who are affected by water resources management decisions, and enhanced capacity for integrated problem solving are also highlighted as critical ingredients (Dore *et al.*, 2012).

In addition to the transboundary governance in the Mekong River (see chapter 2), the Coral Triangle Initiative an excellent example of this option in South East Asia (Box 6.19). Throughout the various development and implementation stage of the Coral Triangle Initiatives, various formal partners which consist of governmental, inter-governmental, non-governmental agencies/ organizations, financial institutions, research institutions, such as the United States Agency for International Development, Australian Government, Asian Development Bank, Global Environment Facility, Conservation International, The Nature Conservancy, and World Wide Fund for Nature, and the Coral Triangle Centre provide various forms of support ranging from financial aid, community engagement and empowerment platforms, conservation programmes. Whilst numerous mechanisms and partnerships are forged at both, regional and national level in the implementation of the Regional and National Plans of Actions and the carrying out of other complementary activities, at the regional level, various platforms have also been established to enable local communities and stakeholders from all six nations and others to collaborate, inspire and be inspired, and build capacity amongst others. Examples of these platforms are the Women's Leadership Forum (see section 6.2.3.3); the CTICFF Regional Business Forum, which seeks to foster public-private partnerships in identifying innovative business solutions which achieves economic and environmental sustainability (Coral Triangle Initiative Regional Business Forum - WWF); and the Coral Triangle Fishers Forum, which engages local fishers, businesses and other stakeholders to address issues relating to IUU, seafood traceability amongst others (Coral Triangle Fishers Forum II and Coral Triangle Fishers Forum - WWF). Several social instruments in the form of voluntary agreements and MOUs (e.g. with research institutions for the sharing of the database) have also been in place to achieve various differing objectives (Coral Triangle Atlas).

Box 6.19 Coral Triangle Initiative on Coral Reefs, Fisheries and Food security [CTICFF]

The Coral Triangle region is located along the equator at the confluence of the Western Pacific and Indian Oceans and includes parts of the exclusive economic zone of six countries: Indonesia, Malaysia, Papua New Guinea, the Philippines, the Solomon Islands and Timor-Leste, known as the Coral Triangle 6 (CT6). This area, although covering only 1.6 per cent of our world's oceans, represents the global epicentre of marine life abundance and diversity. It contains 76 per cent of all known coral species, 53 per cent of the world's coral reefs, the greatest extent of mangrove forests in the world, as well as spawning and juvenile growth areas for the world's largest tuna fishery. The natural resources of the Coral Triangle is estimated to have an annual value of $2.3 billion and directly contribute towards the well-being of about 120 million CT inhabitants (Coral Triangle Initiative on Coral Reefs Fisheries and Food Security issuing body, 2009).

Unfortunately, this mega-biodiverse region encounters significant and increasing threats in the face of rapid population growth, the proliferation of international trade, and economic development. Coastal area conversion, unsustainable fishing (including overfishing and illegal fishing), coastal and marine pollution, and degradation of marine and coastal ecosystems continue to add pressure to a region which is additionally vulnerable to climate change (Coral Triangle Initiative on Coral Reefs Fisheries and Food Security issuing body, 2009).

In response to these threats, the Governments of the CT6 countries, with the added support from other partners, agreed in 2009 to embark on a new multi-lateral initiative which aims to safeguard the rich biological resources of the region and to ensure the sustainable flows of benefits from coastal and marine resources for current and future generations through transformational actions. This initiative was named the Coral Triangle Initiative on Coral Reefs, Fisheries and Food Security (CTI-CFF). This initiative focuses on food security through the sustainable management of natural marine resources while also taking into consideration the impacts of climate change. The CT6 countries have adopted a 10-year regional plan of action that is centred on five goals which relate to: the strengthening of seascapes, the adoption of the ecosystems approach to fisheries management, establishing and implementing effective marine protected areas, increasing community resilience to climate change, and improving the status of threatened species. This regional plan of action is then localised by each of the countries and transposed as national plans of actions, with each member state reporting on their progress to the Coral Triangle Regional Secretariat annually. The implementation of the plans of action is guided by national and regional-level technical working groups for each goal, and facilitated through the governance working groups which oversee the coordination, finance and monitoring and evaluation of the initiative (Coral Triangle Initiative on Coral Reefs Fisheries and Food Security issuing body, 2009; CTI-CFF, 2009, 2017a; Leaders Declaration on Coral Triangle Initiative on Coral Reefs, Fisheries and food security, 2009).

Several biodiversity-related MEAs provide instruments for fostering transboundary cooperation. The Ramsar Convention on Wetlands provides for the establishment of regional initiatives to support the implementation of the Convention and build capacity for wetland management within specific regions and subregions, in response to regional needs (http://www.ramsar.org/activity/ramsar-regional-initiatives). The Agreement for Conservation of African-Eurasian Migratory Waterbirds (AEWA), developed under the framework of the Convention on Migratory Species (CMS), brings together the States through which migratory animals pass, the Range States, and lays the legal foundation for internationally coordinated conservation measures throughout a migratory range (http://www.unep-aewa.org/en/legalinstrument/aewa). The convention provides for the development of agreements tailored for specific taxa and geographic regions. Several CMS agreements already in place are applicable to the Asia-Pacific region. Strengthening agendas related to nature and NCP within the regional bodies as ASEAN and SAARC are also important opportunities for reversing adverse trends in the Asia-Pacific region.

6.4.2.3 Mainstreaming of biodiversity-related goals

The analysis of influential drivers of NCP and human well-being interactions in the Asia-Pacific region (Chapter 5, section 5.3.5.1) indicated population growth and demographic change to be the most prominent regional drivers, followed by climate change. These are followed by agricultural/cropland expansion into natural areas and urbanization. Distribution of influential drivers shows subregional variations, such as the prominence of economic drivers (changing lifestyles and consumption patterns) in South and South East Asia, relatively weaker integration of economic and policy drivers in Oceania and North East Asia and the predominance of climate change related drivers in Pacific Islands and Oceania. It is apparent that enhancing management effectiveness of existing protected areas, or designation of additional protected areas is not going to be sufficient policy interventions for ensuring a secure future of nature and NCP in the Asia-Pacific region. Important policy response is mainstreaming of biodiversity into all development actions, while simultaneously integrating development goals in conservation actions.

Mainstreaming biodiversity has varied meanings and interpretation. A useful reference is to consider biodiversity mainstreaming as the process of embedding biodiversity considerations into policies and strategies (e.g. NBSAP) and practices of critical public and private actors that impact of relying on biodiversity, so that biodiversity is conserved, and sustainably used, locally and globally (Huntley & Redford, 2014). TEEB (2011) recommend six major target sectors wherein biodiversity mainstreaming: namely, a) economic, trade and development policies, b) transport, energy and mining activities, c) agriculture, fisheries and forestry practices, d) corporate strategies and operations, e) development policies and planning at local, national and regional levels, and f) public procurement and private consumption. The Global Green Growth Institute (GGGI), which is a treaty-based international and intergovernmental organization, promotes inclusive and sustainable economic growth by supporting the mainstreaming of sustainable use of natural resources in national policies in several countries in the Asia-Pacific (http://gggi.org/, Box 6.20)

Box 6.20 National Green Growth Roadmap in Asia

Green Growth means fostering economic growth and development while ensuring that natural assets continue to provide the resources and environmental services on which our well-being relies (OECD, 2011). The concept of green growth emerged in the Asia-Pacific region to turn resource constraints and the climate crisis into an economic opportunity that generates a double dividend (higher growth with lower environmental impact) by improving the efficiency of resource use and increasing investments in natural capital to drive economic growth. Realising the promise of green growth will require a bold and ambitious transformation of the economic system. The “visible structure” of the economy, comprising such physical infrastructure as transport, buildings and energy systems, together with the “invisible structure”, which encompasses market prices, governance, regulations and lifestyles, have to be re-oriented to resource efficiency (UNESCAP, 2012).

South Korea is the first country in the World to make Green Growth Strategy a national one (Zelenovskaya, 2012). On the 60th anniversary of the founding of the Republic of Korea in August 2008, the President proclaimed “Low Carbon/Green Growth” as the nation’s vision to guide development during the next 50 years. To implement this vision, the government announced in July 2009 the “National Strategy for Green Growth” up to 2050, which includes mitigating climate change, creating new engines for economic growth and improving the quality of life (Jones & Yoo, 2011).

Cambodia was the first ASEAN country to develop a National Green Growth Roadmap in 2010 (OECD, 2014). The National Green Growth Roadmap is produced by Cambodia for furthering development to benefit the people and conserve and restore the natural capital base to continue economic growth within limits posed by the environmental carrying capacity. The National Green Growth Roadmap focuses on addressing the following seven goals: access to clean water and sanitation, access to renewable energy, access to information and knowledge, access to means for better mobility, access to finance and investments, access to food security (agriculture) and non-chemical products, and access to sustainable landuse (Kingdom of Cambodia, 2010).

Mainstreaming can be applied in multiple settings. Within production landscapes and seascapes wherein natural resource-based industries (such as those related to food and energy production), use of ecosystem approach and landscape / seascape based integrated management approaches can be used as means of achieving the developmental goals while ensuring conservation outcomes (Subramanian *et al*., 2017). Mainstreaming can also focus on enabling policy environments, production and consumption chains, as well as focus on the actions of specific actors as industries, governments or communities (Redford, n.d.). In Indonesia, Building with Nature, a public-private partnership between leading engineering firms, conservation organizations and local communities is enabling application of hybrid engineering approaches for coastal restoration in Java, thus putting to practice NCP within actions of engineering organizations (EcoShape, 2017). The case of India Business Biodiversity Initiative describes a dialogue driven process aimed at mainstreaming biodiversity within corporate sector practices (Box 6.21).

Box 6.21 India Business and Biodiversity Initiative

The India Business and Biodiversity Initiative (IBBI), which was launched in 2014, is a national platform for businesses and its stakeholders for dialogue, learning and sharing, ultimately leading to mainstreaming biodiversity into business practices. This platform is a collaborative effort of the Ministry of Environment, Forest and Climate Change and the Confederation of Indian Industry. As on January 2016, the Initiative had 15 leading Indian corporates as members, who are progressing towards affirmative actions for conserving biodiversity through changes brought about in their business practices. IBBI also closely liaises with similar global initiatives (i.e. The Natural Capital Coalition) and the finance sector initiative (i.e. The Natural Capital Declaration). The initiative is one of the important mechanisms through which the Ministry collaborates with the private sector towards the achievement of the 12 National Biodiversity Targets established under the aegis of the CBD's Strategic Plan for Biodiversity 2011-2020. (http://businessbiodiversity.in/)

At the project level, an example of the use of mainstreaming strategies to influence finance mechanism can be seen in the strategies adopted by Global Environment Facility (Huntley & Redford, 2014). The GEF-6 strategy includes mainstreaming through four suite of activities: a) developing policy and regulatory frameworks that remove perverse subsidies and provide incentives for biodiversity-friendly land and resource use, b) spatial and land use planning to ensure that approximately situated to maximise production without undermining or degrading biodiversity, c) improving and changing production practices to be more biodiversity-friendly, and d) piloting an array of financial mechanism to incentivise actors to change practices that may degrade biodiversity.

UNEP-WCMC (2016) in their assessment of progress made under Aichi Target 2 (biodiversity values integrated into national and local development and poverty reduction strategies and planning processes) in the Asia-Pacific region conclude that while some measures have been taken within the region through revision of NBSAPs, use of EIAs, and national accounting frameworks, the efforts need to be substantially upgraded. In most cases, direct connections of nature towards production processes are recognised, multiple values of nature remain mostly unaddressed. Placing biodiversity goals within sectoral decision-making within those government agencies not directly related to biodiversity issues, such as the Ministries of Finance, Agriculture, Infrastructure, Planning, Tourism and Education and others remains a challenge, requiring further and intensified efforts.

Huntley & Redford (2014) summarise some of the key facets of successful mainstreaming projects: a) enabling environment as democratic and accountable governance, organizational and institutional capacity, information systems, political will and enabling policy frameworks; b) identification and involvement of stakeholders in an iterative and inclusive manner; c) identification and engagement of conservation and development sector leaders and champions; d) clear identification of what needs to be mainstreamed and why; e) identification of elements of biodiversity that is critical to development (nature – human well-being linkages as per the Asia-Pacific Regional Assessment); f) making a clear and transparent business case, including assessment of risks and opportunities; g) using existing implementation frameworks wherever possible, and striving for pull as well as push approaches; h) allocating time as mainstreaming can be a long drawn process, and i) learning and adaptation.

At the policy level, many countries in the Asia-Pacific region have made progress in revising and updating their NBSAPs (Figure 6.8) and developing legal instruments to incorporate the new challenges and meet the obligations under the CBD and other biodiversity-related conventions. However, effective implementation of NBSAPs remains a challenge. The main reason is the limited capacity and knowledge to initiate and implement actions to address these challenges. At the same time, lack of willingness among the policymakers, planners, and field managers to utilise the traditional knowledge available among the indigenous and local communities for managing the biodiversity resources sustainably remains a significant issue. Capacity development needs will have to be addressed at three levels - national, provincial and local. A cadre of biodiversity specialists could be developed at these levels to address BES issues in a coordinated manner. There is also limited knowledge on ecosystem services contribute to national economic growth, employment, and prosperity of the nations, and the risks associated with loss of these services. Therefore, it is important to assess and understand that how countries and regions can benefit from the BES, and to guide policymaking efforts. These assessments can also serve as an important vehicle to raise public awareness when policy changes are difficult to make and implement (TEEB, 2009).

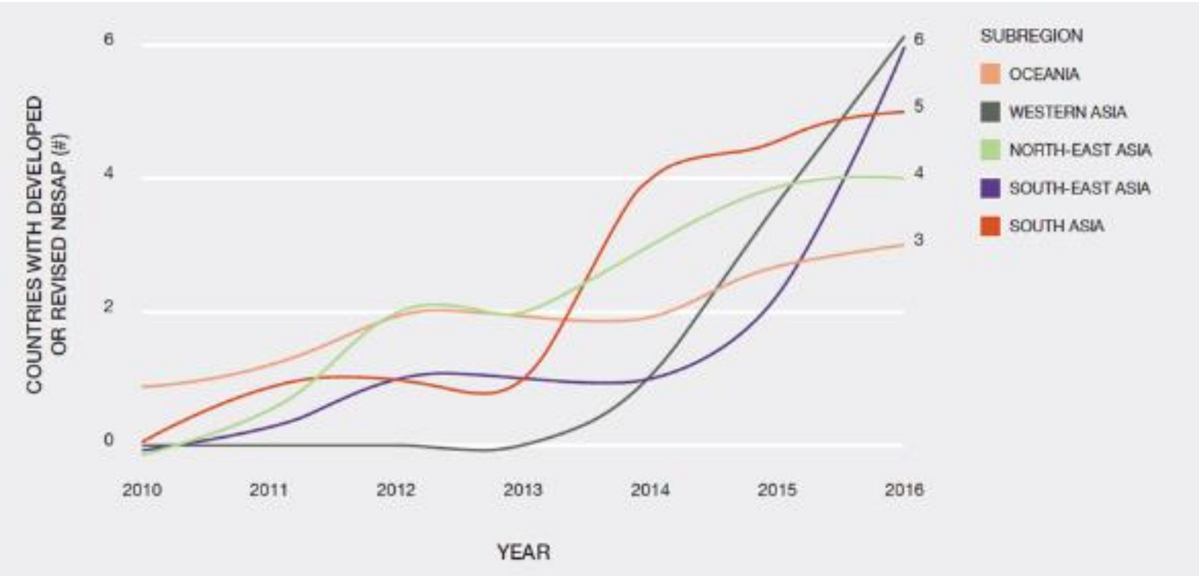


Figure 6.8 Number of Asia-Pacific countries with developed or revised National Biodiversity Strategies and Action Plans by subregion, 2010-2016
Figure prepared by the IPBES Task Group on Indicators and Knowledge and Data Technical Support Unit. Indicator data source: CBD Secretariat.

General capacity on ecosystem services and their economic values needs to be built within the economic planning and financial departments of local, provincial and national governments, to guide coherent policies and decisions for development and well-being that avoid the unknowing trade-offs of high ecosystem service values for lower value production and developments. Additionally, there is a need for capacity building to support relevant departments and policies on ecosystem values from outside government, e.g. through consultancies, academia and think tanks. Capacity is most likely to develop however if there is an accepted, functional, and supported policy assessment framework that creates a demand for it (TEEB, 2009). For example, India's Biological Diversity Act provides a legal framework for enhancing local capacities through the creation of local Biodiversity Management Committees (BMCs) which are constitutional bodies and provide a necessary institutional mechanism and build capacity of Indigenous and Local Communities (ILCs) for conservation and benefit sharing from BES. These committees are supported through the creation of local biodiversity funds which can receive money through benefit sharing mechanism, donations, hunting fees, and charges levied on the usage of resources by outsiders.

6.4.2.4 Co-management and collaborative governance

Co-management and adaptive collaborative governance represent essential strands of policymaking in scenarios of decentralised decision-making in the Asia-Pacific region (Chapter 5, section 5.3.1). Most natural resources in the region were formerly either locally owned and exploited, or they enjoyed some form of open access regime with no clear form of ownership or management (Persoon & van Est, 2003). Policymaking, however, has been predominantly structured on ‘command-and-control’ arrangements, relying on top-down laws, regulations and sanctions (Gunatilake & De Guzman, 2008). Over the past three decades, the use of community-based and collaborative approaches to managing nature has become more prominent (see section 6.2.2.2 and 6.2.3, chapter 2 Box 2.13). Usually defined as the sharing of responsibilities for managing a specified natural resource between the local community and the state, co-management can include a wide variety of arrangements between the extremes of management by a centralised government on the one hand and strict local management on the other. Borrini-Feyerabend & Buchan (1997) refer to a continuum of ‘participation in conservation initiatives’ that runs from full control by agencies in charge (i.e. centralised governance) and no interference or contribution from stakeholders to ‘full control by stakeholders and no interference or contribution from the agency in charge’ (i.e. self/private governance). Concrete management styles thus range from ‘actively consulting, seeking consensus, negotiating, sharing authority to transferring authority and responsibility’ to local communities. Several examples can be drawn from agro-forests, inland systems and marine areas in the region (Figure 6.6). Ban *et al.*, (2011), on assessing the use of marine protected areas as a management tool for coral reef areas indicate three emerging trends significant for advancing coral reef conservation, namely the integration of community marine protected area initiatives with systematic conservation planning, consideration of tightly coupled social and ecological systems and adaptive management and planning.

Co-operative management is widely recognised as one of the primary ways to manage small-scale fisheries in the developing countries (Evans *et al.*, 2011). Fisheries co-management may involve a variety of collaborative arrangement involving government and other stakeholders (Sen & Raakjaer Nielsen, 1996). After examining 22 case studies from different regions of the world, it was identified that there is a shortage of research work exploring the decision-making and other aspects of governance aspect in fisheries co-management (Sen & Raakjaer Nielsen, 1996).

A meta-analysis conducted in 2011 on 204 potential case studies show that fisheries co-management yield benefits for communities or end-user. However, the research shows the lack of comparative data for identifying a generalised trend in different regions for the impact of cooperative management of small-scale fisheries (Evans *et al.*, 2011). It has been suggested that the incorporation of some traditional conservation methods may be useful for the success of marine protected areas in the South Pacific (Lam, 1998). Traditional or customary owners’ participation and fulfilment of their needs for subsistence and economic development may be a critical issue for the success of marine protected areas in the South Pacific (Lam, 1998). Another study on Palau’s protected area network states that the lack of distributive decision-making approach may create uncertainty for long-term sustainability (Gruby & Basurto, 2014). Another study mainly using Solomon Island as an example examines the critical role of customary practices and argues that modern pressures may lead to innovative organizational and political development in respect of customary marine tenure (Hviding, 2006). The importance of hybrid management system for marine environmental protection has been highlighted in another study also (Cinner & Aswani, 2007).

A significant recent trend has been the establishment of Locally Managed Marine Areas (LMMAs) in South Pacific involving 500 communities in 15 states and territories (Govan, 2009). This study also claims that this community-based management approach is very successful in the wake of the challenging issues the region is facing with respect to food security, biodiversity conservation and climate change. However, ensuring considerable environmental or fisheries benefits from the increasing number of marine protected area or not take zones may involve solving problems on the broader fishing area and watersheds. Addressing the issues harmonisation of national law, custom, and benefit sharing mechanism is also vital for the success of community-based natural resources management system in the South Pacific (Clarke & Jupiter, 2010). It is also critical to consider the policy implications of flexibility and heterogeneity of custom and culture as well as socio-political barriers to managing natural resources in the South Pacific Islands countries (Foale & Manele, 2004).

More recently, there is increased adoption of a strategy for collaborative governance in various aspects of policymaking, which brings public and private stakeholders together to engage in consensus-oriented decision-making (Ansell & Gash, 2008). Broad argumentation, Knowledge accumulation, collective learning, inclusive stakeholder participation, well organized participatory processes, and genuine knowledge sharing are critical ingredients of such approach (Primmer *et al.*, 2015). de Koning, Parr, Sengchanthavong, & Phommasane (2016) list out five building blocks of collaborative governance: (i) a participatory governance assessment; (ii) establishing a multi-level collaborative management and governance structure; (iii) participatory zonation based on traditional knowledge and customary rights; (iv) drafting collaborative governance agreements and (v) involving local people as additional protected area management manpower.

6.4.2.5 Fair and equitable sharing of benefits

Scenarios of decentralised solutions as well as global technology are highly likely to be linked with the use of genetic resources for various uses. Our current understanding of genetic resources owes a great deal ILK, thereby rendering due consideration of customary rights within negotiations for the use of genetic resources as of paramount importance. Securing fair and equitable sharing of benefits arising from the use of genetic resources is, therefore, an important policy tool for securing nature for the Asia-Pacific region. But the use of ABS as governance option for BES is limited regarding ecosystems and instruments (Figure 6.6). The CBD recognises the sovereign rights of States over natural resources in areas within their jurisdiction. Parties to the Convention, therefore, have the authority to determine access to genetic resources in areas within their jurisdiction. Users of genetic resources can include research institutes, universities and private companies operating in various sectors such as pharmaceuticals, cosmetics, agriculture, horticulture and biotechnology. Benefits derived from genetic resources may include the result of research and development carried out on genetic resources, the transfer of technologies which make use of those resources, participation in biotechnology research activities, or monetary benefits arising from the commercialisation of products based on genetic resources. Several countries in the Asia-Pacific region have developed policies and mechanisms for the implementation of the ABS.

The Nagoya Protocol (Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilisation) was established in 2010 to promote sharing of the benefits derived from the utilisation of genetic resources in a fair and equitable way (SCBD, 2012). The first step towards achieving this aim was taken in October 2014, when the Nagoya Protocol came into force with ratification by over 50 countries worldwide, and a growing number since. In the Asia-Pacific region, 27 countries have deposited the instrument of ratification, acceptance, approval or accession (out of 57 parties to the CBD). Although the Philippines is amongst those that recently ratified in September 2015, it is the first country not only in the Asia-Pacific region but in the world to have specific national legislation on Access and Benefit Sharing (ABS) through the Philippine Executive Order 247 in 1995 (Box 6.22). Several countries in the Asia-Pacific region have developed policies and implementing mechanisms for ABS. While countries such as Afghanistan, Bhutan, India and Philippines have national or sub-national legislations (Malaysia), others such as China have set up sectoral legislation. At the regional level, ASEAN formulated a draft Framework Agreement on

Access to Biological and Genetic Resources (ASEAN, 2000), while similar frameworks have been mooted for other regions, e.g. a regional ABS framework for the Himalayan region (ICIMOD, 2008). Many countries in Western Asia have launched regional initiatives, and country policies and regulations are in various stages of development (e.g. Iraq, Qatar, Saudi Arabia and the United Arab Emirates). However, there is a need to align these not only with the FAO's International Treaty on Plant Genetic Resources but also with the ABS provisions of the CBD. In Oceania, while some countries including New Zealand, Papua New Guinea, Solomon Islands and Kiribati are yet to ratify the Nagoya Protocol, others such as Australia and French Polynesia have developed sub-national/national level legislative or regulatory mechanisms.

Box 6.22 Philippine Executive Order (EO) No. 247 - First national ABS legislation in the region

The Philippines' EO No. 247 (1995) was the first national law to provide a regulatory framework for ABS and formulated through bottom-up approach with participation of scientists, NGOs, communities and local governments. Its implementation is supported and improved by other legislation such as the Indigenous Peoples Rights Act (IPRA, 1998), Traditional and Alternative Medicine Act (TAMA, 1997), Wildlife Resources Conservation and Protection Act (2001). These laws adhere to the local Prior Informed Consent (PIC), which both foreign and local institutions are required to obtain before collecting and using biodiversity information in areas where local and indigenous. The PIC provides the local and indigenous communities with the opportunity to decide on the use of their traditional knowledge. Although the EO 247 is criticised for having broad regulation scope and the PIC for being time and budget consuming, they remain notable for promoting the rights of local and indigenous communities as well as the objectives of the CBD. The study of Swiderska *et al*. (2001) on the EO 247 highlighted issues for developing ABS policy including involvement of all key stakeholders to promote fair and equitable partnership, participation of stakeholders in policymaking is an essential condition for policy implementation, consultations need to be carefully planned and include local and indigenous communities, etc. , Sources: Smagadi (2005); Swiderska *et al*. (2001); Andersen (2016)

While the CBD offers guidance on access and fair and equitable benefit-sharing, it is the approach taken by countries to adapt the CBD principles through national policies and legislation that is critical to its effective and context-specific implementation (Cabrera Medaglia *et al.*, 2014). Indeed, ABS is considered to be amongst the most controversial policy and regulatory issues in international and national contexts ever since the CBD entered into force over two decades ago (Koetz *et al.*, 2008). The challenges facing operationalisation of ABS policies and effective implementation relate to both access to genetic resources and benefit-sharing (Tvedt & Schei, 2014). Though ABS regulations generally address legal certainty and transparency in requirements for obtaining access, weak institutional arrangements lacking coordination between relevant agencies/stakeholders can pose a hindrance. Often procedural steps for obtaining Prior Informed Consent (PIC) and Mutually Agreed Terms (MAT) are not clearly defined, particularly when PIC and MAT are required not only from a single stakeholder (e.g. government agency) but also from local or indigenous communities. This is particularly significant as ABS generally aims to ensure the safeguarding of traditional knowledge associated with genetic resources. For instance, the ASEAN Framework Agreement on ABS states that local communities must be actively involved in the PIC process such that community practices and customary laws are respected (ASEAN, 2000; Foronda, 2013). At the same time, issues of ownership of genetic resources have to be clearly defined. Most ABS regulations require setting up of mechanisms for sharing of monetary as well as non-monetary benefits.

Moreover, though MAT operates mainly via legal contracts to regulate access and exchange and share the benefits and returns, there is a need for more explicit incentives for private players/companies to enter into such contracts. Besides the inherent complexity of ABS, contract law for ABS is also not yet thoroughly investigated being a relatively new field (Tvedt & Schei, 2014). Nevertheless, ABS offers significant opportunities for supporting biodiversity conservation while safeguarding traditional knowledge and providing a means for encouraging equity in the sharing of benefits accruing from the utilisation of genetic resources.

6.4.2.6 Investments in natural capital

Investments in ecosystem restoration and sustainable management can benefit multiple policy sectors and help achieve policy goals (TEEB, 2009). Several initiatives exist to invest in natural capital in the region (Figure 6.6). These apply to urban development (Box 6.5), water purification and wastewater treatment, regional development, transport and tourism as well as protection from natural hazards and for public health. In the light of expected needs for significant investment in adaptation to climate change, investing in restoring degraded ecosystems also has significant potential for many policy sectors, for example, enhancing the productive capacity of agricultural systems under conditions of increased climate fluctuations and unpredictability, and also providing buffering services against extreme weather events (Marois & Mitsch, 2015). Such investments would, however, require expression of multiple values of nature (Pascual *et al.*, 2017) and embedding in developmental and landscape scale planning (Juffe-Bignoli *et al.*, 2016; Kumar *et al.*, 2016; Pittock & Xu, 2010; Pittock *et al.*, 2015). It is also pertinent to ensure policy coherence amongst sectoral planning, as lack of recognition of nature and NCP can severely limit development (example, the case of Mahanadi Delta, (Kumar & Patnaik, 2016)). Ecosystem restoration investments in the form of structured programmes are being made in several countries of the Asia-Pacific region including Green India Initiative (2007-8), UNDP Green Afghanistan Initiative, Philippine Green Building Initiative (2008), Biodiversity Finance Initiative (2012-2018), etc. For example, the Government of India has announced the Greening India Mission (GIM) under the National Climate Change Action Plan during 2010-2020 (Box 6.23). The overall goal of the mission is the protection, restoration and enhancement of India's forest cover in response to climate change, which will lead to enhanced carbon sinks in sustainably managed forests /other ecosystems, adaptation of vulnerable species/ecosystems to the changing climate and enhanced livelihood opportunities (Bharti, 2015).

Box 6.23 National Mission for a Green India

The Green India Mission was conceived during 2010 and approved during 2014 with an outlay of about $2.0 billion (National Mission for a Green India-National Consultation, 2010). The objectives of the mission are to improve quality of forest cover on 5 m ha, increase further forest/tree cover on forest & non-forest land on another 5 m ha, improve ecosystem services including biodiversity, hydrological services and carbon sequestration as a result of treatment of 10 m ha. It also envisages an increase in the forest-based livelihoods income of about 3 m forest-dependent communities and enhanced annual CO_2 sequestration by 50 to 60 m ton in 2020 (Ministry of Environment and Forests, 2010). Contrary to the expectations, there is an apprehension on the stipulated achievements of the objectives for it lacks scientific input. The mitigation potential has been estimated by merely multiplying the global default biomass growth rate values and area. It is underestimated as it does not include all the carbon pools, phasing, differing growth rates, etc. The mitigation potential estimated using the Comprehensive Mitigation Analysis Process model for the GIM for the year 2020 has the potential to offset 6.4 per cent of the projected national greenhouse gas emissions, compared to the GIM estimate of only 1.5 per cent (Ravindranath & Murthy, 2010). The purpose of addressing climate change under the market-friendly model of Green India Mission has strongly been criticised by India's forest dwellers movements and struggle organizations like Campaign for Survival and Dignity and National Forum of Forest peoples and Forest Workers. They accused that the Mission "in its current form", will lead to increased land grabbing and violation of people's rights (Forest Movement Joint Statement made by NFFPFW & CSD, 2010) and destroy bio-diversity rich natural open forests and grassland in pursuit of planting exotic species for REDD credits (India: Pushing "REDD Plus" at the expense of forests and forest dwellers, 2010).

National forest restoration programs exist in South East, South and Western Asian subregions that can be incentivised by economic drivers but also transparent and strong governance is required for its achievement. Especially in Western Asia, national government financially support afforestation that may halt/ mitigate desertification (Ma, 2008). Investments through Green Public Procurement can be an indirect promotion of investments in natural capital adopted for the sustainable forest production by Oceania, South East and North East Asia (Australian Government, 2013; ICLEI, 2016; MoE, 2016; Zeppel, 2014). Green Public Procurement tends to have a national system such as Eco-BUY in Australia, Eco-label in Malaysia and Eco-mark in Japan. Each system also plays a role of certification and can regulate consumer behavior under the good governance and policy.

The concept of Green Public Procurement has started achieving prominence in the Asia-Pacific region particularly in Japan, China, New Zealand, South Korea, etc. According to TEEB report for policymakers "A product or service can only qualify as 'green' if it goes beyond what is required by law and beyond the performance of products commonly sold in the market. Green Public Procurement helps to green the markets, and ecologically innovative products can increase market share and often get a price premium. Beyond public procurement, some governments and international institutions have also intervened to strengthen or promote markets for products which are generally recognised as being socially or environmentally superior.

6.4.2.7 Environmental regulation, standards and certification

Given the tremendous, pressure on nature and NCP in the Asia-Pacific region, classical policy options of environmental regulation, standards and certification are commonly applied to various environmental challenges (Figure 6.6). Such solution is built upon a command and control approach, based on state control over resources, and specification of strict standards for resource use. The regulatory toolkit includes a wide range of prohibitions, restrictions, mandatory requirements, standards and procedures that directly authorise or limit certain actions or impacts. There are three basic types of regulatory instruments for nature and NCP, namely: (i) Regulation of emissions, which usually involves emissions standards, ambient quality standards and technical performance standards (e.g. air quality management); or management prescriptions for good practice (e.g. in agriculture); (ii) Restrictions on the use of products (e.g. illegally logged timber, activities damaging to endangered species, etc.) or production standards (certification, best practice codes), and (iii) Spatial planning, which involves regulation of land uses that have direct implications for ecosystem services or habitats. In several circumstances, regulation combines incentives-based approaches to gain benefit from regulatory as well as market-based approaches. A common institutional problem for the Asia-Pacific region though stems from limited coordination between developmental and environmental regulation across various governance scales and sectors. This leads to policy tools, as spatial planning and EIAs being compromised by narrow sectoral interests, corruption and mismanagement.

An important policy option for reducing adverse impact on nature and NCP in 'Global technology' scenario is through use of certification, to ensure that commercial producers adhere to predefined environmental and social welfare production standards (Blackman & Rivera, 2010). Producers and industries mainly in the forest and agriculture sector are increasingly applying Voluntary Sustainability Standards (VSS) on their initiatives or in partnerships with development organizations. There are now many VSS schemes that are applied to major export commodities including Fairtrade, Organic, Rainforest Alliance/Sustainable Agriculture Network (RA/SAN), Better Cotton Initiative (BCI), Roundtable on Sustainable Palm Oil (RSPO), Round Table on Responsible Soy (RTRS), Forest Stewardship Council (FSC), and Programme for the Endorsement of Forest Certification (PEFC) (Table 6.4). South East and South Asia have the most substantial number of countries participating in the VSS, while in Western Asia almost nil. Except for Oman and UAE, which participate in PEFC, albeit with very negligible share (Lernoud *et al.*, 2015). China has a significant share to organic soybean and tea, while India to fairtrade and organic cotton. Among the different types of VSS, organic is the most commonly used in the region.

Table 6.4 Share of Asia-Pacific countries in global land area under Voluntary Sustainability Standards, by type of commodities and schemes

Voluntary Sustainability Standards	Global land area (ha)	Oceania		South East Asia		North East Asia		South Asia	
		Country	share	Country	share	Country	share	Country	share
Banana									
Fairtrade	40,624							Sri Lanka	2.54
Organic	52,530			Indonesia	0.06				
				Philippines	16.94				
RA/SAN	109,660			Philippines	3.34				
Cocoa									
Fairtrade	14,034							India	0.21
Organic	267,760			Indonesia	0.01				
				Vietnam	0.77				
RA/SAN	737,551	PNG	0.25	Indonesia	6.34			India	0.18
				Philippines	0.03				
UTZ	1,530,137			Indonesia	4.13				
				Vietnam	0.13				
Coffee									
4C	1,594,405	PNG	0.50	Indonesia	4.60	China	1.37	India	0.43
				Lao P.D.R	0.09				
				Philippines	0.93				
				Thailand	0.99				
				Vietnam	10.50				
Fairtrade	1,297,206			Indonesia	2.14			India	0.35
				Vietnam	2.11				
Organic	798,150	PNG	1.22	Indonesia	9.31			India	0.25
				Lao P.D.R	0.03			Nepal	0.09
				Myanmar	0.01			Sri Lanka	0.01
				Thailand	0.18				
				Timor-Leste	2.84				
RA/SAN	405,083	PNG	0.95	Indonesia	4.01	China	0.10	India	4.48
				Thailand	0.00				
				Vietnam	2.87				
UTZ	549,030			Indonesia	3.00			India	6.34
				Vietnam	11.98				
Cotton									
BCI	2,217,000					China	11.10	Pakistan	22.46
Fairtrade	45,031							India	72.89
Organic	350,033					China	1.93	India	79.06
Oil palm									
RA/SAN	49,844			Indonesia	12.12				
RSPO	2,774,000	PNG	5.17	Indonesia	44.23				
		Solomon Islands	0.27	Malaysia	42.93				
				Thailand	0.70				
Soybeans									
Organic	528,325	Australia	0.01			China	47.54	India	22.15
						Japan	0.15		
RTRS	734,977					China	2.63	India	3.75
Sugarcane									
Fairtrade	186,736	Fiji	36.83					India	4.19

Organic	92,565	French Polynesia	0.01	Philippines	0.43	China	5.46	India	1.73
				Thailand	6.70				
Bonsucro	907,207	Australia	4.85						
Tea									
Fairtrade	122,126					China	1.85	India	14.62
								Sri lanka	5.06
Organic	74,815			Indonesia	4.48	China	53.60	Bangladesh	0.67
				Lao P.D.R	0.33	Japan	2.27	India	18.91
				Myanmar	5.75			Iran	0.03
				Thailand	0.13			Nepal	1.47
				Vietnam	2.54			Sri Lanka	5.88
RA/SAN	472,499			Indonesia	6.43	China	1.26	Bangladesh	0.08
						Japan	0.03	India	24.22
								Sri Lanka	7.27
UTZ	47,828							India	28.59
Forestry									
FSC	186,410,374	Australia	0.68	Indonesia	1.17	Japan	0.21	India	0.40
		Fiji	0.05	Lao P.D.R	0.00	Korea	0.21	Sri Lanka	0.01
		New Zealand	0.68	Malaysia	0.36	China	0.62		
		PNG	0.02	Thailand	0.03				
		Solomon Islands	0.02	Vietnam	0.09				
				Cambodia	0.01				
PEFC	272,062,933	Australia	3.82	Indonesia	0.27	China	2.07		
				Malaysia	1.71				

Note: Does not include countries with a share of less than 0.005 per cent
Data source: Lernoud *et al*. (2017)

Growing demand for environmentally certified products further led to the establishment of country initiatives, such as the Indonesian Ecolabelling Institute which developed Forest Certification Systems in Indonesia (Maryudi, 2009). In Australia and New Zealand, eco-labelling or environmental certificate for seafood have been actively implemented (Wakamatsu & Wakamatsu, 2017). The objectives and scope of certification substantially vary among different certification initiatives, whether it be very specific to conserve forest or agro-forest ecosystems, bird habitats or dolphin populations, or too general to be effective in delivering results for the conservation of BES. It also could be noted that certifications, as a market-based instrument, needs capturing substantial additional payments in the consumer market to cover certification cost and to incentivise environmentally sustainable production, which is, however, so far reported to be marginal and insufficient (Taylor, 2005; Scheyvens *et al.*, 2010). Effective certification systems require specific and meaningful criteria with legitimate validation mechanism, with markets settling upon broadly accepted industry-wide standards and means of raising consumers' awareness (Ghazoul, 2001; Gullison, 2003; Laurance *et al.*, 2010; Schouten & Glasbergen, 2011; Ward, 2008).

Blackman & Rivera (2010) based on an analysis of environmental certification projects in the GEF portfolio, identified four main threats to the effectiveness of eco-certification: i) weak certification standards; ii) noncompliance with certification standards; iii) limited participation, which can stem from supply-side or demand-side factors; and iv) adverse self-selection, whereby actors already engaged in, or intending to engage in, innovative or environmentally friendly practices disproportionally participate in the program. Monitoring and evaluation can be used to improve policy design, increase the accountability or ownership of the stakeholders and identify promising practices that can be applied subsequently in other country settings. Effective enforcement is critical to provide policies with teeth and demonstrate the gravity of environmental offences. Adequate funding for technical equipment and trained staff is essential to realise policy commitment in tackling biodiversity and ecosystem losses. Public-private partnerships can help reduce many of these weaknesses, as in the case of the GIZ project on VSS for coconut oil in Indonesia and the Philippines (Box 6.24).

Box 6.24 Partnerships on VSS programs for coconut oil in South East Asia

The GIZ, together with the private-sector stakeholders BASF, Procter & Gamble (P&G), and Cargill, joined forces and formed a development partnership as part of the develoPPP.de programme of the German Federal Ministry for Economic Cooperation and Development (BMZ). The project, “Sustainable Certified Coconut Oil Production (SCNO) – Strengthening smallholder farmer groups and setting up a chain of custody”, in cooperation with national partners, including the Philippine Coconut Authority and the Agricultural Training Institute, aimed a certified sustainable coconut oil supply chain that supports higher incomes and economic self-reliance among smallholder coconut farmers. The project has been introduced in the Philippines (General Santos in Mindanao, and Southern Leyte) and Indonesia (Amurang, North Sulawesi). The success of the project was attributed to the expertise of the different partners. For example, in addition to the management of copra collection stations and crushing plants, Cargill assists the farmers to organize themselves as an interest group to secure certification for their produce according to the Sustainable Agriculture Network (SAN) of the Rainforest Alliance. The BASF and P&G use the certified crude and oil produced by Cargill for the production of their cosmetics, nutrition and health products. The contributions of the GIZ in the partnership are building farmers’ capacity, enhancing uptake of good agricultural practices (GAP), introducing sustainability standards to the farmers, and managing implementation of the project. All partners participate in providing training to farmer groups on good agricultural practices, sustainability standards and better management practices, with the aim of increasing farm productivity. They provided training materials and training to over 1,000 farmers, and enabled 300 smallholder farmers to become the first Rainforest Alliance certified coconut producers in the world.

Sources: GIZ (n.d.), Cargill (2017)

6.4.2.8 Other relevant governance options

Other options for BES governance include realigning incentives as well as strengthening indicators and accounting systems, both of which have been used to improve the implementation of the above-mentioned options.

Realigning incentives

Measures that provide incentives to conserve biodiversity and sustainable use of its components are increasingly recognised as an important tool for maintaining BES. The CBD identifies the absence of incentive measures as one of the leading causes for the loss of biodiversity and associated ecosystem services. Aichi Biodiversity Target 3 stipulates for reformed incentives, stating that that by 2020, incentives, including subsidies that are harmful to biodiversity are eliminated, phased out or reformed in order to minimise negative impacts on biodiversity (CBD, 2011). Box 6.25 defines the different types of incentive and disincentive measures. Through Target 3, the CBD requires positive incentives for the conservation and sustainable use of biodiversity are developed and applied, consistent and in harmony with the Convention and other relevant international obligations, taking into account national and local socio-economic conditions. By agreeing to this target Parties have committed to developing and applying positive incentives for safeguarding biodiversity.

Box 6.25 Major types of Incentive and Disincentive Measures

1. *Strengthening marketing strategy:* trading mechanisms for changing the relative costs and benefits of specific activities and to improve marketing channels for components of biodiversity, thus encouraging conservation and sustainable use of biological diversity. Examples include transferable fishing quotas, biodiversity prospecting, certification and eco-labelling initiatives; and (see section 6.4.1.7)
2. *Positive measures:* Economic, legal, institutional measures that encourage beneficial activities such as payments for organic farming, agricultural set-aside schemes, public funding or grant-aided land purchases, grants for biodiversity conservation schemes;
3. *Negative incentive measures/disincentives:* Mechanisms to discourage harmful or unsustainable activities such as user fees, pollution taxes, fines, polluter pays or habitat mitigation schemes;
4. Perverse Incentives: Incentives that are harmful for biodiversity (or earlier called under the CBD 'perverse' incentives) emanate from policies or practices that induce or accelerate biodiversity loss. These include harmful subsidies that promote unsustainable farming, forestry or fishing activities. Removing such subsidies helps safeguarding biodiversity.

Source: CBD (2011); OECD (1996)

Positive measures: Use of economic instruments for addressing adverse trends in nature and NCP within developing countries, including major parts of the Asia-Pacific region, require the emphasis of the dual goals of poverty alleviation and environmental conservation. Leimona *et al.* (2015) in their analysis of application of PES instruments in Asia highlight shifting perspectives, from legitimating cost-efficient and effective natural resource management to concerns about fairness in the design and benefit distribution of the scheme. Four major insights are drawn in the analyses, which are highly relevant for structuring an effective PES instrument for the Asia-Pacific region: a) co-investment in environmental stewardship as opposed to a strict and prescriptive PES definition; b) a shared understanding of multiple types of ecological knowledge in providing and managing ES to increase the efficiency and fairness of PES schemes; c) anti-poverty PES to adapt to local conditions in designing the types, forms and expected levels of payments; and d) a multidimensional approach to poverty and livelihoods to enable a broader analysis of local perspectives on PES.

Businesses, governments, and financial institutions are increasingly adopting a policy of no net loss of biodiversity for development activities. The goal of no net loss is intended to help relieve tension between conservation and development by enabling economic gains to be achieved without concomitant biodiversity losses (Gardner *et al.*, 2013). Biodiversity offsets are receiving increasing interest from business, government, finance, and conservation sectors across the world. Considerable concern about biodiversity offsets remains due to differing interpretations of no net loss and the potential for misuse of offsets (Clare *et al.*, 2011; Walker *et al.*, 2009). There is a lack of clear examples where best practice has, beyond a reasonable doubt, delivered no-net-loss outcomes. There is also need for a greater recognition that in some situations, and despite every attempt at mitigation, no net loss of biodiversity can be achieved; that is, development will result in irreplaceable loss of biodiversity. Such development projects may be approved by governments because there is a clear and overriding public interest in the project. In such situations, it may be possible to achieve partial compensation for loss of biodiversity, but a claim of no net loss of biodiversity should not be made (Pilgrim *et al.*, 2013).

Disincentives measures: Negative incentive measures, which include users fees, tariffs, fines, polluter pays, habitat restoration schemes, and enforcement of quotas or limits, are mechanisms that penalise or discourage people on unsustainable use of and/or harmful activities which lead to biodiversity loss (Khan 2015). Economic instruments such as taxes, levies, charges and fees, as well as targeted exemptions from these instruments, are proposed as an important element of the policymaker's toolkit to complement other measures. The basic rationale for the use of taxes and charges in ecosystem policy is provided by the existence of externalities: impacts on ecosystems, which are side-effects of processes of production and consumption, and which do not enter into the calculations of those responsible for the processes. Though looks practicable, these are difficult to implement or enforce, as these require appropriate policy thrust and legal frameworks which is either absent or weak in many countries of the Asia-Pacific region. Furthermore, information on viability and best practices of using negative incentive measures directed towards conservation and sustainable use of biodiversity is limited in the Asia-Pacific region making difficult to assess and discuss here in detail. It is, therefore, important to continue sharing information in experiences and have an in-depth analysis on the design and implementation of disincentive measures.

Incentives Harmful for Biodiversity: Incentives that are harmful to biodiversity, which were called 'perverse' incentives in the past, emanate from policies or practices that results in biodiversity loss due to the side-effects of policies designed to attain other objectives. Subsidies having harmful effects on biodiversity and ecosystem services are classic example of perverse incentives. Some of these subsidies are considered critical drivers that are harmful to BES, as they negatively impact in two ways – 1) *Under-pricing the use of natural resources*: The price charged for using natural resources rarely reflects their real value in terms of the ecosystem services that they provide, whereas very low price often leads to over-exploitation. Subsidies can aggravate this problem be reducing the price further, to below extraction or provisioning costs and 2) *Increasing production:* Subsidies are often provided to support environmentally sensitive sectors e.g. agriculture, energy production and use, fisheries, heavy industry, and transport. Many subsidies serve to reduce costs or enhance revenues leading to below cost pricing for nature's inputs and promoting higher use, production and consumption of subsidised resources (TEEB, 2011). Such support measures that reduce costs or enhance revenue for producers provide incentives to produce in larger quantities than in the absence of the subsidy. This leads to increased use of environmentally harmful inputs (e.g. fertilizers and pesticides) and higher production levels, which in turn aggravate the risk of biodiversity loss and damage to ecosystem services (CBD, 2011). This is particularly true for agricultural and fisheries subsidies. Even green subsidies linked with ecosystem benefits may not be well-targeted. Although declining slightly in some sectors, the overall level of subsidies in the Asia-Pacific region remains remarkably high.

So far, there is limited progress towards achieving Aichi Biodiversity Target 3 globally, especially in terms of non-financial incentives and actions to remove or reforms subsidies that are harmful to biodiversity. If this target is to be achieved more focused approach is needed for the removal of harmful incentives and on developing positive incentives (UNEP-WCMC, 2016a). It is, therefore, important to analyse the effectiveness of the subsidy and to see whether removal or reform the subsidy have a positive impact on biodiversity. TEEB (2009) provides a checklist for policymakers for subsidy reforms. This checklist could be useful to address the impacts of subsidies on biodiversity. Systematic efforts are needed to phase out or reform subsidies in various countries of the Asia-Pacific region. The subsidy reform or removal can alleviate environmental pressures, increase economic efficiency, and reduce the fiscal burden (TEEB for National and International Policymakers, Chapter 6, (TEEB, 2009). Phasing out ineffective subsidies saves funds which can be re-directed to areas including biodiversity with more pressing funding needs.

Perverse incentives are sometimes also generated under other policies and laws, e.g. the establishment of protected areas without effective enforcement and management. Perverse incentives are created for adjacent land users or owners, who have no possibilities of acquiring legal titles, to use protected resources. Such cases have driven land conversion in number of countries, thus resulting in loss of BES (CBD, 2011). Nevertheless, there were also cases wherein forest vegetation has been cleared to own the land through title deed as per the Indian Forest Rights Act 2006 (Bhullar, 2008). Similarly, when policies and/or regulations use pricing instruments, for example licence or user fees, negative impact on biodiversity may occur if fees are set too low or do not increase with inflations, and even if they are set unrealistically too high. This is the case in many countries in the Asia-Pacific region. For example, in Cambodia the royalty for timber harvesting was initially too low which resulted in over-harvesting. When forestry sector reforms raised the royalty to very high levels, it encouraged illicit logging. This indicates that economic measures need to be carefully designed and monitored to produce desired results (CBD, 2011). Therefore, it is important to analyse the implications of new policies and/or laws prior to their implementation to avoid adverse effects on biodiversity and ecosystem services. Gordon *et al*. (2015) assessed the perverse incentives risks associated with biodiversity offset policies and identified four perverse incentives that could arise from well-designed policies like biodiversity offsets. These include i) entrenching baseline biodiversity declines, ii) winding back non-offset conservation actions, iii) crowding out of conservation volunteerism, and iv) false public confidence in environmental outcomes due to marketing offset actions as gains.

In order to mitigate effects of such perverse incentives, countries like Cambodia, India, Pakistan and Nepal have developed policies to promote community participation and building local capacities for natural resources management, particularly for managing protected-areas and conserving biodiversity in open landscapes. Moreover, it is important to realise that subsidies could be a useful tool for environment protection, if designed and implemented effective. UNEP (2008a) developed minimum criteria that any subsidy should fulfil to prevent it from becoming a perverse incentive in the long-run. The criteria underlines that subsidies should be targeted, efficient, soundly based, practical, transparent, and time-bound. Therefore, any action to reform subsidies or perverse incentives could consider using these criteria, as removing or reforming perverse incentives has the potential to make positive contribution to reducing biodiversity loss.

Strengthening indicators and accounting systems

Scenario assessments presented in Chapter 5 indicates emphatically that regional future for the Asia-Pacific region will evolve under narratives of ‘market forces’ and ‘policy reforms’ (section 5.3.2). Strengthening indicators and accounting systems for changes in nature, NCP and consequences for human well-being acquires prominence in terms of policy options, given the impacts the overall decision-making environment under which the aforementioned scenarios are likely to evolve and function.

Use of adjusted income and consumption aggregates, alongside conventional GDP, national income and consumption indicators can serve an important indicator to assess the degree of under-investment in conservation and restoration of nature, or extent of over-use of natural resources (TEEB, 2011). The absence or undervaluation of degradation of nature and NCP in the System of National Accounts (SNA) can underlie policy complacency for effectively addressing adverse changes (Hamilton, 2013). SNA’s historical focus on economic factors of production has limited consideration of the role of nature and NCP in the sustainable development. In February 2012, the UN Statistical Commission (UNSC) approved the System of Environmental and Economic Accounts (SEEA) as an international statistical standard providing method for compiling accounts for material, natural resources, as well as the emission of pollutants like greenhouse gas emissions. Subsystems of the SEEA framework elaborate on specific resources or sectors, including Energy, Water, Fisheries, Land and Ecosystems, and Agriculture (https://unstats.un.org/unsd/envaccounting/seea.asp). Enhanced implementation and reporting on SEAA framework within the Asia-Pacific region is expected to provide a nuanced understanding of trends in nature and NCP in the dominant economic paradigms, thus alerting the policymakers and wider society on consequences of particular consummation and lifestyle trajectories. The fisheries sector provides a good example for strengthening indicators and accounting systems (Box 6.26). Bergamini *et al.* (2013) discuss indicators relevant to sustainable landscape.

Box 6.26 Indicators for sustainable fisheries development

Indicators has been utilised by fisheries sector for decades in order to report the stock status and to provide advice for the sustainable fisheries (FAO, 1999). Variety of types of indicators have been suggested and applied. For example, FAO reports the state of world fish stock every 2 year as “State of World Fisheries and Aquaculture: SOFIA”. Also, one of the most famous fisheries indicators is the Maximum Sustainable Catch (MSY), which theoretically means the amount of catch achieved by avoiding overfishing and keeping the resource biomass at the optimum level. CPUE (Catch per unit effort), an indicator of the effectiveness of fish catch, is another example for dealing with overfishing issues. As for the protection of habitats or coastal areas, per cent seagrass/mangrove cover, per cent marine protected areas cover, juvenile mortality, etc., are often utilised. For the water quality control, the nutrient load frequency or amount from land, frequency of the occurrences of harmful algal brooms, etc. are examples of useful indicators. There are many other types of fishery-related indicators such as fishing capacity-related indicators, economic indicators, technological indicators, social indicators, institutional indicators, etc. (Garcia, 1996). One of the most highly developed and science-based example of indicators utilisation for marine ecosystem conservation can be found at the Great Barrier Reef World Heritage Area. In this case, an integrated monitoring framework of indicators covering ecological, social and economic aspects of the area are developed and implemented for understanding the changes in social-ecological systems and getting feedbacks for better management (Hedge *et al*., 2017).

The World Bank led WAVES partnership (Wealth Accounting and Valuation of Ecosystem Services), which has Philippines and Indonesia as member countries are a significant step in this direction. With an estimated one-fifth of Philippines economic wealth coming from its natural resources, the country's National Statistical Coordination Board was one of the first statistical agencies in the world to implement SEEA. Under the WAVES project, natural capital accounts for select ecosystems (Laguna de Bay and South Palawan) and resources (minerals) has been prepared (https://www.wavespartnership.org/). The Great Barrier Reef is famous for implementing the integrated monitoring framework and using the highly science-based system of indicators (Hedge *et al*. 2017). Also, the Bay of Bengal Large Ecosystem Project is also tackling with the marine pollution at the regional level. It developed the water quality criteria and a set of indicators to monitor the effectiveness of the governance. Because the coastal countries of the Bay of Bengal are developing countries with limited financial resources, the international organizations such as UN FAO or WB have been supporting the project. The International Tropical Timber Organization (ITTO) with 12 Pacific Asian member countries and collaborative initiatives of the Montreal Process and Sustainable Management of Dry Forests in Asia with IUCN have supported the revision of criteria and indicators for sustainable tropical timber production forest including conservation of biodiversity as a criterion (ITTO, 2005). Other governments based organizations such as Montreal Process (i.e. including Australia, China, Japan, New Zealand and Republic of Korea in the Asia-Pacific region), the Regional Initiative for the Development and Implementation of National Level Criteria and Indicators for the Sustainable Management of Dry Forests in Asia formed a network to promote conservation of forest, which is also linked with CBD, FAO and other forest related NGOs.

6.4.3 Linking governance options across scales and sectors

6.4.3.1 Regional and subregional level options

At regional and subregional scale, an emphasis on strengthening transboundary governance (6.4.2.4) would embellish the overall efforts at national and local scales for securing nature and NCP in the Asia-Pacific region. Transboundary governance focused not just on shared ecosystem values but also on the transboundary flow of ecosystem services needs to be strengthened for combating challenges such as transboundary pollution (4.6), regional water and climate security (2.3.1.1, 2.3.4.3), securing migration corridors (2.3.4.3) and controlling the spread of invasive species (3.4.5). Experiences of establishing transboundary conservation areas (such as Kailash landscape, Mekong region, Coral Triangle (for reef ecosystems) and others highlight the critical role of trust building, crafting institutional frameworks for cross-scale action, inclusive stakeholder engagement, availability of information base at multiple scales and across sectors and capacity development for integrated problem-solving mechanisms. Subregional platforms (such as Mangroves for Future (Indian Ocean), Bay of Bengal Inter-governmental Organization (for Bay of Bengal Region), Roundtable on Sustainable Palm Oil (for South East Asia)) have played a significant role in establishing formal and non-formal platforms for collaborative action and sharing of best practices. Coordinated implementation of multilateral environmental agreements and Conventions can also play an enabling role in strengthening transboundary governance by enhancing policymaking, programming and tracking implementation capabilities within the region. The role of international and national NGOs is also gaining prominence at this scale, in generating the required knowledgebase, building capacity, and promoting soft advocacy with the governments (Frank *et al.*, 2007).

6.4.3.2 National and sub-national options

The subregional analysis of direct and indirect drivers of change (section 4.4), scenarios of biodiversity loss along pathways (section 5.3) provide a context in which national and sub-national governance options and priorities can be discerned. Climate change and variability and land use and land cover change emerge as the strongest driver impacting ecosystem services supply in almost all the regions, thus calling for the integration of BES considerations in sectors underlying these two drivers on a priority. Furthermore, assessments also indicate that of the various ecosystems assessed, lowland evergreen forests, alpine ecosystems, limestone karsts, inland wetlands, estuarine and coastal habitats are most threatened (3.2), thus providing a wider ecosystem picture to focus on sectoral integration of conservation measures.

Of the governance options presented in section 6.4.2, mainstreaming BES in development (6.4.4.3), improving governance of protected areas (6.4.2.1), realigning incentives and strengthening indicator and accounting systems (6.4.2.8) require emphasis at the national scale. Additionally, there is a need for providing an enabling governance framework to realise options at local community scale (6.4.4.3 as well as strengthening transboundary governance as discussed in the preceding section. Sectoral integration needs are most prominent for national policymaking for climate change, agriculture, urban development and water management. Integrative approaches such as ecosystem based disaster risk reduction, natural infrastructure, good agriculture-wetland interactions (see further discussion in Section 6.6) can provide sectoral integration opportunities, with the Sustainable Development Goals as an enabling framework for mainstreaming BES in development.

The formulation, adoption, and implementation of the National Biodiversity Strategy and Action Plans (NBSAPs) in many countries in the region have played a key role in the conservation and sustainable management of biodiversity including mainstreaming biodiversity conservation into various national development processes including national development planning and sectoral development planning and strategies. Many countries have incorporated biodiversity conservation into their national development goals. The future national action plans will need to strengthen implementation of National Biodiversity Targets and promotion of mainstreaming of biodiversity through the involvement of relevant stakeholders. Many countries have started the NBSAP development process, while others are implementing those action plans (Misrachi *et al.*, 2012). NBSAPs are effective policy documents at the national level for achieving the objectives that pertain to the country’s obligation to CBD. They are dynamic and responsive documents that allow for changes, addendums, additions, and alterations as the needs arise (Misrachi *et al.*, 2012). Additionally, regional support organizations and international institutions are providing technical backstopping to the national governments, especially in implementation. The emphasis on mainstreaming acquires prominence as the review of the implementation of Aichi Targets in the Asia-Pacific region (6.6) indicates that the targets related to the reduction in pressure from vulnerable ecosystems, reduction in habitat loss and improved financing have almost seen no implementation progress.

There is an increasing interest towards integrated planning for inland water, coastal and marine area development and management in the region. In the face of local and global environmental challenges, Integrated Coastal Management (ICM) has received increasing attention as a policy tool to address multiple management issues in the coastal areas. Many countries have undertaken initiatives to address marine pollution at the national level through the Regional Seas Programmes of UNEP, which included the formulation of the action plans and the implementation of the projects. In addition, ADB undertook studies on investments made in the coastal areas of Cambodia, China and Vietnam. Major international organizations have issued guidelines on ICM including coastal environmental management and environmentally sound development of coastal tourism. Under the commitments to the Ramsar Convention, the wise use and integrated management approaches have increasingly received uptake, but need implementation support in countries of Western Asia, South Asia, South East Asia and parts of Oceania. An effective policy and governance support would be crucial in achieving the objectives of integrated management.

Among other instruments, environmental impact assessment (EIA) has now become a legal requirement for land, sectoral or project development in many countries in the Asia-Pacific region. The EIA has a more crucial role to play in addressing environmental issues surrounding project development (Ogola, 2007). The integration of environment and development is the most important tool in achieving sustainable development. The EIA provides a legal modality for integrating environmental concerns into development planning process, taking into account stakeholders and public involvement in the decision-making process. But several developing countries in the region are still at the infancy stage of developing their EIA systems, so there is a need for capacity building to enable them to use this useful project planning tool. Experiences from several countries in the Asia-Pacific region indicate an increasing awareness of Strategic Environmental Assessments, however, integration requires an improved mix of command and control and with social and cultural, economic and financial instruments, and a transparent stakeholder engagement process framed within the cultural contexts of Asian countries (Victor & Agamuthu, 2014).

One of Asia's critical challenges is the weak environmental governance because of lack of coordination among the sectors and associated institutions and limited human and financial resources. The existing legal mechanisms and implementation challenges and lack of awareness on the environmental and natural capital issues undermine the regional and global commitments that many countries in the region have made. Recognising the unique role of the judiciary in the environment enforcement chain, the ADB has helped in strengthening judicial institutions and promoting an Asian Judges Network on Environment (Mulqueeny & Bonifacio, 2012). Some countries in the region have set up Environmental Courts and Tribunals (ECTs) to deal consistently and promptly with complex environmental litigation. These specialised courts have been established in Bangladesh, India, Pakistan, Japan, China, the Republic of Korea, Malaysia, Thailand and the Philippines. The ECTs are expected to make fair and transparent decisions in the environmental and natural resource cases and promote a balance between the environment and development. In many countries, court rulings have contributed to enhanced implementation of environmental laws by penalising polluting industries and giving explicit directives to the government.

Beyond national governments, the private sector has an increasing role to play at national level, particularly in the areas of sustainable production and consumption. From helping to bridge the financing gap that exists globally, the sector has an immense role to play through creation of standards, efficient production processes, and certification, which is likely to be incrementally more effective in countries of North East Asia and Oceania (aligned with Global Technology pathway) and South East Asia (aligned with consumption change pathway). Likewise, civil society organizations can play an important bridge role in communicating the learnings from local level to national scale governance.

At the national scale, and for all subregions of the Asia-Pacific region, there is a need to strengthen knowledgebase on BES. Increased efforts towards implementing indicators that can assist in reflecting the implication of economic development on BES can assist in improving policymaking and programming. Improved attention to the estimation of inclusive wealth is a positive change in this direction (5.3.3.5). However, efforts are required for enhanced implementation of Green Accounting.

6.4.3.3 Local level actions

Governance options such as co-management and collaborative governance shall bear high relevance for South Asia and Western Asia wherein decentralised solutions are projected to secure the best possible future for biodiversity. While there is evidence of the increased role of local communities in the management of natural resources in the region, particularly forests, challenges related to genuine participation, decentralisation and providing adequate policy support would need to be addressed (Rasul & Karki, 2007). Human rights-based approaches can serve as an important part by strengthening shared and community governance models, providing opportunities for duty bearers and right holders to negotiate fair outcomes while also ensuring the protection of the rights of vulnerable communities and groups (also see section 6.4.1.4).

Local level actions in North East Asia and Oceania, wherein global technology pathway is likely to secure the best future for biodiversity, can benefit from governance options of fair and equitable sharing of benefit, complemented by the use of economic and financial instruments such as Payments for Ecosystem Services. Implementation, however, would need to be based on broader perspective, including consideration of poverty outcomes, and equity and fairness in the distribution of costs and benefits (Leimona *et al.*, 2015). In South East Asia, local level actions related to regulations, standards and certification are likely to complement the preferred pathway of consumption change. Investment into the development of consumer and producer market standards, product certification, sui generis protection systems, and sustainable supply chains bear increased prominence for this region (also see section 6.4.2.7).

Given the complexity in trends in drivers and their impacts on nature and NCP, the mechanism for learning from local level action to enable cross-sectoral and cross-scale integration in policymaking is crucial (Berkes, 2004). Integration local and traditional knowledge within the learning mechanism would help encapsulate the learnings within policy and governance processes. The role of civil society acquires significance at the local level, by enabling downscaling the global and regional thinking processes, as well as feeding back experiences into national scale governance mechanism (Frank *et al.*, 2007).

6.4.4 Policy instrument mix

Single policy instrument reliance may not be rewarding as every instrument has strengths and weaknesses. Therefore, the better strategy is to harness the strength of a policy instrument and offset its weakness by using a complementary policy instrument. A mix of suitable policy instruments is often needed, tailored to specific policy goals. But combinations of policies may have a variety of effects, not all of which are positive (Gunningham & Sinclair, 1999). Therefore, smart policy mixes use a variety of instruments which act together coherently to achieve intended outcomes. In this context, they offer the opportunity to address various ecosystem services and stakeholders at the same time. A mapping of instruments, mixes and mode of governance (Figure 6.9) affirms existing mapping be-tween instruments, policy options and governance modes, which is an opportunity for broad-basing these interlinkages to achieve a sustainable future for nature and NCP in the region. Policy mixes need to take into account all local actors (e.g. how they are impacted, what are their responses) and support as well as mobilise local leaders. This is possible by going beyond silo policymaking, in particular policies to protect BES need to come not just from the ‘environmental’ policymaking processes, but also from other sectoral policies such as fisheries, agriculture, forestry, energy, food and beverages, extractive industries, transport, tourism and health (TEEB, 2011). For example, wildlife poaching and trafficking is the result of a number of issues, including demand for wildlife or wildlife parts; low incomes leading to economic decisions to poach; ineffective border control and customs, enforcement, and penalties; and organized criminal groups. To effectively address poaching and trafficking, a policy mix would need to address all or a number of these issues, including educating consumers to decrease demand, educating communities where poaching is prevalent and introducing alternative livelihoods, building capacity for border control and customs, tightening enforcement and legislation, increasing penalties for poachers, and international collaboration to track down and prosecute criminal groups (Ariffin, 2015; Damania *et al.*, 2003; Verheij *et al.*, 2010).

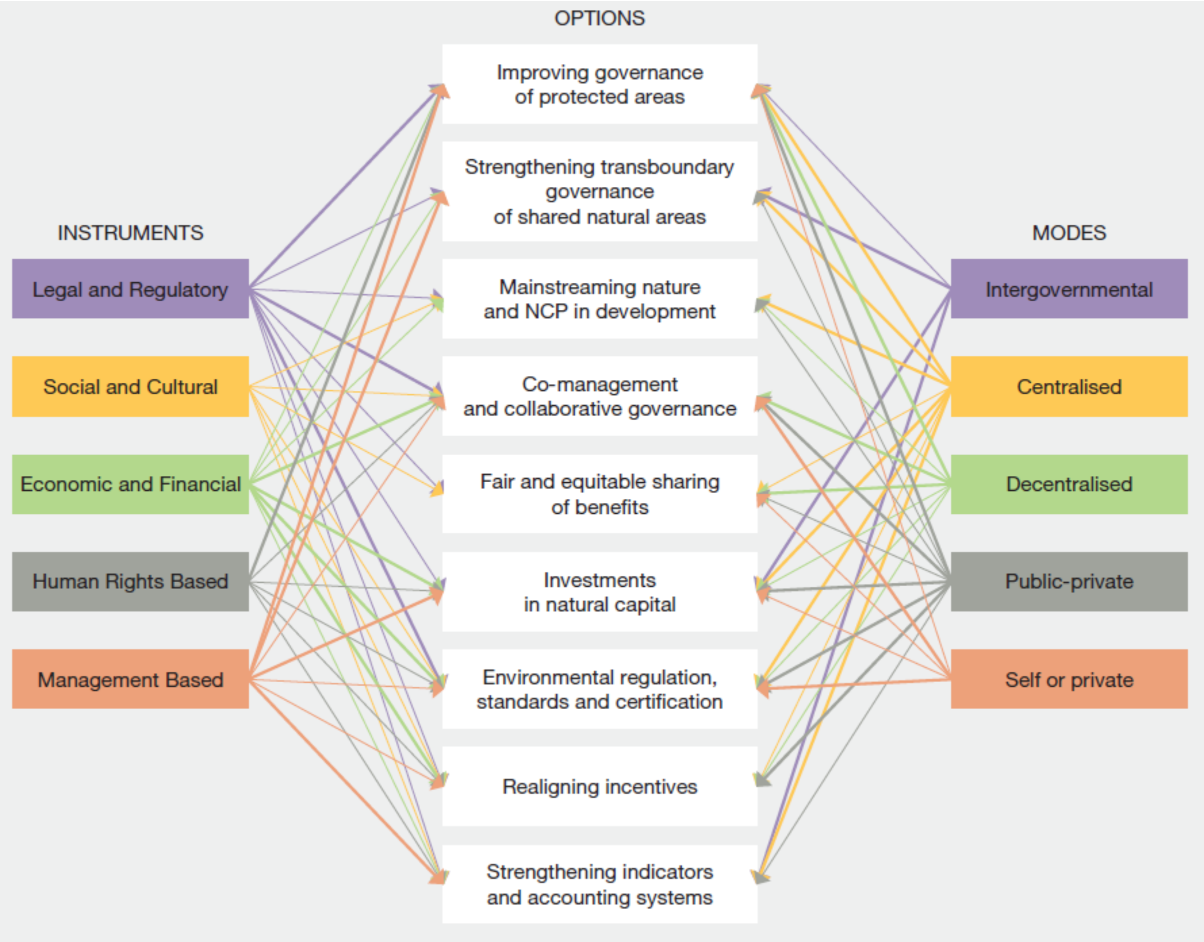


Figure 6.9 Policy instrument mix and governance modes for the governance options in the Asia-Pacific region
Note: Thicker arrows imply more extensive use of instrument and modes in the respective options.
Source: authors' assessment of governance options.

It is also crucial that policy mixes take into account local populations because certain policy instruments are insensitive to distributional concerns and may in some cases be socially regressive. Governments need to ensure that appropriate distributional measures are in place as part of the policy mix to counteract this (TEEB, 2009). One example of this would be the often discussed replacement of income tax with a carbon tax. While the former is considered socially progressive when higher income brackets pay a higher rate of tax, the latter could be socially regressive as it would raise prices on energy and goods for which lower-income households spend a higher percentage of their income. However, introducing policies that support lower-income households, e.g. through transfer payments, together with the change in tax regimes would alleviate or counteract the social regressiveness of a carbon tax policy (Morris & Munnings, 2013; Preston *et al.*, 2013).

As identified in this assessment, the Asia-Pacific region is facing a number of drivers of change including inter alia climate change, degradation and fragmentation of habitats, the introduction of invasive species, and pollution of soil, air, water, and rapid increase in demand for the commodities with the rapidly growing middle class. Policy instruments only targeting biodiversity conservation are not enough multifarious considering aspect of direct and indirect drivers. Regional, national and sub-national level policy initiatives are needed to prevent the destruction of biodiversity due to direct and indirect drivers.

In addition to policy instruments discussed above, well-targeted investments in BES, such as the establishment of protected areas and restoration of degraded landscapes, can provide high rates of return and deliver co-benefits (e.g. to livelihoods, tourism and climate change mitigation and adaptation). In particular, to combat vulnerability to climate change impacts, investing in ecosystems that deliver resilience, such as protection from storms, floods and droughts would in many cases be cheaper than investments in grey infrastructure for equivalent services (TEEB, 2011, Chapter 10). One example of this is the demarcation of 100 hectares of expected reclaimed land as protected area for mangrove forest in Demak, Central Java. The area had faced severely eroding coastlines and land subsidence, for which the building of seawalls and wave barriers had failed to address. A group of organizations led by Wetlands International introduced the concept of “Building with Nature” which involved the use of permeable dams to break waves and trap sedimentation, allowing land reclamation and eventually the recolonisation of the area by mangrove forests for protection against erosion, seawater intrusion, and coastal flooding. The project also aims to enhance production from sustainable aquaculture for the local community (Tonnejick *et al.*, 2015; Wetlands International, 2015).

The right policy mixes for each nation would depend on each country’s local context. Governments are encouraged to review their local context through two steps (TEEB, 2011, Chapter 10):

- How ecosystem services relate to their economic growth, employment, and prosperity, and the risks associated with their loss; and
- Evaluate current policies to reveal contradictions (e.g. subsidies which incentivise harmful behaviour) and identify potential improvements.

Economic insights from national assessments can help identify which economic instruments are more likely to create cost-effective solutions as well as support the design of policy implementation, e.g. if damage costs are high, this suggests penalties could also be high, and may also suggest a greater allocation of funds for enforcement and monitoring, depending on the local context (TEEB, 2011), Chapter 7). Involving local stakeholders can also help with developing effective policies because they often have access to information or expertise not available to the general public. Moreover, they stand to win or lose the most from policy changes. They can play a central role in setting policy targets and implementing concrete solutions (TEEB, 2010).

6.5 Achieving Aichi Biodiversity Targets

In 2010 the Strategic Plan for Biodiversity 2011-2020 was agreed upon in the tenth conference of parties of the Convention on Biological Diversity, which stipulates twenty Aichi Biodiversity Targets with a view to achieving its vision for “*Living in harmony with nature, where, by 2050, biodiversity is valued, conserved, restored and wisely used, maintaining ecosystem services, sustaining a healthy planet and delivering benefits essential for all people*” (UNEP/CBD/COP/DEC/X/2). The fourth Global Biodiversity Outlook (GBO-4) (SCBD, 2014) conducted an interim review on the progress towards the Aichi Biodiversity Targets, which indicated that most of the Aichi Biodiversity Targets are not likely to be met by 2020 under the current trajectories. The regional chapters of GBO-4, i.e. for Asia and the Pacific (UNEP-WCMC, 2016a) and for Western Asia (UNEP-WCMC, 2016a), identified regionally specific trends and challenges, including declining biodiversity and natural habitats especially in tropical forests, associating with increasing production and consumption, unsustainable harvest of forest and marine resources, as well as with deteriorating eutrophication, alien species invasion and other threats to vulnerable ecosystems. Table 6.5 presents more detailed assessment on the progress towards twenty Targets clustered under five strategic goals, for five subregions in the Asia-Pacific region, referring to the contents of the earlier chapters and sections of the current assessment, datasets on IPBES’s core indicators, as well as to the two GBO-4 regional chapters. Major challenges, ongoing policy responses and future opportunities for each strategic goal are presented below:

Strategic goal A: Address the underlying causes of biodiversity loss by mainstreaming biodiversity across government and society

BES conservation objectives are increasingly integrated into overarching development framework of the countries through formulating and enacting national green growth policies, as well as into sectoral policies such as payments for ecosystem services (PES) in North East Asia and South East Asia, REDD-plus in South East Asia and South Asia, as well as biodiversity offsets in North East Asia, South Asia and Oceania. National initiatives to engage business sector are slowly emerging, such as IBBI in India and JBIB in Japan. Urban planning in the Asia-Pacific region increasingly takes into account NCP provided by urban ecosystems, in some cases with a view to attracting international recognition and business investments. Sustainable consumption and production has become widely promoted through voluntary sustainability standards or national policies, with some successful cases in PEFC and FSC certifications in North East Asia and Oceania, national forest certification in Oceania, North East Asia and South East Asia, as well as green public procurement in North East Asia, South East Asia and Oceania. However, several challenges remain such as continued agriculture subsidies harmful to biodiversity. Ecosystems cannot be kept within safe ecological limits with increasing consumption patterns. Future opportunities include:

- Realignment of incentives in various means, e.g. through integrating agroforestry in REDD-plus to achieve carbon and rural livelihood benefits;
- Clarification of the benefits from ecosystems for justifying PES schemes;
- Urban planning that integrate urban ecosystems in which nature and NCP are maintained and further enriched;
- Integrated policies covering positive and negative incentives and engaging all relevant stakeholders; and
- Partnership among companies and industry associations, civil society and governments to promote sustainable practices.

Strategic goal B: Reduce the direct pressures on biodiversity and promote sustainable use

Policy instruments focused on land use and land cover changes (LULCC) have become common, including national forest restoration programmes in South East Asia, South Asia, and Western Asia. Policies in Western Asia place particular emphasis on the benefits of forest protected areas for socio-cultural resilience. Yet, driven by growing regional and global populations and economies, unsustainable practices in agriculture, aquaculture, and forestry continue to deteriorate nature and NCP. Sustainability-certified forestry and agriculture are picking up in the region but insufficient to reverse the trend. Uncontrolled fisheries continue, with 3.36 per cent of total fish catch in the Asia-Pacific region certified by MSC. Subregional conventions are in place in South East Asia, South Asia, Western Asia and Oceania for abating transboundary air pollution and the pollution of transboundary waterbodies, and thereby for safeguarding critical ecosystem services. Overall rate of the spread of invasive alien species shows no sign of slowing, despite the increasing number of countries, particularly in Oceania, that have taken preventive measures. Multiple land and marine based pressures, including eutrophication, continue to deteriorate vulnerable ecosystems including coral reefs. Future opportunities include:

- Strengthening governance and reinforcing economic incentives for putting LULCC policies down to the ground;
- Better recognition of the critical importance of sustainable agriculture for maintaining and building natural capital beyond productivity, including social and environmental aspects;
- Financial conservation incentives, such as those exemplified by, among others, PES in India and payment transfer in China;
- Strengthening border control or quarantine measures to prevent the introduction of invasive alien species; and
- Integrated management of fisheries, coastal zones, and inland watersheds.

Strategic goal C: Improve the status of biodiversity by safeguarding ecosystems, species and genetic diversity

Protected area coverage has increased particularly in North East Asia in pace to achieve Target 11, while the effectiveness of protected areas for BES conservation depends on country and local circumstances. Co-management and collaborative governance are recognised effective for protected area management. Policies for co-management and collaborative governance are found in North East Asia, South Asia and Oceania, with some successful cases. UNESCO BIRUP (Biosphere Integrated Rural Urbanisation Programme) in North East Asia emerged as a useful mechanism for land management around protected areas. The Indigenous People's and Community Conserved Territories and Areas (ICCAs) and the recognition of Sacred Natural Sites (SNSs) are upscaling throughout the Asia-Pacific region. Transboundary collaboration among the countries that share important species and areas is accelerating. However, the evidence on the effectiveness of protected areas and other area-based measures, such as those referred to here, to halt rapid biodiversity loss deriving from strong socio-economic drivers in the region are yet piecemeal. The Management Effectiveness Evaluation (MEE) tool, provided by IUCN-WCPA, can help assess protected area management effectiveness, as demonstrated in tiger reserves in India. Genetic diversity of domesticated livestock continues to be eroded, and the wild relatives of domesticated crop species are kept under threat. Future opportunities include:

- Further strengthening of protected area management and other effective area-based conservation measures[75] through, among others, upscaling and sharing good practices in co-management and collaborative governance across scales and sectors;
- Adaptive management of protected areas supported by periodical measurement using, for example, MEE;
- Incentivise for local stakeholders by fully taking into account the importance of BES in their specific socio-cultural context; and
- Policies, including incentives, to promote the conservation of local varieties of crops and livestock breeds in production systems.

Strategic goal D: Enhance the benefits to all from biodiversity and ecosystem services

Efforts have been made to enhance the recognition and to safeguard nature and NCP. Satoyama Initiative is one of such efforts that have captured reciprocal benefits between people and nature rooting in the experiences in various landscapes and seascapes in the region and beyond. Agroecosystems provide several essential services but are not appropriately protected under legal and regulatory framework. The wise use approach of Ramsar Convention is widely taken by countries for wetland protection in the Asia-Pacific region, which highlights the compatibility of human use the conservation of wetlands. In the face of exacerbating natural disaster risks especially in South Asia and South East Asia, the role of sustainable forest management and agroforestry to mitigate flood risks is now well understood. Successful grazing land management cases are found, including the one in Australia through PES scheme. Engagement of landowners is imperative for ecosystem restoration in the Pacific, where community land ownership is predominant. Since its enactment in 2014, several the Asia-Pacific region countries developed national policies and mechanisms for the implementation of the Nagoya Protocol, while challenges remain for other countries in complying with the ABS provisions of CBD. Future opportunities include:

- Incentives for nature-symbiotic agriculture and silviculture, including agroforestry, that generate multiple NCP including flood regulation;
- Promote co-management and shared governance in which tenure and management rights of, and fair and equitable benefit sharing for indigenous people and local communities are ensured;
- Economically viable restoration activities coupled with employment and income generation;
- Stronger leadership and governance to ensure fair and equitable benefit sharing, with regard to the implementation of REDD-plus safeguards and ABS provisions; and
- Clear incentives for private sector to enter into legal contracts to regulate ABS

Strategic goal E: Enhance implementation through participatory planning, knowledge management and capacity building

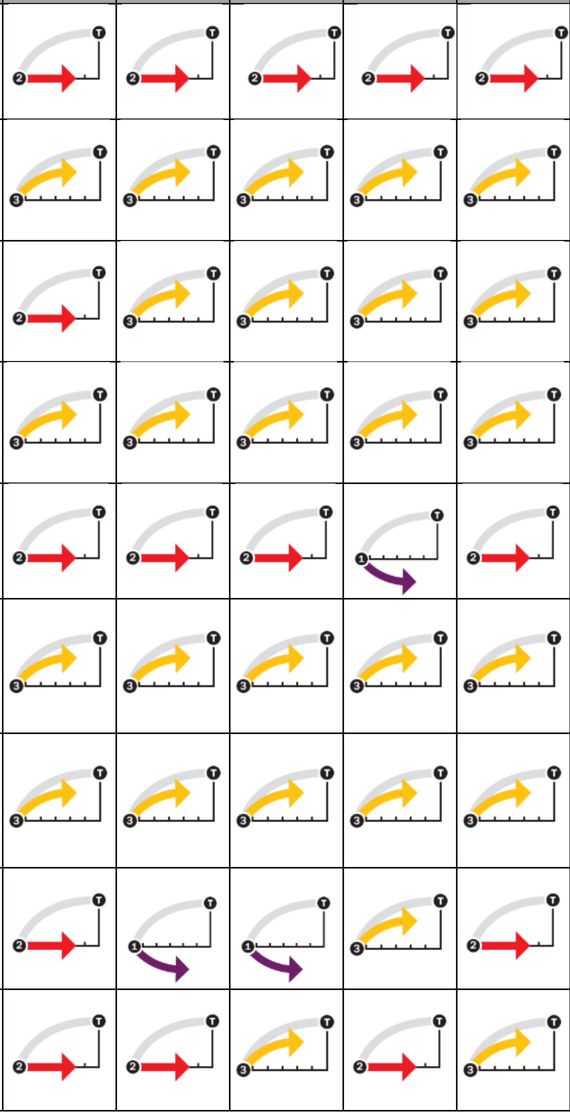
[75] Defined as "*A geographically defined space, not recognised as a protected area, which is governed and managed over the long-term in ways that deliver the effective and enduring in-situ conservation of biodiversity, with associated ecosystem services and cultural and spiritual values*" in (IUCN, 2017)

Increasing number of countries in the Asia-Pacific region have formulated or updated NBSAPs in pace to achieve Target 17, while its effective implementation remains a major challenge. Traditional knowledge is declining. IPLC's aspiration for control over their traditional territories is incorporated in UN Declaration on the Rights of Indigenous People. This, and accumulated body of knowledge on IPLCs as nature custodians, have assisted in upscaling Community Conserved Territories and Areas (ICCAs) and increasing the recognition of sacred natural sites (SNSs) as "other effective area-based conservation measures" throughout the Asia-Pacific region (see section 6.4.1.4). Examples include environmental law component of ADB Coral Triangle Pacific Project; and Indigenous Protected Area (IPA) programme in Australia. REDD-plus Safeguards require respecting IPLC's knowledge and rights. Relevant national legislations are in place in South East Asia. Regional and national initiatives for BES knowledge sharing are growing, such as Asia-Pacific Biodiversity Observation Network (AP-BON), J-BON (Japan) and K-BON (Korea). Now global total investments for the achievement of the Aichi Targets fall short by fivefold, 80 per cent of which come from national budget allocations, ODA and debt-for-nature swap. National investments in BES conservation have become prevalent, including those in afforestation for combatting desertification in Western Asia. Future opportunities include:

- Supporting countries to update and implement NBSAPs in various ways, e.g. reflecting NBSAP in the national and sub-national policies of relevant sectors, as well as facilitating the formulation of Local Biodiversity Strategies and Action Plans (LBSAPs);
- Initiatives to support traditional and local knowledge and to promote customary sustainable use;
- Improving access to and capacity for mobilising data and information to strengthen science underpinning of policymaking and implementation; and
- Five new areas can be sought for additional fundraising including, but not limited to, PES, biodiversity offset, green products, public-private partnership, and charities, as well as international finance.

Table 6.5 Progress and policy options towards achieving the Aichi Biodiversity Targets in the Asia-Pacific subregions

Aichi Biodiversity Targets		Progress					
Strategic Goal	**Target**	**Western Asia**	**South Asia**	**North East Asia**	**South East Asia**	**Oceania**	**Indicator /references[76]**
A. Address the underlying causes of biodiversity loss by mainstreaming biodiversity across government and society	1. Awareness of biodiversity increased						L (UNEP-WCMC, 2016a, 2016b)
	2. Biodiversity values integrated						C 6.2.2.1; 6.4.1.3; 6.4.4.3[77]; L (UNEP-WCMC, 2016b, 2016a)
	3. Incentives reformed						C 6.4.1.3; 6.4.2.8; [78]; L (UNEP-WCMC, 2016b, 2016a)
	4. Sustainable production and consumption						I Ecological Footprint, FSC/PEFC Certified Forest Management Area; L (Lernoud *et al.*, 2015)[79]
B. Reduce the direct pressures on biodiversity and promote sustainable use	5. Habitat loss halved or reduced						C 3.2.1.1; L (UNEP-WCMC, 2016b, 2016a)[80]
	6. Sustainable management of marine living resources						I MSC Certified Catch; C 4.6; 6.2.2.1; 6.2.3.1[81]
	7. Sustainable agriculture, aquaculture and forestry						I FSC/PEFC Certified Forest Management Area; nitrogen use efficiency[82]; C 4.6; 6.2.2.1; L (Lernoud *et al.*, 2015)
	8. Pollution reduced						I Nitrogen Deposition Index; C 6.2.1
	9. Invasive alien species prevented and controlled						C 4.1.4; 4.6; 6.2.2.1; L (UNEP-WCMC, 2016b, 2016a)



[76] Relied on the best available sources for assessing the progress towards each target in each subregion from: I IPBES core indicators; C cross-referencing the current Asia-Pacific Regional Assessment; and L literature (mainly from the regional chapters of Global Biodiversity Outlook 4 (UNEP-WCMC, 2016b, 2016a)

[77] Subregions in which successful cases in integrating biodiversity values into policies or sectors are found are rated as "Progress, but at an insufficient rate", while quantitative data to assess the progress towards Target 2 are generally lacking.

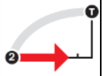
[78] While the GBO4 regional chapters rated "no significant overall progress", subregions in which dedicated efforts for reforming incentives for the conservation and sustainable use of BES are rated "Progress, but at an insufficient rate".

[79] In addition to the subregions rated relatively higher by the IPBES core indicators, i.e. smaller footprint and larger FSC/PEFC certified forest management area, those including the countries ranked within top 10 regarding the area certified under voluntary sustainability standard initiatives are rated "Progress, but at an insufficient rate". It should be noted that separating the production and consumption sides likely to produce different results.

[80] While forest cover is increasing, or forest loss has been halted, in four subregions except for SE Asia, GBO 4 regional chapters indicate that the trends in habitat loss have not yet been reversed.

[81] Subregions with the countries in which national policies or local actions towards sustainable fisheries are in place are rated as "Progress, but at an insufficient rate", while quantitative data to assess the progress towards Target 7 are generally lacking.

[82] The Indicator on nitrogen use efficiency does not significantly influence the assessment on the progress towards Target 7, as the value stayed almost stable except for slight increase in efficiency in SE Asia and decrease in NE Asia, which are in line with the trends in the FSC/PEFC Certified Forest Management Area in these two subregions.

	10. Pressures on vulnerable ecosystems reduced						C 3.2.3.5; 4.4.8[83]; 4.6; L (UNEP-WCMC, 2016b, 2016a)
C. Improve the status of biodiversity by safeguarding ecosystems, species and genetic diversity	11. Protected areas increased and improved						I species protection index; protected area surface coverage and KBA coverage; C 6.2.1, 6.4.2.1, 6.4.4.2; L (Leverington *et al.*, 2010)
	12. Extinction prevented						I Red List Index; L (UNEP-WCMC, 2016b, 2016a)[84]
	13. Genetic diversity maintained	Insufficient data to assess progress					I Local breeds at risk of extinction)[85]; L (UNEP-WCMC, 2016b, 2016a)
D. Enhance the benefits to all from biodiversity and ecosystem services	14. Ecosystems and essential services safeguarded						C 2.3.2[86]; 2.3.3.4; 3.2.5.6; 6.2.1; 6.2.2.1; 6.4.2.1; L (UNEP-WCMC, 2016b, 2016a)[87]
	15. Ecosystems restored and resilience enhanced				Insufficient data to assess progress	Insufficient data to assess progress	C 2.3.2[88]; 6.4.2.6; L (UNEP-WCMC, 2016b, 2016a)
	16. Nagoya Protocol in force and operational						C 6.4.2.5; L Parties to the Nagoya Protocol (CBD Secretariat, 2017)
E. Enhance implementation through participatory planning, knowledge management and capacity-building	17. NBSAPs adopted as policy instruments						I Countries with NBSAP; L (UNEP-WCMC, 2016b, 2016a)[89]
	18. Traditional knowledge respected						C 2.3.2[90] ; 3.2.5; 6.2.3.2; 6.4.1.4; L (UNEP-WCMC, 2016b, 2016a)

83 These sections, while describing general trends of and threats to vulnerable coastal ecosystems including coral reefs, provide limited quantitative data disaggregated to each subregion.

84 Whereas the Red List Index indicates downward trend of species extinction risk for the Asia-Pacific region, the assessment here referred to the results shown in the GBO4 regional chapters which referred to multiple sources including the Red List Index

85 Whereas the data on an IPBES core indicator on local breeds at risk of extinction is available, it only shows the snapshot of extinction risk as of 2016 but not the trend of the changes in extinction risks.

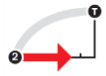
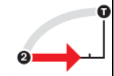
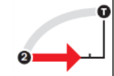
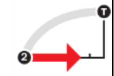
86 Whereas quantitative data are not available, subregions in which successful cases in safeguarding ecosystems and essential services are presented in earlier chapters or the regional chapters of GBO4 are rated “Progress, but at an insufficient rate”

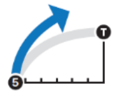
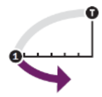
87 GBO4 regional chapters pointed insufficient data for assessing Target 4. The presentation of the assessment results is likely to be changed after Ch2’s work on the new table on spatial and temporal spread of economic values.

88 Whereas quantitative data are not available, subregions in which successful cases in restoring ecosystems and thereby enhancing their resilience are presented in earlier chapters or the regional chapters of GBO4 are rated “Progress, but at an insufficient rate”

89 All CBD parties in the Asia-Pacific region are projected to complete the formulation of NBSAPs by 2020, but the number of post-2010 NBSAPs remains 24 as of March 2017

90 Whereas quantitative data are not available, subregions in which cases of the contributions of traditional knowledge and practices to conserving and sustainably using biodiversity, and where possible their recognition in government policies, are presented in earlier chapters or the regional chapters of GBO4 are rated “Progress, but at an insufficient rate”

	19. Knowledge improved, shared and applied						I species status information index[91]; C 6.2.1; 6.2.2.2; L UNEP-WCMC, 2016a, 2016b)
	20. Financial resources from all sources increased	Insufficient data to assess progress					C 6.2.2.2; L (UNEP-WCMC, 2016b, 2016a)

				
On track to exceed target	**On track to achieve target**	**Progress, but at an insufficient rate**	**No significant overall progress**	**Moving away from target**

6.6 Achieving SDGs: synergies and trade-offs

The 2030 Global Agenda known as Sustainable Development Goals (SDGs) provides a basic framework for sustainable development, in which 17 goals and 169 targets are provided encompassing social, economic and environmental aspects of sustainable development. Compared to the previous Millennium Development Goals (MDGs), the SDGs has significantly enhanced consideration of environmental concerns into post 2015 development agenda and thereby may provide an effective impetus towards objectives of major biodiversity related conventions such as CITES, CBD, UNFCCC, UNCCD, CMS, and the Ramsar Convention. The key feature of SDGs for their implementation is to follow bottom-up approach, in which countries select their own targets, strategies and reporting mechanisms based on their priorities and capacities. However, it would create new challenges for countries to establish not only their own targets, but also necessary policies and institutional frameworks for achieving those targets (Jungcurt, 2016).

In line with the SDG Target 17.14 "*Enhance policy coherence for sustainable development*", and for efficient implementation of SDGs cutting across several sectors, a number of studies highlighted the need for integrative approaches to SDGs implementation. De Franco, Torres and Madrid (2014), based on an analysis on the linkages of SDGs and BES, draw a pyramid diagram where BES-related SDGs (14, 15) combined with goal 17 form foundations for other goals such as sustainable consumption and production (Goals 7, 9, 11, 12, 13), inclusive economic growth (Goals 8 and 10) and human dignity (Goals 1, 2, 3, 4, 5, 6, and 16). Rockström and Sukhdev (2016) proposed "the wedding cake" diagram which illustrated food as central to all other SDGs, and biosphere, including goals 6 (water), 13 (climate), 14 (life below water) and 15 (life on land) constitute the foundation for other goals. UNESCAP (UNESCAP, 2017) and Zhou and Moinuddin (2017) looked at the SDGs interlinkages centring on water (Goal 6). Niestroy (2016) clustered SDGs into three concentric circles where well-being (SDGs 1, 3, 4, 5, 10) was placed at centre and natural environment (SDGs 13, 14 and 15) in the outer circle. These mostly placed BES-related goals (SDGs 14 and 15) as the basis for, or at peripheral of other sets of goals. Some focused on quantitative network analysis to identify which SDGs and targets are interlinked and how, and others tried to build conceptual model to explain how SDGs can be clustered and interlinked through theoretical works.

Figure 6.10 gives more detailed picture on how BES objectives are interlinked with non-BES SDGs (i.e. other than SDGs 14 and 15) based on the facts found mainly in the Asia-Pacific region. These facts were identified by a review of academic literature and earlier chapters of the current assessment,

[91] Species status information index is a sole quantitative dataset available for assessing the subregional progress against Target 19, but species status information only captures one of several aspects of the Target. Thus the assessment here took into account qualitative and anecdotal description presented in the reginal chapters of GBO4.

labelled with NCP (nature's contributions to people), DD (direct drivers), ID (indirect drivers) and OF (other facts) in accordance with the IPBES Conceptual Framework, and mapped in a spectrum between synergy and trade-off between BES and non-BES SDGs. The scope of the facts presented here includes the possible by-products in an effort to accomplish non-BES goals/targets, e.g. increasing agricultural production causes biodiversity loss. The table demonstrates that synergies are mostly associated with NCP, and trade-offs frequently are with direct and indirect drivers. The table, although far from exhaustive, implies that BES goals can be the best accomplished under SDGs by moving away from right to left of the table, i.e. when the efforts towards non-BES SDGs reinforce NCP and minimise the indirect and direct drivers. On this basis, narratives on the nature of the linkages, as well as the directions towards reinforcing the synergies between BES and non-BES SDGs are presented below:

SDG 1: *Globally and in the Asia-Pacific region, people's income level tends to be low in the areas rich in biodiversity, and where people depend more on BES for income and risk insurance (well established). BES continue being overexploited, or poverty continues with protected biodiversity, without conserving BES and ensuring resource access by those dependent on BES. Poverty eradication and BES conservation can be compatible through various intervention options, such as community-based natural resource management, Indigenous Protected Areas (IPA), and community-based ecotourism.*

SDG 2: *In the Asia-Pacific region approximately 481 - 579 million people directly depend on nature for food and livelihoods. Healthy BES underpin sustainable and productive agriculture. Various traditional agriculture landscapes found throughout the Asia-Pacific region provide cradles of many local crop and livestock varieties (well established). Agriculture intensification increases crop yield, but with indiscriminate agrochemical inputs, sacrifices BES beyond food production (well established). Integrated Pest/Nutrient Management (IPM/INM), agroforestry and sustainable pastoralism, among others, can arbitrate the trade-offs. Traditional sustainable agricultural systems practiced by IPLCs in the Asia-Pacific region can be revisited to reinforce reciprocal benefits to nature and agriculture.*

SDG 3: *Healthy BES are essential for human health in diverse aspects, e.g. clean air and water provision, diverse and nutritious dietary sources, pharmaceutical genetic resources, human immunity development, regulation of pests and pathogens, as well as interactions with nature that improve psychological and physical health (well established). "One-Health" approach, an integrative approach to human-animal-ecological health interactions, was introduced to the Asia-Pacific region. ASEAN Agreement on Transboundary Haze Pollution is in force to tackle the connection between forest/land fires and their human health impacts.*

SDG 4: *Higher education background improves people's support to BES conservation. BES provide opportunities for humans to acquire knowledge and to develop skills that help human society to prosper (well established). Several natural sites in the Asia-Pacific region are used for education and nature-based tourism. Community schools set up by some indigenous communities in South East Asia help hand down to younger generations the traditional knowledge that is central to sustainable agriculture and landscape management, and also improve education access in remote areas.*

SDG 5: *Women and girls play key role to maintain agrobiodiversity that underpin food and livelihood security in South East Asia and Western Asia. Women in Pacific islands have important role to support sustainable fisheries through their engagement in early childhood development when children's moral and cultural norms are formed (established but incomplete).*

SDG 6: *Water security, a concept that encompass water quantity, quality and functioning water system, in the Asia-Pacific region is supported by a rich mix of different ecosystem types including forests, grasslands, wetlands, cultivated areas and terrestrial waterbodies (well established). Degradation of watershed ecosystems, as well as over-extraction and poor management of surface and ground waters seriously undermine water security (well established). Payments for Ecosystem*

Services (PES), is increasingly used for incentivising watershed protection by upstream communities and thus for ensuring downstream water security.

SDG 7: *The heavy reliance of the poor on biomass fuel for household energy consumption, largely due to limited energy access, leads to forest biomass overexploitation. The Asia-Pacific region boasts large untapped potential for hydropower development. Watershed forests prevents soil erosion and downstream sedimentation, and thereby contribute to the longevity of reservoirs and hydropower facility. Biofuel energy is another potential source for increasing power supply (well established). Large scale hydropower development impacts river ecosystems, and expanding biofuel crop production compete for lands with forests and food production (well established).*

SDG 8: *Conservation awareness penetrates along globalisation and increased state revenue strengthens BES conservation. Beautiful natural scenery and wildlife attract tourists who bring economic opportunities (well established). Large-scale land investments, e.g. for plantation, mining and tourism, while creating job opportunities, can negatively affect forests and water resources. Increased income changes consumption volumes and patterns, and thereby multiplies pressures on BES (well established). Under this backdrop, countries in the region are taking initiative to integrate NCP into development through green growth policies especially in South East Asia.*

SDG 9: *Infrastructure development can negatively affect BES when poorly planned (well established). "Green infrastructure", a concept which takes into account the complementarity between the functions of built infrastructure and ecosystem functions for enhanced resilience, was recently introduced to the Asia-Pacific region.*

SDG 10: *Local stakeholders' participation and fair and equitable benefit sharing are imperative for the success of community-based natural resource management and community-based ecotourism. The Nagoya Protocol represents multilateral legal instrument to ensure equity concerning the use of genetic resources.*

SDG 11: *Rapid urbanization in the Asia-Pacific region impacts BES through land conversion, hydrological cycle changes, as well as the changes in lifestyles and consumption patterns (well established). Urbanisation however can be a sustainability solution through concentrating industry, trade, transport, health care, education and pollution treatment in relatively small areas (well established). Urban ecosystems are increasingly integrated into urban planning in several the Asia-Pacific countries with explicit recognition of NCP. Cultural and natural heritages in the Asia-Pacific region are increasingly recognised and conserved, with 332 UNESCO World Heritage sites inscribed.*

SDG 12: *Increased cash crop production and natural resource extraction, as well as the rapid urbanization coinciding with changing food habits, material uses, and leisure preferences, increasingly affect BES in the region (well established). Voluntary sustainability standards (VSS) and green public procurement, among others, have become common instruments.*

SDG 13: *Climate change affects BES, and ecosystem functions mitigate climate change and its impacts (well established). The massive expansion of biofuel crop production for renewable energy can significantly undermine BES sustainability and food security (well established). Ecosystem-based mitigation and adaptation measures became increasingly available, including REDD-plus, EbA and Eco-DRR, while their climate and BES outcomes are not yet well documented.*

SDG 16: *Unclear land tenure, weak governance, corruption, political unrest and local conflicts exacerbate land degradation and resource overexploitation. Competition for scarce resource sometimes triggers conflicts (established but incomplete). Devolution of and enhanced local participation in decision-making improve conservation outcomes in some cases through, for example, community-based natural resource management, co-management, collaborative governance, ICCAs and IPAs, in which local institutions and customary laws play pivotal roles in BES governance. Multi-stakeholder collaboration in conservation movement can assist peace building and stability.*

SDG 17: *Global partnership, technology and finance, among others, constitute critical enabling environment for acting on BES sustainability: Regional and transboundary collaboration between the countries which share important species, areas or issues became strengthened; Biotechnology is a key contributor to food and environmental security, human health and BES conservation; Information and knowledge sharing platforms have become increasingly available and play key role in raising public awareness on environmental issues; Achievement of the Aichi Biodiversity Targets requires the amount of investment five times more than the current one.*

Taking into account the synergistic linkages between BES and non-BES goals as illustrated in Figure 6.10, there are increasing number of initiatives that take ecosystem-based integrative approaches to multiple objectives related to different SDGs. Box 6.27 presents a few examples of such initiatives in the Asia-Pacific region. A robust strategy for ecosystem-based integrative approach to multiple SDGs can be established upon the experiences from such examples, with a clear view to addressing specific SDGs, targets, and indicators for reinforcing the integration of BES goals into actions under the SDGs framework.

Figure 6.10 Synergies and Trade-offs between BES-related goals and other SDGs

SDGS AND TARGETS COHERENT TO BES SUSTAINABILITY	SYNERGY		TRADE-OFF
1 End poverty in all its forms everywhere *–1.4 "… ensure that all men and women, in particular the poor and the vulnerable, have equal rights to economic re-sources, as well as access to basic services, ownership and control over land and other forms of property, inheritance, natural resources, …"*	NCP 9, 12, 13, 14 Higher dependency of the poor on biodiversity for income and risk insurance (Roe, 2010) (GL, SA, EA, SEA) NCP 16 Interventions for BES conservation, e.g. ecotourism development, can benefit poverty reduction (Roe, 2010) (GL, SA, EA, SEA) OP Community-based natural resource management (CBNRM), Indigenous Protected Area (IPA) (Australia) and the likes as an approach to linking community rights and livelihood with conservation, which saw some successful cases. REDD+ Safeguards stipulate conditions relating to human rights, such as respect for the knowledge and rights of IPLCs (6.2.3.2, 6.4.1.2, 6.4.1.4). (APR)	OF The global spatial co-occurrence of biodiversity and poverty hotspots (Fisher & Christopher, 2007). OF Poverty can affect BES, and changes in BES or policies for BES conservation can positively or negatively affect poverty (W. M. Adams et al., 2004; Agrawal & Redford, 2006; Turner et al., 2012).	ID Current economic development, while bringing people up from 'poverty' to 'adequate food and clothing', tend to sacrifice environmental quality (Hubacek, Guan, & Barua, 2007) (APR) ID Agricultural expansion for meeting food security contribute to poverty reduction. Technological innovation enhances food productivity but increases unemployment in rural agricultural sector (Dijk, Rooij, & Hilderink, 2014) (SEA) OF Eviction of indigenous/local people for gazetting protected areas (Colchester, 1994, pp 25-42) (GL, SA, SEA)
2 End hunger, achieve food security and improved nutrition and promote sustainable agriculture *–2.4 "ensure sustainable food production systems and implement resilient agricultural practices …, that help maintain ecosystems, …"* *–2.5 "maintain the genetic diversity of seeds, cultivated plants and farmed and domesticated animals and their related wild species"*	NCP 1 Some traditional agricultural practices help maintain ecosystems and wild/domesticated species (Bruun, de Neergaard, Lawrence, & Ziegler, 2009; Kehlenbeck & Maass, 2004; Jeffrey A. McNeely & Schroth, 2006) (also see 2.3.2) (NEA, SEA, GL) NCP 2 Dependence of food crop production on animal pollination (Potts et al., 2016) (GL) (Also see Table 2.3.3 (2.3.3.4)). Economic value of pollination and seed dispersal by animals in APR is provided in Table 2.3.3 (2.3.3.4) NCP 2, 4, 6, 8, 9 Healthy BES underpin sustainable and productive agriculture, e.g. through water and nutrients supply, pollination, climate regulation, and disaster risk reduction (Romanelli & Cooper, 2015) (also see 2.3.2) (SEA, GL) NCP 8 Soil retention (2.3.2) (NEA). Monetary value of ecosystem's functions to form, protect and decontaminate soils and sediments in APR is provided in Table 2.3.3 (2.3.3.4) NCP 10 The regulation, by ecosystems or organisms, of pests, pathogens, predators, competitors, etc. that affect humans, plants and animals in APR (monetary value is pro-vided in Table 2.3.3 (2.3.3.4)) NCP 12 Direct dependence of the poor on nature for food and livelihoods, being estimated between 481 and 579 mil-lion (2.4.1.3) (APR). APR as the world's largest marine and freshwater fish producers (2.3.2, 2.4.1.3) (APR). Monetary value of the production of food from wild, managed or domesticated organism across various ecosystems in APR is provided in Table 2.3.3 (2.3.3.4)). NCP 12 Agrobiodiversity contributes to sustainable agricultural pro-duction and also to biodiversity conservation (Thrupp, 2000) (also see 6.2.2.1) OP Opportunities with integrated pest management (IPM), integrated nutrient management (INM) and other agroecosystem centred approach to improve the stock and use of natural capital (Pretty, 2008) OP Sustainable pastoralism and rangeland biodiversity conservation are mutually reinforcing (Foggin, 2016) (NEA); land productivity in desert ecosystem exclusively relies on bio-logical resources (J. A. McNeely, 2003)		DD Competition over agricultural land, e.g. expanding palm oil production can undermine food-security, and also replaces forests (Koh & Ghazoul, 2010) (SEA) DD Agricultural intensification and infra-structure expansion … led to significant LULCC in rural areas (4.4.1, 4.2.2 and 4.4.5) (also see SCBD, 2014) (APR) DD Agricultural activities cause serious soil degradation (4.1.3) (SA, SEA) DD Livestock overgrazing cause land degradation across APR, leading to soil erosion, degradation and salinization and biodiversity decline (4.1.2) (APR) DD Overexploitation of non-timber forest products (NTFPs) pose significant pressures on these natural resource bases (4.1.2) (APR) DD Overfishing led to the reduction of biomass of target and by-caught species (4.1.2) (APR) DD Aquaculture development in APR impacts freshwater and coastal ecosystems through introducing invasive alien species, diseases and pollution (4.1.2) (APR) DD Water pollution caused by agriculture runoff (4.1.3, 4.4.5, 4.4.7)
3 Ensure healthy lives and promote well-being for all at all ages *–3.9 "… substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination"*	NCP 2, 3, 6, 7, 8, 12, 14, 16 BES provide clean air and water, support agricultural production, supply diverse and nutritious dietary sources and pharmaceutical components, help develop human immunity and contribute to human mental and physical health (Alves et al., 2007; Romanelli & Cooper, 2015) (also see 2.3.2) (SEA, GL) NCP 3 Ecosystem's function to clean air in APR (monetary value provided in Table 2.3.3 (2.3.3.4) NCP 10 Pathogen spread risks associated with ecosystem changes and biodiversity loss (Epstein, 1995; Morand et al., 2014) (GL, APR). The monetary value of the regulation, by ecosystems or organisms, of pests, pathogens, predators, competitors, etc. that affect humans, plants and animals in APR is provided in Table 2.3.3 (2.3.3.4) NCP 14 The monetary value of the medicinal, biochemical and genetic resource from various ecosystem types in APR is provided in table 2.3.3 (2.3.3.4) OP "One-Health" approach promotes integrative action to address human, animal and ecological health interactions (Walther et al., 2016) OP National Action Plan for Peatlands was issued in Malaysia aiming at haze free ASEAN region through sustainable management of peatlands and promoting regional cooperation (6.2.2.1)		
4 Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all *–4.7 "all learners acquire the knowledge and skills needed to promote sustainable development"*	NCP 15 Provision, by landscapes, seascapes, habitats or organisms of opportunities for the development of the capabilities that allow humans to prosper through education, acquisition of knowledge and development of skills for well-being (Monetary value provided in Table 2.3.3 (2.3.3.4) (APR)) NCP 15 Education and nature-based tourism (2.3.2) (SEA) NCP 15 Informal community schools can help transmit ILKP to younger generations, and also can improve education access in remote areas (Alangui, Ichikawa, & Takahashi, 2017) (SEA) OP Higher education background improves people's support to BES sustainability (Liu, Ouyang, & Miao, 2010; Masud & Kari, 2015) (NEA, SEA)		ID Increasing number of children in indigenous communities have obtained access to formal education in government schools, which resulted in limited opportunity for the transmission of ILKP to younger generations (Alangui et al., 2017)
5 Achieve gender equality and empower all women and girls	OP Women and girls play key role to maintain agro-biodiversity that underpin food and livelihood security (Abdelali-Martini et al., 2008; Alangui et al., 2017) (SEA, WA) OP Women's role to support sustainable fisheries in Pacific islands through their engagement in early childhood development when children's moral and cultural norms are formed (Ram-Bidesi, 2015) (O)		

SDGS AND TARGETS COHERENT TO BES SUSTAINABILITY	SYNERGY		TRADE-OFF
Ensure availability and sustainable management of water and sanitation for all *–6.3 "improve water quality by reducing pollution, eliminating dumping and minimizing re-lease of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse"* *–6.6 "protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes"*	NCP 6 Ecosystem's functions to regulate freshwater quantity, flow and timing (monetary value provided in table 2.3.3 (2.3.3.4)) (APR) NCP 7 Regulation of freshwater and coastal water quality by ecosystems (monetary value provided in Table 2.3.3 (2.3.3.4)) (APR) NCP 6, 7, 8 Water security, including water quantity, quality and functioning water system, as one of the key nature's contributions to people and good quality of life (2.3.2, 2.4.1.1) (NEA, SA, WA, O, APR) OF Degradation of watershed ecosystems, as well as over-extraction and poor management of surface and ground waters seriously undermine water security (2.4.1.1) (SA, WA). OP Payments for Ecosystem Services (PES) is increasingly used for incentivising watershed protection by upstream com-munities and thus for ensuring downstream water security (6.4.1.3) (SA) OP Sub-regional conventions are in place for abating trans-boundary pollution and thereby safeguarding transboundary flow of ecosystem services, including water security, are in place (6.2.1) (SA, WA)		
Ensure access to affordable, reliable, sustainable and modern energy for all *–7.2 "increase substantially the share of renewable energy in the global energy mix"*	NCP 6, 8 Watershed forests secure the functioning of hydroelectric power stations downstream (2.3.2) (SA) NCP 11 The poor heavily reliant on biomass fuel use (2.4.3). The monetary value of the ecosystem's function to produce biomass-based fuels in APR is provided in Table 2.3.3 (2.3.3.4)) (APR) OF Limited access of the poor to modern energy sources drives overusing biomass, and thereby causes forest loss and degradation (2.4.1.2)		DD Hydropower offers clean energy and has high unutilised potential in APR, but concerns remains on their environmental impacts (4.1.2) DD Biofuel energy has potential to enhance energy security while reducing GHG emissions, but can be a threat to forest and biodiversity depending on where and how biofuel is produced (Koh & Ghazoul, 2008; Phalan, 2009)
Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all *–SDG 8.4 "decouple economic growth from environmental degradation, in accordance with the 10-Year Framework of Programmes on Sustainable Consumption and Production"*	NCP 16 The monetary value of landscapes, seascapes, habitats or organisms to provide opportunities for tourism is provided in Table 2.3.3 (2.3.3.4)) (APR). ID Globalization strengthened attitudes favouring conservation and state effectiveness accompany economic growth" (4.2.2) (APR) OP Community- and protected areas-based ecotourism highly likely to be successful in conserving biodiversity (4.2.2) (APR) OP Green growth policies and strategies, such as green growth plans, that aim to mainstream nature and NCP into development have become widespread (6.4.4.3) (SEA) OP Increasing investments in urban ecosystems conservation and rehabilitation with a view to attracting international investments and recognition (6.2.2.1) (NEA)	OF Agriculture and aquaculture, as forms of modified ecosystems, remain as the main livelihood basis for local people in APR (2.4.1.4)	DD large scale land investment can create job opportunities and thereby local economy, but can negatively affect forests and those relying on forests for livelihood" (2.5.2.3) DD Unsustainable mining, natural resource collection, livestock grazing and tourism, which are unanimously driven by economic interests, have led to the degradation of many ecosystems (4.1.2.4) DD Land use changes, water withdrawal for agriculture, urbanization and economic growth will impact future water availability as well as quality, particularly in small water-sheds (Chapter 5/APRA) DD Invasive alien species along rapid economic and demographic growth (4.1.4, 4.2.2, 4.4.6, 4.4.8 and 4.5.2) (APR) DD Increasing wastes, including hazardous substances, impact ecosystems (4.1.3) (APR) ID Economic growth changes consumption volumes and patterns and levels of investment in infrastructure, and thereby result in some threats to BES (4.2.2) (APR) ID Market-based globalization will largely impact BES negatively, until there is adequate institutional framework to control/compensate the loss in natural areas (5.1.2) (APR)
Build resilient infrastructure, promote sustainable industrialization and foster innovation *–9.4 "By 2030, upgrade infra-structure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, … ."*	NCP 1, 4, 6, 7, 8, 16, 17 "Green infrastructure" or "green and blue infrastructure" concept can integrate BES aspects into designing resilient infra-structure, in which urban greens can serve as habitats for variety of species including rare and endangered species, and provide multiple ecosystem services (Artmann *et al*., 2017; Kazmierczak & Carter, 2010) (GL)		DD Deposition of air pollutants directly and indirectly, e.g. through soil acidification and eutrophication of surface, ground and coastal waters, poses threats to ecosystems (4.1.3) (APR) ID Road construction causes deforestation and habitat fragmentation (4.2.2) (APR) ID Large-scale and rapid infrastructure development has led to negative impacts on previously salient natural scenery, such as coastal and alpine landscapes (4.2.2)

SDGS AND TARGETS COHERENT TO BES SUSTAINABILITY	SYNERGY		TRADE-OFF
Reduce inequality within and among countries	NCP 14 Fair and equitable benefit sharing principle for REDD+ enterprises (6.4.1.4) OP Nagoya Protocol represents multilateral legal framework for ensuring equity concerning the use of genetic resources. Since the enactment of Nagoya Protocol in 2014, several countries in APR have set up and started implementing national and/or sub-national policies and legislations on access and equitable benefit sharing (ABS) (6.4.2.5)		
Make cities and human settlements inclusive, safe, resilient and sustainable *–11.4 "Strengthen efforts to protect and safeguard the world's cultural and natural heritage"* *–11.5 "… significantly reduce the number of deaths and … people affected and substantially decrease the direct economic losses … caused by dis-asters, …"* *–11.7 "… provide universal access to safe, inclusive and accessible, green and public spaces …"*	NCP 9 Flood mitigation and sand storm prevention (2.3.2) (NEA, SA); sustainable forest management and agroforestry in major watershed contribute to flood mitigation (6.4.1.5) (SA and SEA) NCP 9 Ecosystem's functions to regulate hazards and extreme events: monetary values provided in Table 2.3.3 (2.3.3.4)) (APR) NCP 3, 4, 6, 7, 8, 9, 16 Urban ecosystems conservation and rehabilitation have become integrated into urban planning with explicit recognition of NCPs (6.2.2.1) (APR) OP Urbanisation can be a sustainability solution through the concentration of industry, trade, transport, health care and education in relatively small areas, as well as through efficient treatment of pollution (4.4.1, 4.4.6) (APR) OP Recognition and conservation of cultural and natural heritage is now widespread in APR, with 251 cultural 69 natural 12 mixed heritage sites inscribed as UNESCO World Heritage (UNESCO, 2017)		DD Urbanisation in APR negatively impact BES through land conversion and by changes in lifestyles and consumption patterns (4.1.1, 4.4.6) DD Alternation of land uses due to urbanization / economic development will lead to significant changes in hydrological cycles, there-by, impacting water availability and quality (SEA) (Kim, Hoi, Choi, & Park, 2013; Ty, Sunada, Ichikawa, & Oishi, 2012) DD Urbanization results in strong trade-offs in net primary productivity, carbon sequestration, water yield and soil retention, unless strict planning codes are enforced (V. M. Adams, Pressey, & Álvarez-Romero, 2016; Pei, Li, Liu, Lao, & Xia, 2015; Yang et al., 2016) DD Domestic sewage causes water pollution (4.1.3) (APR) ID Growing urban population growth causes environmental degradation and biodiversity loss (4.2.1) (APR)
Ensure sustainable consumption and production patterns *–12.2 "… sustainable management and efficient use of natural resources"* *–12.4 "… sound management of chemicals and all wastes …"* *–12.7 "… public procurement practices that are sustainable …"* *–12.8 "…lifestyles in harmony with nature"*	OP Green public procurement and voluntary certification mechanism on timber (e.g. PEFC, FSC and other national certification mechanisms) (NEA, SEA, O) and eco-labelling of food products (NEA, O) have become widely practiced (6.2.2.2, 6.4.2.6, 6.4.2.7) OP The adoption of voluntary sustainability standards (VSS) in APR is now picking up, with 9 countries in the region are counted amongst the global "top-ten" countries regarding the area certified under major international certification schemes (6.4.2.7)	OF Rapid economic development and changing consumption pattern, while improving the poverty situation in India and China, will significantly impact air quality and pollution levels (Hubacek et al., 2007)	ID Integration into regional and global economy and rapid urbanisation coincide with in-creased production of high-value cash crops and excessive natural resource extraction (4.1.1, 4.2.2, 4.4.5) ID Changing food habits, material uses and leisure preferences along economic growth affect forest and coastal ecosystems (4.2.3) (APR)
Climate Action *–13.5 "Strengthen resilience and adaptive capacity to cli-mate-related hazards and natural disasters in all countries"*	NCP 4 Ecosystem carbon sequestration (2.3.2) (NEA). Agroforestry is expected to contribute to multiple objectives beyond carbon sequestration, such as agricultural production and habitat provision (6.2.2.1) (SA, SEA) NCP 9 Flood mitigation and sand storm prevention (2.3.2) (NEA, SA) DD Projected changes in climate are considered to be significant stressor on BES and human well-being, which include the spread of invasive alien species. (4.1.5) OP Protected areas contribute to enhancing socio-cultural resilience to climate change (6.2.1, 6.4.4)		DD Significant increase in bioenergy production is one of central preconditions for a scenario towards achieving 2°C goal agreed upon in the Paris Agreement of UNFCCC, but will sacrifice biodiversity conservation, food production and water security (Fuss et al., 2014) (GL)
Promote just, peaceful and inclusive societies *–16.3 "Promote the rule of law at the national and international levels and ensure equal access to justice for all"* *–16.6 "develop effective, ac-countable and transparent institutions at all levels"*	ID Unclear land tenure, weak governance, corruption, political unrest and even local conflicts … exacerbate illegal logging, mining, poaching, overgrazing and over-exploitation (4.2.5, 4.4.1, 4.4.2, 4.4.5, 4.4.6) DD&ID In Yemen, almost 80% of internal conflicts stemmed from rising demand for water due to population growth and poor water management (2.4.1.1) (WA) OP Co-management or collaborative governance can be effective for protected area management (NE, SA and O) (6.2.3.1, 6.4.4.2). Devolution of forest management to lower-levels of decision making resulted in positive forest conservation and local livelihoods outcomes (2.5.1.2) (SA, SEA). Local institutions and customary law have important roles to play in the conservation and recovery of ecosystems and natural resources (2.5.2.1) (O) OP Participation of multiple stakeholders in conservation movement assisted peace building in Lebanon (J. A. McNeely, 2003) OP The coverage of Indigenous People's and Community Con-served Territories and Areas (ICCAs) and the recognition of sacred natural sites (SNSs) are increasing throughout APR as important components of protected landscapes. Indigenous Protected Area (IPA) programme in Australia now co-vers 30% of the total of state protected areas. (6.4.1.4)		OF Institutions and organisations influence the provision of ecosystem services to human well-being in different ways (2.5) OF In some cases protected areas have imposed physical, economic and cultural displacement, which led to political conflicts (2.5.3.2)

SDGS AND TARGETS COHERENT TO BES SUSTAINABILITY	SYNERGY	TRADE-OFF
Revitalize the global partnership for sustainable development *–17.7 "Promote the development, transfer, dissemination and diffusion of environmentally sound technologies to developing countries … ."* *–17.16 "Enhance the Global Partnership for Sustainable Development …"* *–17.17 "Encourage and pro-mote effective public, public-private and civil society partnerships …"*	ID Information and knowledge sharing platforms are key to … increasing awareness about environmental issues, … ." (4.2.4) (APR, GL) ID Biotechnology for food, health, environmental security and biodiversity conservation (4.2.4) (APR, GL) OP Achievement of BD goals require the amount of investment five times more than the present one. Currently 80% comes from non-market mechanisms, e.g. domestic budget allocations, ODA and debt-for-nature swaps and subsidies re-form. There are five areas for possible finance increment: PES, biodiversity offsets, green products, PPP and international development finance. (6.2.2.2) OP Transboundary collaboration for BES conservation is accelerating, e.g. Coral Triangle Initiative, Heart of Borneo Initiative, ASEAN Agreement on Transboundary Haze Pollution, Biodiversity Conservation Corridor Initiative under the Greater Mekong Subregion (GMS) Core Environment Programme; Montreal process for exchanging information on forest trend changes across countries in NEA and O (6.2.1, 6.2.2.2)	ID Advancement and application of technologies enabled increased supply of food, energy, water and other materials. This significantly affected BES at one hand, but has improved the capacity of local communities to adapt to climate and non-climatic changes at the other hand (4.2.4) (APR) ID Technologies have both positive and negative implications to BES sustainability (4.2.4) (APR, GL)

NCP 1 NATURE'S CONTRIBUTIONS TO PEOPLE (18 CATEGORIES: REFER TO TABLE 2.1 (2.3.1))

DD DIRECT DRIVERS OF BES CHANGES

ID INDIRECT DRIVERS OF BES CHANGES

OP OPPORTUNITIES FOR ENHANCING SYNERGIES

OF OTHER FACTS

GL: GLOBAL OR AREA NOT SPECIFIED
APR: ASIA PACIFIC REGION
NEA: NORTH-EAST ASIA
SEA: SOUTH-EAST ASIA
SA: SOUTH ASIA
WA: WESTERN ASIA
O: OCEANIA

Box 6.27 Ecosystem-based integrative approaches in the Asia-Pacific region

Tackling land degradation –SDGs 1, 2, 3, 15, and 17
Land degradation, habitat loss, and food security are inter-linked through their impacts on food production as well as on household incomes and food prices. In most regions, the crucial issue is how food security might be affected by land degradation over time, even if cropland is not lost irreversibly to degradation (Scherr, 1999a). Based on econometric analysis using new data on soil and climate, it was now confirmed that differences in land quality contribute to significant differences in agricultural productivity, and food security between countries (Hamdy & Aly, 2014; Oldeman, 2000; Scherr, 1999b; Wiebe, 2003). Farmers' responses to land degradation and its potential impacts on yields may translate into actual effects on agricultural productivity. At the global scale, the significant negative on-site and off-site impacts of land degradation on ecosystem goods and services require a concerted effort by the international community to prevent and control it. Past efforts to address this issue were not very effective mainly because they were based on a sectoral approach that had the unintended effect of fragmentation of policies, institutions, and sustainable management of land resources. Therefore, a holistic and integrated approach to land degradation prevention and control, covering both ecosystem and socioeconomic dimensions, is needed (Hamdy & Aly, 2014).

Ecosystem-based approach to climate change adaptation and disaster risk reduction –SDGs 1, 3, 6, 11, 13, 14 and 15
In the face of increasing frequency and intensity of natural disasters and extreme climatic events, particularly in the Asia-Pacific region, ecosystem-based adaptation (EbA) and ecosystem-based disaster risk reduction (Eco-DRR) have now gained momentum. The Partnership for Environment and Disaster Risk Reduction (PEDRR) –an international alliance of UN agencies, NGOs, and research institutions promotes implementation and scaling-up of Eco-DRR in line with the Sendai Framework for Disaster Risk Reduction (http://pedrr.org/about-us/). PEDRR recognises the role of healthy ecosystems, such as coral reefs, mangroves, forests and wetlands, to function as natural buffers or protective barriers against natural hazards, as well as to build resilience among local communities by maintaining important livelihood opportunities. An assessment of the state of knowledge on EbA and Eco-DRR was conducted by the CBD Secretariat and compiled in the CBD Technical Series No. 85 (Lo, 2016). The report suggests that adoption of EbA and Eco-DRR approach can strengthen synergies between SDG 11, 13, 14 and 15.

Satoyama Initiative –SDGs 1, 2, 3, 6, 12, 14, 15
Satoyama Initiative aims to enhance understanding and awareness of the importance of socio-ecological production landscapes and seascapes (SEPLS) where "harmonious interaction between people and nature maintain biodiversity while providing humans with the goods and services needed for their livelihoods, survival and well-being in a sustainable manner". An accumulating body of knowledge from the International Partnership for Satoyama Initiative (IPSI), as well as from its collaborative activities with member organizations, such as UNDP, GEF and the Ministry of the Environment of Japan, has revealed the crucial importance of an integrative landscape/seascape approach to multiple SDGs including Goals 14 and 15 (Conservation International Japan, 2016; IGES, 2016; Mock, 2014; Mock & Tschentscher, 2016; UNU-IAS & IGES, 2015, 2016).

"One Health" approach –SDGs 3 and 15
One Health is defined as "*a collaborative, multi-sectoral, and trans-disciplinary approach ... with the goal of achieving optimal health outcomes recognising the interconnection between people, animals, plants, and their shared environment*" (CDC, 2017). Asia, especially South East Asia, is recognised as one of the hotspots for One Health approach taking into account its dense human and domestic animal populations (Binot *et al.*, 2015). ASEAN established a working group on One Health in 2008 in its secretariat and has convened regional meetings such as the meeting of the ASEAN Ministers of Agriculture and Forestry in 2010. The scope is currently limited to animal, human and public health issues and not holistic enough to incorporate socio-ecological processes

that are crucial for addressing zoonotic diseases. More comprehensive view on human-nature interactions is needed for implementing One Health in South East Asia, based on the importance of nature not only for human health but also for other critical ecosystem services to support rural livelihood, security and culture (Walther *et al.*, 2016).

6.7 Conclusions

Policymaking for securing a positive future for nature and NCP in the Asia-Pacific region needs to be done within an environment of pressing economic and development policy priorities. The Global Biodiversity Outlook-4 (SCBD, 2014), amongst other challenges, specifically highlights the need for mainstreaming biodiversity into sectoral policies and planning processes, especially habitat fragmentation and land degradation (3.3.2) which are considered major contributors to terrestrial biodiversity loss. Integrating BES aspects into sectoral goals and targets is imperative for the implementation of various biodiversity-related MEAs, and other regional and subregional instruments. Limited capacity in the region for mainstreaming BES into sectoral policy-planning processes, and effective implementation of biodiversity-related MEAs, need urgent attention.

The trends of biodiversity loss and intensifying drivers and pressures operate within a backdrop of modifying consumption and production patterns resulting from economic growth and globalisation (4.1.1; 4.2.2; 4.2.3; 4.4.5). Sustainable solutions to food, water and energy security are emerging in select economies through scientific advances, implementation of new technology, and increased investment in research and development (4.2.4), but need upscaling support through enabling policies and regional exchanges. A mix of economic and financial, cultural and social, and management based instruments are required to promote sustainable production and consumption across the subregions.

Designation and management of protected areas have been the cornerstone of biodiversity conservation in the Asia-Pacific region. However, despite an increase in coverage, at least 75 per cent of Key Biodiversity Areas remain unprotected (3.2.6), and the region is not on track on meeting the Aichi Target 11 (6.5). For protected areas to effectively contribute to a secure future for nature and NCP in the Asia-Pacific region, measures for enhanced representativeness of the protected areas network, and improved management effectiveness, specifically addressing capacity and financing gaps are required. Conventional public finance instruments would need to be complemented by financial and economic instruments which diversify funding base while promoting equity in sharing of conservation costs and benefits, keeping local cultural and socio-political contexts in consideration.

The complex interactions between direct and indirect drivers and impacts of nature and NCP indicate that policymaking would need to operate in a dynamic and uncertain environment (4.3, 4.6). For environmental governance to alter these interlinked drivers, adaptive and collaborative governance would need to be accorded primal focus (6.4.2.4). A critical challenge would be to remove policy inertia by increasing responsiveness to learning and feedback mechanisms.

Several subregional institutional initiatives have resulted in enhanced opportunities for managing transboundary ecosystems and sustaining the flow of transboundary ecosystem services for human well-being (2.3.4, 2.3.4.1, 2.3.4.2, 2.3.4.3, 2.3.4.4, 2.5.1.2), however their value is not optimally utilised (*2.3.4.2)*. Regional transboundary systems of environmental management is highly likely to form an important complement to governance efforts at national and global levels in the Asia-Pacific region (6.4.2.2), particularly to address issues of transboundary pollution (4.6), regional water and climate security (2.3.1.1, 2.3.4.3), securing migration corridors (2.3.4.3) and management of invasive species (3.4.5). Trust building, crafting institutional frameworks for cross-scale action, inclusive stakeholder engagement, availability of information base at multiple scales and across sectors and capacity development for integrated problem-solving are some of the critical ingredients of strengthening transboundary action in the Asia-Pacific region. Conventions and Biodiversity-related

MEAs can play an enabling role in strengthening transboundary collaboration, provided their implementation is enhanced by building adequate policymaking, programming, and implementation tracking capabilities within the region.

Assessments have also confirmed limitations in current knowledge of status and trends in biodiversity and NCP (Chapter 3), interactions of BES with human well-being (5.4), drivers and pressures (Chapter 4) and likely scenarios for future (Chapter 5). Available scenarios research trend suggests a higher emphasis on provisioning ecosystem services, as compared with regulating, and supporting ecosystem services (Section 5.3.2.2). Conventional indicators of economic progress (such as GDP and HDI) have indicated increasing trends (Chapter 5) in the backdrop of declining inclusive wealth, declining biodiversity, and consequent human well-being impacts. Effective policymaking for securing biodiversity and NCP in the region would require increased efforts on improved natural capital accounting and reporting, so that the suite of indicators guiding policymaking for economic development are broadened and made more comprehensive.

To sum up, this chapter showed that the emerging governance options (6.4.2) have potential to reverse negative trends and reduce impacts of drivers on BES, which in turn can support the achievement of ABTs and SDGs. However, many institutional challenges still need to be addressed to enhance the policy mix and participatory governance across scales and sectors (6.4.1, 6.4.3). This chapter presented best practices for the different options (Figure 6.6), which can guide decision makers in overcoming these challenges and creating opportunities for better BES governance.

References

Aalbersberg, B., Tawake, A., & Parras., T. (2005). Village by village: recovering Fiji's coastal fisheries. In World Resources 2005: the wealth of the poor: managing ecosystems to fight poverty. *World Resources Institute, Washington D.C. 144-152*. Retrieved from http://pdf.wri.org/wrr05_lores.pdf

Abdullah, A. (2002). *A Review and Analysis of Legal and Regulatory Aspects of Forest Fires in South East Asia*. Jakarta, Indonesia: Project FireFight South East Asia.

Acosta-Michlik, L., Lucht, W., Bondeau, A., & Beringer, T. (2011). Integrated assessment of sustainability trade-offs and pathways for global bioenergy production: Framing a novel hybrid approach. *Renewable and Sustainable Energy Reviews*, *15*(6), 2791–2809. https://doi.org/10.1016/J.RSER.2011.02.011

Acosta, L., Magcale-Macandog, D., Kumar, K., Cui, X., Eugenio, E., Macandog, P., Salvacion, A., & Eugenio, J. (2016). The Role of Bioenergy in Enhancing Energy, Food and Ecosystem Sustainability Based on Societal Perceptions and Preferences in Asia. *Agriculture*, *6*(2), 19. https://doi.org/10.3390/agriculture6020019

Ahmad, S. S., Sherazi, A., & Shah, M. T. A. (2010). A preliminary study on climate change causing decline in forest cover area in district Chakwal, Pakistan. *Pakistan Journal of Botany*.

Aichi. (1994). 21 Activities for Local and Global Environmental Conservation towards 21 Activities for Local and Global Environmental Conservation towards.

Aichi. (2017). *Ecological Network*. Japan. Retrieved from http://www.pref.aichi.jp/kankyo/sizen-ka/shizen/ecologicalnetwork/index.html

AIPP. (2013). *Research on the Roles and Contributions of Indigenous Women in Sustainable Forest Management in Mekong Countries/Asia*. *Brain* (Vol. 735). Chiang Mai Thailand: Asia Indigenous Peoples Pact (AIPP).

Åkerlund, U. (2006). *Urban and peri-urban forestry and greening in west and Central Asia Experiences, constraints and prospects*. *FAO Livelihood Support Programme, LSP Working Paper 36*.

Albert, J. A., Olds, A. D., Albert, S., Cruz-Trinidad, A., & Schwarz, A. M. (2015). Reaping the reef: Provisioning services from coral reefs in Solomon Islands. *Marine Policy*, *62*, 244–251. https://doi.org/10.1016/j.marpol.2015.09.023

Ali, H., Shafi, M. M., Khan, H., Mussawer, S., & Khan, M. (2015). Socio-economic benefits of community based trophy hunting programs. *Environmental Economics*, *6*(1).

Arlidge, W.N.S., J.W. Bull, P.F.E. Addison, M.J. Burgass, D. Gianuca, T.M. Gorham, C. Jacob, N. Shumway, S.P. Sinclair, J.E.M. Watson, C. Wilcox, and E.J. Milner-Gulland. (2018). A Global Mitigation Hierarchy for Nature Conservation, BioScience Vol. 68 No. 5. https://academic.oup.com/bioscience

Anaya, J. (2005). Indigenous peoples' participatory rights in relation to decisions about natural resource extraction: the more fundamental issue of what rights indigenous peoples have in lands and resources. *Arizona Journal of International & Comparative Law*, *22*(1), 7–17.

Andersen, R. (2016). *Governing Agrobiodiversity: Plant Genetics and Developing Countries*. New York, USA: Routledge. Retrieved from https://www.routledge.com/Governing-Agrobiodiversity-Plant-Genetics-and-Developing-Countries/Andersen/p/book/9780754647416

Angelsen, A., Brockhaus, M., Sunderlin, W. D., & Verchot, L. V. (2012). Analysing REDD+. In *Analysing REDD+: Challenges and choices* (pp. 111–127). https://doi.org/10.17528/cifor/003805

Angulo-Valdés, J. A., & Hatcher, B. G. (2010). A new typology of benefits derived from marine protected areas. *Marine Policy*, *34*(3), 635–644. https://doi.org/10.1016/j.marpol.2009.12.002

Ansell, C., & Gash, A. (2008). Collaborative governance in theory and practice. *Journal of Public Administration Research and Theory*, *18*(4), 543–571. https://doi.org/10.1093/jopart/mum032

APFNet, & FAO. (2015). *Assessment of Progress Towards the APEC 2020 Forest Cover Goal*.

Ariffin, M. (2015). Enforcement Against Wildlife Crimes in West Malaysia : the Challenges, *10*(1), 19–26.

Artmann, M., Kohler, M., Meinel, G., Gan, J., & Ioja, I.-C. (2017). How smart growth and green infrastructure can mutually support each other — A conceptual framework for compact and green cities. *Ecological Indicators, in press*. https://doi.org/10.1016/J.ECOLIND.2017.07.001
Aryal, K., & Kerkhoff, E. (2008). *The right to practice shifting cultivation as a traditional occupation in Nepal: A case study to apply ILO Conventions Nos. 111 (Employment and Occupation) and 169 (Indigenous and Tribal Peoples)*. Kathmandu. Retrieved from http://www.ilo.org/global/publications/lang--en/index.htm
ASEAN. (2000). The ASEAN Framework Agreement on Access to Biological and Genetic Resources. Member States of the Association of South East Asian Nations (ASEAN).
ASEAN Centre for Biodiversity. (2010). *ASEAN biodiversity outlook.* Retrieved from http://www.aseanbiodiversity.org/index.php?option=com_phocadownload&view=category&download=2:asean-biodiversity-outlook&id=3:acb-books
Asia-Pacific Economic Cooperation. (2007). Sydney APEC Leaders' Declaration on Climate Change, Energy Security and Clean Development.
Asquith, N. M., Vargas, M. T., & Wunder, S. (2008). Selling two environmental services: In-kind payments for bird habitat and watershed protection in Los Negros, Bolivia. *Ecological Economics*, *65*(4), 675–684. https://doi.org/10.1016/j.ecolecon.2007.12.014
Assche, K. Van, Beunen, R., & Duineveld, M. (2014). *Evolutionary Governance Theory - An Introduction*. Heidelberg: Springer. Retrieved from http://www.springer.com/us/book/9783319009834
Aswani, S., & Hamilton, R. J. (2004). Integrating indigenous ecological knowledge and customary sea tenure with marine and social science for conservation of bumphead parrotfish (Bolbometopon muricatum) in the Roviana Lagoon, Solomon Islands. *Environmental Conservation*, *31*(1), 69–83.
Atmodjo, E., Lamers, M., & Mol, A. (2017). Financing marine conservation tourism: Governing entrance fees in Raja Ampat, Indonesia. *Marine Policy*, *78*(January), 181–188. https://doi.org/10.1016/j.marpol.2017.01.023
Australian Government. (2013). Sustainable Procurement Guide. Australian Government, Department of Sustainability, Environment, Water, Population and Communities. https://doi.org/10.3403/9780580698613
Australian Government. (2014). Carbon Credits (Carbon Farming Initiative) Act 2011, (101).
Australian Government. (2017). National Landcare Programme. Retrieved from http://www.nrm.gov.au/national-landcare-programme
Baker, A. C., Glynn, P. W., & Riegl, B. (2008). Climate change and coral reef bleaching: An ecological assessment of long-term impacts, recovery trends and future outlook. *Estuarine, Coastal and Shelf Science*, *80*(4), 435–471. https://doi.org/10.1016/j.ecss.2008.09.003
Balooni, K., & Inoue, M. (2007). Decentralized Forest Management in South and Southeast Asia. *Journal of Forestry*, *105*(8), 414–420.
Bao, P.N., B.K. Mitra, T. Kuyama (2017). Integrated Approach for Sustainable Hydropower Development in the Mekong River Basin. Environment and Natural Resources Research, 7(1), pp.60-74.
Ban, N. C., Adams, V. M., Almany, G. R., Ban, S., Cinner, J. E., McCook, L. J., Mills, M., Pressey, R. L., & White, A. (2011). Designing, implementing and managing marine protected areas: Emerging trends and opportunities for coral reef nations. *Journal of Experimental Marine Biology and Ecology*, *408*(1–2), 21–31. https://doi.org/10.1016/j.jembe.2011.07.023
Banks, S. A., & Docker, B. B. (2014). Delivering environmental flows in the Murray-Darling Basin (Australia)—legal and governance aspects. *Hydrological Sciences Journal*, *59*(3–4), 688–699. https://doi.org/10.1080/02626667.2013.825723
Baumann, P., & Farrington, J. (2003). Decentralising natural resource management: Lessons from local government reform in India. *Natural Resource Perspectives*, *86*, 1–4.
Beban, A. (2014). Is organic agriculture a viable strategy in contexts of rapid agrarian transition? Evidence from Cambodia. Journal of Agriculture, Food Systems, and Community Development 4: 131-147.
Bell, J. D. D., Johnson JE, Ganachaud AS, Gehrke PC, Hobday AJ, Hoegh-Guldberg O, Le Borgne R, Lehodey P, Lough JM, Pickering T, Pratchett MS, Waycott, M., Johnson, J., Ganachaud, A.,

Gehrke, P., Hobday, A., Hoegh-Guldberg, O., Le Borgne, R., Lehodey, P., Lough, J., Pickering, T., & Pratchett, MS, M, W. (2011). *Vulnerability of tropical Pacific fisheries and aquaculture to climate change. Secretariat of the Pacific Community, Noumea, New Caledonia.* Noumea, New Caledonia.: Secretariat of the Pacific Community.

Bell, J. D., Kronen, M., Vunisea, A., Nash, W. J., Keeble, G., Demmke, A., Pontifex, S., & Andréfouët, S. (2009). Planning the use of fish for food security in the Pacific. *Marine Policy*. https://doi.org/10.1016/j.marpol.2008.04.002

Bellamy, J. A., & Johnson, A. K. L. (2000). Integrated resource management: Moving from rhetoric to practice in Australian agriculture. *Environmental Management*. https://doi.org/10.1007/s002679910021

Bennett, N. J., & Dearden, P. (2014). Why local people do not support conservation: Community perceptions of marine protected area livelihood impacts, governance and management in Thailand. *Marine Policy*, *44*, 107–116. https://doi.org/10.1016/j.marpol.2013.08.017

Berg, M. (2009). The Role of Inter- and NonGovernmental Organizaions. In G. M. Kutting (Ed.), *Conventions, Treaties And Other Responses To Global Issues* (Vol. II, pp. 107–130). Oxford, United Kingdom: EOLSS Piblishers/UNESCO.

Bergamini, N., Blasiak, R., Eyzaguirre, P., Ichikawa, K., Mijatovic, D., Nakao, F., & Subramanian, S. M. (2013). *Indicators of Resilience in Socioecological Production Landscapes (SEPLs)*. *UNU-IAS Policy Report*. Tokyo: United Nations University Institute of Advanced Studies (UNU-IAS). Retrieved from http://archive.ias.unu.edu/resource_centre/Indicators-of-resilience-in-sepls_ev.pdf

Berkes, F. (2004). Rethinking Community-Based Conservation, *18*(3), 621–630.

Berkes, F. (2015). *Coasts for People: Interdisciplinary Approaches to Coastal and Marine Resource Management*. Routledge.

Bernstein, S. (2011). Legitimacy in intergovernmental and non-state global governance. *Review of International Political Economy*, *18*(1), 17–51. https://doi.org/10.1080/09692290903173087

Berque, J., & Matsuda, O. (2013). Coastal biodiversity management in Japanese satoumi. *Marine Policy*, *39*(1), 191–200. https://doi.org/10.1016/j.marpol.2012.10.013

Bhatta, L. D., van Oort, B. E. H., Rucevska, I., & Baral, H. (2014). Payment for ecosystem services: possible instrument for managing ecosystem services in Nepal. *International Journal of Biodiversity Science Ecosystem Services & Management*, *10*(4), 289–299. https://doi.org/10.1080/21513732.2014.973908

Binot, A., Duboz, R., Promburom, P., Phimpraphai, W., Cappelle, J., Lajaunie, C., Goutard, F. L., Pinyopummintr, T., Figuié, M., & Roger, F. L. (2015). A framework to promote collective action within the One Health community of practice: Using participatory modelling to enable interdisciplinary, cross-sectoral and multi-level integration. *One Health*, *1*, 44–48. https://doi.org/10.1016/j.onehlt.2015.09.001

Bissonnette, J., & De Koninck, R. (2015). Large Plantations versus Smallholdings in Southeast Asia: Historical and Contemporary Trends. Retrieved from www.plaas.org.za/bicas

Blackman, A., & Rivera, J. (2010). *Environmental Certification and the Global Environment Facility. A STAP Advisory Document*. Washington DC.

Blaser, J. (2010). *Forest law compliance and governance in tropical countries: A region-by-region assessment of the status of forest law compliance and governance, and recommendations for improvement*.

Blasiak, R., Pittman, J., Yagi, N., Sugino, H., Change, E., & Group, G. (2016). Negotiating the use of biodiversity in marine areas beyond national jurisdiction. *Frontiers in Marine Science*, *3*(November), 1–10. https://doi.org/10.3389/fmars.2016.00224

Boer, B., & Clarke, P. (2012). *Legal Frameworks for Ecosystem-Based Adaptation to Climate Change in the Pacific Islands*. Apia, samoa: SPREP.

Borrini-Feyerabend, G., & Buchan, D. (Eds.). (1997). *Beyond fences : seeking social sustainability in conservation* (First). Gland, Switzerland: IUCN.

Borrini-Feyerabend, G., & Hill, R. (2015). Governance for the conservation of nature. *Protected Area Governance and Management*, 169–206.

Bos, M., Pressey, R. L., & Stoeckl, N. (2015). Ocean & Coastal Management Marine conservation fi nance : The need for and scope of an emerging fi eld. *Ocean and Coastal Management*, *114*, 116–128. https://doi.org/10.1016/j.ocecoaman.2015.06.021

Brussaard L., Caron P., Campbell B., Lipper L., Mainka S., Rabbinge R., Babin D., Pulleman M. (2010). Reconciling biodiversity conservation and food security: scientific challenges for a new agriculture. Current Opinion in Environmental Sustainability 2:34–42.

Brock, A. (2015). Biodiversity Banking: From Theory to Practice in Sabah, Malaysia, E-International relations. https://www.e-ir.info/2015/07/23/biodiversity-banking-from-theory-to-practice-in-sabah-malaysia/

Bryant, D., Burke, L., Mcmanus, J., & Spalding, M. (2011). *Reefs at risk: A Map-Based Indicator of Threats to the World's Coral Reefs*.

Bull, J. W., Suttle, K. B., Gordon, A., Singh, N. J., & Milner-Gulland, E. J. (2013). Biodiversity offsets in theory and practice. *Oryx*, *47*(03), 369–380. https://doi.org/10.1017/S003060531200172X

Bullinger, C., & Haug, M. (2012). Current Research on South-East Asia In and Out of the Forest: Decentralisation and Recentralisation of Forest Governance in East Kalimantan, Indonesia. *ASEAS – Austrian Journal of South-East Asian Studies*, *5*(2), 243–262. https://doi.org/10.4232/10.ASEAS-5.2-4

Butchart, S. H. M., Clarke, M., Smith, R. J., Sykes, R. E., Scharlemann, J. P. W., Harfoot, M., Buchanan, G. M., Angulo, A., Balmford, A., Bertzky, B., Brooks, T. M., Carpenter, K. E., Comeros-Raynal, M. T., Cornell, J., Ficetola, G. F., Fishpool, L. D. C., Fuller, R. A., Geldmann, J., Harwell, H., Hilton-Taylor, C., Hoffmann, M., Joolia, A., Joppa, L., Kingston, N., May, I., Milam, A., Polidoro, B., Ralph, G., Richman, N., Rondinini, C., Segan, D. B., Skolnik, B., Spalding, M. D., Stuart, S. N., Symes, A., Taylor, J., Visconti, P., Watson, J. E. M., Wood, L., & Burgess, N. D. (2015). Shortfalls and Solutions for Meeting National and Global Conservation Area Targets. *Conservation Letters*, *8*(5), 329–337. https://doi.org/10.1111/conl.12158

Butchart, S. H. M., Scharlemann, J. P. W., Evans, M. I., Quader, S., Aricò, S., Arinaitwe, J., Balman, M., Bennun, L. A., Bertzky, B., Besançon, C., Boucher, T. M., Brooks, T. M., Burfield, I. J., Burgess, N. D., Chan, S., Clay, R. P., Crosby, M. J., Davidson, N. C., de Silva, N., Devenish, C., Dutson, G. C. L., Fernández, D. F. D., Fishpool, L. D. C., Fitzgerald, C., Foster, M., Heath, M. F., Hockings, M., Hoffmann, M., Knox, D., Larsen, F. W., Lamoreux, J. F., Loucks, C., May, I., Millett, J., Molloy, D., Morling, P., Parr, M., Ricketts, T. H., Seddon, N., Skolnik, B., Stuart, S. N., Upgren, A., Woodley, S., Clarke, M., Smith, R. J., Sykes, R. E., Scharlemann, J. P. W., Harfoot, M., Buchanan, G. M., Angulo, A., Balmford, A., Bertzky, B., Brooks, T. M., Carpenter, K. E., Comeros-Raynal, M. T., Cornell, J., Ficetola, G. F., Fishpool, L. D. C., Fuller, R. A., Geldmann, J., Harwell, H., Hilton-Taylor, C., Hoffmann, M., Joolia, A., Joppa, L., Kingston, N., May, I., Milam, A., Polidoro, B., Ralph, G., Richman, N., Rondinini, C., Segan, D. B., Skolnik, B., Spalding, M. D., Stuart, S. N., Symes, A., Taylor, J., Visconti, P., Watson, J. E. M., Wood, L., & Burgess, N. D. (2012). Protecting important sites for biodiversity contributes to meeting global conservation targets. *Conservation Letters*, *7*(3), 329–337. https://doi.org/10.1111/conl.12158

Buuveibaatar, B., Strindberg, S., Kaczensky, P., Payne, J., Chimeddorj, B., Naranbaatar, G., Amarsaikhan, S., Dashnyam, B., Munkhzul, T., Purevsuren, T., Hosack, D. A., & Fuller, T. K. (2017). Mongolian Gobi supports the world's largest populations of khulan Equus hemionus and goitered gazelles Gazella subgutturosa. *Oryx*, *51*(4), 639–647. https://doi.org/10.1017/S0030605316000417

Cabrera Medaglia, J., Perron-Welch, F., & Phillips, F.-K. (2014). Overview of National and Regional Measures on Access and Benefit Sharing: Challenges and Opportunities in Implementing the Nagoya Protocol - Third Edition. Montreal: Centre for International Sustainable Development Law (CISDL). Retrieved from www.cisdl.org

Campbell, B. M. (2009). Beyond Copenhagen: REDD+, agriculture, adaptation strategies and poverty. *Global Environmental Change*, *19*(4), 397–399. https://doi.org/10.1016/j.gloenvcha.2009.07.010

Campese, J., Sunderland, T., Greiber, T., & Oviedo, G. (2009). *Rights-based approaches*. IUCN and CIFOR.

Cargill. (2017). BASF, Cargill, P&G and GIZ collaborate to drive production of sustainable certified coconut oil in the Philippines and Indonesia, https://www.cargill.com/2017/basf-cargill-pg-giz-collaborate-sustainable-coconut-oil

Carnus, J.-M., Parrotta, J., Brockerhoff, E., Arbez, M., Jactel, H., Kremer, A., Lamb, D., O'Hara, K., & Walters, B. (2006). Planted forests and biodiversity. *Journal of Forestry*, *104*(2), 65–77.

Castillo, G. B., Chan, S., Wenjun, L., Yanbo, L., Fatah, H. L., Malivarn, S., Lee, K. F., Anda, A. D., Laengcharoen, P., Chien, P. C., & Laplante, B. (2015). *Fiscal Gaps and Financing of Southeast Asia's Protected Areas: A Cross-Country Analysis*. Quezon City, Phillipines. Retrieved from http://www.eepsea.org/pub/rr/2015-RR13Castilloetal.pdf

CBD. (2011). *Incentive measures for the conservation and sustainable use of biological diversity: case studies and lessons learned* (CBD Technical Series No. 56). Montreal, Canada. Retrieved from https://www.cbd.int/doc/publications/cbd-ts-56-en.pdf

CBD. (2013). *Resourcing the Aichi Biodiversity Targets: A First Assessment of the Resources Required for Implementing the Strategic Plan for Biodiversity 2011-2020. Report of the High-Level Panel on Global Assessment of Resources for Implementing the Strategic Plan fo*. *Scientific American* (Vol. 307). https://doi.org/10.1038/scientificamerican1012-41

CBD Secretariat. (2017). Parties to the Nagoya Protocol. Retrieved November 12, 2017, from https://www.cbd.int/abs/nagoya-protocol/signatories/

CCAFS. (2017). *Climate Change, Agriculture and Food Security*.

CCB, & VCS. (2015). MONITORING & IMPLEMENTATION REPORT.

CCBA. (2013). *Climate , Community & Biodiversity Standards. Third Edition*. Arlington, VA, USA. Retrieved from https://s3.amazonaws.com/CCBA/Third_Edition/CCB_Standards_Third_Edition_December_2013.pdf

CDC. (2017). One Health Basics | One Health | CDC. Retrieved September 17, 2017, from https://www.cdc.gov/onehealth/basics/index.html

Centre for Forestry Planning and Statistics (CFPS). (2009). *Indonesia forestry outlook study* (Asia-Pacific Forestry Sector Outlook Study II, Working Paper No. APFSOS II/WP/2009/13). Bangkok.

Centre for Standardization and Environment. (2013). *Principles, Criteria and Indicators for a System for Providing Information on REDD+ Safeguards Implementation in Indonesia*.

Chaudhry, P., Bagra, K., & Singh, B. (2011). Urban Greenery Status of Some Indian Cities: AShort Communication. *International Journal of Environmental Science and Development*, *2*(2), 98–101. https://doi.org/10.7763/IJESD.2011.V2.104

Chavan, S. P. (2013). Role of Joint Forest Management Committees in the Conservation of Forest and Environment. *Indian Streams Research Journal*, *3*(6), 1–5.

Chazdon, R. L. (2008). Beyond Deforestation: Restoring Forests and Ecosystem Services on Degraded Lands. *Science*, *320*(5882), 1458–1460. https://doi.org/10.1126/science.1155365

Chin, S.-C. (2008). Biodiversity conservation in Singapore. *BGJournal*, *5*(2). Retrieved from https://www.bgci.org/resources/article/0585/

Chisholm, R. A., Wijedasa, L. S., & Swinfield, T. (2016). The need for long-term remedies for Indonesia's forest fires. *Conservation Biology*, *30*(1), 5–6. https://doi.org/10.1111/cobi.12662

Christie, P., Campbell, L. M., & Armada, N. (2014). Stewardship in tropical small-scale fisheries: Community and national perspectives. In R. and C. Garcia (Ed.), *Governance of Marine Fisheries and Biodiversity Conservation* (pp. 333–345). Willey Blackwell.

Chuenpagdee, R., Fraga, J., & Euan, J. (2000). Importance of marine protected areas and their benefits: the local community's perspectives. *World Fish Report*.

Chunmei, W., & Zhaolan, L. (2010). Environmental policies in China over the past 10 years: Progress, problems and prospects. *Procedia Environmental Sciences*, *2*(5), 1701–1712. https://doi.org/10.1016/j.proenv.2010.10.181

Cinner, J. E., & Aswani, S. (2007). Integrating customary management into marine conservation. *Biological Conservation*, *140*(3–4), 201–216. https://doi.org/10.1016/j.biocon.2007.08.008

City of Sydney. (2017). *Environmental Action 2016 – 2021: Strategy and Action Plan*.

Clare, S., Krogman, N., Foote, L., & Lemphers, N. (2011). Where is the avoidance in the implementation of wetland law and policy? *Wetlands Ecology and Management*. https://doi.org/10.1007/s11273-011-9209-3
Clark, N. E., Boakes, E. H., McGowan, P. J. K., Mace, G. M., & Fuller, R. A. (2013). Protected Areas in South Asia Have Not Prevented Habitat Loss: A Study Using Historical Models of Land-Use Change. *PLoS ONE*. https://doi.org/10.1371/journal.pone.0065298
Clarke, P., & Jupiter, S. (2010). Law, custom and community-based natural resource management in Kubulau District (Fiji). *Environmental Conservation*, *37*(1), 98–106. https://doi.org/10.1017/S0376892910000354
Clements, C., Bonito, V., Grober-Dunsmore, R., & Sobey, M. (2012). Effects of small, Fijian community-based marine protected areas on exploited reef fishes. *Marine Ecology Progress Series*, *449*, 233–243. https://doi.org/10.3354/meps09554
Clifton, J., & Majors, C. (2012). Culture, Conservation, and Conflict: Perspectives on Marine Protection Among the Bajau of Southeast Asia. *Society & Natural Resources: An International Journal*, *25*(7), 716–725. https://doi.org/10.1080/08941920.2011.618487
Colfer, C. J. P. (2011). Marginalized Forest Peoples' Perceptions of the Legitimacy of Governance: An Exploration. *World Development*, *39*(12), 2147–2164. https://doi.org/10.1016/j.worlddev.2011.04.012
Conservation International Japan. (2016). GEF-Satoyama Project Fact Sheet. Tokyo: Conservation International Japan. Retrieved from http://gef-satoyama.net/wp/wp-content/uploads/2016/07/GEF-Satoyama-Project-factsheet-2Ed-1.pdf
Convention_on_Wetland. (2008). Ramsar COP10 DR 31, page 2.
Coral Triangle Initiative on Coral Reefs Fisheries and Food Security issuing body. (2009). *Regional plan of action : Coral Triangle Initiative on Coral Reefs, Fisheries and Food Security (CTI-CFF)*. Jakarta: Interim Regional CTI Secretariat. Retrieved from https://nla.gov.au/nla.cat-vn7045714
Cormier, R., Kelble, C. R., Anderson, M. R., Allen, J. I., Grehan, A., & Gregersen, Ó. (2016). Moving from ecosystem-based policy objectives to operational implementation of ecosystem-based management measures. *ICES Journal of Marine Science: Journal Du Conseil*, *74*, fsw181. https://doi.org/10.1093/icesjms/fsw181
Couzens, E., & Honkonen, T. (Eds.). (2011). *International Environmental Lawmaking and Diplomacy Review 2010*. Joensuu, Finland: Department of Law, University of Eastern Finland.
Craik, W., Palmer, D., & Sheldrake, R. (2016). Is Australia's national biosecurity system and the underpinning Intergovernmental Agreement on Biosecurity fit for the future?
Credite Suisse, WWF, & McKinsey & Company. (2014). *Conservation Finance: Moving beyond donor funding toward an investor-driven approach*.
CTI-CFF. (2009). Joint Ministerial Statement on the Coral Triangle Initiative. Port Moresby, Papua New Guinea, Papua New Guinea. Retrieved from http://coraltriangleinitiative.org/sites/default/files/resources/SOM 1 Ministerial Statement.doc
CTI-CFF. (2017a). Governance Working Groups. Retrieved October 20, 2017, from http://www.coraltriangleinitiative.org/governance-working-groups
CTI-CFF. (2017b). Turning the Tide in Marine Conservation – The Women Leaders Forum of the Coral Triangle Initiative on Coral Reefs, Fisheries and Food Security. Retrieved January 16, 2018, from http://www.coraltriangleinitiative.org/news/turning-tide-marine-conservation—-women-leaders-forum-coral-triangle-initiative-coral-reefs-fi
Curran, L. M. (2004). Lowland Forest Loss in Protected Areas of Indonesian Borneo. *Science*, *303*(5660), 1000–1003. https://doi.org/10.1126/science.1091714
DAFF. (2013). *National Food Plan Our food future*. Retrieved from http://www.agriculture.gov.au/ag-farm-food/food/publications/national_food_plan/white-paper?wasRedirectedByModule=true
Damania, R., & Hatch, J. (2005). Protecting Eden: markets or government? *Ecological Economics*, *53*(3), 339–351. https://doi.org/10.1016/j.ecolecon.2004.09.015
Damania, R., Stringer, R., Karanth, K. U. U., & Stith, B. (2003). The Economics of Protecting Tiger Populations : Linking Household Behaviour to Poaching and Prey Depletion. *Land Economics*, *79*, 1–38. https://doi.org/10.2307/3146867

DANIDA. (2007). *Community-Based Natural Resource Management*. *Technical Advisory Service*. Retrieved from http://www.netpublikationer.dk/um/8283/pdf/Technical_note_marts_2007-Community-Base.pdf

Davidson, N. C. (2014). How much wetland has the world lost? Long-term and recent trends in global wetland area. *Marine and Freshwater Research*, *65*(10), 934–941. https://doi.org/10.1071/MF14173

Davies, K. (2015). Ancient and new Legal landscapes: Customary law and climate change, a Vanuatu case study. *Asia Pacific Journal of Environmental Law*, *18*(2013), 43–67.

De-Franco, M. R. B., Torres, D. E. A. V., & Madrid, D. C. J. A. (2014). SDGs Post-2015 Biodiversity & Ecosystem Services. UN Department of Economic and Social Affairs. Retrieved from http://biodiversitysd.blogspot.jp/2015/08/sdgs-post-2015-biodiversity-ecosystem.html

de Koning, M., Parr, J. W. K., Sengchanthavong, S., & Phommasane, S. (2016). PARKS-22.2-de-Koning-et-al-10.2305IUCN.CH_.2016.PARKS-22-2MdK.en_. *Parks*, *22.2*, 27–40.

Deacon, R. T. (2012). Fishery management by harvester cooperatives. *Review of Environmental Economics and Policy*, *6*(2), 258–277.

Department of Tourism Art & Culture. (2013). *World Heritage*. India. Retrieved from http://es.calameo.com/read/00332997247675cccaf1e

Díaz, S., Demissew, S., Carabias, J., Joly, C., Lonsdale, M., Ash, N., Larigauderie, A., Adhikari, J. R., Arico, S., Báldi, A., Bartuska, A., Baste, I. A., Bilgin, A., Brondizio, E., Chan, K. M., Figueroa, V. E., Duraiappah, A., Fischer, M., Hill, R., Koetz, T., Leadley, P., Lyver, P., Mace, G. M., Martin-Lopez, B., Okumura, M., Pacheco, D., Pascual, U., Pérez, E. S., Reyers, B., Roth, E., Saito, O., Scholes, R. J., Sharma, N., Tallis, H., Thaman, R., Watson, R., Yahara, T., Hamid, Z. A., Akosim, C., Al-Hafedh, Y., Allahverdiyev, R., Amankwah, E., Asah, T. S., Asfaw, Z., Bartus, G., Brooks, A. L., Caillaux, J., Dalle, G., Darnaedi, D., Driver, A., Erpul, G., Escobar-Eyzaguirre, P., Failler, P., Fouda, A. M. M., Fu, B., Gundimeda, H., Hashimoto, S., Homer, F., Lavorel, S., Lichtenstein, G., Mala, W. A., Mandivenyi, W., Matczak, P., Mbizvo, C., Mehrdadi, M., Metzger, J. P., Mikissa, J. B., Moller, H., Mooney, H. A., Mumby, P., Nagendra, H., Nesshover, C., Oteng-Yeboah, A. A., Pataki, G., Roué, M., Rubis, J., Schultz, M., Smith, P., Sumaila, R., Takeuchi, K., Thomas, S., Verma, M., Yeo-Chang, Y., & Zlatanova, D. (2015). The IPBES Conceptual Framework — connecting nature and people. *Current Opinion in Environmental Sustainability*, *14*, 1–16. Retrieved from http://www.sciencedirect.com/science/article/pii/S187734351400116X

Dicks, B. L. V, Viana, B., Bommarco, R., Brosi, B., Arizmendi, C., Cunningham, S. A., Galetto, L., Hill, R., Lopes, V., Pires, C., & Taki, H. (2016). What governments can do to safeguard pollination services. *Science*, *354*(6315).

Dixon, J. A. (1993). Economic benefits of marine protected areas. *Oceanus*, *(Fall)*, 35–40.

Dixon, M. J. R., Loh, J., Davidson, N. C., Beltrame, C., Freeman, R., & Walpole, M. (2016). Tracking global change in ecosystem area: The Wetland Extent Trends index. *Biological Conservation*, *193*, 27–35. https://doi.org/10.1016/j.biocon.2015.10.023

DoF. (2017). *Silviculture for Forest Management. Proceedings of the First National Silviculture Workshop, Kathmandu, Nepal, 19-21 February 2017*. Retrieved from https://ifro.ku.dk/english/research/projects/projects_development/scifor/newsbxjune2014/conferences/Proceedings_SilviWS_2017.pdf

Dong, S., Chettri, N., Sharma, E., Dong, S., Chettri, N., & Sharma ICIMOD, B. E. (2017). Himalayan Biodiversity: Trans-boundary Conservation Institution and Governance. In S. Dong, J. Bandyopadhyay, & S. Chaturvedi (Eds.), *Environmental Sustainability from the Himalayas to the Oceans : Struggles and Innovations in China and India* (pp. 127–129). Switzerland: Springer International Publishing. https://doi.org/10.1007/978-3-319-44037-8_6

Dore, J., Lebel, L., & Molle, F. (2012). A framework for analysing transboundary water governance complexes, illustrated in the Mekong Region. *Journal of Hydrology*. https://doi.org/10.1016/j.jhydrol.2012.07.023

Drew, J. A. (2005). Use of traditional ecological knowledge in marine conservation. *Conservation Biology*, *19*(4), 1286–1293. https://doi.org/10.1111/j.1523-1739.2005.00158.x

Dulay, M. P. (2015). Indigenous Agroforestry Systems of Ifugao , Philippines, *5*(1), 45–51. https://doi.org/10.5923/j.re.20150501.04

Dung, N. T., & Webb, E. L. (2008). Incentives of the forest land allocation process: implications for forest management in Nam Dong district, Central Vietnam. In G. Webb, E.L. and Shivakoti (Ed.), *Decentralization, Forests and Rural Communities: Policy Outcomes in South and Southeast Asia.* (pp. 269–291). SAGE Publications.

Eagles, P. F. J., Bowman, M. E., & Tao, T. C.-H. (2001). *Guidelines for Tourism in Parks and Protected Areas of East Asia IUCN – The World Conservation Union*.

Ebeling, J., & Yasue, M. (2008). Generating carbon finance through avoided deforestation and its potential to create climatic, conservation and human development benefits. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *363*(1498), 1917–1924. https://doi.org/10.1098/rstb.2007.0029

EcoShape. (2017). Building with Nature. Retrieved from https://www.ecoshape.org/en/

Ecosystem Marketplace. (2013). *Maneuvering the Mosaic: State of the Voluntary Carbon Markets 2013*.

Edwards, K., Scheyvens, H., Stephenson, J., & Fujisaki, T. (2014). Community based forest biomass monitoring: A manual for training local level facilitators. Hayama: IGES. https://pub.iges.or.jp/pub/community-based-forest-biomass-monitoring-0

Emerton, L. (2000). Using Economic Incentives for Biodiversity Conservation. IUCN – The World Conservation Union. Retrieved from https://portals.iucn.org/library/efiles/edocs/PDF-2000-002.pdf

Engel, S., Pagiola, S., & Wunder, S. (2008). Designing Payments for Environmental Services in Theory and Practice: An Overview of the Issues. https://doi.org/10.1016/j.ecolecon.2008.03.011

Evans, L., Cherrett, N., & Pemsl, D. (2011). Assessing the impact of fisheries co-management interventions in developing countries: A meta-analysis. *Journal of Environmental Management*, *92*(8), 1938–1949. https://doi.org/10.1016/j.jenvman.2011.03.010

Fabinyi, M. (2016). Sustainable seafood consumption in China. *Marine Policy, 74*(June), 85–87. https://doi.org/10.1016/j.marpol.2016.09.020

FAO. (2003). *Fisheries Management 2: The Ecosystem Approach to Fisheries* (FAO Technical Guidelines for Responsible Fisheries 4-Suppl.2). Rome. Retrieved from file:///C:/Users/okayasu/AppData/Local/Mendeley Ltd./Mendeley Desktop/Downloaded/FAO - 2003 - Fisheries Management 2 The Ecosystem Approach to Fisheries.pdf

FAO. (2010). *Forestry policies, legislation and institutions in Asia and the Pacific Trends and emerging needs for 2020* (Working Paper Series No. APFSOS II/WP/2010/34). Bangkok, Thailand.

FAO. (2013). ISPM 15: Regulation of wood packaging material in international trade, (2009), 1–20. Retrieved from https://www.ippc.int/sites/default/files/documents/20131115/ispm_15_2009_en_2013-11-15_2013111509:00--504.61 KB.pdf

FAO. (2015a). *Regional Overview of Food Insecurity. Asia and the Pacific. Towards a Food Secure Asia and the Pacific*. Bangkok, Thailand. Retrieved from http://www.fao.org/3/a-i4624e.pdf

FAO. (2015b). *Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries in the Context of Food Security and Poverty Eradication*. Rome. Retrieved from http://www.fao.org/3/a-i4356e.pdf

FAO. (2016). *The State of World Fisheries and Aquaculture 2016. Contributing to food security and nutrition for all*. Rome. Retrieved from http://www.fao.org/3/a-i5555e.pdf

FAO. (2017). *The future of food and agriculture – Trends and challenges*. Rome.

Farrier, D. (2003). Emerging Patterns in Environmental Legislation in Pacific Island Countries. *Journal of South Pacific Law*, *7*(1).

Ferraro, P. J., Hanauer, M. M., Miteva, D. a, Canavire-Bacarreza, G. J., Pattanayak, S. K., & Sims, K. R. E. (2013). More strictly protected areas are not necessarily more protective: evidence from Bolivia, Costa Rica, Indonesia, and Thailand. *Environmental Research Letters*, *8*(2), 025011. https://doi.org/10.1088/1748-9326/8/2/025011

Ferraro, P. J., Hanauer, M. M., & Sims, K. R. E. (2011). Conditions associated with protected area success in conservation and poverty reduction. *Proceedings of the National Academy of Sciences of the United States of America*, *108*(34), 13913–13918. https://doi.org/10.1073/pnas.1011529108

Ferse, S. C. a., Máñez Costa, M., Máñez, K. S., Adhuri, D. S., & Glaser, M. (2010). Allies, not aliens: increasing the role of local communities in marine protected area implementation. *Environmental Conservation*, *37*(Laffoley 2008), 23–34. https://doi.org/10.1017/S0376892910000172

Fitzherbert, E. B., Struebig, M. J., Morel, A., Danielsen, F., Brühl, C. A., Donald, P. F., & Phalan, B. (2008). How will oil palm expansion affect biodiversity? *Trends in Ecology and Evolution*, *23*(10), 538–545. https://doi.org/10.1016/j.tree.2008.06.012

Foale, S., & Manele, B. (2004). Social and political barriers to the use of Marine Protected Areas for conservation and fishery management in Melanesia. *Asia Pacific Viewpoint*. https://doi.org/10.1111/j.1467-8373.2004.00247.x

Ford, J., & Martinez, D. (2000). Traditional ecological knowledge, ecosystem science, and environmental management. *Ecological Applications*, *10*(5), 1249–1250. https://doi.org/10.1017/CBO9781107415324.004

Forest Trends, & The Katoomba Group. (2010). *Payments for Ecosystem Services: Getting Started in Marine and Coastal Ecosystems A Primer Payments for Ecosystem Services: Getting Started in Marine and Coastal Ecosystems: A Primer*. Retrieved from http://www.forest-trends.org/documents/files/doc_2374.pdf

Foronda, A. C. T. M. (2013). *An Urgent Need: Institutionalizing Access to Genetic Resources and Benefit Sharing in Southeast Asia*. Retrieved from http://www.aseanbiodiversity.org/index.php?option=com_phocadownload&view=category&id=5&Itemid=117&current=110

Frank, D. J., Longhofer, W., & Schofer, E. (2007). World Society, NGOs and Environmental Policy Reform in Asia. *International Journal of Comparative Sociology*, *48*(4), 275–295. https://doi.org/10.1177/0020715207079530

Garaway, C., & Esteban, N. (2002). The impact of marine protected areas on poorer communities living in and around them: institutional opportunities and constraints: Appendix 1 – methodology for case study fieldwork. *DFID NRSP PROJECT R7976*, (December).

Garcia, S. (1996). Indicators for Sustainable Development of Fisheries. In *2nd World Fisheries Congress. Workshop on Fisheries Sustainability Indicators. Brisbane, Australia, August, 1996*. Rome, Italy: FAO. Retrieved from http://www.fao.org/docrep/W4745E/w4745e0f.htm

Garcia, S. M., Rice, J., & Charles, A. (2014). *Governance of Marine Fisheries and Biodiversity Conservation: Interaction and Co-evolution*. *Governance of Marine Fisheries and Biodiversity Conservation: Interaction and Co-evolution* (Vol. 9781118392). Wiley Blackwell.

Gardner, R.C., Barchiesi, S., Beltrame, C., Finlayson, C.M., Galewski, T., Harrison, I., Paganini, M., Perennou, C., Pritchard, D.E., Rosenqvist, A., and Walpole, M. 2015. (2015). State of the World ' s Wetlands and their Services to People : A compilation of recent analyses. *Ramsar Briefing Note*, *no. 7*(June), 1–20. https://doi.org/10.2139/ssrn.2589447

Gardner, C. J., Nicoll, M. E., Mbohoahy, T., Oleson, K. L. L., Ratsifandrihamanana, A. N., Ratsirarson, J., René de Roland, L. A., Virah-Sawmy, M., Zafindrasilivonona, B., & Davies, Z. G. (2013). Protected areas for conservation and poverty alleviation: Experiences from Madagascar. *Journal of Applied Ecology*, *50*(6), 1289–1294. https://doi.org/10.1111/1365-2664.12164

Gardner, T. A., Von Hase, A., Brownlie, S., Ekstrom, J. M. M., Pilgrim, J. D., Savy, C. E., Stephens, R. T. T., Treweek, J., Ussher, G. T., Ward, G., & Ten Kate, K. (2013). Biodiversity Offsets and the Challenge of Achieving No Net Loss. *Conservation Biology*, *27*(6), 1254–1264. https://doi.org/10.1111/cobi.12118

Garnett, T., Appleby, M. C., Balmford, A., Bateman, I. J., Benton, T. G., Bloomer, P., Burlingame, B., Dawkins, M., Dolan, L., Fraser, D., Herrero, M., Hoffmann, I., Smith, P., Thornton, P. K., Toulmin, C., Vermeulen, S. J., & Godfray, H. C. J. (2013). Sustainable Intensification in Agriculture: Premises and Policies. *Science*, *341*(6141), 33–34. https://doi.org/10.1126/science.1234485

Gautam, A. P., & Shivakoti, G. P. (2008). Evolution, Impacts and Challenges of Community-based Forestry in Nepal. In G. Webb, E.L. and Shivakoti (Ed.), *Decentralization, Forests and Rural Communities: Policy Outcomes in Southeast Asia* (pp. 150–176). SAGE Publications.

GCF. (2015). *Environmental and Social Safeguards at the Green Climate Fund*. *Green Climate Fund Handbook*.

Gehring, T. (2006). *Institutional interaction in global environmental governance: Synergy and conflict among international and EU policies*. Retrieved from https://books.google.co.jp/books?hl=ja&lr=&id=JqYRtzFcZHUC&oi=fnd&pg=PR7&dq=institutional+interaction+in+global+environmental+governance&ots=X8RDt2T4_w&sig=5cKdbRgQeE0VxynY_avvkoW5U4o

Gehring, T., & Oberthür, S. (2008). Interplay: Exploring Institutional Interaction. In O. Young, L. A. King, & H. Schroeder (Eds.), *Institutions and Environmental Change: Principal Findings, Applications, and Research Frontiers* (pp. 187–223). Massachusets: Cambridge University Press.

Gell, F. R., & Roberts., C. M. (2003). The Fishery Effects of Marine Reserves and Fishery Closures. *WWF-US, 1250 24th Street, NW, Washington, DC 20037, USA.*

Ghazoul, J. (2001). Barriers to Biodiversity Conservation in Forest Certification. *Conservation Biology*, *15*(2), 315–317. Retrieved from http://www.jstor.org/stable/2641828?seq=1#page_scan_tab_contents

Gillett, R. (2009). Fisheries in the economies of the Pacific island countries and territories. *Mandaluyong City, Philippines: Asian Development Bank.*, 521 pp.

Gilligan, B. (2006). *The Indigenous Protected Areas Programme 2006 Evaluation*. Canberra. Retrieved from https://www.environment.gov.au/indigenous/publications/pubs/ipap-evaluation.pdf

GIZ (n.d.). Sustainable certified coconut oil, https://www.giz.de/en/worldwide/54556.html

Glaser, M., Breckwoldt, A., Deswandi, R., Radjawali, I., Baitoningsih, W., & Ferse, S. C. A. (2015). Of exploited reefs and fishers - A holistic view on participatory coastal and marine management in an Indonesian archipelago. *Ocean and Coastal Management*, *116*, 193–213. https://doi.org/10.1016/j.ocecoaman.2015.07.022

Göcke, K. (2013). Protection and Realization of Indigenous Peoples' Land Rights at the National and International Level. *Goettingen Journal of International Law*, *1*(5), 87–154. https://doi.org/10.3249/1868-1581-5-1-goecke

Goka, K. (2010). Biosecurity measures to prevent the incursion of invasive alien species into Japan and to mitigate their impact. *Rev. Sci. Tech. Off. Int. Epiz*, *29*(2), 299–310.

Goka, K., Okabe, K., & Takano, A. (2013). Recent cases of invasive alien mites and ticks in Japan: Why is a regulatory framework needed? *Experimental and Applied Acarology*, *59*(1–2), 245–261. https://doi.org/10.1007/s10493-012-9609-y

Gordon, A., Bull, J. W., Wilcox, C., & Maron, M. (2015). FORUM: Perverse incentives risk undermining biodiversity offset policies. *Journal of Applied Ecology*, *52*(2), 532–537. https://doi.org/10.1111/1365-2664.12398

Gore, T., Ozdemiroglu, E., Eadson, W., Gianferrara, E., & Phang, Z. (2013). *Green Infrastructure's contribution to economic growth: a review*. https://doi.org/10.5367/te.2013.0211

Govan, H. (2009). *Status and potential of locally-managed marine areas in the South Pacific: meeting nature conservation and sustainable livelihood targets through wide-spread implementation of LMMAs*. *Coral Reef Initiatives for the Pacific*.

Govan, H. (2015). *Area-Based Management Tools for Coastal Resources in Fiji, Kiribati, Solomon Islands, Tonga And Vanuatu. Volume 1: Status, capacity and prospects for collaborative resource management. Volume 2: Country reports*. *Report for the Marine and Coastal Biodiversity Management in Pacific Island Countries (MACBIO) project*. Suva, Fiji Islands.

Govan, H., Tawake, A., & Tabunakawai, K. (2006). Community-based marine resource management in the South Pacific. *Parks*, *16*(1), 63–67.

Government of Dubai. (2013). *Green Building Regulations & Specifications*. *Government of Dubai*.

Government of Dubai, & Dubai Municipality. Al Sa'fat- Dubai Green Building Evaluation System, Version 1. § (2016).

Government of Indonesia. (2012). REDD+ national strategy. *Indonesian REDD+ Task Force*, (June), 4–44.

Grogan, P., Lalnunmawia, F., & Tripathi, S. K. (2012). Shifting cultivation in steeply sloped regions: A review of management options and research priorities for Mizoram state, Northeast India. *Agroforestry Systems*. https://doi.org/10.1007/s10457-011-9469-1

Gruby, R. L., & Basurto, X. (2014). Multi-level governance for large marine commons: Politics and polycentricity in Palau's protected area network. *Environmental Science and Policy*, *36*, 48–60. https://doi.org/10.1016/j.envsci.2013.08.001

Grumbine, R. E., Dore, J., & Xu, J. (2012). Mekong hydropower: Drivers of change and governance challenges. *Frontiers in Ecology and the Environment*. https://doi.org/10.1890/110146

Gullison, R. E. (2003). Does forest certification conserve biodiversity? *Oryx*, *37*(02), 153–165. https://doi.org/10.1017/S0030605303000346

Gunatilake, H., & De Guzman, F. D. (2008). Market-based approaches for managing the Asian environment: A review. *ADB Economics Working Paper Series*, *124*(124), 1–42.

Gunningham, N., & Sinclair, D. (1999). Regulatory Pluralism: Designing Policy Mixes for Environmental Protection. *Law & Policy*, *21*(1), 49–76. https://doi.org/10.1111/1467-9930.00065

Gutiérrez, N. L., Hilborn, R., & Defeo, O. (2011). Leadership, social capital and incentives promote successful fisheries. *Nature*, *470*(7334), 386–389. https://doi.org/10.1038/nature09689

Guzman, A. B. de. (2004). A Fishery in Transition: Impact of a Community Marine Reserve on a Coastal Fishery in Northern Mindanao, Philippines. *EEPSEA Research Report 2004-RR6*.

Haaland, C., & Konijnendijk Van Den Bosch, C. (2015). Challenges and strategies for urban green - space planning in cities undergoing densification : a review 2 3, 1–39. https://doi.org/10.1016/j.ufug.2015.07.009

Haase, D., Frantzeskaki, N., & Elmqvist, T. (2014). Ecosystem services in urban landscapes: Practical applications and governance implications. *Ambio*, *43*(4), 407–412. https://doi.org/10.1007/s13280-014-0503-1

Hamdy, A., & Aly, A. (2014). Land degradation, agriculture productivity and food security. In *Fifth International Scientific Agricultural Symposium. Agrosym 2014.* Sarajevo.

Hamilton, K. E. (2013). *Biodiversity and National Accounting* (Policy Research working paper; no. WPS 6441). Washington, DC. Retrieved from http://documents.worldbank.org/curated/en/972551468181726417/Biodiversity-and-national-accounting

Handayani, A. P. (2010). Oil Palm, Biodiversity and Indonesian Law Wildlife Conservation Society - Indonesia Program Oil Palm, Biodiversity and Indonesian Law.

Hargreaves-Allen, V. (2004). *Estimating the Total Economic Value of Coral Reefs for Residents of Sampela, a Bajau Community in Wakatobi Marine National, Sulawesi: A Case Study*. London.

Hashim, M., Ito, S., Numata, S., Hosaka, T., Hossain, M. S., Misbari, S., Yahya, N. N., & Ahmad, S. (2017). Using fisher knowledge, mapping population, habitat suitability and risk for the conservation of dugongs in Johor Straits of Malaysia. *Marine Policy, 78*(July 2016), 18–25. https://doi.org/10.1016/j.marpol.2017.01.002

Hayashi, K. (2010). *Economic Incentives for Green Initiatives in Nagoya city , Japan*.

Hedge, P., Molloy, F., Sweatman, H., Hayes, K. R., Dambacher, J. M., Chandler, J., Bax, N., Gooch, M., Anthony, K., & Elliot, B. (2017). An integrated monitoring framework for the Great Barrier Reef World Heritage Area. *Marine Policy*, *77*, 90–96. https://doi.org/10.1016/j.marpol.2016.12.014

Heilmann, D. (2015). After Indonesia's Ratification: The ASEAN Agreement on Transboundary Haze Pollution and Its Effectiveness as a Regional Environmental Governance Tool. *Journal of Current Southeast Asian Affairs*, 95–121.

Hodgson, G. M. (1997). Economics, Environmental Policy, and the Transcendence of Utilitarianism. In *Valuing nature? Economics, Ethics, and Environment* (pp. 48–63). London: Routledge.

Hoekstra, J. M., Boucher, T. M., Ricketts, T. H., & Roberts, C. (2004). Confronting a biome crisis: global disparities of habitat loss and protection. *Ecology Letters*, *8*(1), 23–29. https://doi.org/10.1111/j.1461-0248.2004.00686.x

Holling, C. S. (1986). The Resilience of Terrestrial ecosystems. *Sustainable of Terrestrial Ecosystems*.

Hoq, M. E. (2007). An analysis of fisheries exploitation and management practices in Sundarbans mangrove ecosystem, Bangladesh. *Ocean and Coastal Management*, *50*(5–6), 411–427. https://doi.org/10.1016/j.ocecoaman.2006.11.001

Hossain, S. T. (2012). Organic farming in populated area: Bangladesh - an example of case study, 105–113.

Hu, N.-T. A. (2012). Integrated Oceans Policymaking: An Ongoing Process or a Forgotten Concept? *Coastal Management*, *40*(2), 107–118. https://doi.org/10.1080/08920753.2012.652506

Hu, S., Niu, Z., Chen, Y., Li, L., & Zhang, H. (2017). Global wetlands: Potential distribution, wetland loss, and status. *Science of the Total Environment*, *586*, 319–327. https://doi.org/10.1016/j.scitotenv.2017.02.001

Hughes, S., Yau, A., Max, L., Petrovic, N., Davenport, F., Marshall, M., McClanahan, T. R., Allison, E. H., & Cinner, J. E. (2012). A framework to assess national level vulnerability from the perspective of food security: The case of coral reef fisheries. *Environmental Science and Policy*, *23*, 95–108. https://doi.org/10.1016/j.envsci.2012.07.012

Hunnam, P., Brodnig, G., Khawar, H., & Khan, M. M. (2003). *Mid-term Evaluation Report on Mountain Areas Conservancy Project, Pakistan*.

Huntley, B. J., & Redford, K. H. (2014). *Mainstreaming biodiversity in Practice: a STAP advisory document*. Washington D.C.

Huppes, G., & Simonis, U. E. (2009). Enviromental Policy Instruments. In J. J. Boersema & L. Reijnders (Eds.), *Principles of Environmental Sciences* (p. 241). Springer.

Hussain, M. G., & Hoq, M. E. (Eds.). (2010). *Sustainable Management of Fisheries Resources of the Bay of Bengal - Compilation of national and regional workshop reports* (SBOBLMEP P). Support to Sustainable Management of the BOBLME Project, Bangladesh Fisheries Research Institute. Retrieved from http://www.boblme.org/documentRepository/BOB Bangladesh Report.pdf

Hviding, E. (2006). Knowing and managing biodiversity in the Pacific Islands: challenges of environmentalism in Marovo Lagoon. *International Social Science Journal*. https://doi.org/10.1111/j.1468-2451.2006.00602.x

Ibrahim, R. (2016). *Towards a sustainable landscape of urban parks in Kuala Lumpur , Malaysia : A study from a management perspective*. University of Sheffield.

ICIMOD. (2008). Regional Framework on Access and Benefit Sharing (ABS) in the Himalayan Region. International Centre for Integrated Mountain Development (ICIMOD).

ICLEI. (2016). Annual Report 2016.

Idajati, H., Pamungkas, A., & Vely Kukinul, S. (2016). The Level of Participation in Mangrove Ecotourism Development, Wonorejo Surabaya. *Procedia - Social and Behavioral Sciences*, *227*(November 2015), 515–520. https://doi.org/10.1016/j.sbspro.2016.06.109

IFAD. (2004). *Enhancing the Role of Indigenous Women in Sustainable Development*. *Third Session of the Permanent Forum on Indigenous Issues*.

IFAD. (2006). *Community-based natural resource management How knowledge is managed , disseminated and used*. Retrieved from https://www.ifad.org/documents/10180/91e476ea-679a-46f0-9e0f-5240e0bf1acb

IGES. (2016). *The Satoyama Development Mechanism 2015*. Hayama, Japan. Retrieved from https://pub.iges.or.jp/system/files/publication_documents/pub/newsletter/5530/SDM2015_web_0704.pdf

IIED, n.d. Programme for the Endorsement of Forest Certification (PEFC), https://shapingsustainablemarkets.iied.org/programme-endorsement-forest-certification-pefc

Institute for Global Environmental Strategies. (2008). *Climate change policies in the Asia-Pacific: Re-uniting climate change and sustainable development*. Kanagawa, Japan: Institute for Global Environmental Strategies.

International Fund for Agricultural Development (2005) Organic Agriculture and Poverty Reduction in Asia: China and India focus. 134p.

International Plant Protection Convention. (2017). Adapted international standards for phytosanitary measures. Retrieved from https://www.ippc.int/core-activities/standards-setting/ispms

International Social Work. (2014). Global Agenda for Social Work and Social Development: First report - promoting social and economic equalities. *International Social Work*, *57*(4 Suppl), 3–16. https://doi.org/10.1177/0020872814534139

IOC. (2007). *National Ocean Policy. The Basic Texts from: Australia, Brazil, Canada, China, Colombia, Japan, Norway, Portugal, Russian Federation, United States of America*. Paris: UNESCO.

IPSI (International Partnership for the Satoyama Initiative). (2010). Satoyama Initiative. Retrieved from http://satoyama-initiative.org/about/

Islam, M. S. N., & Gnauck, A. (2009). Threats to the Sundarbans Mangrove Wetland Ecosystems from Transboundary Water Allocation in the Ganges Basin: A Preliminary Problem Analysis. *International Journal of Ecological Economics and Statistics*, *13*, 64–78. Retrieved from http://ceser.in/ceserp/index.php/ijees/issue/archive%5Cnhttp://search.ebscohost.com/login.aspx?direct=true&db=eoh&AN=1047867&lang=fr&site=ehost-live

ITTO. (2005). Revised ITTO criteria and indicators for the sustainable management of tropical forests including reporting format. ITTO Policy Development Series No.15, (15).

IUCN-WAME. (2007). *Conservation Efforts in West Asia - Annual Report 2007*. Retrieved from http://cmsdata.iucn.org/downloads/iucn_annual_report_4web.pdf

IUCN. (2014). IUCN – Marriott Partnership in Thailand, (March), 0–1.

IUCN. (2015). *Annual Report 2009 At a glance*.

IUCN. (2017). Draft Guidelines for Recognizing and Reporting Other Effective Area-Based Conservation Measures (OECMs). IUCN-World Commission on Protected Areas Task Force on Other Effective Area-based Conservation Measures. Retrieved from https://www.iucn.org/sites/dev/files/content/documents/guidelines_on_oecms_-_consultation_draft_incorporating_vancouver_inputs_-_april_2017.docx

IUCN SSC. (2012). IUCN SSC Guiding Principles on Trophy Hunting as a Tool for Creating Conservation Incentives. Gland: IUCN.

IUFRO. (2012). *Understanding relationships between biodiversity, carbon, forests and people: the key to achieving REDD+ objectives. A global assessment report prepared by the Global Forest Expert Panel on Biodiversity, Forest Management and REDD+*. (J. a Parrotta, C. Wildburger, & S. Mansourian, Eds.), *IUFRO World Series* (Vol. 31). https://doi.org/1016-3263

Iwasaki, S. (2014). Driving forces of the long-enduring institutional mechanism of Padu system in Negombo Lagoon, Sri Lanka. *Marine Policy*, *50*, 190–196. https://doi.org/10.1016/j.marpol.2014.05.020

Janečka, J. E., Munkhtsog, B., Jackson, R. M., Naranbaatar, G., Mallon, D. P., & Murphy, W. J. (2011). Comparison of noninvasive genetic and camera-trapping techniques for surveying snow leopards. *Journal of Mammalogy*, *92*(4), 771–783. https://doi.org/10.1644/10-MAMM-A-036.1

Jay, M., M, M., & A, B. (2003). Biosecurity, a biodiversity policy dilemma for New Zealand. *Land Use Policy*, *64*(7), 121–129.

Jenkins, A. P., Jenkins, C. L., & Reynolds., J. B. (2007). Successes and challenges of managing coral reefs in Papua New Guinea through locally managed marine areas. . *Alternate Visions LLC. 7 Pp., Accessed 1*.

Jentoft, S. (1989). Fisheries co-management: delegating government responsibility to fishermen's organizations. *Marine Policy*, *13*, 137–154.

Johan Rockström, & Pavan Sukhdev. (2016). How food connects all the SDGs - Stockholm Resilience Centre. Retrieved September 15, 2017, from http://www.stockholmresilience.org/research/research-news/2016-06-14-how-food-connects-all-the-sdgs.html

Johannes, R. E. (1984). Marine conservation in relation to traditional life-styles of tropical artisanal fishermen. *The Environmentalist*, *4*, *Supplem*(7), 30–48. Retrieved from http://www.sciencedirect.com/science/article/B7P6N-4F20033-4Y/2/f5f30f5ffa2804c6bf0bbc4172a001cd

Johannes, R. E. (1998). The case for data-less marine resource management: Examples from tropical nearshore finfisheries. *Trends in Ecology and Evolution*, *13*(6), 243–246. https://doi.org/10.1016/S0169-5347(98)01384-6

Johannes, R. E. (2002). the Renaissance of Community-Based Marine Resource Management in Oceania. *Annual Review of Ecology and Systematics*, *33*(1), 317–340. https://doi.org/10.1146/annurev.ecolsys.33.010802.150524

Johannes, R. E., & Hickey, F. R. (2004). *Evolution of village-based marine resource management in Vanuatu*. *Coastal region and small island papers 15, UNESCO,*. Paris.

John-O. (2007). Reducing Carbon Emissions from Deforestation in the Ulu Masen Ecosystem, Aceh, Indonesia ~ A Triple-Benefit Project Design Note for CCBA Audit ~.

Jones, R. S., & Yoo, B. (2011). Korea's Green Growth Strategy MITIGATING CLIMATE CHANGE AND DEVELOPING NEW GROWTH ENGINES. *OECD Economics Department Working Papers* , (798). https://doi.org/10.1787/5kmbhk4gh1ns-en

Juffe-Bignoli, D., Burgess, N. D., Bingham, H., Belle, E. M. S., de Lima, M. G., Deguignet, M., Bertzky, B., Milam, a N., Martinez-Lopez, J., Lewis, E., Eassom, A., Wicander, S., Geldmann, J., van Soesbergen, A., Arnell, a P., O'Connor, B., Park, S., Shi, Y. N., Danks, F. S., MacSharry, B., & Kingston, N. (2014). *Protected Planet Report 2014*. *Protected Planet Report*. Cambridge, UK: UNEP-WCMC. https://doi.org/DEW/1233/CA

Juffe-Bignoli, D., Harrison, I., Butchart, S. H. M., Flitcroft, R., Hermoso, V., Jonas, H., Lukasiewicz, A., Thieme, M., Turak, E., Bingham, H., Dalton, J., Darwall, W., Deguignet, M., Dudley, N., Gardner, R., Higgins, J., Kumar, R., Linke, S., Milton, G. R., Pittock, J., Smith, K. G., & van Soesbergen, A. (2016). Achieving Aichi Biodiversity Target 11 to improve the performance of protected areas and conserve freshwater biodiversity. *Aquatic Conservation: Marine and Freshwater Ecosystems*, *26*, 133–151. https://doi.org/10.1002/aqc.2638

Jungcurt, S. (2016). Living with Harmony with Nature to Transform our World: the CBD's Contribution to SDG implementation. Retrieved from http://sd.iisd.org/policy-updates/living-in-harmony-with-nature-to-transform-our-world-the-cbds-contribution-to-sdg-implementation/

Jupp, T., Fitzsimons, J., Carr, B., & See, P. (2015). New partnerships for managing large desert landscapes: Experiences from the Martu Living Deserts Project. *Rangeland Journal*, *37*(6), 571–582. https://doi.org/10.1071/RJ15047

Kaczensky, P., Enkhsaikhan, N., Ganbaatar, O., & Walzer, C. (2008). The Great Gobi B Strictly Protected Area in Mongolia - refuge or sink for wolves Canis lupus in the Gobi? *Wildlife Biology*, *14*(4), 444–456. https://doi.org/10.2981/0909-6396-14.4.444

Kaczensky, P., Ganbaatar, O., Von Wehrden, H., & Walzer, C. (2008). Resource selection by sympatric wild equids in the Mongolian Gobi. *Journal of Applied Ecology*, *45*, 1762–1769. https://doi.org/10.1111/j.1365-2664.2007.0@@@@.x

Kakakhel, S. (2012). Environmental Challenges in South Asia. *ISAS Insights*, (189), 1–10. Retrieved from https://www.files.ethz.ch/isn/154116/ISAS_Insight_189_-_Environmental_Challenges_in_South_Asia_19102012221512.pdf

Karim, M. S. (2008a). Future of the Haze Agreement– Is the Glass Half Empty or Half Full?'. *Environmental Policy and Law*.

Karim, M. S. (2008b). UNCLOS and Regional Action for Protection of the Marine Environment: Perspectives of the South Asian Seas Regio. *Bangladesh Institute of International and Strategic Studies Journal*, *29*, 415–430.

Karim, M. S. (2009). Implementation of the MARPOL Convention in Bangladesh. *Macquarie Journal of International and Comparative Environmental Law*, *5*.

Karim, M. S. (2017). The Biodiversity Act, 2017: A Concise Overview. In A. Al Faruque & Chowdhury M Jashim Ali (Eds.), *New Dimensions of Law: Analysis of Selected Laws of Bangladesh* (pp. 95–102). Chittagong: University of Chittagong.

Karmebäck, V. N., Wairore, J. N., Jirström, M., & Nyberg, G. (2015). Assessing gender roles in a changing landscape: diversified agro-pastoralism in drylands of West Pokot, Kenya. *Pastoralism*, *5*(1), 21. https://doi.org/10.1186/s13570-015-0039-4

Kato, K., & Takahashi, W. (2000). *An Overview of Regional/Subregional Environmental Cooperation In Asiaand the Pacific*. Retrieved from https://pub.iges.or.jp/system/files/publication_documents/pub/discussionpaper/923/overview_asia_pacific.pdf

Kazmierczak, A., & Carter, J. (2010). *Adaptation to climate change using green and blue infrastructure: A database of case studies*. Manchester. Retrieved from http://orca.cf.ac.uk/64906/1/Database_Final_no_hyperlinks.pdf

Kerkhoff, E, E., & Sharma, E. (2006). *Debating shifting cultivation in the eastern Himalayas: Farmer's innovations as lessons for policy*. (A. K. T. A. Beatrice Murray, Dharma R. Maharjan, Ed.). Kathmandu, Nepal. Retrieved from http://lib.icimod.org/record/7409/files/attachment_19.pdf

Kijtewachakul, N., Shivakoti, G. P., & Webb, E. L. (2008). Evolution of Community-based Management and Forest Health in Northern Thailand: Case Study of Nahai and Huai-muang Villages in Sopsai Watershed, Thawangpa District, Nan Province. In G. Webb, E.L. and Shivakoti (Ed.), *Decentralization, Forests and Rural Communities: Policy Outcomes in Southeast Asia* (pp. 232–268). SAGE Publications.

Kim, C.-G., & Lim, S. S. (2015). An Evaluation of the Environmentally Friendly Direct Payment Program in Korea*. *Journal of International Economic Studies*, (29), 3–22.

Kinch, J., Anderson, P., Richards, E., Talouli, A., Vieux, C., Peteru, C., & Suaesi, T. (2010). *Outlook Report on the State of the Marine Biodiversity in the Pacific Islands Region Outlook Report on the State of the Marine Biodiversity in the Pacific Islands Region SPREP Library/IRC Cataloguing-in-Publication Data*. *SPREP*. Retrieved from https://wedocs.unep.org/rest/bitstreams/16345/retrieve

Kingdom of Cambodia. (2010). The National Green Growth Roadmap, (March 2010), 57.

Kissinger, G., Patterson, C., & Neufeldt, H. (2013). *Payments for ecosystem services schemes: project-level insights on benefits for ecosystems and the rural poor* (ICRAF Working Paper No. 172). Nairobi, Kenya. Retrieved from http://dx.doi.org/10.5716/WP13001.PDF

Kittinger, J. N. (2013). Human Dimensions of Small-Scale and Traditional Fisheries in the Asia-Pacific Region. *Pacific Science*, *67*(3), 315–325. https://doi.org/10.2984/67.3.1

Knowlton, N. (2001). The future of coral reefs. *Proceedings of the National Academy of Sciences*, *98*(10), 5419–5425. https://doi.org/10.1073/pnas.091092998

Knuth, L. (2006). *Greening cities for improving urban livelihoods: Legal, policy and institutional aspects of urban and peri-urban forestry in West and Central Asia*. *FAO Livelihood Support Programme, LSP Working Paper 37*. Retrieved from http://www.fao.org/forestry/15803-084381c53bd202e5c270652af25bbe368.pdf

Koczberski, G., & Curry, G. N. (2005). Making a living: Land pressures and changing livelihood strategies among oil palm settlers in Papua New Guinea. *Agricultural Systems*, *85*(3 SPEC. ISS.), 324–339. https://doi.org/10.1016/j.agsy.2005.06.014

Koetz, T., Bridgewater, P., van den Hove, S., & Siebenhüner, B. (2008). The role of the Subsidiary Body on Scientific, Technical and Technological Advice to the Convention on Biological Diversity as science–policy interface. *Environmental Science & Policy*, *11*(6), 505–516. Retrieved from http://www.sciencedirect.com/science/article/pii/S1462901108000464

Koh, K.-L., & Karim, M. S. (2012). South East Asian Environmental Legal Governance. In S. *et al*. Alam (Ed.), *Routledge Handbook of International Environmental Law* (pp. 461–478).

Koh, K.-L., & Karim, M. S. (2017). The role of ASEAN in shaping regional environmental protection. In P. Hirsch (Ed.), *Routledge Handbook of the Environment in Southeast Asia* (pp. 315–333). New York: Routledge. Retrieved from https://eprints.qut.edu.au/60314/

Koh, L. P., & Wilcove, D. S. (2008). Is oil palm agriculture really destroying tropical biodiversity? *Conservation Letters*, *1*(2), 60–64. https://doi.org/10.1111/j.1755-263X.2008.00011.x

Kok, M. T. J., Tyler, S., Prins, A. G., Pintér, L., Baumüller, H., Bernstein, J., Tsioumani, E., Venema, H. D., & Grosshans, R. (2010). Prospects for mainstreaming ecosystem goods and services in international policies. *Biodiversity*, *11*(1–2), 49–54. https://doi.org/10.1080/14888386.2010.9712647

Krishnamurthy, R. R., DasGupta, R., Chatterjee, R., & Shaw, R. (2014). Managing the Indian coast in the face of disasters & climate change: a review and analysis of India's coastal zone management policies. *Journal of Coastal Conservation*, *18*(6), 657–672. https://doi.org/10.1007/s11852-014-0339-7

Kronen, M., Magron, F., McArdle, B., & Vunisea, A. (2010). Reef finfishing pressure risk model for Pacific Island countries and territories. *Fisheries Research*, *101*(1–2), 1–10. https://doi.org/10.1016/j.fishres.2009.08.011

Kumar, R., Kaushik, M., Kumar, S., Ambastha, K., Sircar, I., Patnaik, P., & Vervest, M.-J. (2016). Integrating landscape dimensions in disaster risk reduction: A cluster planning approach. In F. G. Renaud, K. Sudmeier-Rieux, M. Estrella, & U. Nehren (Eds.), *Ecosystem-Based Disaster Risk Reduction and Adaptation in Practice* (Vol. 42, pp. 271–291). Switzerland: Springer International Publishing. https://doi.org/10.1007/978-3-319-43633-3_12

Kumar, R., & Patnaik, P. (2016). Wetlands of Mahanadi Delta (India). In C. M. Finlayson, G. R. Milton, R. C. Prentice, & N. C. Davidson (Eds.), *The Wetland Book: Distribution, Description and Conservation* (pp. 1–14). Netherlands: Springer Netherlands. https://doi.org/10.1007/978-94-007-6173-5

Lam, M. (1998). Consideration of customary marine tenure system in the establishment of marine protected areas in the South Pacific. *Ocean and Coastal Management*, *39*(1–2), 97–104. https://doi.org/10.1016/S0964-5691(98)00017-9

Lambeck, R. J. (1999). Landscape planning for biodiversity conservation in agricultural regions: a case study from the wheatbelt of Western Australia. *Biodiversity Technical Papper*, *No. 2*, 1–96 i–x.

Langley, A., Wright, A., Hurry, G., Hampton, J., Aqorua, T., & Rodwell, L. (2009). Slow steps towards management of the world's largest tuna fishery. *Marine Policy*, *33*, 271–279. https://doi.org/10.1016/j.marpol.2008.07.009

Larson, A. M., & Ribot, J. C. (2004). Democratic Decentralisation through a Natural Resource Lens: An Introduction. *European Journal of Development Research*, *16*(1), 1–25. https://doi.org/10.1080/09578810410001688707

Laurance, W. F., Koh, L. P., Butler, R., Sodhi, N. S., Bradshaw, C. J. A., Neidel, J. D., Consunji, H., & Mateo Vega, J. (2010). Improving the performance of the Roundtable on Sustainable Palm Oil for nature conservation. *Conservation Biology : The Journal of the Society for Conservation Biology*, *24*(2), 377–381. https://doi.org/10.1111/j.1523-1739.2010.01448.x

Leaders Declaration on Coral Triangle Initiative on Coral Reefs, Fisheries and food security. (2009). Manado, Indonesia. Retrieved from http://coraltriangleinitiative.org/sites/default/files/resources/Leader Declaration coral triangle initiative_0.pdf

Lee, J. Y., & Anderson, C. D. (2013). The Restored Cheonggyecheon and the Quality of Life in Seoul. *Journal of Urban Technology*, *20*(4), 3–22. https://doi.org/10.1080/10630732.2013.855511

Leimona, B., van Noordwijk, M., de Groot, R., & Leemans, R. (2015). Fairly efficient, efficiently fair: Lessons from designing and testing payment schemes for ecosystem services in Asia. *Ecosystem Services*, *12*, 16–28. https://doi.org/10.1016/j.ecoser.2014.12.012

Leisher, C., Beukering, P. van, & Scherl, L. M. (2007). Nature's Investment Bank: how marine protected areas contribute to poverty reduction . *Report*, *The Nature*, Available on: http://www.nature.org/initiatives/p.

Lernoud, J., Potts, J., Sampson, G., Voora, V., Willer, H., & Wozniak, J. (2015). *The State of Sustainable Markets – Statistics and Emerging Trends 2015*. Geneva. Retrieved from http://www.intracen.org/uploadedFiles/intracenorg/Content/Publications/2014_2015_365 - The State of Sustainable Markets_Low-res.pdf

Lernoud, J., Potts, J., Sampson, G., Garibay, S., Lynch, M., Voora, V., Willer, H., & Wozniak, J. (2017). *The State of Sustainable Markets – Statistics and Emerging Trends*. Geneva. Retrieved from http://www.intracen.org/uploadedFiles/intracenorg/Content/Publications/State-of-Sustainable-Market-2017_web.pdf

Leverington, F., Costa, K. L., Courrau, J., Pavese, H., Nolte, C., Marr, M., Coad, L., Burgess, N., Bomhard, B., & Hockings, M. (2010). *Management effectiveness evaluation in protected areas – a global study. Second Edition.* Brisbane AUSTRALIA. Retrieved from http://old.unep-wcmc.org/medialibrary/2011/04/05/307dd818/Leverington et al. 2010.pdf

Lim, T. W. (2013). Malaysia: Illegalities in Forest Clearance for Large-scale Commercial Plantations, 1–42. Retrieved from http://www.forest-trends.org/publication_details.php?publicationID=4195

Lo, V. (2016). *Synthesis report on experiences with ecosystem-based approaches to climate change adaptation and disaster rsk reduction*. *Secretariat of the Convention on Biological Diversity* (Vol. Technical). Montreal. https://doi.org/10.1080/14888386.2007.9712830
Lubchenco, J., Cerny-Chipman, E. B., Reimer, J. N., & Levin, S. A. (2016). The right incentives enable ocean sustainability successes and provide hope for the future. *Proceedings of the National Academy of Sciences of the United States of America*, 201604982. https://doi.org/10.1073/pnas.1604982113
Ma. (2008). The status and trends of forests and forestry in West Asia.
Macfadyen, S., Tylianakis, J. M., Letourneau, D. K., Benton, T. G., Tittonell, P., Perring, M. P., G??mez-Creutzberg, C., B??ldi, A., Holland, J. M., Broadhurst, L., Okabe, K., Renwick, A. R., Gemmill-Herren, B., & Smith, H. G. (2015). The role of food retailers in improving resilience in global food supply. *Global Food Security*. https://doi.org/10.1016/j.gfs.2016.01.001
Mack, R. N., Simberloff, D., Mark Lonsdale, W., Evans, H., Clout, M., & Bazzaz, F. A. (2000). BIOTIC INVASIONS: CAUSES, EPIDEMIOLOGY, GLOBAL CONSEQUENCES, AND CONTROL. *Ecological Applications*. https://doi.org/10.1890/1051-0761(2000)010[0689:BICEGC]2.0.CO;2
Mackay, K. T. (2001). Managing Fisheries for Biodiversity : Case Studies of Community Approaches to Fish Reserves among the Small Island States of the Pacific. *Heritage*, 1–46.
Mackinnon, J. (2002). Status of Biodiversity in Asia. In J. Carew-Reid (Ed.), *Biodiversity Planning in Asia* (p. 49-72). Gland, Switzerland and Cambridge, UK: IUCN. Retrieved from http://icem.com.au/portfolio-items/biodiversity-planning-in-asia-3/
Maeda, & Yoshida. (2009). Maeda & Yoshida 2009 Responses of birds in rice fields to winter.
MAFF. (2007). MAFF (2007) Current situation and problems on organic farming.
MAFF. (2009). Plant protection act. Retrieved from http://www.japaneselawtranslation.go.jp/law/detail/?id=25&vm=04&re=01
MAFF. (2011a). Amendment of enforcement regulations regard-ing revisions of imported plant inspection.
MAFF. (2011b). 自然再生事業実施計画の作成状況 平成28年3月 実施計画名 実施主体 協議会名 作成日.
Makagon, J. E., Jonas, H., & Roe, D. (2014). *Human Rights Standards for Conservation PART I Which standards apply to which conservation actors?* Retrieved from www.iied.org%5Cnwww.facebook.com/theIIED%5Cnwww.iied.org/pubs%5Cnhttp://pubs.iied.org/14631IIED
Makino, M., & Matsuda, H. (2011). Ecosystem-based management in the Asia-Pacific region. In R. Ommar, R. Perry, K. Cochrane, & P. Cury (Eds.), *World Fisheries: A Social-Ecological Analysis* (pp. 322–333). Wiley-Blackwells.
Malayang, Ben, S., Hahn, T., Kumar, P., Authors, L., Maharaj, S., Bohensky, E., Domingos, T., Filer, C., Authors, C., Agard, J. B. R., Dong, S., Espaldon, M. V., Gokhale, Y., Hefny, M., Lundberg, J., Patwardhan, A., Ramirez, E. C., Talukdar, B., Tomich, T., Moles, R., & Plesnik, J. (2005). Responses to Ecosystem Change and to Their Impacts on Human Well-Being. *Focus*, *4*, 203–226.
Malaysia: Prime Minister's Department. (2015). *Eleventh Malaysia Plan: 2016-2020 - Anchoring Growth on People*. Putrajaya, Malaysia: Economic Planning Unit, Malaysia.
Manoa, P. E., & Veitayaki, J. (2009). Regional ocean governance in the pacific revisited. *Ocean Yearbook Online*, *23*, 503–520.
Marois, D. E., & Mitsch, W. J. (2015). Coastal protection from tsunamis and cyclones provided by mangrove wetlands – a review. *International Journal of Biodiversity Science, Ecosystem Services & Management*, *11*(1), 71–83. https://doi.org/10.1080/21513732.2014.997292
Marschke, M., & Wilkings, A. (2014). Is certification a viable option for small producer fish farmers in the global south? Insights from Vietnam. *Marine Policy*, *50*, 197–206. https://doi.org/10.1016/j.marpol.2014.06.010
Maryudi, 2009. Forest Certification For Community-Based Forest Management In Indonesia: Does Lei Provide A Credible Option? Institute for Global Environmental Strategies (IGES) Forest

Conservation, Livelihoods, and Rights Project. https://pub.iges.or.jp/pub/forest-certification-community-based-forest
Mathur, V. (n.d.). Establishing Indigenous Community Conserved Areas In The Philippines. Retrieved January 16, 2018, from http://nbsapforum.net/#read-best-practice/803
Matson, P. A., Parton, W. J., Power, A. G., & Swift, M. J. (1997). Agricultural Intensification and Ecosystem Properties.
McClanahan, T. R., Marnane, M. J., Cinner, J. E., & Kiene, W. E. (2006). A Comparison of Marine Protected Areas and Alternative Approaches to Coral-Reef Management. *Current Biology*, *16*(14), 1408–1413. https://doi.org/10.1016/j.cub.2006.05.062
McDermott, C. L., Coad, L., Helfgott, A., & Schroeder, H. (2012). Operationalizing social safeguards in REDD+: Actors, interests and ideas. *Environmental Science and Policy*, *21*, 63–72. https://doi.org/10.1016/j.envsci.2012.02.007
McLeod, E., Szuster, B., & Salm, R. (2009). Sasi and Marine Conservation in Raja Ampat, Indonesia. *Coastal Management*, *37*(6), 656–676. https://doi.org/10.1080/08920750903244143
McMurdo, J. M., & Gardner, J. (2009). *Traditional Pacific Land Rights and International Law : Tensions and Evolution*.
McNeely, J. A. (2003). Biodiversity in arid regions: values and perceptions. *Journal of Arid Environments*, *54*(1), 61–70. https://doi.org/10.1006/JARE.2001.0890
McNeely, J. A., Mooney, H. A., & Neville, L. E. (2001). Global Strategy on Invasive Alien Species. *IUCN Gland, Switzerland and Cambridge,UK*, 50.
Millennium Ecosystem Assessment. (2005). *Ecosystems and Human Well-being: Synthesis*. Washington, DC: Island Press.
Mills, M., Jupiter, S. D., Pressey, R. L., Ban, N. C., & Comley, J. (2011). Incorporating Effectiveness of Community-Based Management in a National Marine Gap Analysis for Fiji. *Conservation Biology*, *25*(6), 1155–1164. https://doi.org/10.1111/j.1523-1739.2011.01749.x
Ministry of Environment and Forests, Government of India. (2010). *National Mission for a Green India (Under The National Action Plan on Climate Change)*. New Delhi. Retrieved from www.moef.gov.in/sites/default/files/GIM_Mission Document-1.pdf
Ministry of Environment and Water, U. A. E. (2014). البيولوجي للتنوع الوطنية االستراتجية (National Biodiversity Strategy and Action Plan, UAE). Retrieved from https://www.cbd.int/doc/world/ae/ae-nbsap-01-ar.pdf
Ministry of Environment Government of Japan, ICRI, & WWF. (2015). *Case studies: from Ridge to Reef: Implementing coral reef conservation and management through a community-based approach emphasizing land-sea connectivity*.
Misrachi, M., Bubb, P., & Stanwell-Smith, D. (2012). *Southeast Asia Capacity Building Workshop on Indicators as part of NBSAP updating Workshop Report, 25 - 28 March 2012, Green World Hotel, Tam Dao, Viet Nam*. Retrieved from https://www.cbd.int/doc/meetings/ind/wsind-nbsap-sasia-01/official/wsind-nbsap-sasia-01-report-en.pdf
Miteva, D. A., Pattanayak, S. K., & Ferraro, P. J. (2012). Evaluation of biodiversity policy instruments: What works and what doesn't? *Oxford Review of Economic Policy*, *28*(1), 69–92. https://doi.org/10.1093/oxrep/grs009
Miyamoto, M., Mohd Parid, M., Noor Aini, Z., Michinaka, T. (2014). Proximate and underlying causes of forest cover change in Peninsular Malaysia. *Forest Policy and Economics*, *44*, 18–25. https://doi.org/10.1016/j.forpol.2014.05.007
Miyazaki, M. (2011). Feasibility of a biodiversity banking scheme in Japan. Bulletin of the Faculty of management. *Journal of Atomi University*, *11*, 19–42.
Miyazawa, N. (2013). Customary law and community- based natural resource management in post-conflict Timor-Leste.
Mizuta, D. D., & Vlachopoulou, E. I. (2017). Satoumi concept illustrated by sustainable bottom-up initiatives of Japanese Fisheries Cooperative Associations. *Marine Policy*, *78*(July 2016), 143–149. https://doi.org/10.1016/j.marpol.2017.01.020
MoE. (2016). Basic Policy on Promoting Green Purchasing, (February).
Mock, G. (2014). *COMMUNITIES IN ACTION FOR LANDSCAPE RESILIENCE AND SUSTAINABILITY: The COMDEKS Programme*. Now York. Retrieved from

https://comdeksproject.files.wordpress.com/2014/10/communities-in-action-comdeks-web-v2.pdf

Mock, G., & Tschentscher, T. (2016). *A COMMUNITY-BASED APPROACH TO RESILIENT AND SUSTAINABLE LANDSCAPES: Lessons from Phase II of the COMDEKS Programme*. New York. Retrieved from https://comdeksproject.files.wordpress.com/2016/11/comdeks-ii-case-study-publication-web-version-final.pdf

MOE. (2002). Law for the Promotion of Nature Restoration.

MOE. (2004). Invasive Alien Species Act. *Nature Conservation Bureau, The Ministry of the Environment Government of Japan*, *78*(78), 1–15. Retrieved from http://www.env.go.jp/nature/intro/

MOEFCC, G. of I. (1988). National Forest Policy Government of India Ministry of Environment, Forests and climate change. *Development*, 34–36.

Moller, H., MacLeod, C., Haggerty, J., Rosin, C., Blackwell, G., Perley, C., Meadows, S., Weller, F., & Gradwohl, M. (2008). Intensification of New Zealand agriculture Implications for biodiversity.

Momse, J. H. (1996). Women farmers: Environmental managers of the world. Retrieved from http://archive.unu.edu/unupress/unupbooks/uu03pe/uu03pe07.htm

Morris, D. F., & Munnings, C. (2013). *Progressing to a Fair Carbon Tax Policy Design Options and Impacts to Households*. Washington D.C.

Moser, C., Norton, A., Conway, T., Ferguson, C., & Vizard, P. (2001). *To claim our rights: Livelihood security, human rights and sustainable development*. London, UK: Overseas Development Institute.

Mukul, S. A., Herbohn, J., Rashid, A. Z. M. M., & Uddin, M. B. (2014). Comparing the effectiveness of forest law enforcement and economic incentives to prevent illegal logging in Bangladesh. *International Forestry Review*, *16*(3), 363–375. https://doi.org/10.1505/146554814812572485

Muller, S. (2003). Towards Decolonisation of Australia's Protected Area Management: the Nantawarrina Indigenous Protected Area Experience. *Australian Geographical Studies*, *41*(1), 29–43.

Mulongoy, K. J., & Gidda, S. B. (2008a). *Ecological, Economic, Cultural and Social Benefits of Protected Areas*. *Secretariat of the Convention on Biological Diversity*. Montreal, Canada. Retrieved from https://www.cbd.int/doc/publications/cbd-value-nature-en.pdf

Mulongoy, K. J., & Gidda, S. B. (2008b). Ecological, Economic, Cultural and Social Benefits of Protected Areas. *Secretariat of the Convention on Biological Diversity*, 30. Retrieved from https://www.cbd.int/doc/publications/cbd-value-nature-en.pdf

Mulqueeny, K., & Bonifacio, S. (2010). *Asian Judges: Green Courts and Tribunals, and Environmental Justice* (Vol. Law and Po). Manila, Philippines: Asian Development Bank. Retrieved from https://www.adb.org/sites/default/files/publication/27654/2010-brief-01-asian-judges.pdf

Mulqueeny, K., & Bonifacio, S. (2012). *Environmental Governance and the Courts in Asia: An Asian Judges Network on the Environment*. *Law and Policy Reform Brief No. 1*. Manila, Philippines.

Murshed-e-Jahan, K., Belton, B., & Viswanathan, K. K. (2014). Communication strategies for managing coastal fisheries conflicts in Bangladesh. *Ocean and Coastal Management*, *92*, 65–73. https://doi.org/10.1016/j.ocecoaman.2014.01.003

Nagendra, H., Karmacharya, M., & Karna, B. (2008). Disentangling a Complex Web: Forests, People and Decentralization in Nepal. In G. Webb, E.L. and Shivakoti (Ed.), *Decentralization, Forests and Rural Communities: Policy Outcomes in Southeast Asia* (pp. 209–231). SAGE Publications.

Nagle, J. C. (2009). The effectiveness of biodiversity law. *Journal of Land Use and Environmental Law*, 1–40.

Nasuchon, N. (2009). Coastal management and community management in Malaysia, Vietnam, Cambodia and Thailand, with a case study of Thai fisheries management. *Fisheries Management*, 91.

National Native Title Tribunal. (2007). *The Gunditjmara People's native title determinations* (Vol. 1993).

National Native Title Tribunal. (2018). Native Title Determinations. Retrieved March 26, 2018, from http://www.nntt.gov.au/assistance/Geospatial/Pages/Maps.aspx

National Parks Board Singapore. (2017). Nature Ways.
Native Women's Association of Canada. (2014). Aboriginal Women and Aboriginal Traditional Knowledge (ATK): Input and Insight on Aboriginal Traditional Knowledge.
Nepal, I. (2013). Payment for Ecosystem Services in Nepal: Prospect, Practice and Process.
NFFPFW, & CSD. (2010). A Formula for More Land and Resource Grabbing: Dangers of the Green India Mission, Joint Statement by Forest Movements in India. National Forum of Forest People and Forest Workers (NFFPFW) and Campaign for Survival and Dignity (CSD).
Nicolai, S., Bhatkal, T., Hoy, C., & Aedy, T. (2016). *The SDGs in Asia and the Pacific*. London.
Niestroy, I. (2016). *How Are We Getting Ready? The 2030 Agenda for Sustainable Development in the EU and its Member States: Analysis and Action So Far*. Bonn. Retrieved from https://www.die-gdi.de/uploads/media/DP_9.2016.pdf
Nikkei. (2017, September 6). Japan to keep urban farmland green with new incentives. *Nikkei Asian Review*. Retrieved from https://asia.nikkei.com/Politics-Economy/Policy-Politics/Japan-to-keep-urban-farmland-green-with-new-incentives
Nomura, H, Yabe, M., Nishio, T., Izumi, M., Hirai, K., Kurokawa, T.(2012) Framework for improvement of farmland biodiversity in Japan. Journal of Environmental Planning and Management, 56: 743-758
North, D. C. (1990). *Institutions, Institutional Change and Economic Performance*. Cambridge: Cambridge University Press.
North, D. C. (1997). The contribution of the new institional economics to an understanding of the transition problem. *WIDER Annual Lectures 1*, 1–29.
Novak Colwell, J. M., & Axelrod, M. (2017). Socio-economic impacts of a closed fishing season on resource-dependent stakeholders in Tamil Nadu, India: Differences in income and expenditure effects by occupational group. *Marine Policy*, *77*(October 2016), 182–190. https://doi.org/10.1016/j.marpol.2016.10.026
O'Connor, D. (1994). *Managing the environment with rapid industrialisation : lessons from the East Asian experience*. Paris: Development Centre of the Organization for Economic Co-operation and Development.
OECD. (1996). *Saving biological diversity : economic incentives*. Paris: Organization for Economic Co-operation and Development. Retrieved from https://books.google.co.in/books/about/Saving_Biological_Diversity.html?id=RQ1ap-hCNu8C
OECD. (2008). Sustainable Manufacturing and Eco-Innovation, Dsti/Ind(2008)16/Rev1, 1–33.
OECD. (2011). Towards Green Growth. *Oecd 50*, (May 2011), 146. https://doi.org/10.1787/9789264111318-en
OECD. (2013). Biodiversity Offsets - Effective desgin and implementation. *Scaling Up Finance Mechanisms For Biodiversity*, (October), 8.
OECD. (2014). *Towards Green Growth in Southeast Asia*.
OECD. (2015). Development Co-operation Report 2015 Making Partnerships Effective Coalitions for Action Partnerships are powerful drivers of development Post - 2015 partnerships will bring new and evolving roles A policy framework for post - 2015 partnerships.
Ogola, P. F. A. (2007). Environmental impact assessment general procedures. In *Surface Exploration for Geothermal Resources*.
Oldeman, L, R. (2000). *Impact of soil degradation: a global scenario* (Working Paper 2000/01). *Paper presented the International Conference on Managing Natural Resources for Sustainable Agricultural Production in the 21st Century, New Delhi, 14-18 February 2000*. Wageningen, Netherlands. Retrieved from http://isric.org/isric/webdocs/docs/ISRIC_Report_2000_01.pdf
Ottaviani, D., & Scialabba, N. . (2011). *Payments for Ecosystem Services and Food Security*. Rome, Italy. Retrieved from http://www.fao.org/docrep/014/i2100e/i2100e.PDF
Oviedo, G., & Fincke, A. (2009). *Indigeneous Peoples and Climate Change*.
Pagiola, S. (2007). Guidelines for " Pro-Poor " Payments for Environmental Services, (April), 1–2.
Palm Oil Health. (2017). Malaysian Sustainable Palm Oil certification to be mandatory by 2019. Retrieved October 19, 2017, from http://www.palmoilhealth.org/faq/malaysian-sustainable-palm-oil-certification-mandatory-2019/

Palmer. (2015). Ruminations on the problems with the Resource Management Act Sir Geoffrey Palmer QC Keynote address to the Local Government, (November), 1–25. Retrieved from https://www.planning.org.nz/Attachment?Action=Download&Attachment_id=3538

Park, M. S., & Youn, Y.-C. (2013). Development of urban forest policy-making toward governance in the Republic of Korea. *Urban Forestry & Urban Greening*, *12*(3), 273–281. https://doi.org/10.1016/j.ufug.2013.04.004

Parker, C., Cranford, M., Oakes, N., & Leggett, M. (2012). The Little Biodiversity Finance Book: a guide to proactive investment in natural capital (PINC), 197.

Pascal, N. (2011). *Cost-Benefit analysis of community-based marine protected areas: 5 case studies in Vanuatu, South Pacific*. Moorea, French Polynesia.

Pascal, N. (2013). *Coral Reef Ecosystem Services Economic Valuation Experiences From The South Pacific*.

Pascal, N. (2014). *Analysis of economic benefits of mangrove ecosystems. Case studies in vanuatu: Eratap and Crab Bay*.

Pascal, N., Brander, L., Crossman, N., & Dang, T. (2014). *Regional research to inform the high level panel on global assessment of resources for implementing the strategic plan for biodiversity 2011-2020. Final report for Australasia and Pacific region. CBD technical report*.

Pascual, U., Balvanera, P., Díaz, S., Pataki, G., Roth, E., Stenseke, M., Watson, R. T., Başak Dessane, E., Islar, M., Kelemen, E., Maris, V., Quaas, M., Subramanian, S. M., Wittmer, H., Adlan, A., Ahn, S., Al-Hafedh, Y. S., Amankwah, E., Asah, S. T., Berry, P., Bilgin, A., Breslow, S. J., Bullock, C., Cáceres, D., Daly-Hassen, H., Figueroa, E., Golden, C. D., Gómez-Baggethun, E., González-Jiménez, D., Houdet, J., Keune, H., Kumar, R., Ma, K., May, P. H., Mead, A., O'Farrell, P., Pandit, R., Pengue, W., Pichis-Madruga, R., Popa, F., Preston, S., Pacheco-Balanza, D., Saarikoski, H., Strassburg, B. B., van den Belt, M., Verma, M., Wickson, F., & Yagi, N. (2017). Valuing nature's contributions to people: the IPBES approach. *Current Opinion in Environmental Sustainability*, *26*, 7–16. https://doi.org/10.1016/j.cosust.2016.12.006

Pattnaik, A. K., & Kumar, R. (2016). Lake Chilika (India): Ecological Restoration and Adaptive Management for Conservation and Wise Use. In C. M. Finlayson, G. R. Milton, R. C. Prentice, & N. C. Davidson (Eds.), *The Wetland Book: Distribution, Description and Conservation* (pp. 1–14). Springer Netherlands. https://doi.org/10.1007/978-94-007-6173-5

PBL Netherlands Environmental Assessment Agency. (2012). *Roads from Rio+20 Pathways to achieve global sustainability goals by 2050*. The Hague.

PBL Netherlands Environmental Assessment Agency. (2014). *Integrated Assessment of Global Environmental Change with IMAGE*. The Hague.

Persoon, G. A., & van Est, D. M. E. (2003). Co-management of Natural Resources: The Concept and Aspects of Implementation. In G. A. Persoon, D. M. E. van Est, & P. E. Sajise (Eds.), *Co-Management of Natural Resources in Asia: A Comparative Perspective* (First, p. 1024). Oslo, Denmark: Nordic Institute of Asian Studies Press.

Phelps, J., Webb, E. L., & Agrawal, A. (2010). Does REDD+ Threaten to Recentralize Forest Governance? *Science*, *328*(5976), 312–313. https://doi.org/10.1126/science.1187774

Pilgrim, J. D., Brownlie, S., Ekstrom, J. M. M., Gardner, T. A., von Hase, A., ten Kate, K., Savy, C. E., Theo Stephens, R. T., Temple, H. J., Treweek, J., & Ussher, G. T. (2013). Offsetability is highest for common and widespread biodiversity: Response to Regnery *et al*. *Conservation Letters*. https://doi.org/10.1111/conl.12026

Pingali, P. L. (2001). Environmental consequences of agricultural commercialization in Asia. *Environment and Development Economics*, *6*, 483–502.

Pittock, J., Finlayson, C. M., Arthington, A. H., Roux, D. J., Matthews, J. H., Biggs, H., Blom, E., Flitcroft, R., Froend, R., Harrison, I., Hermoso, V., Junk, W., Kumar, R., Linke, S., Nel, J., Nunes da Cunha, C., Pattnaik, A., Pollard, S., Rast, W., Thieme, M., Turak, E., Turpie, J., van Niekerk, L., Willems, D., & Viers, J. (2015). Managing freshwater, river, wetland and estuarine protected areas. In *Protected Area Governance and Management* (pp. 569–608).

Pittock, J., & Xu, M. (2010). *Controlling Yangtze River Floods: A new approach*. *World Resources Report Case Study*. Washington DC. Retrieved from http://www.researchgate.net/publication/258844942_World_Resources_Report_Case_Study._Controlling_Yangtze_River_floods_A_new_approach/file/60b7d52b1b5356a7a2.pdf

Polidoro, B. A., Elfes, C. T., Sanciangco, J. C., Pippard, H., & Carpenter, K. E. (2011). Conservation Status of Marine Biodiversity in Oceania: An Analysis of Marine Species on the IUCN Red List of Threatened Species. *Journal of Marine Biology*, *2011*, 1–14. https://doi.org/10.1155/2011/247030

Pollnac, R. B., & Crawford, B. (2000). *Discovering factors that influence the success of community-based marine protected areas in the Visayas, Philippines*. *Coastal Management Report # 2229. PCAMRD Book Series No. 33*.

Pomeroy, R., Parks, J., Courtney, K., & Mattich, N. (2016). Improving marine fisheries management in Southeast Asia: Results of a regional fisheries stakeholder analysis. *Marine Policy*, *65*, 20–29. https://doi.org/10.1016/j.marpol.2015.12.002

Pomeroy, R. S., & Berkes, F. (1997). Two to tango: The role of government in fisheries co-management. *Marine Policy*, *21*, 465–480.

Potts, J., Lynch, M., Wilkings, A., Huppé, G., Cunningham, M., & Voora, V. (2014). *The State of Sustainability Initiatives Review 2014*. Retrieved from http://www.iisd.org/publications/state-sustainability-initiatives-review-2014-standards-and-green-economy

Prakash, S., Thangappan, T., Kumar, A., Raghavan, R., Rhyne, A., Tlusty, M. F., & Subramoniam, T. (2017). Marine aquarium trade in India : Challenges and opportunities for conservation and policy. *Marine Policy*, *77*(August 2016), 120–129. https://doi.org/10.1016/j.marpol.2016.12.020

Preston, B. J., & Hanson, C. (2013). The globalisation and harmonisation of environmental law: An Australian perspective. *Asia Pacific Journal of Environmental Law*.

Preston, I., White, V., Browne, J., Dresner, S., Ekins, P., & Hamilton, I. (2013). *Designing carbon tax to protect low-income households*. York. Retrieved from https://www.jrf.org.uk/report/designing-carbon-taxation-protect-low-income-households

Pretty, L.N., Noble A.D., Bossio D., Dixon J., Hine R.E., Penningdevris F.W.T., Morison J.I.L. (2006). Resource-conserving agriculture increases yields in developing countries. Environmental Science & Technology 40: 1114-1119.

Primmer, E., Jokinen, P., Blicharska, M., Barton, D. N., Bugter, R., & Potschin, M. (2015). Governance of Ecosystem Services: A framework for empirical analysis. *Ecosystem Services*. https://doi.org/10.1016/j.ecoser.2015.05.002

Rahaa, A. K., Zaman, S., Sengupta, K., Bhattacharya, S. B., Raha, S., Banerjee, K., & Mitra, A. (2014). Climate Change and Sustainable Livelihood Programmes: A case study from the Indian Sundarbans. *The Journal of Ecology (Photon)*, *113*, 297–304.

Rahman, M., Hossain, Y., Ahamed, F., B.R. Subba, F., Abdallah, E. M., & Ohtomi, J. (2012). Biodiversity in the Padma Distributary of the Ganges River , Northwestern Bangladesh : Recommendations for Conservation. *World Journal of Zoology*, *7*, 328–337. https://doi.org/10.5829/idosi.wjz.2012.7.4.6634

Ramakrishnan, P. S. (1992). *Shifting agriculture and sustainable development : an interdisciplinary study from north-eastern India*. UNESCO.

Ramakrishnan, P. S., Rao, K. S., Chandrashekara, U. M., Chhetri, N., Gupta, H. K., Patnaik, S., Saxena, K. G., & Sharma, E. (2012). South Asia. In J. A. Parrotta & R. L. Trosper (Eds.), *Traditional Forest-Related Knowledge: Sustaining Communities, Ecosystems and Biocultural Diversity* (pp. 315–356). Springer Netherlands. https://doi.org/10.1007/978-94-007-2144-9_9

Raman, T. R. S. (1996). Impact of shifting cultivation on diurnal squirrels and primates in Mizoram, northeast India: A preliminary study. *Current Science*, *70*(8), 747–750.

Raman, T. R. S. (2001). Effect of slash-and-burn shifting cultivation on rainforest birds in Mizoram, Northeast India. *Conservation Biology*, *15*(3), 685–698. https://doi.org/10.1046/j.1523-1739.2001.015003685.x

Ramsar Convention Secretariat. (2016). *An Introduction to the Convention on Wetlands (previously The Ramsar Convention Manual).* (5th ed.). Gland, Switzerland: Ramsar Convention Secretariat.

Ranganathan, J., & Lucas, N. (2008). *A Guide for Decision Makers*. *Control* (Vol. 2). https://doi.org/10.1371/journal.pone.0024378

Ransom, J. I., Kaczensky, P., Lubow, B. C., Ganbaatar, O., & Altansukh, N. (2012). A collaborative approach for estimating terrestrial wildlife abundance. *Biological Conservation*. https://doi.org/10.1016/j.biocon.2012.05.006

Rasool, G., & Karki, M. (2007). Participatory forest management in South Asia: a comparative analysis of policies, institutions and approaches.
Rasul, G., & Karki, M. (2007). *Participatory Forest Management in South Asia. A Comparative Analysis of Policies, Institutions and Approaches*. Kathmandu, Nepal.
Ravindranath, N. H., & Murthy, I. K. (2010). Greening India Mission. *Current Science*, *99*(4), 390–395. Retrieved from http://www.currentscience.ac.in/Downloads/article_id_099_04_0444_0449_0.pdf
Ravishankar, T., Gnanappazham, L., Ramasubramanian, R., Sridhar, D., Navamuniyammal, M., & Selvam, V. (2004). Atlas of Mangrove Wetlands of India: Part 2 - Andhra Pradesh, 151p.
Reading, R. P., Bedunah, D. J., & Amgalanbaatar, S. (2006). Conserving Biodiversity on Mongolian Rangelands: Implications for Protected Area Development and Pastoral Uses. Retrieved from https://www.fs.fed.us/rm/pubs/rmrs_p039/rmrs_p039_001_017.pdf
Reading, R. P., Mix, H. M., Lhagvasuren, B., Feh, C., Kane, D. P., Dulamtseren, S., & Enkhbold, S. (2001). Status and distribution of khulan (Equus hemionus) in Mongolia. *Journal of Zoology*, *254*, 381–389.
Redford, Kent, H. (n.d.). *Mainstreaming Biodiversity Conservation: A Framing Paper for the Scientific and Technical Advisory Panel of the Global Environment Facility V. 13 May*. Retrieved from http://www.stapgef.org/stap/wp-content/uploads/2013/09/Mainstreaming-Biodiversity-at-GEF-V.-May-13.pdf
Rey, D., & Swan, S. R. (2014). A country-led safeguards approach: guidelines fir national REDD+ programmes, (SNV), 63.
Ribot, J. C. (2002). *Democratic Decentralization of Natural Resources Democratic Decentralization of Natural Resources Institutionalizing Popular Participation Institutionalizing Popular Participation*. Washington, DC. Retrieved from pdf.wri.org/ddnr_full_revised.pdf
Rights and Resources Initiative. (2015). Who Owns the World’s Land? A global baseline of formally recognized indigenous and community land rights., (September), 56. Retrieved from http://www.rightsandresources.org/wp-content/uploads/GlobalBaseline_web.pdf
Rist, L., Feintrenie, L., & Levang, P. (2010). The livelihood impacts of oil palm: Smallholders in Indonesia. *Biodiversity and Conservation*. https://doi.org/10.1007/s10531-010-9815-z
Roberts, C. M., & Hawkins, J. P. (2000). *Fully-protected marine reserves: a guide.*
Robinson, J. G. (2012). Common and Conflicting Interests in the Engagements between Conservation Organizations and Corporations. *Conservation Biology*, *26*(6), 967–977. https://doi.org/10.1111/j.1523-1739.2012.01914.x
Rochette, J., Billé, R., Molenaar, E. J., Drankier, P., & Chabason, L. (2015). Regional oceans governance mechanisms: A review. *Marine Policy*, *60*, 9–19. https://doi.org/10.1016/j.marpol.2015.05.012
Rocliffe, S., Peabody, S., Samoilys, M., & Hawkins, J. P. (2014). Towards a network of locally managed marine areas (LMMAs) in the Western Indian Ocean. *PLoS ONE*, *9*(7). https://doi.org/10.1371/journal.pone.0103000
Roe, M. (2013). *Maritime governance and policy-making*. *Maritime Governance and Policy-Making* (Vol. 9781447141). London: Springer-Verlag. https://doi.org/10.1007/978-1-4471-4153-2
Rogers, T.S. & Morrison J. (2010). Agriculture for Growth: learning from experience in the Pacific
Romero, C., E.O. Sills, M.R. Guariguata, P.O. Cerutti, G. Lescuyer and F.E. Putz, 2017. Evaluation of the impacts of Forest Stewardship Council (FSC) certification of natural forest management in the tropics: a rigorous approach to assessment of a complex conservation intervention, International Forestry Review Vol.19(S2), pp. 36-49.
ROPME. (2013). *State of the Marine Environment Report - 2013 ROPME/GC-16/1-ii*. Kuwait. Retrieved from www.ropme.org
Rosander, M. N. (2008). *Illegal Logging: Current Issues and Opportunities for Sida/SENSA Engagement in Southeast Asia Illegal Logging: Current Issues and Opportunities for Sida/ SENSA Engagement in Southeast Asia*. Bangkok. Retrieved from http//www.recoftc.org
Roy, R. D. (2005). Traditional customary laws and indigenous peoples in Asia. *Report / Minority Rights Group International (MRG*.
Ruddle, K. (1994). *A guide to the literature on traditional community-based fishery management in the Asia-Pacific tropics*. *FAO Fisheries Circular* (Vol. 869). Rome.

Ruddle, K. (1997). Traditional Marine Resources Management Systems in the Asia-Pacific Region: Design Principles and Policy Options. *Workshop on Integrated Reef Resources Management in the Maldives - Bay of Bengal Programme*, 1–7. Retrieved from http://www.fao.org/docrep/X5623E/x5623e0w.htm#paper 13: traditional marine resources management systems in the asia pacific re

Ruddle, K., & Hickey, F. R. (2008). Accounting for the mismanagement of tropical nearshore fisheries. *Environment, Development and Sustainability*, *10*(5), 565–589. https://doi.org/10.1007/s10668-008-9152-5

Sahani, M., Zainon, N. A., Wan Mahiyuddin, W. R., Latif, M. T., Hod, R., Khan, M. F., Tahir, N. M., & Chan, C. C. (2014). A case-crossover analysis of forest fire haze events and mortality in Malaysia. *Atmospheric Environment*, *96*, 257–265. https://doi.org/10.1016/j.atmosenv.2014.07.043

Sahota, A. (2006). Overview of the Global Market for Organic Food & Drink. In H. Willer & M. Yussefi (Eds.), *The World of Organic Agriculture. Statistics and Emerging Trends 2006* (pp. 69–73). International Federation of Organic Agriculture Movements (IFOAM), Bonn, Germany and Research Institute of Organic Agriculture FiBL, Frick, Switzerland.

Salazar, R.C. (2005). Social and institutional opportunities and constraints of organic agriculture in the Philippines. Conference on International Agricultural Research for Development 5p.

Salcedo-La Viña, C., & Morarji, M. (2016). Making Women'S Voices Count in Community Decision-Making on Land Investments, (July), 1–32.

Sawhney, P., & Perkins, M. A. . (2015). *Emerging Climate Change Adaptation Issues in the Asia-Pacific Region*.

Sayer, J., Sunderland, T., Ghazoul, J., Pfund, J.-L., Sheil, D., Meijaard, E., Venter, M., Boedhihartono, A. K., Day, M., Garcia, C., van Oosten, C., & Buck, L. E. (2013). Ten principles for a landscape approach to reconciling agriculture, conservation, and other competing land uses. *Proceedings of the National Academy of Sciences*, *110*(21), 8349–8356. https://doi.org/10.1073/pnas.1210595110

SCBD. (2012). *Draft decisions for the eleventh meeting of the conference of the parties to the convention on biological diversity*. Hyderabad, India. Retrieved from https://www.cbd.int/doc/meetings/cop/cop-11/official/cop-11-01-add2-en.pdf?

SCBD. (2014). *Global Biodiversity Outlook 4: A mid-term assessment of progress towards the implementation of the Strategic Plan for Biodiversity 2011-2020*. Montréal: Secretariat of the Convention on Biological Diversity. https://doi.org/10.1093/aje/kwq338

Scherr, S. J. (1999a). *Poverty-Environment interactions in agriculture: Key factors and policy*. New York: United Nations Development Programme and European Commission.

Scherr, S. J. (1999b). *Soil Degradation: A Threat to Developing-Country Food Security by 2020?* (Food, Agriculture and the Environment Discussion Papers No. 27). https://doi.org/0-89629-631-8

Scheyvens, H., Lopez-Casero, F., Gene, E. I., & Hyakumura, K. (2010). Conserving tropical forests: Reforming the tropical forest products trade towards sustainable consumption and production. In IGES (ed.), Sustainable consumption and production in the Asia-Pacific region: Effective responses in a resource constrained world. Hayama: IGES. https://pub.iges.or.jp/pub/conserving-tropical-forests-reforming-tropical

Scheyvens, H. (2011). *Critical Review of Selected Forest Regulatory Initiatives: Applying a Rights Perspective*.

Scheyvens, H., & Lopez-Casero, F. (2013). Managing forests as a renewable asset for present and future generations: Verifying legal compliance in forestry in Papua New Guinea.

Schneider, S. H., & Root, T. L. (1996). Ecological implications of climate change will include surprises. *Biodiversity and Conservation*, *5*(9), 1109–1119. https://doi.org/10.1007/BF00052720

Schrier-Uijl, A.P., M. Silvius, F. Parish, K.H. Lim, S. Rosediana, and G. Anshari. (2013). Environmental and social impacts of oil palm cultivation on tropical peat – a scientific review, Reports from the Technical Panels of the 2nd Greenhouse Gas Working Group of the Roundtable on Sustainable Palm Oil (RSPO).

Schouten, G., & Glasbergen, P. (2011). Creating legitimacy in global private governance: The case of the Roundtable on Sustainable Palm Oil. *Ecological Economics*, *70*(11), 1891–1899. https://doi.org/10.1016/j.ecolecon.2011.03.012

Schultz, L., Folke, C., Österblom, H., & Olsson, P. (2015). Adaptive governance, ecosystem management, and natural capital. *Proceedings of the National Academy of Sciences of the United States of America*, *112*(24), 7369–7374. https://doi.org/10.1073/pnas.1406493112

Secretariat of the Convention on Biological Diversity. (2010). *Global Biodiversity Outlook 3*. Montreal, Canada.

Sen, S., & Raakjaer Nielsen, J. (1996). Fisheries co-management: a comparative analysis. *Marine Policy*, *20*(5), 405–418. https://doi.org/10.1016/0308-597X(96)00028-0

Shackleton, D. M. (2001). A Review of Community-Based Trophy Hunting Programs in Pakistan. IUCN/SSC Caprinae Specialist Group.

Shackleton, S., Campbell, B., Wollenberg, E., & Edmunds, D. (2002). Devolution and community-based natural resource management: Creating space for local people to participate and benefit? *Natural Resource Perspectives*, *76*, 1–6.

Sheinkman, M., McKinley, J., Adaro, C., Bandyopadhyay, S., & Panda, A. (2015). *Climate-Smart Agriculture (CSA) Technologies in Asia CCAFS Workshop Report*. Copenhagen, Denmark. Retrieved from https//cgspace.cgiar.org/rest/bitstreams/59980/retrieve

Sheldon, R. D., Kamp, J., Koshkin, M. A., Urazaliev, R. S., Iskakov, T. K., Field, R. H., Salemgareev, A. R., Khrokov, V. V., Zhuly, V. A., Sklyarenko, S. L., & Donald, P. F. (2013). Breeding ecology of the globally threatened Sociable Lapwing Vanellus gregarius and the demographic drivers of recent declines. *Journal of Ornithology*, *154*(2), 501–516. https://doi.org/10.1007/s10336-012-0921-4

Sheppard, C., Al-Husiani, M., Al-Jamali, F., Al-Yamani, F., Baldwin, R., Bishop, J., Benzoni, F., Dutrieux, E., Dulvy, N. K., Durvasula, S. R. V., Jones, D. A., Loughland, R., Medio, D., Nithyanandan, M., Pilling, G. M., Polikarpov, I., Price, A. R. G., Purkis, S., Riegl, B., Saburova, M., Namin, K. S., Taylor, O., Wilson, S., & Zainal, K. (2010). The Gulf: a young sea in decline. *Marine Pollution Bulletin*, *60*(1), 13–38. https://doi.org/10.1016/j.marpolbul.2009.10.017

Shepsle, K. A., & Weingast, B. R. (1981). Structure-induced equilibrium and legislative choice. *Public Choice*, *37*(3), 503–519. https://doi.org/10.1007/BF00133748

Sherman, K. (2014). Adaptive management institutions at the regional level: The case of Large Marine Ecosystems. *Ocean & Coastal Management*, *90*, 38–49. https://doi.org/10.1016/J.OCECOAMAN.2013.06.008

Shibao, P. (2015). Why palm oil expanded, and what keeps it growing. Retrieved from https://news.mongabay.com/2015/03/why-palm-oil-expanded-and-what-keeps-it-growing/

Shine, C., Williams, N., & Gündling, L. (2000). *A Guide to Designing Legal and Institutional Frameworks on Alien Invasive Species*. *Environmental Policy and Law Paper No. 40*. Retrieved from http://www.issg.org/pdf/publications/GISP/Guidelines_Toolkits_BestPractice/Shine_etal_2000_EN.pdf

Shivakoti, G. P., & Ostrom, E. (2008). Facilitating Decentralized Policies for Sustainable Governance and Management of Forest Resources in Asia. In G. Webb, E.L. and Shivakoti (Ed.), *Decentralization, Forests and Rural Communities: Policy Outcomes in Southeast Asia* (pp. 292–310). SAGE Publications.

Smagadi, A. (2005). National measures on access to genetic resources and benefit sharing: the case of the Philippines. *Law, Environment and Development Journal*, *1*(1), 50. Retrieved from http://www.lead-journal.org/content/05050.pdf

Smyth, D. (2007). Dhimurru Indigenous Protected Area: sole management with partners. In T. Bauman & D. Smyth (Eds.), *Indigenous Partnerships in Protected Area Management in Australia: Three case studies* (pp. 100–126). Canberra: Australian Institute of Aboriginal and Torres Strait Islander Studies. Retrieved from http://www.australiancollaboration.com.au/pdf/Reports/Indigenous-Partnerships.pdf

Smyth, D. (2009). Just Add Water? Taking Indigenous Protected Areas into Sea Country. In D. Smyth & G. Ward (Eds.), *Indigenous Governance and Management of Protected Areas in Australia* (pp. 95–110). Canberra: Australian Institute of Aboriginal and Torres Strait Islander Studies.

Retrieved from https://aiatsis.gov.au/sites/default/files/products/report_research_outputs/2008-protecting-country-ch8-smyth.pdf

Sodhi, N. S., Brooks, T. M., Koh, L. P., Acciaioli, G., Erb, M., Tan, A. K., Curran, L. M., Brosius, P., Lee, T. M., Patlis, J. M., Gumal, M., Lee, R. J. (2006) Biodiversity and human livelihood crises in the Malay Archipelago. Conservation Biology 20: 1811–1813.

Somanathan, E., Prabhakar, R., & Singh, B. (2009). Decentralization for cost-effective conservation. *PNAS*, *106*(11), 4143–4147.

Southeast Asian Fisheries Development Center (SEAFDEC). (2006). *Regional Guidelines for Responsible Fisheries in Southeast Asia, Supplementary Guidelines on Co-management using Group User Rights, Fishery Statistics, Indicators and Fisheries Refugia*. Bangkok. Retrieved from http://www.unepscs.org/Refugia_Training/Fisheries Refugia Concept/11-ASEAN-SEAFDEC-Regional-Guidelines-on-the-Use-of-Fisheries-Refugia.pdf

SPREP. (1999). *Coastal Management Profiles: A Directory of Pacific Island Governments and non-Government Agencies with Coastal Management Related Responsibilities*. *Environment*. Apia, Samoa: South Pacific Regional Environment Programme.

Springer, J., Campese, J., & Painter, M. (2011). Conservation and Human Rights : Key Issues and Contexts., (October), 45.

Squires, D. (2014). Biodiversity Conservation in Asia. *Asia & the Pacific Policy Studies*, *1*(1), 144–159. https://doi.org/10.1002/app5.13

Stoker, G. (1998). Governance as theory: five propositions. *International Social Science Journal*, *50*(155), 17–28. https://doi.org/10.1111/1468-2451.00106

Strelein, L. M., & Weir, J. K. (2009). Conservation and human right in the context of native title in Australia. In *Rights-based approaches : exploring issues and opportunities for conservation* (p. 305). Center for International Forestry Research. Retrieved from https://books.google.co.jp/books?hl=ja&lr=lang_ja%7Clang_en&id=bZyj6fP9UBEC&oi=fnd&pg=PA123&dq=Strelein+Weir+2009+Gunditjmara&ots=MuB4g1Z3NE&sig=1UVw7wr_kXUVTOadBTVGy_n6LgI#v=onepage&q=Strelein Weir 2009 Gunditjmara&f=false

Subramanian, S. M., Chakraborty, S., & Ichikawa, K. (2017). *Mainstreaming Socio-Ecological Production Landscape Management Approaches. UNU-IAS Policy Brief - No. 8*. Tokyo, Japan. Retrieved from https://collections.unu.edu/eserv/UNU:6026/UNUIAS_PB_8.pdf

Sunchindah, A. (2015). Transboundary Haze Pollution Problem in Southeast Asia : Reframing ASEAN ' s Response. Retrieved from http://www.eria.org/ERIA-DP-2015-82.pdf

Sutton, A. M., & Rudd, M. A. (2015). The effect of leadership and other contextual conditions on the ecological and socio-economic success of small-scale fisheries in Southeast Asia. *Ocean & Coastal Management*, *114*, 102–115. https://doi.org/10.1016/j.ocecoaman.2015.06.009

Suwarno, A., Hein, L., & Sumarga, E. (2015). Governance, Decentralisation and Deforestation: The Case of Central Kalimantan Province, Indonesia. *Quarterly Journal of International Agriculture*, *54*(1), 77–100.

Swiderska, K., Dano, E., & Dubois, O. (2001). *Developing the Philippines' Executive Order No. 247 on Access to Genetic Resources*. London. Retrieved from https://www.cbd.int/financial/bensharing/philippines-order.pdf

Swiderska, K., Roe, D., Siegele, L., & Grieg-Gran, M. (2008). The Governance of Nature and the Nature of Governance. *Policy That Works for Biodiversity and Livelihoods*, (the Swedish International Biodiversity Program funded by Sida), 1–173. https://doi.org/10.1017/S0014479709991049

Tacconi, L., & Bennett, J. (1997). Protected area assessment and establishment in Vanuatu: a socioeconomic apporach. *ACIAR Monograph N^{o}38 - 180pp.*

Takahashi, W. (2000). *Environmental cooperation in Northeast Asia*. Retrieved from https://pub.iges.or.jp/system/files/publication_documents/pub/discussionpaper/924/neasia.pdf

Tan, A. K.-J. (2004). Environmental laws and institutions in Southeast Asia: A review of recent developments. *Sybil*, *8*(2004), 177. Retrieved from http://heinonlinebackup.com/hol-cgi-bin/get_pdf.cgi?handle=hein.journals/singa8&section=15

Tan, P. Y., Wang, J., & Sia, A. (2013). Perspectives on five decades of the urban greening of Singapore. *Cities*, *32*, 24–32. https://doi.org/10.1016/j.cities.2013.02.001

Tang, L., Shao, G., Piao, Z., Dai, L., Jenkins, M. A., Wang, S., Wu, G., Wu, J., & Zhao, J. (2010). Forest degradation deepens around and within protected areas in East Asia. *Biological Conservation*. https://doi.org/10.1016/j.biocon.2010.01.024

Tarte, S. (2009). The Convention for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean: Implementation Challenges from a Historical Perspective. In *Navigating Pacific Fisheries: Legal and Policy Trends in the Implementation of International Fisheries Instruments in the Western and Central Pacific Region* (pp. 204–220).

Tawake, A., & Aalbersberg, W. G. L. (2002). *Community-Based Refugia Management in Fiji*. *Coastal Protection For and By the People of the Indo-Pacific: Learning from 13 Case Studies*. Suva, Fiji.

Taylor, P. L. (2005). In the market but not of it: Fair trade coffee and forest stewardship council certification as market-based social change. *World Development*, *33*, 129–147. https://doi.org/10.1016/j.worlddev.2004.07.007

Techera, E. J. (2015). Enhancing legal frameworks for biodiversity conservation in the Pacific. *Pacific Conservation Biology*, *21*(1), 87–96. https://doi.org/10.1071/PC14906

TEEB. (2009). *The Economics of Ecosystems and Biodiversity for National and International Policy Makers*. (Patrick ten Brink, Ed.). London and Washington: Earthscan.

TEEB. (2010). *The Economics of Ecosystems and Biodiversity: Mainstreaming the economics of Nature: A synthesis of the approach, conclusions and recommendations of TEEB. Environment*. Retrieved from http://www.iges.or.jp/jp/news/topic/pdf/1103teeb/teeb_synthesis_j.pdf

TEEB. (2011). *The Economics of Ecosystems and Biodiversity: TEEB for National and International Policy Makers*. (P. ten Brink, Ed.). London and Washington: Earthscan.

Teh, L. C. L. S. L., Teh, L. C. L. S. L., Ben Starkhouse, Sumaila, U. R., Starkhouse, B., & Rashid Sumaila, U. (2009). An overview of socio-economic and ecological perspectives of Fiji's inshore reef fisheries. *Marine Policy*, *33*(5), 807–817. https://doi.org/10.1016/j.marpol.2009.03.001

Termmahawong, W. (2014). Oil palm production in Thailand -with a special focus on small scale producers.

The Star Online. (2017). MSPO certification mandatory by 2019 - Nation | The Star Online. Retrieved from https://www.thestar.com.my/news/nation/2017/02/25/mspo-certification-mandatory-by-2019-govt-aims-for-sustainable-oil-palm-industry/

The World Bank. (2000). *Voices from the village: a comparative study of coastal resource management in the Pacific Islands - Final Report*. *Pacific Islands Discussion Paper* (Vol. 9). Washington DC, USA.

The World Bank. (2016). *The Cost of Fire: An Economic Analysis of Indonesia's 2015 Fire Crisis*. Jakarta, Indonesia.

Thompson, I. D., Okabe, K., Tylianakis, J. M., Kumar, P., Brockerhoff, G., Schellhorn, N. A., Parrotta, J. A., & Nasi, R. (2011). Forest Biodiversity and the Delivery of Ecosystem Goods and Services: Translating Science into Policy. *Articles 972 BioScience*, *61*(12). https://doi.org/10.1525/bio.2011.61.12.7

Tilman, D., Gassman, Matson, Naylor, & Polasky. (2002). Agricultural sustainability and intensive production practices. *Nature*, *418*, 671–677. Retrieved from https://www.nature.com/articles/nature01014

Tonnejick, F., Winterwerp, H., van Weesenbeeck, B., Bosma, R., Noor, Y. R., & Wilms, T. (2015). *Building with Nature Indonesia Securing Eroding Delta Coastlines: Design and Engineering Plan*.

Townsend, R., Shotton, R., & Uchida, H. (2008). *Case studies in fisheries self-governance*. *FAO. Fisheries Technical Paper*. Retrieved from http://www.fao.org/documents/card/en/c/231f629d-848a-5b52-8bcd-67ab287c1a61/

Tran, N. Van, Rodriguez, U.-P., Chan, C. Y., Phillips, M. J., Mohan, C. V., Henriksson, P. J. G., Koeshendrajana, S., Suri, S., & Hall, S. (2017). Indonesian Aquaculture Futures – Part 1: An analysis of fish supply and demand in Indonesia to 2030 and role of aquaculture using the AsiaFish Model. *Marine Policy*, *79*(November 2016), 25–32. https://doi.org/10.1016/j.marpol.2017.02.002

Tripathi, A. (2014). The invasive potential of parasitic monogenoids (platyhelminthes) via the aquarium fish trade: an appraisal with special reference to India. *Reviews in Aquaculture*, *6*(3), 147–161. https://doi.org/10.1111/raq.12035

Tscharntke, T., Clough, Y., Wanger, T. C., Jackson, L., Motzke, I., Perfecto, I., Vandermeer, J., & Whitbread, A. (2012). Global food security, biodiversity conservation and the future of agricultural intensification. *Biological Conservation*. https://doi.org/10.1016/j.biocon.2012.01.068

Tumendemberel, O., Proctor, M., Reynolds, H., Boulanger, J., Luvsamjamba, A., Tserenbataa, T., Batmunkh, M., Craighead, D., Yanjin, N., & Paetkau, D. (2015). Gobi bear abundance and inter-oases movements, Gobi Desert, Mongolia. *Ursus*, *26*(2), 129–142. https://doi.org/10.2192/URSUS-D-15-00001.1

Tvedt, M. W., & Schei, P. J. (2014). The term ‘genetic resources’: flexible and dynamic while providing legal certainty? In S. Oberthür & G. K. Rosendal (Eds.), *Global Governance of Genetic Resources Access and Benefit Sharing after the Nagoya Protocol* (p. 282). London: Routledge, Taylor and Francis.

Tyler, S. (2006). *Communities, Livelihoods, and Natural Resources: Action Research and Policy Change in Asia*. Ottawa: International Development Research Centre.

UN. (2007). Indigenous Peoples - Lands, Territories and Natural Resources. Retrieved from http://www.un.org/esa/socdev/unpfii/documents/6_session_factsheet1.pdf

UN. (2010). Gender and Indigenous Peoples ’ Environment. Retrieved from http://www.un.org/esa/socdev/unpfii/documents/BriefingNote1_GREY.pdf

UNDP. (n.d.). Gender Development Index (GDI) | Human Development Reports. Retrieved January 16, 2018, from http://hdr.undp.org/en/content/gender-development-index-gdi

UNEP-SACEP. (2002). *Handbook on National Environmental Legislation and Institutions in South Asia*. (R. Hasan, Ed.).

UNEP-WCMC. (2016a). *The State of Biodiversity in Asia and the Pacific: A mid-term review of progress towards the Aichi Biodiversity Targets*. *Report*. Cambridge, UK. Retrieved from https://www.cbd.int/gbo/gbo4/outlook-asiapacific-en.pdf

UNEP-WCMC. (2016b). *The State of Biodiversity in West Asia: a mid-term reveiw of progress towards the Aichi Biodiversity Targets*. Cambridge, UK.

UNEP-WCMC & IUCN. (2016). Protected Planet: The Global Database on Protected Areas Management Effectiveness (GD-PAME) [On-line], [Oct 2016], Cambridge, UK: UNEP-WCMC and IUCN. Retrieved from www.protectedplanet.net.

UNEP-WCMC, & IUCN. (2017). Protected Planet: The World Database on Protected Areas (WDPA) [On-line] [Oct 2017]. Retrieved from www.protectedplanet.net

UNEP-WCMC and Korea National Park Service (2016). Protected Planet National Technical Series: Republic of Korea. UNEP-WCMC: Cambridge, UK.

UNEP. (2004). *People and reefs: successes and challenges in the management of coral reef marine protected areas. United Nations Environment Programme-Regional Seas Programme, Nairobi, Kenya. 103 pp.* Nairobi, Kenya.

UNEP. (2008). *Reforming Energy Subsidies*. *United Nations Environment Programme, Division of Technology, Industry and Economics*. Retrieved from http://www.unep.org/pdf/pressreleases/reforming_energy_subsidies.pdf

UNEP. (2010). *State of Biodiversity in Asia and the Pacific*. Bangkok. Retrieved from http://www.unep.org/delc/Portals/119/regional brief for Asia and Pacific.pdf

UNEP. (2012). *Global Environment Outlook 5: Environment for the future we want*. Nairobi. Retrieved from http://www.unep.org/geo/geo5.asp

UNEP. (2014a). *South Asia Environment Outlook 2014*. UNEP, SAARC and DA. Retrieved from http://www.roap.unep.org/pub/index.cfm

UNEP. (2014b). UNEP signs Landmark Agreement with League of Arab States to Strengthen Partnership on Environment and Sustainable Development. Retrieved from http://web.unep.org/newscentre/unep-signs-landmark-agreement-league-arab-states-strengthen-partnership-environment-and-sustainable

UNEP. (2016). *GEO-6 Regional Assessment for Asia and the Pacific*. Nairobi, Kenya: United Nations Environment Programme. Retrieved from http://web.unep.org/geo-6-global-environment-outlook-regional-assessment-asia-and-pacific

UNESCAP. (n.d.). MAJOR GROUPS (pp. 302–315).

UNESCAP. (2012). *Low Carbon Green Growth Roadmap for Asia and the Pacific: Turning resource constraints and the climate crisis into economic growth opportunities*.

UNESCAP. (2017). *Integrated approaches for Sustainable Development Goals planning: The case of Goal 6 on water and sanitation*. Bangkok. Retrieved from http://www.unescap.org/sites/default/files/publications/Integrated Approaches for SDG Planning_0.pdf

UNFCCC. (2011). Report of the Conference of the Parties on its sixteenth session, held in Cancun from 29 November to 10 December 2010. *Decision 1/CP.16*, (March), 1–31. Retrieved from http://unfccc.int/resource/docs/2010/cop16/eng/07a01.pdf

UNFCCC. (2015). *ADOPTION OF THE PARIS AGREEMENT Proposal by the President*. Paris.

United Nations, Asian Development Bank, & United Nations Development Programme. (2017). *Eradicating Poverty and Promoting Prosperity in a Changing Asia-Pacific*. Bangkok, Thailand: United Nations.

United Nations Development Programme. (2012). The Future We Want: Biodiversity and Ecosystems - Driving Sustainable Development. Biodiversity and Ecosystems Global Framework 2012-2020, 80. Retrieved from http://www.undp.org/content/dam/undp/library/Environment and Energy/biodiversity/UNDP-Biodiversity-and-Ecosystems-Global-Framework-2012-2020.pdf

United Nations University Institute of Advanced Studies Operating Unit Ishikawa/Kanazawa. (2011). *Biological and Cultural Diversity in Coastal Communities, Exploring the Potential of Satoumi for Implementing the Ecosystem Approach in the Japanese Archipelago. CBD Technical Series*. Retrieved from https://www.cbd.int/doc/publications/cbd-ts-61-en.pdf

UNREDD. (2010). Background: International Framework for REDD+ Implementation.

UNU-IAS, & IGES. (2015). *Satoyama Initiative Thematic Review vol.1: Enhancing Knowledge for Better Management of Socio-ecological Production Landscapes and Seascapes (SEPLS)*. Tokyo. Retrieved from http://satoyama-initiative.org/wp-content/uploads/2015/12/SITR-v1-web.pdf.pdf

UNU-IAS, & IGES. (2016). *Satoyama Initiative Thematic Review vol. 2: Mainstreaming concepts and approaches of socio-ecological production landscapes and seascapes into policy and decision-making*. Tokyo. Retrieved from http://satoyama-initiative.org/wp-content/uploads/2016/11/SITR-vol2-web-version.pdf

Upadhyay, V. P. (1995). An ecological analysis of Himalayan Forest Ecosystems. In R.C.Mohanty (Ed.), *Environment, change and Management* (pp. 62–69). New Delhi: Kamla Raj Publishers. Retrieved from http://www.vpupadhyay.org/papers/RC Mohanty ED.pdf

van Beukering, P., Brander, L., Tompkins, E., & McKenzie, E. (2007). *Valuing the Environment in Small Islands - An Environmental Economics Toolkit*. Retrieved from http://www.jncc.gov.uk/page-4065

Vanclay, F. (2004). Social principles for agriculture extension to assist in the promotion of natural resource management. *Australian Journal of Experimental Agriculture*, *44*, 213–222.

Varkkey, H. (2014). Regional cooperation, patronage and the ASEAN Agreement on transboundary haze pollution. *International Environmental Agreements: Politics, Law and Economics*, *14*, 65–81. https://doi.org/10.1007/s10784-013-9217-2

Varkkey, H. M. (2012). The Asean Way and Haze Mitigation Efforts. *Journal of International Studies*, *8*, 77–97. Retrieved from http://jis.uum.edu.my

Vatn, A. (2015). Markets in environmental governance. From theory to practice. *Ecological Economics*, *117*, 225–233. https://doi.org/10.1016/j.ecolecon.2014.07.017

Vaz, J., & Agama, A. L. (2013). Seeking synergy between community and state-based governance for biodiversity conservation: The role of Indigenous and Community-Conserved Areas in Sabah, Malaysian Borneo. *Asia Pacific Viewpoint*, *54*(2), 141–157. https://doi.org/10.1111/apv.12015

Veitayaki, J. (2000). Fisheries resource-use culture in Fiji and its implications. In A. (ed.). 2000. Hooper (Ed.), *Culture and sustainable development in the Pacific.* (pp. 116–130). Canberra, Australia: The Australian National University EPress and Asia Pacific Press.

Velasquez, J., Yashiro, M., Yoshimura, S., & Ono, I. (2005). *Innovative communities: People-centred approaches to environmental management in the Asia-Pacific region*. Tokyo: United Nations University Press.

Vella, K. (2016). Communiqué G7 Toyama Environment Ministers' Meeting, European Commission. https://ec.europa.eu/commission/commissioners/2014-2019/vella/blog/communique-g7-toyama-environment-ministers-meeting_en

Verheij, P., Foley, K.-E., & Engel, K. (2010). *Reduced To Skin and Bones : An Analysis of Tiger Seizues from 11 Tiger Range Countries (2000 - 2010)*. Cambridge, UK: TRAFFIC International.

Vermeulen, S., & Sheil, D. (2007). Partnerships for tropical conservation. *Oryx*, *41*(04). https://doi.org/10.1017/S0030605307001056

Victor, D., & Agamuthu, P. (2014). Policy trends of strategic environmental assessment in Asia. *Environmental Science & Policy*, *41*, 63–76. https://doi.org/10.1016/J.ENVSCI.2014.03.005

Victor, D. G., Raustiala, K., & Skolnikoff, E. B. (Eds.). (2008). *The Implementation and effectiveness of International Environmental Commitments: Theory and Practice*. Cambridge, MA: The MIT Press.

Vince, J., Brierley, E., Stevenson, S., & Dunstan, P. (2017). Ocean governance in the South Pacific region: Progress and plans for action. *Marine Policy*, *79*(December 2016), 40–45. https://doi.org/10.1016/j.marpol.2017.02.007

Virk, A. T. (1999). *Integrating wildlife conservation with community-based development in Northern Areas Pakistan*. University of Montana.

Wai, O. K. (2006). Organic Farming in Asia. In H. Willer & M. Yussefi (Eds.), *The World of Organic Agriculture. Statistics and Emerging Trends 2006* (pp. 108–117). International Federation of Organic Agriculture Movements (IFOAM), Bonn, Germany and Research Institute of Organic Agriculture FiBL, Frick, Switzerland.

Wakamatsu, M., & Wakamatsu, H. (2017). The certification of small-scale fisheries. *Marine Policy*, *77*(December 2016), 97–103. https://doi.org/10.1016/j.marpol.2016.12.016

Walker, S., Brower, a L., Stephens, R. T. T., & Lee, W. G. (2009). Why bartering biodiversity fails. *Conservation Letters*. https://doi.org/10.1111/j.1755-263X.2009.00061.x

Walther, B. A., Boëte, C., Binot, A., By, Y., Cappelle, J., Carrique-Mas, J., Chou, M., Furey, N., Kim, S., Lajaunie, C., Lek, S., Méral, P., Neang, M., Tan, B.-H., Walton, C., & Morand, S. (2016). Biodiversity and health: Lessons and recommendations from an interdisciplinary conference to advise Southeast Asian research, society and policy. *Infection, Genetics and Evolution*, *40*, 29–46. https://doi.org/10.1016/j.meegid.2016.02.003

Walzer, C., & Kaczensky, P. (2005). Wild camel training and collaring mission for the Great Gobi, a strictly protected area in Mongolia, (December), 1–32.

Ward, T. J. (2008). Barriers to biodiversity conservation in marine fishery certification. *Fish and Fisheries*, *9*(2), 169–177. https://doi.org/10.1111/j.1467-2979.2008.00277.x

Washitani, I. (2004). Invasive alien species problems in Japan: an introductory ecological essay. *Global Environmental Research*, *8*(1), 1–12. https://doi.org/citeulike-article-id:7474085

Webb, E. L. (2008). Forest policy as a change context in Asia. In *Decentralization, Forests and Rural Communities: Policy Outcomes in Southeast Asia* (pp. 21–43). SAGE Publications.

Webb, E. L., & Dorji, L. (2008). The Evolution of Forest-Related Institutions in Bhutan: Adaptations of Local People to the Rising State. In G. Webb, E.L. and Shivakoti (Ed.), *Decentralization, Forests and Rural Communities: Policy Outcomes in Southeast Asia* (pp. 68–92). SAGE Publications.

Wescott, C. G. (2001). E-Government in the Asia-pacific region. *Asian Journal of Political Science*, *9*(2), 1–24. https://doi.org/10.1080/02185370108434189

Westphal, M., Hughes, G., & Brömmelhörster, J. (2013). *Economics of Climate Change in East Asia*.

Wetlands International. (2015). Building with Nature Indonesia - reaching scale for coastal resilience. *Wetlands International*. Retrieved from http://www.wetlands.org/WatchRead/Currentpublications/tabid/56/mod/1570/articleType/ArticleView/articleId/3698/Building-with-Nature-in-Indonesia.aspx

WFC. (2008). Lessons Learned and best practices in the management of coral reefs. *The WorldFish Center - Working Papers*, *37642*, 8 pp. Retrieved from http://ideas.repec.org/b/wfi/wfbook/37642.html

Wiebe, K. (2003). *Linking Land Quality, Agricultural Productivity, and Food Security* (Agricultural Economic Report No. 823). Washington. Retrieved from http://www.ers.usda.gov/media/522187/aer823_1_.pdf

Wilkie, D. S., Morelli, G. A., Demmer, J., Starkey, M., Telfer, P., & Steil, M. (2006). Parks and people: Assessing the human welfare effects of estiablishing protected areas for biodiversity conservation. *Conservation Biology*, *20*(1), 247–249. https://doi.org/10.1111/j.1523-1739.2006.00291.x

Wong, P. P. (2009). Rethinking post-tsunami integrated coastal management for Asia-Pacific. *Ocean and Coastal Management*, *52*(7), 405–410. https://doi.org/10.1016/j.ocecoaman.2009.04.013

Wood, A. L., Butler, J. R. A., Sheaves, M., & Wani, J. (2013). Sport fisheries: Opportunities and challenges for diversifying coastal livelihoods in the Pacific. *Marine Policy*, *42*, 305–314. https://doi.org/10.1016/j.marpol.2013.03.005

World Bank. (n.d.). Indicator data - Women, Business and the Law. Retrieved January 16, 2018, from http://wbl.worldbank.org/data/exploretopics/accessing-institutions

World Resources Institute. (2008). *World Resources: Roots of Resilience - Growing the Wealth of the Poor. Washington, DC*. https://doi.org/ISBN 978-1-56973-600-5

World Trade Organization. (2011a). Dispute settlement: dispute ds367. Retrieved from https://www.wto.org/english/tratop_e/dispu_e/cases_e/ds367_e.htm

World Trade Organization. (2011b). Asia-Pacific case stories: A snapshot of Aid for Trade on the ground. 40p.

Wright, A., Stacey, N., & Holland, P. (2006). The cooperative framework for ocean and coastal management in the Pacific Islands: Effectiveness, constraints and future direction. *Ocean and Coastal Management*, *49*(9–10), 739–763. https://doi.org/10.1016/j.ocecoaman.2006.06.013

Wunder, S. (2005). Payments for environmental services: some nuts and bolts. *CIFOR Occasional Paper No. 42*, (42), 24p. Retrieved from http://www.cifor.cgiar.org/Knowledge/Publications/Detail?pid=1760

WWF-Indonesia. (2012). *Rewetting of Tropical Peat Swamp Forest in Sebangau National Park , Central Kalimantan , Indonesia*.

Wynen, E., & Mason, S. (2006). Organic Farming in Australia/Oceania. In H. Willer & M. Yussefi (Eds.), *The World of Organic Agriculture. Statistics and Emerging Trends 2006* (pp. 118–129). International Federation of Organic Agriculture Movements (IFOAM), Bonn, Germany and Research Institute of Organic Agriculture FiBL, Frick, Switzerland.

Xu, W., Xiao, Y., Zhang, J., Yang, W., Zhang, L., Hull, V., Wang, Z., Zheng, H., Liu, J., Polasky, S., Jiang, L., Xiao, Y., Shi, X., Rao, E., Lu, F., Wang, X., Daily, G. C., Ouyang, Z., Haddad, N. M., & Lei, G. (2017). Strengthening protected areas for biodiversity and ecosystem services in China. *Proceedings of the National Academy of Sciences*, *114*(7), 1601–1606. https://doi.org/10.1073/pnas.1620503114

Yanagi, T. (2013). *Japanese Commons in the Coastal Seas: How the Satoumi Concept Harmonizes Human Activity in Coastal Seas with High Productivity and Diversity*. Tokyo: Springer Japan. https://doi.org/10.1007/978-4-431-54100-4

Yang, J., Huang, C., Zhang, Z., & Wang, L. (2014). The temporal trend of urban green coverage in major Chinese cities between 1990 and 2010. *Urban Forestry and Urban Greening*, *13*(1), 19–27. https://doi.org/10.1016/j.ufug.2013.10.002

Yasmi, Y., Broadhead, J., Enters, T., & Genge, C. (2010). *Forestry policies, legislation and institutions in Asia and the Pacific - Trends and emerging needs for 2020*. Food and Agriculture Organization (FAO). Retrieved from http://www.fao.org/docrep/013/i1722e/i1722e00.pdf

Yonariza and Shivakoti, G. P. (2008). Decentralization Policy and Revitalization of Local Institutions for Protected Area Co-management in West Sumatra, Indonesia. In G. Webb, E.L. and Shivakoti (Ed.), *Decentralization, Forests and Rural Communities: Policy Outcomes in Southeast Asia* (pp. 128–149). SAGE Publications.

Young, O. R. (2005). Why is There No Unified Theory of Environmental Governance? In P. Dauvergne (Ed.), *Handbook of Global Environmental Politics* (pp. 170–184). Cheltenham, UK: Edward Elgar Publishing.

Young, O. R., & Underdal, A. (Eds.). (2004). *Regime Consequences: Methodological Challenges and Research Strategies*. Dordrecht, The Netherlands: Kluwer Academic Publishers.

Yu, W. (2016). University of Copenhagen Agricultural and agri-environment policy and sustainable agricultural development in.

Zanella, M. A., Schleyer, C., & Speelman, S. (2014). Why do farmers join Payments for Ecosystem Services (PES) schemes? An Assessment of PES water scheme participation in Brazil. *Ecological Economics*, *105*, 166–176. https://doi.org/10.1016/j.ecolecon.2014.06.004

Zelenovskaya, E. (2012). Green Growth Policy in Korea : A case study, 1–6.

Zeppel, H. (2014). Green Procurement by Local Government : A Review of Sustainability Criteria. *ACSBD Working Paper No. 8*. Retrieved from https://eprints.usq.edu.au/25109/1/GPLocalGov-ACSBD WP 8 (Zeppel, 2014).pdf

Zhou, X., & Moinuddin, M. (2017). *Sustainable Development Goals Interlinkages and Network Analysis: A practical tool for SDG integration and policy coherence*. Hayama. Retrieved from http://www.iges.or.jp

Appendix 1. Glossary

Abundance (ecological)
The size of a population of a particular life form in a given area.

Acceptance
Acceptance of the Platform's outputs at a session of the Plenary signifies that the material has not been subjected to line-by-line discussion and agreement, but nevertheless presents a comprehensive and balanced view of the subject matter.

Acidification
Ongoing decrease in pH away from neutral value of 7. Often used in reference to oceans, freshwater or soils, in response to uptake of carbon dioxide from the atmosphere.

Adaptation
Adjustment in natural or human systems to a new or changing environment, whether through genetic or behavioural change.

Adaptation response
Responsive outcome from adaptations, either antropogenic (such as adaptations to environmental change) or natural (such as species adaptations, possibly arising from selective pressures).

Adaptive capacity
The general ability of institutions, systems, and individuals to adjust to potential damage, to take advantage of opportunities, or to cope with the consequences.

Adaptive co-management
An extension of Co-management. A means of sustaining socio-ecological systems by building their resilience and adaptive capacity and establishing sustainable pathways as well as providing a novel institutional arrangement to generate adaptive responses.

Adaptive management
A systematic process for continually improving management policies and practices by learning from the outcomes of previously employed policies and practices. In active adaptive management, management is treated as a deliberate experiment for purposes of learning.

Adoption
Adoption of an IPBES report is a process of section-by-section (and not line-by-line) endorsement, as described in section 3.9, at a session of the Plenary.

Agricultural extension
A service whereby knowledge about agricultural practices, technologies, tools, and innovations is conveyed to farmers and rural people.

Agricultural intensification
An increase in agricultural production per unit of inputs (which may be labour, land, time, fertilizer, seed, feed or cash).

Agricultural production landscapes
See "Agro ecological zones".

Agrobiodiversity
The result of natural selection processes and the careful selection and inventive developments of farmers, herders and fishers over millennia. A vital sub-set of biodiversity.

Agro-chemicals
An agrochemical or agrichemical, a contraction of agricultural chemical, is a chemical product used in agriculture. In most cases, agrichemical refers to pesticides including insecticides, herbicides, fungicides and nematicides. It may also include synthetic fertilizers, hormones and other chemical growth agents, and concentrated stores of raw animal manure.

Agro-deforestation
The removal of trees or de-emphasis on the planting and/or protection of trees in the context of existing agroecosystems.

Agro-ecosystem
A human activity system that provides specific services and possesses certain characteristics such as defined biodiversity, a determined ecological succession and food webs and nutrient cycles.

Agroforestry
Rural and urban agricultural land use systems in which trees or tree-like perennial and forests are deliberately planted or protected along with agricultural crops and/or animals and associated wild species.

Aichi (Biodiversity) Targets
The 20 targets set by the Conference of the Parties to the Convention for Biological Diversity (CBD) at its tenth meeting, under the Strategic Plan for Biodiversity 2011-2020.

Alternative futures
Plausible future pathways either arising from or forming scenario assessments, often presented as narratives that explore or articulate possibilities.

Alternative trajectories
Variable pathways or routes leading to plausible Alternative Futures.

Ameliorative policy arrangements
Policy combinations that act to improve condistions or situations.

Animism
The attribution of a soul to plants, inanimate objects, and natural phenomena.

Annual
In Botany, refers to plants that grow from seed to maturity, reproduction and death in one year. Related terms are biennial (plants that take two years to complete their life cycles), and perennial (plants that take several many years to complete their life cycles).

Anthropogenic assets
Built-up infrastructure, health facilities, or knowledge - including indigenous and local knowledge systems and technical or scientific knowledge - as well as formal and non-formal education, technology (both physical objects and procedures), and financial assets. Anthropogenic assets have been highlighted to emphasize that a good quality of life is achieved by a co-production of benefits between nature and people.

Anthropogenic pressure
Caused or influenced by humans.

Aphotic zone
Aphotic zone is the portion of a lake or ocean where there is little or no sunlight. It is formally defined as the depths beyond which less than 1 per cent of sunlight penetrates.

Approval
Approval of the Platform's outputs signifies that the material has been subject to detailed, line-by-line discussion and agreement by consensus at a session of the Plenary.

Aquaculture
The farming of aquatic organisms, including fish, molluscs, crustaceans and aquatic plants, involving interventions such as regular stocking, feeding, protection from predators, to enhance production. (In contrast, aquatic organisms which are exploitable by the public as a common property resource, are classed as fisheries, not aquaculture).

Archetypes
In the context of scenarios, an over-arching scenario that embodies common characteristics of a number of more specific scenarios.

Arid ecosystems
Those in which water availability severely constrains ecological activity.

Arid regions
A region is arid when it is characterized by a severe lack of available water, to the extent of hindering or preventing the growth and development of plant and animal life. Environments subject to arid climates tend to lack vegetation and are called xeric or desertic.

Asia-Pacific region
One of 4 regions defined in the IPBES framework and includes 62 countries or territories from five subregions, namely Oceania (American Samoa*, Australia, Commonwealth of the Northern Mariana Islands*, Cook Islands, Fiji, French Polynesia*, Guam*, Hawai'i*, Kiribati, Marshall Islands, Federated States of Micronesia, Nauru, New Caledonia*, New Zealand, Niue*, Palau, Papua New Guinea, Pitcairn Island*, Samoa, Solomon Islands, *Tokelau, Tonga, Tuvalu, Vanuatu, Wallis and Futuna, and oceanic and sub-Antarctic islands in the Pacific and Indian Oceans*), South-East Asia (Brunei Darussalam, Cambodia, Indonesia, Lao People's Democratic Republic, Malaysia, Myanmar, Philippines, Singapore, Thailand, Timor-Leste, and Viet Nam), North-East Asia (China, Democratic People's Republic of Korea, Japan, Mongolia, and Republic of Korea), South Asia (Afghanistan, Bangladesh, Bhutan, India, Iran (Islamic Republic of), Maldives, Nepal, Pakistan and Sri Lanka), Western Asia (Bahrain, Iraq, Jordan, Lebanon, Kuwait, Oman, Palestine (State of), Qatar, Saudi Arabia, Syrian Arab Republic, United Arab Emirates, and Yemen). *Overseas territory.

Assessment reports
Assessment reports are published outputs of scientific, technical and socioeconomic issues that take into account different approaches, visions and knowledge systems, including global assessments of biodiversity and ecosystem services with a defined geographical scope, and thematic or methodological assessments based on the standard or the fast-track approach. They are to be composed of two or more sections including a summary for policymakers, an optional technical summary and individual chapters and their executive summaries. Assessments are the major output of IPBES, and they contain syntheses of findings on topics that have been selected by the IPBES Plenary.

Back-casting
An analytical technique used to search for target-seeking scenarios that fulfil a predefined goal, or set of goals.

Ballast water
Ballast water is water carried in ships' ballast tanks to improve stability, balance and trim. It is taken up or discharged when cargo is unloaded or loaded, or when a ship needs extra stability in foul

weather. When ships take on ballast water, plants and animals that live in the ocean are also picked up.

Baseline
A minimum or starting point with which to compare other information (e.g. for comparisons between past and present or before and after an intervention).

Benefit sharing
Distribution of benefits between stakeholders.

Benefits
Advantage that contributes to well-being from the fulfilment of needs and wants.

Benthic
Occurring at the bottom of a body of water; related to benthos.

Benthos
A group of organisms, other invertebrates, that live in or on the bottom in aquatic habitats.

Biocapacity
The definition that follows is for the purpose of this assessment only: "Biocapacity" has a variety of definitions, but is defined by the Global Footprint Network the as "the ecosystems' capacity to produce biological materials used by people and to absorb waste material generated by humans, under current management schemes and extraction technologies". The 'biocapacity' indicator used in this report is based on the Global Footprint Network unless otherwise specified.

Biocultural diversity
The diversity exhibited collectively by natural and cultural systems. It incorporates three concepts: firstly, that the diversity of life includes human cultures and languages; secondly, that links exist between biodiversity and human cultural diversity; and finally, that these links have developed over time through mutual adaptation and possibly co-evolution between humans, plants and animals.

Biodiversity
The variability among living organisms from all sources including, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems.

Biodiversity hotspot
A generic term for an area high in such biodiversity attributes as species richness or endemism. It may also be used in assessments as a precise term applied to geographic areas defined according to two criteria: (i) containing at least 1,500 species of the world's 300,000 vascular plant species as endemics, and (ii) having lost 70 per cent of its primary vegetation.

Biodiversity loss
The reduction of any aspect of biological diversity (i.e. diversity at the genetic, species and ecosystem levels) is lost in a particular area through death (including extinction), destruction or manual removal; it can refer to many scales, from global extinctions to population extinctions, resulting in decreased total diversity at the same scale.

Biodiversity offset
A biodiversity offset is a tool proposed by developers and planners for compensating for the loss of biodiversity in one place by biodiversity gains in another.

Biofuel
Fuel made from biomass.

Biomass
The mass of non-fossilized and biodegradable organic material originating from plants, animals and micro-organisms in a given area or volume.

Biome
Biomes are global-scale zones, generally defined by the type of plant life that they support in response to average rainfall and temperature patterns. For example, tundra, coral reefs or savannas.

Biophysical system
An assemblage of interacting biological and physical processes.

Biosphere
The sum of all the ecosystems of the world. It is both the collection of organisms living on the Earth and the space that they occupy on part of the Earth's crust (the lithosphere), in the oceans (the hydrosphere) and in the atmosphere. The biosphere is all the planet's ecosystems.

Biota
All living organisms of an area; the flora and fauna considered as a unit.

Black carbon
Black carbon is a carbonaceous aerosol. It is produced both naturally and by human activities as a result of the incomplete combustion of fossil fuels, biofuels, and biomass. Primary sources include emissions from diesel engines, cook stoves, wood burning and forest fires. Black carbon particles strongly absorb sunlight and give soot its black color. Thus, black carbon has emerged as a major contributor to global climate change, possibly second only to $CO2$ as the main driver of change.

Bottom-up
Systems driven by basic or lower-order processes.

Brackish water
Water that has more salinity than fresh water, but not as much as seawater. It may result from mixing of seawater with fresh water, as in estuaries, or it may occur in brackish fossil aquifers. Technically, brackish water contains between 0.5 and 30 grams of salt per litre—more often expressed as 0.5 to 30 parts per thousand (‰), which is a specific gravity of between 1.005 and 1.010. Thus, brackish covers a range of salinity regimes and is not considered a precisely defined condition.

Bushmeat
Meat for human consumption derived from wild animals.

Bushmeat hunting
Bushmeat (or wild meat) hunting is a form of subsistence hunting that entails the harvesting of wild animals for food and for non-food purposes, including for medicinal use.

Business-As-Usual (BAU)
IPCC term case assumes that future developments follow those of the past and no changes in policies will take place.

Bycatch
The commercially undesirable species caught during a fishing process.

Calibration (of models)
The use of observations, or in some cases a reference model, during model development to ensure that the model output compares favourably with the properties of the system being modelled.

Capacity-building (or development)
Defined by the United Nations Development Programme as "the process through which individuals, organizations and societies obtain, strengthen and maintain their capabilities to set and achieve their own development objectives over time". IPBES promotes and facilitates capacity-building, to improve the capacity of countries to make informed policy decisions on biodiversity and ecosystem-services.

Carbon cycle
The carbon cycle is the process by which carbon is exchanged among the ecosystems of the Earth.

Carbon offset
A compensation for carbon dioxide emissions resulting from industrial or other human activity; a quantifiable amount of such compensation as a tradable commodity.

Carbon sequestration
A method of reducing greenhouse gases by injecting carbon dioxide produced in other kinds of industrial processes into deep underground wells or beds of underground materials so that it does not enter the atmosphere. Transfer of atmospheric CO^2 into long-lived pools and storing it securely so it is not immediately reemitted.

Carbon storage
The technological process of capturing waste carbon dioxide from industry or power generation, and storing it so that it will not enter the atmosphere.

Carbon taxes
A compulsory contribution to state revenue, levied by the governments on business profits, or added to the cost of goods, services, and transactions in proportion to the consequential amounts of carbon released into the atmosphere.

Carrying capacity
The upper limit of habitats, ecosystems, landscapes, waterscapes or seascapes or any other appropriate geographic unit to provide tangible and intangible goods and services (including aesthetics and spiritual services) in a sustained way without altering its bio-geo-chemical characteristics, ecosystem functions and endangering its own resilience to climate change, natural and anthropogenic perturbations.

Certainty
In the context of IPBES, the summary terms to describe the state of knowledge are the following:

Well established (Certainty term (q.v.)): comprehensive meta-analysis or other synthesis or multiple independent studies that agree.

Established but incomplete (Certainty term (q.v.)): general agreement although only a limited number of studies exist but no comprehensive synthesis and, or the studies that exist imprecisely address the question.

Unresolved (Certainty term (q.v.)): multiple independent studies exist but conclusions do not agree.

Inconclusive (Certainty term (q.v.)): limited evidence, recognising major knowledge gaps

Chemosynthetic ecosystem
Ecosystems including hot vents, cold seeps, mud volcanoes and sulphidic brine pools are highly fractured and diverse deep-water habitats shaped by dynamic, small- and large-scale geological processes, which vary substantially in time and space.

Climate change
Climate change is a change in the statistical distribution of weather patterns when that change lasts for an extended period of time (i.e., decades to millions of years). Climate change may refer to a change

in average weather conditions, or in the time variation of weather within the context of longer-term average conditions. Climate change is caused by factors such as biotic processes, variations in solar radiation received by Earth, plate tectonics, and volcanic eruptions. Certain human activities have been identified as primary causes of ongoing climate change, often referred to as global warming.

Climate Smart Agriculture (CSA)
Agriculture that sustainably increases productivity, resilience (adaptation), reduces/removes GHGs (mitigation), and enhances achievement of national food security and development goals.

Coastal squeeze
It refers to intertidal habitat loss which arises due to the high water mark being fixed by a defense, and the low water mark migrating landwards in response to sea level rise.

Co-benefit strategies
Practices in response to problems that provide added benefits, above and beyond the direct benefits. They are referred to as "multiple benefits" or "synergies".

Cold seep
Area of the seafloor where gases and fluids are released without incurring a significant temperature rise in the surrounding environment.

Collaborative governance
Governing arrangement where one or more public agencies directly engage non-state stakeholders in a collective decision-making process that is formal, consensus-oriented, and deliberative and that aims to make or implement public policy or manage public programs or assets.

Co-management
Process of management in which government shares power with resource users, with each given specific rights and responsibilities relating to information and decision-making.

Community-based forest management
See "Community Based Natural Resource Management".

Community-based natural resource management
Community-based natural resource management: an approach to natural resource management that involves the full participation of indigenous peoples’ and local communities and resource users in decision-making activities, and the incorporation of local institutions, customary practices, and knowledge systems in management, regulatory, and enforcement processes. Under this approach, community-based monitoring and information systems are initiatives by indigenous peoples and local community organizations to monitor their community’s well-being and the state of their territories and natural resources, applying a mix of traditional knowledge and innovative tools and approaches.

Conceptual Framework
The Platform’s conceptual framework is a tool for building shared understanding across disciplines, knowledge systems and stakeholders of the interplay between biodiversity and ecosystem drivers, and of the role they play in building a good quality of life (link to CF diagram).

Contingent Valuation
The contingent valuation method is used to estimate economic values for all kinds of ecosystem and environmental services. It can be used to estimate both use and non-use values.

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) is an international agreement between governments. Its aim is to ensure that international trade in specimens of wild animals and plants does not threaten their survival.

Co-production
Essentially a relationship between service provider and service user that draws on the knowledge, ability and resources of both to develop solutions to issues that are claimed to be successful, sustainable and cost-effective, changing the balance of power from the professional towards the service user. The approach is used in work with both individuals and communities.

Coral Triangle
Geographical term for a roughly triangular area of tropical ocean that includes the coastal waters of Malaysia, Indonesia, Timor-Leste, Philippines, Papua New Guinea and Solomon Islands and is recognised as the global centre of coral reef and marine biodiversity and a global conservation priority.

Corridors
A geographically defined area which allows species to move between landscapes, ecosystems and habitats, natural or modified, and ensures the maintenance of biodiversity and ecological and evolutionary processes.

Coupled social-ecological systems (CSES)
Social-ecological systems are complex, integrated systems in which humans are part of nature.

Crop intensification
Increasing yields, area of extent and/or environmental impacts of agricultural production.

Cropland
A land cover/use category that includes areas used for the production of crops for harvest.

Cross-scale Analysis
Cross-scale effects are the result of spatial and/or temporal processes interacting with other processes at another scale. These interactions create emergent effects that can be difficult to predict.

Cross-sectoral
Relating to, or affecting, more than one sector (distinct part of society, or of a nation's economy).

Cryosphere
The cryosphere is those portions of Earth's surface where water is in solid form, including sea ice, lake ice, river ice, snow cover, glaciers, ice caps, ice sheets, and frozen ground (which includes permafrost).

Cultural ecosystem services
The Millennium Ecosystem Assessment defined cultural ecosystem services as “the nonmaterial benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experiences”. Cultural ecosystem services have been included in many other typologies of ecosystem services and referred to variously as cultural services, life-fulfilling functions, information functions, amenities and fulfillment, cultural and amenity services, or socio-cultural fulfillment.

Customary law
Customary law forms part of forms part of international and domestic law and stems from the customary norms of a particular group of peoples

Daoism

A Chinese philosophy based on the writings of Lao-tzu, advocating humility and religious piety.

Decision-making framework
System for logical interpretation of evidence leading to decision options that can be objectively evaluated.

Decomposition
Breakdown of complex organic substances into simpler molecules or ions by physical, chemical and/or biological processes.

Deforestation
Human-induced conversion of forested land to nonforested land. Deforestation can be permanent, when this change is definitive, or temporary when this change is part of a cycle that includes natural or assisted regeneration.

Degraded land
Land in a state that results from persistent decline or loss of biodiversity and ecosystem functions and services that cannot fully recover unaided.

Desertification
“Desertification” means land degradation in arid, semi-arid and dry sub-humid areas resulting from various factors, including climatic variations and human activities. Desertification does not refer to the natural expansion of existing deserts.

Development pathways
Plausible future options either arising from or forming scenario assessments, often presented as narratives that explore or articulate possibilities for human economic development.

Direct driver
See "driver".

Downscaling
The transformation of information from coarser to finer spatial scales through statistical modelling or spatially nested linkage of structural models.

Driver
In the context of IPBES, drivers of change are all the factors that, directly or indirectly, cause changes in nature, anthropogenic assets, nature’s contributions to people and a good quality of life.
Direct drivers of change can be both natural and anthropogenic. Direct drivers have direct physical (mechanical, chemical, noise, light etc.) and psychological (disturbance etc.) impacts on nature and its functioning, and on people and their interaction. Direct drivers unequivocally influence biodiversity and ecosystem processes. They are also referred to as ‘pressures’. Direct drivers include, inter alia, climate change, pollution, land use change, invasive alien species and zoonoses, including their effects across regions.
Indirect drivers are drivers that operate diffusely by altering and influencing direct drivers as well as other indirect drivers (also referred to as ‘underlying causes’). Interactions between indirect and direct drivers create different chains of relationship, attribution, and impacts, which may vary according to type, intensity, duration, and distance. These relationships can also lead to different types of spill-over effects. Global indirect drivers include economic, demographic, governance, technological and cultural ones, among others. Special attention is given, among indirect drivers, to the role of institutions (both formal and informal) and impacts of the patterns of production, supply and consumption on nature, nature’s contributions to people and good quality of life.

Drylands

Drylands comprise arid, semi-arid and dry sub-humid areas. The term excludes hyper-arid areas, also known as deserts. Drylands are characterised by water scarcity and cover approximately 40 per cent of the world's terrain.

Eco-Communalism
Shorthand for "ecological communalism", an environmental philosophy based on simple living, self-sufficiency, sustainability, and local economies.

Ecological destruction
See "Ecosystem degradation".

Ecological Footprint
Ecological footprint has a variety of definitions, but is defined by the Global Footprint Network the as "a measure of how much area of biologically productive land and water an individual, population or activity requires to produce all the resources it consumes and to absorb the waste it generates, using prevailing technology and resource management practices. The ecological footprint indicator used in this report is based on the Global Footprint Network unless otherwise specified.

Ecological infrastructure
Ecological infrastructure refers to the natural or semi-natural structural elements of ecosystems and landscapes that are important in delivering ecosystem services. It is similar to 'green infrastructure', or ‘green and blue infrastructure’ a term sometimes applied in a more urban context. The ecological infrastructure needed to support pollinators and improve pollination services includes patches of semi-natural habitats, including hedgerows, grassland and forest, distributed throughout productive agricultural landscapes, providing nesting and floral resources. Larger areas of natural habitat are also ecological infrastructure, although these do not directly support agricultural pollination in areas more than a few kilometers away from pollinator-dependent crops.

Ecological processes
The physical and biological actions or events that link organisms and their environment.

Economic and financial instruments
Economic and financial instruments can be used to change people’s behavior towards desired policy objectives. Instruments typically encompass a wide range of designs and implementation approaches. They include traditional fiscal instruments, including for example subsidies, taxes, charges and fiscal transfers. Additionally, instruments such as tradable pollution permits or tradable land development rights rely on the creation of new markets. Further instruments represent conditional and voluntary incentive schemes such as payments for ecosystem services. All these can in principle be used to correct for policy or/and market failures and reinstate full-cost pricing. They aim at reflecting social costs or benefits of the conservation and use of biodiversity and ecosystem services of a public good nature (“getting the price right”). Financial instruments, in contrast, are often extra-budgetary and can be financed from domestic sources or foreign aid, external borrowing, debt for nature swaps, etc. It should be noted that economic instruments do not necessarily imply that commodification of environmental functions is promoted. Generally, they are meant to change behavior of individuals (e.g., consumers and producers) and public actors (e.g., local and regional governments).

Eco-region
A large area of land or water that contains a geographically distinct assemblage of natural communities that:
(a) Share a large majority of their species and ecological dynamics;
(b) Share similar environmental conditions, and;
(c) Interact ecologically in ways that are critical for their long-term persistence. In contrast to biomes, an ecoregion is generally geographically specific, at a much finer scale. For example, the “East African Montane Forest” eco-region of Kenya (WWF eco-region classification) is a geographically specific and coherent example of the globally occurring “tropical and subtropical forest” biome.

Ecosystem
A dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit.

Ecosystem degradation
A persistent (long-time) reduction in the capacity to provide ecosystem services.

Ecosystem function
The flow of energy and materials through the biotic and abiotic components of an ecosystem. It includes many processes such as biomass production, trophic transfer through plants and animals, nutrient cycling, water dynamics and heat transfer.

Ecosystem health
A state or condition of an ecosystem that expresses attributes of biodiversity within "normal" ranges, relative to its ecological stage of development. Ecosystem health depends inter alia on ecosystem resilience and resistance.

Ecosystem management
An approach to maintaining or restoring the composition, structure, function, and delivery of services of natural and modified ecosystems for the goal of achieving sustainability. It is based on an adaptive, collaboratively developed vision of desired future conditions that integrates ecological, socioeconomic, and institutional perspectives, applied within a geographic framework, and defined primarily by natural ecological boundaries.

Ecosystem services
The benefits people obtain from ecosystems. These include provisioning services such as food and water; regulating services such as flood and disease control; cultural services such as spiritual, recreational, and cultural benefits; and supporting services such as nutrient cycling that maintain the conditions for life on Earth. The concept ''ecosystem goods and services'' is synonymous with ecosystem services.

Ecotourism
Sustainable travel undertaken to access sites or regions of unique natural or ecological quality, promoting their conservation, low visitor impact, and socio-economic involvement of local populations.

El Nino
An irregularly recurring flow of unusually warm surface waters from the Pacific Ocean toward and along the western coast of South America that prevents upwelling of nutrient-rich cold deep water and that disrupts typical regional and global weather patterns.

Endangered species
A species at risk of extinction in the wild.
Endemic species Endemic species are plants and animals that exist only in one geographic region.

Endemism
The ecological state of a species being unique to a defined geographic location, such as an island, nation, country or other defined zone, or habitat type; organisms that are indigenous to a place are not endemic to it if they are also found elsewhere.

Energy security
A. The uninterrupted availability of energy sources at an affordable price; B. The association between national security and the availability of natural resources for energy consumption within nation states. Long-term measures to increase energy security often center on diversifying energy sources.

Environmental assets
Naturally occurring living and non-living entities of the Earth, together comprising the bio-physical environment, that jointly deliver ecosystem services to the benefit of current and future generation.

Equitable
Fair and impatial.

Euphotic zone
The euphotic zone is the layer closer to the surface of the ocean or lake that receives enough light for photosynthesis to occur.

Eutrophic
A condition of an aquatic system in which increased nutrient loading leads to progressively increasing amounts of algal growth and biomass accumulation. When the algae die off and decompose, the amount of dissolved oxygen in the water becomes reduced.

Eutrophication
See "Eutrophic".

Exclusive Economic Zone areas
An Exclusive Economic Zone is a concept adopted at the Third United Nations Conference on the Law of the Sea (1982), whereby a coastal State assumes jurisdiction over the exploration and exploitation of marine resources in its adjacent section of the continental shelf, taken to be a band extending 200 miles from the shore.
The Exclusive Economic Zone comprises an area which extends either from the coast, or in federal systems from the seaward boundaries of the constituent states (3 to 12 nautical miles, in most cases) to 200 nautical miles (370 kilometres) off the coast. Within this area, nations claim and exercise sovereign rights and exclusive fishery management authority over all fish and all Continental Shelf fishery resources.

Exposure
The state of having no protection from something potential harmful.

Extensive grazing
Extensive grazing is that in which livestock are raised on food that comes mainly from natural grasslands, shrublands, woodlands, wetlands, and deserts. It differs from intensive grazing, where the animal feed comes mainly from artificial, seeded pastures.

Externality
A positive or negative consequence (benefits or costs) of an action that affects someone other than the agent undertaking that action and for which the agent is neither compensated nor penalized through the markets.

Extinction debt
The future extinction of species due to events in the past, owing to a time lag between an effect such as habitat destruction or climate change, and the subsequent disappearance of species.

Feedback
The modification or control of a process or system by its results or effects.

Fire-stick farming
The practice of indigenous Australians to use fire to burn vegetation to facilitate hunting and to change the composition of the plant and animal species of an area. It was coined by Australian archaeologist Rhys Jones.

Flagship species
Species that, by being charismatic or famous, can attract funding which will help conservation of other species at the same time (ex..Giant Panda).

Food security
The World Food Summit of 1996 defined food security as existing "when all people at all times have access to sufficient, safe, nutritious food to maintain a healthy and active life".

Forest
A minimum area of land of 0.05 - 1.0 hectares with tree crown cover (or equivalent stocking level) of more than 10–30 per cent with trees with the potential to reach a minimum height of 2–5 m at maturity in situ. A forest may consist either of closed forest formations where trees of various stories and undergrowth cover a high proportion of the ground or open forest.

Forest degradation
A reduction in the capacity of a forest to produce ecosystem services such as carbon storage and wood products as a result of anthropogenic and environmental changes.

Fragmentation
The process or state of breaking or being broken into fragments. Often used in reference to habitats.

Functional traits
A feature of an organism, which has demonstrable links to the organism's function (Lavorel *et al*. 1997). As such, a functional trait determines the organism's response to pressures (Response trait), and/or its effects on ecosystem processes orservices(Effect trait).Functional traits are considered as reflecting adaptations to variation in the physical and biotic environment and trade-offs (ecophysiological and/or evolutionary) among different functions within an organism. In plants, functional traits include morphological, ecophysiological, biochemical and regeneration traits, including demographic traits(at population level). In animals, these traits are combined with lifehistory and behavioural traits (e.g. guilds, organisms that use similar resources/habitats).

Global warming
The observed century-scale rise in the average temperature of the Earth's climate system and its related effects.

Good quality of life
Within the context of the IPBES Conceptual Framework – the achievement of a fulfilled human life, a notion which may varies strongly across different societies and groups within societies. It is a context-dependent state of individuals and human groups, comprising aspects such as access to food, water, energy and livelihood security, and also health, good social relationships and equity, security, cultural identity, and freedom of choice and action. "Living in harmony with nature", "living-well in balance and harmony with Mother Earth" and "human well-being" are examples of different perspectives on a "Good quality of life".

Governance
The processes of governing, whether undertaken by a government, market or other social network, whether over a family, tribe, formal or informal organization or territory and whether through the laws, norms, power or language of an organized society.

Grassland
Ecosystem characterized by more or less closed herbaceous vegetation layer, sometimes with a shrub layer, but – in contrast to savannas – without trees. Different types of grasslands are found under a broad range of climatic conditions.

Green Public Procurement (GPP)
A process whereby public authorities seek to procure goods, services and works with a reduced environmental impact throughout their life-cycle when compared to goods, services and works with the same primary function that would otherwise be procured.

Habitat
The place or type of site where an organism or population naturally occurs. Also used to mean the environmental attributes required by a particular species or its ecological niche.

Habitat degradation
A general term describing the set of processes by which habitat quality is reduced. Habitat degradation may occur through natural processes (e.g. drought, heat, cold) and through human activities (forestry, agriculture, urbanization).

Habitat fragmentation
A general term describing the set of processes by which habitat loss results in the division of continuous habitats into a greater number of smaller patches of lesser total and isolated from each other by a matrix of dissimilar habitats. Habitat fragmentation may occur through natural processes (e.g., forest and grassland fires, flooding) and through human activities (forestry, agriculture, urbanization).

Harmful algal blooms
They occur when colonies of algae (simple plants that live in the sea and freshwater) grow out of control and produce toxic or harmful effects on people, fish, shellfish, marine mammals and birds.

Harmonization
The process of bringing together, and comparing, models or scenarios to make them compatible or consistent with one another.

Human values
See "Values"

Human well-being
See "Good Quality of Life".

Hydrothermal vent
A fissure on the floor of a sea out of which flows waterthat has been heated by underlying magma. Th e watercan be as hot as 400°C (752°F) and usually containsdissolved minerals that precipitate out of it uponcontact with the colder seawater, building a stack ofminerals, or chimney.Hydrothermal vents fo rm anecosystem for microbes and animals, such astubeworms, giant clams, and blind shrimp, thatcan withstand the hostile environment. The hottest hydrothermal vents are called black smokers because they spew iron and sulfide which combine to form iron mono sulfide, a black compound.

Impact assessment
A formal, evidence-based procedure that assesses the economic, social, and environmental effects of public policy or of any human activity.

Important Bird & Biodiversity Areas (IBAs)
A Key Biodiversity Area identified using an internationally agreed set of criteria as being globally important for bird populations.

Inclusive wealth
An economic concept that seeks to incorporate natural capital into national wealth estimates, beyong GDP.

Indicators
A quantitative or qualitative factor or variable that provides a simple, measurable and quantifiable characteristic or attribute responding in a known and communicable way to a changing environmental condition, to a changing ecological process or function, or to a changing element of biodiversity.

Indigenous and local knowledge systems
Indigenous and local knowledge systems are social and ecological knowledge practices and beliefs pertaining to the relationship of living beings, including people, with one another and with their environments. Such knowledge can provide information, methods, theory and practice for sustainable ecosystem management.

Indigenous communities
Social groups of indigenous peoples.

Indigenous peoples and local communities (IPLCs)
Indigenous people are also known as first peoples, aboriginal peoples, native peoples, or autochthonous peoples, are ethnic groups who are descended from and identify with the original inhabitants of a given region, in contrast to groups that have settled, occupied or colonized the area more recently. The distinctive groups, usually maintaining traditions or other aspects of an early culture that is associated with a given region, are protected in international or national legislation as having a set of specific rights based on their linguistic and historical ties to a particular territory, prior to later settlement, development, and or occupation of a region.
Local community is a self-identified human group that relates to a life environment in collective ways that participate to define a shared territory and culture. The members of a local community have frequent chances of direct (possibly face-to-face) encounters and possess some common history, traditions, institutions, language, values and life plans. A local community can be long-standing ('traditional') or relatively new, include a single or multiple ethnic identities and be permanently settled or mobile. A local community should have a form of political identity that enables it to exercise its rights and responsibilities with respect to its territory and neighbors.

Industrial effluents
Industrial effluent is in general considered to be industrial wastewater - treated or untreated - that flows out of a sewage treatment facility or the wastewater discharge from industrial facilities. Generally refers to wastes discharged into surface waters.

Industrialization
Industrialisation or industrialization is the period of social and economic change that transforms a human group from an agrarian society into an industrial society, involving the extensive re-organization of an economy for the purpose of manufacturing.

Institutional failure
These are often catalogued as (i) law and policy failures (e.g., perverse subsidies), (ii) market failures (externalities in the use of public goods and services), (iii) organizational failure (e.g., lack of transparency and political legitimacy in decision-making) and (iv) informal institutional failures (e.g., break of collective action norms due to erosion of trust.

Institutions
Encompasses all formal and informal interactions among stakeholders and social structures that determine how decisions are taken and implemented, how power is exercised, and how responsibilities are distributed.

Integrated assessment models (IAMs)
Interdisciplinary models that aim to describe the complex relationships between environmental, social, and economic drivers that determine current and future state of the ecosystem and the effects of global change, in order to derive policy-relevant insights. One of the essential characteristics of

integrated assessments is the simultaneous consideration of the multiple dimensions of environmental problems.

Integrated pest management (IPM)
Is also known as Integrated Pest Control (IPC). It is a broadly-based approach that integrates various practices for economic control of pests (q.v.). IPM aims to suppress pest populations below the economic injury level (i.e., to below the level that the costs of further control outweigh the benefits derived). It involves careful consideration of all available pest control techniques and then integration of appropriate measures to discourage development of pest populations while keeping pesticides and other interventions to economically justifiable levels with minimal risks to human health and the environment. IPM emphasizes the growth of a healthy crop with the least possible disruption to agro-ecosystems and encourages natural pest control mechanisms.

Intellectual and cultural property (ICP)
An umbrella legal term used in national and international forums to identify indigenous peoples' rights to protect their specific cultural knowledge and intellectual property.

Intensive agriculture
Intensive agriculture involves various types of agriculture with higher levels of input and output per unit of agricultural land area. It is characterized by a low fallow ratio, higher use of inputs such as capital and labor, and higher crop yields per unit land area.

Interactions
Mutual or reciprocal action or influence.

Inter-generational equity
Inter-generational equity stipulates the rights and obligations of the current and future generations regarding the use of the environment. In the context of sustainable development, the Brundtland Report conceptualised it as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs”.

Intra-generational equity
Intra-generational equity relates to notions of fairness and justice across the communities and states within the present generation.

Invasive alien species
Species whose introduction and/or spread by human action outside their natural distribution threatens biological diversity, food security, and human health and well-being. “Alien” refers to the species’ having been introduced outside its natural distribution (“exotic”, “non-native” and “non-indigenous” are synonyms for “alien”). “Invasive” means “tending to expand into and modify ecosystems to which it has been introduced”. Thus, a species may be alien without being invasive, or, in the case of a species native to a region, it may increase and become invasive, without actually being an alien species.

Invasive species (Invasive alien species)
See "Invasive alien species".

IPBES Conceptual Framework
A simplified representation of the complex interactions between the natural world and human societies. This framework emerged from an extensive process of consultation and negotiation, leading to formal adoption by the second IPBES Plenary (IPBES/2/4), and therefore represents a key foundation for all IPBES activities. The framework recognizes different knowledge systems, including indigenous and local knowledge (ILK) systems, which can be complementary to those based on science.

IUCN category
IUCN protected area management categories classify protected areas according to their management objectives.

IUCN Red List
The IUCN Red List of Threatened Species provides taxonomic, conservation status and distribution information on plants, fungi and animals that have been globally evaluated using the IUCN Red List Categories and Criteria.

Kelp
A large brown seaweed that typically has a long, tough stalk with a broad frond divided into strip.

Key Biodiversity Areas (KBAs)
Sites contributing significantly to the global persistence of biodiversity. They represent the most important sites for biodiversity worldwide, and are identified nationally using globally standardised criteria and thresholds.

Keystone species
Species that maintain the organization and diversity of their ecological communities and are thus exceptional, relative to the rest of the community, in their importance.
Species that, despite low biomass, exert strong effects on the structure of the communities they inhabit.

Knowledge systems
A body of propositions that are adhered to, whether formally or informally, and are routinely used to claim truth. They are organized structures and dynamic processes (a) generating and representing content, components, classes, or types of knowledge, that are (b) domain-specific or characterized by domain-relevant features as defined by the user or consumer, (c) reinforced by a set of logical relationships that connect the content of knowledge to its value (utility), (d) enhanced by a set of iterative processes that enable the evolution, revision, adaptation, and advances, and (e) subject to criteria of relevance, reliability, and quality.

Kyoto Protocol
An international agreement linked to the United Nations Framework Convention on Climate Change, which commits its Parties by setting internationally binding emission reduction targets.
Land degradation refers to the many processes that drive the decline or loss in biodiversity, ecosystem functions or services and includes the degradation of all terrestrial ecosystems.
Land use The human use of a specific area for a certain purpose (such as residential; agriculture; recreation; industrial, etc.). Influenced by, but not synonymous with, land cover. Land use change refers to a change in the use or management of land by humans, which may lead to a change in land cover.

Land cover
The surface cover on the ground, whether vegetation, urban infrastructure, water, bare soil or other. Identifying, delineating and mapping land cover is important for global monitoring studies, resource management, and planning activities. Identification of land cover establishes the baseline from which monitoring activities (change detection) can be performed, and provides the ground cover information for baseline thematic maps.

Landscape
An area delineated by an actor for a specific set of objectives, constitutes an area in which entities, including humans, interact according to rules (physical, biological, and social) that determine their relationships; Place-based systems that result from interactions between people, land, institutions (laws, rules and regulations) and values. Interactive aspects that define a landscape are functional interactions, negotiated spaces and multiple scales.

Land use change
Land use refers to the modification or management of natural environments into human dominated environments, such as settlements, semi-natural and agricultural areas
Level of resolution Degree of detail captured in an analysis. A high level of resolution implies a highly detailed analysis, usually associated with finer spatial and temporal scales. A low level of resolution implies a less detailed analysis, usually associated with coarser spatial and temporal scales.

Limestone karsts
Referred to simply as karsts are sedimentary rock outcrops that consist primarily of calcium carbonate.

Living in harmony with nature
Within the context of the IPBES Conceptual Framework – a perspective on good quality of life based on the interdependence that exists among human beings, other living species and elements of nature. It implies that we should live peacefully alongside all other organisms even though we may need to exploit other organisms to some degree.
Mainstreaming biodiversity Mainstreaming means integrating actions related to conservation of biodiversity into strategies relating to production sectors.

Mangrove
Group of trees and shrubs that live in the coastal intertidal zone. Mangrove forests only grow at tropical and subtropical latitudes near the equator because they cannot withstand freezing temperatures.

Mean Species Abundance (Species abundance)
An indicator of naturalness or biodiversity intactness. It is defined as the mean abundance of original species relative to their abundance in undisturbed ecosystems. An MSA (Mean Species Abundance) of 0 per cent means a completely destructed ecosystem, with no original species remaining.

Meta-analysis
A quantitative statistical analysis of several separate but similar experiments or studies in order to test the pooled data for statistical significance.

Migration
Seasonal movement of animals from one region to another for food, breeding, etc.
Millennium Ecosystem Assessment The Millennium Ecosystem Assessment (MEA) is a major assessment of the human impact on the environment published in 2005.

Mining
Mining is the extraction of valuable minerals or other geological materials from the earth usually from an orebody, lode, vein, seam, reef or placer deposits. These deposits form a mineralized package that is of economic interest to the miner.

Mitigation
In the context of IPBES, an intervention to reduce negative or unsustainable uses of biodiversity and ecosystems.

Models
Qualitative or quantitative representations of key components of a system and of relationships between these components. Benchmarking (of models) is the process of systematically comparing sets of model predictions against measured data in order to evaluate model performance.
Validation (of models) typically refers to checking model outputs for consistency with observations. However, since models cannot be validated in the formal sense of the term (i.e. proven to be true), some scientists prefer to use the words ""benchmarking"" or “evaluation"".

A dynamic model is a model that describes changes through time of a specific process.
A process-based model (also known as "mechanistic model") is a model in which relationships are described in terms of explicitly stated processes or mechanisms based on established scientific understanding, and model parameters therefore have clear ecological interpretation, defined beforehand.
Hybrid models are models that combine correlative and process-based modelling approaches.
A correlative model (also known as "statistical model") is a model in which available empirical data are used to estimate values for parameters that do not have predefined ecological meaning, and for which processes are implicit rather than explicit.
Integrated assessment models are interdisciplinary models that aim to describe the complex relationships between environmental, social, and economic drivers that determine current and future state of the ecosystem and the effects of global change, in order to derive policy-relevant insights. One of the essential characteristics of integrated assessments is the simultaneous consideration of the multiple dimensions of environmental problems.

Modified
Altered or changed.

Monoculture
The agricultural practice of producing or growing a single crop, plant, or livestock species, variety, or breed in a field or farming system at a time.

Mother Earth
An expression used in a number of countries and regions to refer to the planet Earth and the entity that sustains all living things found in nature with which humans have an indivisible, interdependent physical and spiritual relationship.

Multi Stakeholder based scenario development
See "Participatory scenario development".

Multi-criteria analysis
A sub-discipline of operations research that explicitly evaluates multiple conflicting criteria in decision-making.

Multifunctionality
The condition of being multifunctional; diversity of function.

Native species
Indigenous species of animals or plants that naturally occur in a given region or ecosystem.

Natural capital
The world's stocks of natural assets which include geology, soil, air, water and all living things.

Nature
In the context of the Platform, refers to the natural world with an emphasis on biodiversity. Within the context of western science, it includes categories such as biodiversity, ecosystems (both structure and functioning), evolution, the biosphere, humankind's shared evolutionary heritage, and biocultural diversity. Within the context of other knowledge systems, it includes categories such as Mother Earth and systems of life, and it is often viewed as inextricably linked to humans, not as a separate entity.

Nature's contributions to people
Nature's contributions to people (NCP) are all the contributions, both positive and negative, of nature (i.e. biodiversity, ecosystems, and their associated ecological and evolutionary processes) to good quality of life for humanity. The positive contributions from nature (benefits) include such things as food provision, water purification, and artistic inspiration, whereas negative contributions

(detriments), include e.g. pathogens, disease vectors, or predation that damage people, their built infrastructure, or their domesticated animals and plants. While some NCP are considered exclusively positive or negative, many NCP may be perceived as benefits or detriments depending on the cultural context.

Net Present Value
The value in the present of a sum of money, in contrast to some future value it will have when it has been invested at compound interest.

Non-timber forest products
Non-timber forest products (NTFPs) are useful substances, materials and/or commodities obtained from forests which do not require harvesting (logging) trees. They include game animals, fur-bearers, nuts, seeds, berries, mushrooms, oils, foliage, pollarding, medicinal plants, peat, mast, fuelwood, fish, spices and forage.

Non-anthropocentric
A non-anthropocentric value is a value centered on something other than human beings. These values can be non-instrumental (e.g. a value ascribed to the existence of specific species for their own sake) or instrumental to non-human ends (e.g. the instrumental value a habitat has for the existence of a specific species).

Non-Indigenous Species (Non-native species)
See "Invasive Alien Species".

Non-linear
Not arranged in a straight line, not sequential or straightforward.

Oil spill
An oil spill is the release of a liquid petroleum hydrocarbon into the environment, especially the marine ecosystem, due to human activity, and is a form of pollution.

One Health
The One Health Initiative is a movement to forge co-equal, all inclusive collaborations between physicians, osteopathic physicians, veterinarians, dentists, nurses and other scientific-health and environmentally related disciplines.

Organic agriculture
Any system that emphasises the use of techniques such as crop rotation, compost or manure application, and biological pest control in preference to synthetic inputs. Most certified organic farming schemes prohibit all genetically modified organisms and almost all synthetic inputs. Its origins are in a holistic management system that avoids off-farm inputs, but some organic agriculture now uses relatively high levels of off-farm inputs.

Overexploitation
Overexploitation means harvesting species from the wild at rates faster than natural populations can recover. Includes overfishing, and overgrazing.

Overgrazing
Overgrazing occurs when plants are exposed to intensive grazing for extended periods of time, or without sufficient recovery periods. It can be caused by either livestock in poorly managed agricultural applications, game reserves, or nature reserves. It can also be caused by immobile, travel restricted populations of native or non-native wild animals.

Paris Agreement

Agreement within the United Nations Framework Convention on Climate Change (UNFCCC) dealing with greenhouse gas emissions mitigation, adaptation and finance starting in the year 2020.

Participatory governance
A variant or subset of governance which puts emphasis on democratic engagement, in particular through deliberative practices.

Participatory scenario development (and planning)
Approaches characterised by more interactive, and inclusive, involvement of stakeholders in the formulation and evaluation of scenarios. Aimed at improving the transparency and relevance of decision-making, by incorporating demands and information of each stakeholder, and negotiating outcomes between stakeholders.

Particulate matter
Particulate matter (PM), also known as atmospheric particulate matter, or suspended particulate matter (SPM) are microscopic solid or liquid matter suspended in Earth's atmosphere. Sources of particulate matter can be natural or anthropogenic. They have impacts on climate and precipitation that adversely affect human health.

Payment for ecosystem services (PES)
A payment mechanism that involves a series of payments to land or other natural resource owners in return for a guaranteed flow of ecosystem services or certain actions likely to enhance their provision over-and-above what would otherwise be provided in the absence of payment.

Peatlands
Wetlands which accumulate organic plant matter in situ because waterlogging prevents aerobic decomposition and the much slower rate of the resulting anaerobic decay is exceeded by the rate of accumulation.

Pelagic
Organisms that live in the water column.

Permafrost
Perennially frozen ground that occurs wherever the temperature remains below 0°C for several years. Ground (soil or rock and included ice and organic material) that remains at or below 0°C for at least two consecutive years.

Persistent organic pollutants
Persistent organic pollutants are organic compounds that are resistant to environmental degradation through chemical, biological, and photolytic processes. Because of their persistence, persistent organic pollutants bioaccumulate with potential adverse impacts on human health and the environment.

Phytoplankton
Phytoplankton are the autotrophic components of the plankton community and a key part of oceans, seas and freshwater basin ecosystems.

Plankton
Aquatic organisms that drift or swim weakly. Phytoplankton are the plant forms of plankton (e.g., diatoms), and are the dominant plants in the sea. Zooplankton are the animal forms of plankton.

Plenary
Within the context of IPBES – the decision-making body comprising all of the members of IPBES.

Policy-support tools

Approaches and techniques based on science and other knowledge systems that can inform, assist and enhance relevant decisions, policymaking and implementation at local, national, regional and global levels to protect nature, thereby promoting nature's benefits to people and a good quality of life.

Pollution
Pollution is the introduction of contaminants into the natural environment that cause adverse change.

Poverty line
A level of personal or family income below which one is classified as poor according to governmental standards. It is also referred as poverty threshold.

Precautionary principle
Pertains to risk management and states that if an action or policy has a suspected risk of causing harm to the public or to the environment, in the absence of scientific consensus that the action or policy is not harmful, the burden of proof that it is not harmful falls on those taking an action. The principle is used to justify discretionary decisions when the possibility of harm from making a certain decision (e.g., taking a particular course of action) is not, or has not been, established through extensive scientific knowledge. The principle implies that there is a social responsibility to protect the public from exposure to harm, when scientific investigation has found a plausible risk or if a potential plausible risk has been identified.

Predictive modelling
The use of statisitics or other analytical methods to make predictions into the future.

Primary production
The conversion of energy to organic substances by photosynthetic and chemosynthetic autotrophic organisms.

Prior informed consent (PIC)
Before access to knowledge or genetic resources takes place(Prior), based on truthful information about the use that will be made of the knowledge or genetic resources that is adequate for the authority to understand the implications(Informed), the government, stakeholders or rights holders could be explicit consent(consent).

Protected area
A protected area is a clearly defined geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values.

Provisioning services
The products people obtain from ecosystems; may include food, freshwater, timber, fibres, medicinal plants.

Qualitative storylines
Articulation of narratives describing plausible futures based on or relating to measures of the quality of key compnents rather than their quantity (c.f. Quantitative approaches).

Quantitative models
Statistical or other analytical descriptions of processes defined by quantities or metrics.

Ramsar Convention on Wetlands
The Convention on Wetlands, called the Ramsar Convention, is an intergovernmental treaty that provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources.

Ramsar Site
A wetland site designated of international importance especially as Waterfowl Habitat under the Ramsar Convention, an intergovernmental environment treaty established in 1975 by UNESCO, coming into force in 1975.
A wetland of international significance in terms of ecology, botany, zoology, limnology or hydrology. Such site meets at least one of the criteria of Identifying Wetlands of International Importance set by Ramsar Convention and is designated by appropriate national authority to be added to Ramsar list.

Rangeland
Natural grasslands used for livestock grazing.

Recreational values
Monetary or non-monetary worth given to the human recreational use of ecosystems, areas or other natural phenomena.

REDD-plus (reducing emission from deforestation and forest degradation)
A global mechanism designed to offer positive incentives to reduce emissions from deforestation and forest degradation, and to promote the conservation, management and enhancement of forest stocks in developing countries (http://theredddesk.org/encyclopaedia/reducing-emissions-deforestation-and-forest-degradation-redd-and-role-conservation)
REDD-plus stands for countries' efforts to reduce emissions from deforestation and forest degradation, and foster conservation, sustainable management of forests, and enhancement of forest carbon stocks.

Regional Cooperation Platforms
Initiatives or other efforts to provide means by which organizations or individuals with a global region (such as the Asia-Pacific) can work together towards a common or mutual aim, or for common or mutual benefit. Examples include the Association of Southeast Asian Nations (ASEAN) and the Shanghai Cooperation Organization (SCO).

Rehabilitation
Rehabilitation refers to restoration activities that move a site towards a natural state baseline in a limited number of components (i.e. soil, water, and/or biodiversity), including natural regeneration, conservation agriculture, and emergent ecosystems.

Reports
“Reports” shall mean the main deliverables of the Platform, including assessment reports and synthesis reports, their summaries for policymakers and technical summaries, technical papers and technical guidelines.

Resilience
The level of disturbance that an ecosystem or society can undergo without crossing a threshold to a situation with different structure or outputs. Resilience depends on factors such as ecological dynamics as well as the organizational and institutional capacity to understand, manage, and respond to these dynamics.

Resolution (spatial or temporal)
See “Scale”.

Restoration
Any intentional activities that initiates or accelerates the recovery of an ecosystem from a degraded state.

Richness
Ecological diversity of organisms, including genetic or taxonomic diversity (q.v. Biodiversity).

Rights based approaches
A conceptual framework for the process of human development that is normatively based on international human rights standards and operationally directed to promoting and protecting human rights.

Sacrilegious
Involving or committing sacrilege.

Salinization
The process of increasing the salt content in soil is known as salinization. Salination can be caused by natural processes such as mineral weathering or by the gradual withdrawal of an ocean. It can also come about through artificial processes such as irrigation.

Satoyama Initiative
A global initiative with the purpose of realizing "societies in harmony with nature" through the conservation and advancement of "socio-ecological production landscapes and seascapes (SEPLS)" around the world.

Satoyama-satoumi
Satoyama is the Japanese term for a socio-ecological production landscape (SEPL) represented by a mosaic of different ecosystem types: secondary forests, timber plantations, farmlands, irrigation ponds, and grasslands—along with human settlements. Satoyama is managed through the interaction between ecosystems and humans to create ecosystem services for human well-being.
Satoumi refers to Japan's coastal areas where human interaction over time has resulted in a higher degree of productivity and biodiversity. Foundational to both concepts is the positing of a relationship of interaction between humans and their environment, coupled with the notion that properly maintained the relationship is mutually beneficial.

Savanna
Ecosystem characterized by a continuous layer of herbaceous plants, mostly grasses, and a discontinuous upper layer of trees that may vary in density

Scale
The spatial, temporal, quantitative and analytical dimensions used to measure and study any phenomenon. The temporal scale is comprised of two properties: 1) temporal extent – the total length of the time period of interest for a particular study (e.g. 10 years, 50 years, or 100 years); and 2) temporal grain (or resolution) – the temporal frequency with which data are observed or projected within this total period (e.g. at 1-year, 5-year or 10-year intervals). The spatial scale is comprised of two properties: 1) spatial extent – the size of the total area of interest for a particular study (e.g. a watershed, a country, the entire planet); and 2) spatial grain (or resolution) – the size of the spatial units within this total area for which data are observed or predicted (e.g. fine-grained or coarse-grained grid cells).

Scenario
Representations of possible futures for one or more components of a system, particularly for drivers of change in nature and nature's benefits, including alternative policy or management options.
Exploratory scenarios (also known as "explorative scenarios" or "descriptive scenarios") are scenarios that examine a range of plausible futures, based on potential trajectories of drivers – either indirect (e.g. socio-political, economic and technological factors) or direct (e.g. habitat conversion, climate change).
Target-seeking scenarios (also known as "goal-seeking scenarios" or "normative scenarios") are scenarios that start with the definition of a clear objective, or a set of objectives, specified either in terms of achievable targets, or as an objective function to be optimized, and then identify different pathways to achieving this outcome (e.g. through backcasting).

Intervention scenarios are scenarios that evaluate alternative policy or management options – either through target seeking (also known as “goal seeking” or “normative scenario analysis”) or through policy screening (also known as “ex-ante assessment”). Policy-evaluation scenarios are scenarios, including counterfactual scenarios, used in ex-post assessments of the gap between policy objectives and actual policy results, as part of the policy-review phase of the policy cycle. Policy-screening scenarios are scenarios used in ex-ante assessments, to forecast the effects of alternative policy or management options (interventions) on environmental outcomes."

Scenario analysis (Scenario based analysis)
Quantitative or qualitative exploration of future pathways through use of scenarios.

Sea mount
A seamount is a mountain rising from the ocean seafloor that does not reach to the water's surface (sea level), and thus is not an island. Seamounts are typically formed from extinct volcanoes that rise abruptly and are usually found rising from the seafloor to 1,000–4,000 m (3,300–13,100 ft) in height.

Sea Surface Temperature
Sea surface temperature (SST) is the water temperature close to the ocean's surface. The exact meaning of surface varies between 1mm and 20 metres below the sea surface.

Sea-level rise
The average height of the ocean's surface is higher than the daily changes of the tides.

Seascape
Seascape can be defined as a spatially hetero - geneous area of coastal environment (ie intertidal, brackish) that can be perceived as a mosaic of patches, a spatial gradient, or some other geometric patterning. The tropical coastal “seascape” often includes a patchwork of mangroves, seagrass beds, and coral reefs that produces a variety of natural resources and ecosystem services.

Sewage
Sewage (or domestic wastewater or municipal wastewater) is a type of wastewater that is produced from a community of people.

Sector
A distinct part of society, or of a nation's economy.

Selective logging
Extracting one or a few tree species instead of for example clearcutting of forests. Trees are only felled when they reach a particular height. This allows young trees a guaranteed life span and the forest will regain full maturity after around 30-50 years.

Shifting cultivation (Swidden)
Shifting cultivation is an agricultural system in which plots of land are cultivated temporarily, then abandoned and allowed to revert to their natural vegetation while the cultivator moves on to another plot.

Shinto shrine
A building or other construction associated with a Japanese religion (Shinto) which incorporate the worship of ancestors and nature spirits.

Silvopastoralism
Combination of livestock—cattle, sheep, goats, other ruminants—with trees or other woody perennials and forages on the same unit of land.

Smriti Veda
A Hindu religious text containing traditional teachings on religion.

Societies
Aggregations of people involved in persistent social interactions or sharing geographical or social territories, often with individual political authorities and dominant cultural expectations.

Socioecological system
An ecosystem, the management of this ecosystem by actors and organizations, and the rules, social norms, and conventions underlying this management.

Species
An interbreeding group of organisms that is reproductively isolated from all other organisms, although there are many partial exceptions to this rule in particular taxa. Operationally, the term species is a generally agreed fundamental taxonomic unit, based on morphological or genetic similarity, that once described and accepted is associated with a unique scientific name.

Species composition
The array of species in a specific region, area, or assembly.

Species richness
The number of species within a given sample, community, or area.

Stakeholders
Any individuals, groups or organizations who affect, or could be affected (whether positively or negatively) by a particular issue and its associated policies, decisions and action.

Storylines (or scenario storylines)
Qualitative narratives which provide the descriptive framework from which quantitative exploratory scenarios can be formulated.

Subregion
See “Asia-Pacific region”.

Summary for policymakers
A component of any report, providing a policy-relevant but not policy prescriptive summary of that report.

Sustainability
A characteristic or state whereby the needs of the present and local population can be met without compromising the ability of future generations or populations in other locations to meet their needs.

Sustainable Development Goals (SDGs)
A set of goals adopted by the United Nations on September 25, 2015 to end poverty, protect the planet, and ensure prosperity for all as part of a new sustainable development agenda. Each goal has specific targets to be achieved over the next 15 years.

Sustainable use (of biodiversity and its components)
The use of components of biological diversity in a way and at a rate that does not lead to the long-term decline of biological diversity, thereby maintaining its potential to meet the needs and aspirations of present and future generations.

Swidden
See "Shifting cultivation".

Synergies
The interaction or cooperation of two or more agents to produce a combined effect greater than the sum of their separate effects.

Synthesis reports
Synthesis reports further distil and integrate materials drawing from assessment reports, are written in a non-technical style suitable for policymakers and address a broad range of policy-relevant questions. They are to be composed of two sections: a summary for policymakers, and a full report.

Systematic review
Collation and critical analysis of multiple research studies or papers, using a structured methodology.

Taxon
A category applied to a group in a formal system of nomenclature, e.g., species, genus, family etc. (plural: taxa)

Temporal Scales
Measurements or other observations reported along a time series.

Tenure security
An agreement between an individual or group to land and residential property, which is governed and regulated by a legal and administrative framework includes both customary and statutory systems.

Threatened species
In the IUCN Red List terminology, a threatened species is any species listed in the Red List categories Critically Endangered, Endangered, or Vulnerable. See https://portals.iucn.org/library/efiles/documents/RL-2001-001-2nd.pdf

Thresholds
Magnitudes or intensities that must be exceeded for a certain reaction, phenomenon, result, or condition to occur or be manifested.

Tipping point
A set of conditions of an ecological or social system where further perturbation will cause rapid change and prevent the system from returning to its former state.

Top down
Systems driven by top level or higher-order processes.

Total Economic Value
A concept in cost–benefit analysis that refers to the value derived by people from a natural resource, a man-made heritage resource or an infrastructure system, compared to not having it.

Trade-off
A trade-off is a situation where an improvement in the status of one aspect of the environment or of human well-being is necessarily associated with a decline in or loss of a different aspect. Trade-offs characterize most complex systems, and are important to consider when making decisions that aim to improve environmental and/or socio-economic outcomes. Trade-offs are distinct from synergies (the latter are also referred to as “win-win” scenarios): synergies arise when the enhancement of one desirable outcome leads to enhancement of another.

Traditional Knowledge (TK)
The concept of Traditional Knowledge (TK) in CBD has two characteristics. Firstly, CBD defines TK as one kind of knowledge, innovations and practices which is helpful to conservation and sustainable use of biodiversity. Secondly, CBD limits the TK to link with Indigenous and Local

Communities (ILCs) embodying traditional lifestyles, i.e. these TK were created and preserved by ILCs and they are accumulated, developed and inherited generation by generation.

Transboundary
Flows, interactions, relationships across boundary, in reference to jurisdictions, political units, physical nature features.

Transhumance
The action or practice of moving livestock from one grazing ground to another in a seasonal cycle, typically to lowlands in winter and highlands in summer.

Translocation
The human-mediated movement of living organisms from one area, with release in another.

Trees outside Forest (TOF)
All trees excluded from the definition of forest and other wooded lands. Trees outside the forest are located on "other lands", mostly on farmlands and built-up areas, both in rural and urban areas.

Trophic cascades
The chain of knock - on extintions observed or predicted to occur following the loss of one or a few species that play a critical role (e.g. as a pollinator) in ecosystem functioning.

Uncertainty
Any situation in which the current state of knowledge is such that:
(1) the order or nature of things is unknown,
(2) the consequences, extent, or magnitude of circumstances, conditions, or events is unpredictable, and
(3) credible probabilities to possible outcomes cannot be assigned.
Uncertainty can result from lack of information or from disagreement about what is known or even knowable. Uncertainty can be represented by quantitative measures (e.g., a range of values calculated by various models) or by qualitative statements (e.g., reflecting the judgment of a team of experts)."

Units of analysis
The IPBES Units of Analysis result from subdividing the Earth's surface into units solely for the purposes of analysis. The following have been identified:
IPBES units of analysis (terrestrial):

- Tropical and subtropical dry and humid forests
- Temperate and boreal forests and woodlands
- Mediterranean forests, woodlands and scrub
- Tundra and High Mountain habitats
- Tropical and subtropical savannas and grasslands
- Temperate Grasslands
- Deserts and xeric shrublands
- Wetlands – peatlands, mires, bogs
- Urban/Semi-urban
- Cultivated areas (incl. cropping, intensive livestock farming etc.)

IPBES units of analysis (aquatic, including both marine and freshwater units):

- Cryosphere
- Aquaculture areas
- Inland surface waters and water bodies/freshwater
- Shelf ecosystems (neritic and intertidal/littoral zone)
- Open ocean pelagic systems (euphotic zone)
- Deep-Sea

- Coastal areas intensively used for multiple purposes by humans

These IPBES terrestrial and aquatic units of analysis serve as a framework for comparison within and across assessments and represent a pragmatic solution, which may evolve as the work of IPBES develops. The IPBES terrestrial and aquatic units of analysis serve the purposes of IPBES, and are not intended to be prescriptive for other purposes.

Upanishad
Each of a series of Hindu sacred treatises written in Sanskrit c.800–200 BC, expounding the Vedas in predominantly mystical and monistic terms.

Upscaling
The process of scaling information from local, fine-grained resolution to global, coarse-grained resolution.

Usufruct right
A legal right accorded to a person or party that confers the temporary right to use and derive income or benefit from someone else's property.

Values

- Values systems: Set of values according to which people, societies and organizations regulate their behaviour. Value systems can be identified in both individuals and social groups (Pascual *et al*., 2017).
- Value (as principles): A value can be a principle or core belief underpinning rules and moral judgments. Values as principles vary from one culture to another and also between individuals and groups (IPBES/4/INF/13).
- Value (as preference): A value can be the preference someone has for something or for a particular state of the world. Preference involves the act of making comparisons, either explicitly or implicitly. Preference refers to the importance attributed to one entity relative to another one (IPBES/4/INF/13).
- Value (as importance): A value can be the importance of something for itself or for others, now or in the future, close by or at a distance. This importance can be considered in three broad classes. 1. The importance that something has subjectively, and may be based on experience. 2. The importance that something has in meeting objective needs. 3. The intrinsic value of something (IPBES/4/INF/13).
- Value (as measure): A value can be a measure. In the biophysical sciences, any quantified measure can be seen as a value (IPBES/4/INF/13).
- Non-anthropocentric value: A non-anthropocentric value is a value centered on something other than human beings. These values can be non-instrumental or instrumental to non-human ends (IPBES/4/INF/13).
- Intrinsic value: The value inherent to nature, independent of human experience and evaluation, and therefore beyond the scope of anthropocentric valuation approaches (IPBES/4/INF/13).
- Anthropocentric value: Human-centred, the value that something has for human beings and human purposes (IPBES/4/INF/13).
- Instrumental value: The direct and indirect contribution of nature’s benefits to the achievement of a good quality of life. Within the specific framework of the Total Economic Value, instrumental values can be classified into use (direct and indirect use values) on the one hand, and non-use values (option, bequest and existence values) on the other. Sometimes option values are considered as use values as well (IPBES/4/INF/13).
- Non-instrumental value: The value attributed to something as an end in itself, regardless of its utility for other ends.
- Relational value: The values that contribute to desirable relationships, such as those among people and between people and nature, as in “Living in harmony with nature”

(IPBES/4/INF/13).

- Integrated valuation: The process of collecting, synthesizing, and communicating knowledge about the ways in which people ascribe importance and meaning of NCP to humans, to facilitate deliberation and agreement for decision-making and planning (Pascual *et al.*, 2017).

Vulnerability
The inability (of a system or a unit) to withstand the effects of a hostile environment, such as ecosystem and human society. The quality or state of being exposed to the possibility of being damaged.

Water Security
The reliable availability of an acceptable quantity and quality of water for health, livelihoods and production, coupled with an acceptable level of water-related risks.

Water Stress
Physiological stress experienced by a plant as a result of a lack of available moisture or a low water potential in the surrounding soil; an instance of this. Economic or political pressures in a country or region as a result of insufficient access to fresh water.

Well-being
A perspective on a good life that comprises access to basic resources, freedom and choice, health and physical well-being, good social relationships, security, peace of mind and spiritual experience. Human well-being is a state of being with others and the environment. Well-being is achieved when individuals and communities can act meaningfully to pursue their goals and everyone can enjoy a good quality of life. The concept of human well-being is used in many western societies and its variants, together with living in harmony with nature, and living well in balance and harmony with Mother Earth.

Western science
(Also called modern science, Western scientific knowledge or international science) is used in the context of the IPBES conceptual framework as a broad term to refer to knowledge typically generated in universities, research institutions and private firms following paradigms and methods typically associated with the 'scientific method' consolidated in Post-Renaissance Europe on the basis of wider and more ancient roots. It is typically transmitted through scientific journals and scholarly books. Some of its central tenets are observer independence, replicable findings, systematic scepticism, and transparent research methodologies with standard units and categories.

Wetlands
Areas that are subject to inundation or soil saturation at a frequency and duration, such that the plant communities present are dominated by species adapted to growing in saturated soil conditions, and/or that the soils of the area are chemically and physically modified due to saturation and indicate a lack of oxygen; such areas are frequently termed peatlands, marshes, swamps, sloughs, fens, bogs, wet meadows, etc.

World Heritage Sites
A World Heritage Site is a landmark or area which is selected by the United Nations Educational, Scientific and Cultural Organization (UNESCO) as having cultural, historical, scientific or other form of significance, and is legally protected by international treaties. The sites are judged important to the collective interests of humanity.

Zoonotic diseases
Zoonotic disease or zoonoses are directly transmitted from animals to humans via various routes of transmission (e.g. air - influenza; bites and saliva - rabies).