7 Building capacity for developing, interpreting and using scenarios and models

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Key finding

Regional, sub-regional and national similarities and differences currently exist in the capacity for scenario development and modelling for biodiversity and ecosystem services. Human resources and technical skills required for scenario and modelling for biodiversity and ecosystem services are not evenly spread across the regions. Differences in capacities for modelling and scenario analyses biodiversity and ecosystem services (BES) are most apparent in human resources, infrastructure and technical skills for BES modelling. External organizations may serve to fill gaps in capacity in nations with smaller economies through provision of technical and/or financial resources. (7.1)

Capacity for modelling and scenario analysis for biodiversity and ecosystem services is challenged by inadequate training and human capacity to utilize biodiversity and ecosystem services software and modelling tools. While many accessible and appropriate software and modelling tools exist, communication of their availability and training in their use is required. Existing networks can be better utilized as IPBES partners to facilitate training opportunities. (7.2)

Issues of accessibility and compatibility of datasets required for biodiversity and ecosystem services modelling and scenario analysis challenge the ability to develop models and scenarios, and utilize data and model results in international biodiversity assessments. While many platforms have been developed to serve as repositories of BES datasets, duplication of effort is common, and inconsistencies between formatting and operating standards and lack of complementarity need to be addressed to optimize use of data platforms and their associated datasets in BES modelling and scenario analysis. (7.3)

While the development of biodiversity and ecosystem services modelling and scenario analysis is improving, similar resourcing is required to develop and/or utilize tools to incorporate biodiversity and ecosystem services concepts into national and global policy and decision making. Training and development of the human capacity to integrate these tools is required to enable incorporation of these tools into policy and decision making. Currently few scenario tools are available to policy makers that focus on biodiversity and ecosystem services; rather, most scenario analyses are focused on business or economic growth scenarios. (7.4)

A wide range of qualitative and quantitative participatory tools are available to facilitate stakeholder engagement in biodiversity and ecosystem services scenario development. Involvement of diverse stakeholders in development of scenarios is an integral part of successful scenario development. This involvement should include both developing capacity for stakeholder and local and traditional knowledge communities to participate in model and scenario development for biodiversity and ecosystem services, and ongoing communication of scenario results. Support for bidirectional communication, including recognising stakeholder needs for management and policy, is required between local and national government and stakeholder groups and local and traditional knowledge communities. (7.5)

Key recommendations

The IPBES Task Force on Capacity Building should partner with the many global programmes, partnerships and initiatives that provide opportunities for human resource and skills development. The IPBES Task Force on Capacity Building should work with existing MEAs, international organizations and initiatives to provide resources to support joint training initiatives with IPBES to enable participation in the IPBES Work Programme. These partners provide a wide range of training courses, workshops, internships and collaborative projects. Long-term partnerships should be established with universities in developing and developed countries to train practitioners in tools and software for scenario development and modelling through the development of short courses and establishment of MPhil fellowships. (7.2.2, 7.2.3, 7.5.3, 7.6.1, 7.6.2)

IPBES should provide guidelines and documentation for recommended tools for biodiversity and ecosystem services scenario development and modelling (models, software and databases). Documentation should be translated into each of the six UN languages, where appropriate, using clear terminology that the users and developers of models and scenarios can understand. IPBES should develop and support network and user forums for people to ask questions and interact with other users of models and scenarios, to promote knowledge exchange and development of capacity within and between regions. (7.2.1, 7.2.2, 7.6.1)

IPBES should identify standardized global environmental data-sets that are required to support IPBES assessments using models and scenarios of biodiversity and ecosystem services. In cooperation with other partners and donors, IPBES should develop guidelines for data collection to build and improve upon environmental data-sets that underpin functional relationships between biodiversity and ecosystem services in IPBES models and assessments. Global and regional advisory platforms should be established to develop and adopt global standards and formats for global data and metadata, certify the quality of the datasets, and promote global web-based access to these datasets. (7.3.1, 7.3.2, 7.6.4)

The IPBES Catalogue of Policy Support Tools and Methodologies (Deliverable 3d) should include guidelines and tools to enable incorporation of biodiversity and ecosystem services models and

scenarios into decision-making processes. Guidelines are required to detail effective strategies for mainstreaming scenario processes at different geographic scales to allow their integration into participatory approaches, decision-making processes and public awareness across different policy, planning and management contexts. IPBES should identify local, regional and global scales at which modelling and scenario analyses should be considered in order to identify and provide capacity for integrating models and scenarios into decision making. (7.4.1, 7.5.3, 7.6.1)

The IPBES Task Force on Indigenous and Local Knowledge Systems should identify and build networks to engage and incorporate local and traditional knowledge communities in IPBES assessments. IPBES should identify universities, research institutions and NGOs with experience and/or relationships in the formulations and building of scenarios or models that incorporate indigenous and local knowledge, and develop networks to share new methods that integrate modern science with traditional and local knowledge. IPBES should identify indigenous, local and stakeholder groups and their local representatives who have networks and/or mechanisms for distribution of information (indigenous technical personnel, organizations). IPBES should develop mechanisms to enhance communication between indigenous, local and stakeholder groups and local governments so that they are the mechanism of IPBES's connection with the local environment. (7.4.2, 7.4.3, 7.5.1, 7.5.2, 7.6.3, 7.6.5)

7.1 Introduction

Previous chapters have introduced the methodologies for scenario analysis and modelling of biodiversity and ecosystem services (BES), discussing a wide range of tools that can be used to support IPBES assessment and decision making. This chapter reviews the underlying capacity required to support scenario analysis and modelling across a broad range of spatial scales (global, regional and sub-regional), and decision-making contexts. Key capacities required for scenario development and modelling include: enhancing the capacity to undertake and use scenarios in assessments, including strengthening human resources and infrastructure; improving access to, and guidelines for, user-friendly software tools for scenario analysis, modelling and decision-support systems; improving regional and national access to, and inter-operability of, quality standardized data-sets; developing methods for better incorporation of local data and knowledge; and developing synergies with existing Global Assessments for data and scenario sharing. Key capacities also include development of effective strategies for mainstreaming scenario processes at different geographic scales to allow their integration into participatory approaches, decision-making processes and public awareness across different policy, planning and management contexts. This chapter presents strategies to balance human resources, infrastructure and data accessibility to enable BES scenario development and modelling at the regional, sub-regional and national scales.

7.1.1 Capacity building for biodiversity and ecosystem services scenario development and modelling

The UNDP defines capacity development for environmental sustainability 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. Components of capacity include skills, systems, structures, processes, values, resources and powers that together, confer a range of political, managerial and technical capabilities' (UNDP 2011). Within the IPBES framework, the IPBES Task Force on Capacity Building has identified five key capacity building categories: 1) capacity to participate effectively in implementing the IPBES work programme; 2) capacity to carry out and use national and regional assessments; 3) capacity to locate and mobilize financial and technical resources; 4) capacity to access data, information and knowledge; and 5) capacity for enhanced and meaningful multi-stakeholder engagement (Annex 4, Capacity Building Task Force, April 2015). Within a framework of BES scenario analysis and modelling, capacity development includes human resources and technical capacity required to support scenario analysis and modelling across a broad range of spatial scales (global, regional, sub-regional, national and local) and decision-making contexts (Figure 7.1). Key aspects of the capacity required for scenario development and modelling include:

1. Capacity to participate effectively in the development and use of scenarios and models in IPBES assessments
2. Capacity to access data, information and knowledge
3. Capacity to integrate scenarios and models within the policy and decision-making framework of IPBES assessments
4. Capacity for meaningful engagement with multiple stakeholders

Capacity building for scenario analysis and modelling also must consider capacity to support development of effective strategies for mainstreaming scenario processes at different geographic scales. There are many entry points and strategies for developing IPBES scenarios across scales to allow their integration into participatory approaches, decision-making processes and public awareness across different policy, planning and management contexts (Table 7.1).

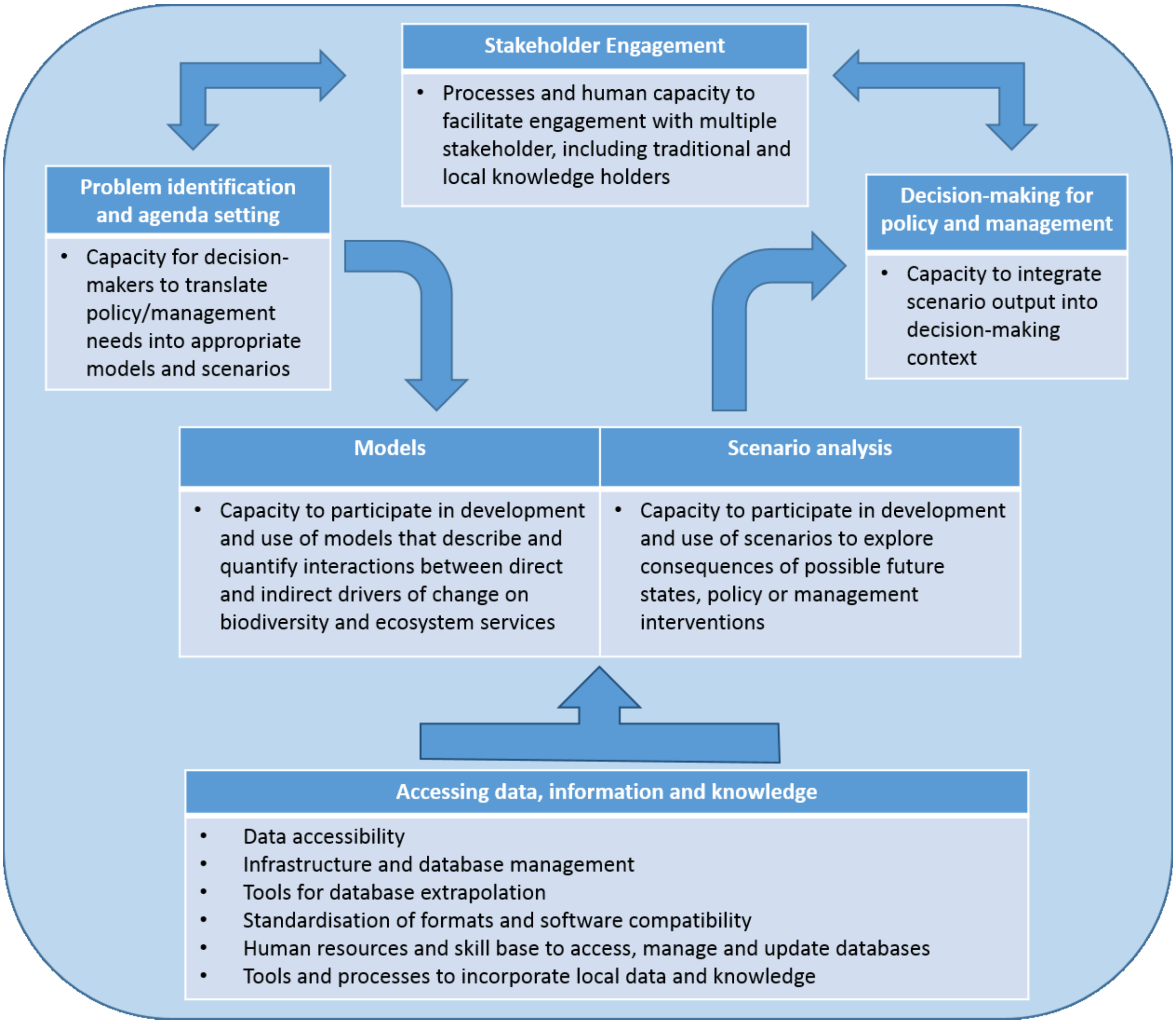

Figure 7.1.: Capacity building requirements for BES scenario analysis and modelling.

Table 7.1.: Capacity building objectives, strategies, actions and entry points for developing IPBES models and scenarios.

Capacity Building Goal	**Strategies**	**Actions and entry points**
Enhance national and regional networks, individuals and team capacities to carry out and use scenarios exercises within IPBES assessments	• Establish or strengthen regional networks of experts • Update and complement knowledge and skills in scenarios • Improve research capacities of universities and other research and training institutions • Implement BES scenario and model training	• Map current expertise/capacities (local and regional) • Identify needs • Regular training national and regional workshops to share methodologies • Workshops for specific technical aspects • Assistance in conducting scenarios within assessments on the ground. • Train new and emerging actors (in an applied setting) • Developing curricula relating to ecosystem services (ES) and development of scenarios • Involving students and young researchers (fellowships)
Enhance institutional expertise, particularly on the science–policy interface, for effective adoption and use of the scenario findings.	• Engage stakeholders • Enhance the science policy interface in support of implementing scenarios • Improve the shared knowledge base • Improve an understanding of the decision-making process on the part of the scientific community • Improve capacity for transdisciplinary and trans-sectorial communication	• Establishment of inclusive assessment governance structure (stakeholders, scientists, policy makers, local organizations or individuals) • Networking and face to face meetings with multiple stakeholder groups • Dialogue and development of visioning exercises with multiple actors (scientists, government officials, policymakers and other stakeholders) • Dialogues on scenario approaches to improve the shared knowledge base (including qualitative and participatory approaches) • Training on communication skills
Strengthen institutional and organizational structures at all levels	• Assess, revise and develop scenarios capacities • Enhance the capacity to participate effectively in IPBES assessments • Develop capacity to locate and mobilize financial and technical resources • Establish exchange programme and technical assistance	• Develop plans of actions • Establishing institutional partnerships at all scales • IPBES matchmaking i.e. to bring together experts, practitioners, mentors, local knowledge holders and financial resources • Increase cooperation between centers of excellence/institutions • Create common platforms, working groups of Indigenous Local Knowledge (ILK) and modern knowledge communities

7.1.2 Current capacity to effectively participate in the development and use of scenarios and models in IPBES assessments

Regional, sub-regional and national similarities and differences exist in people's capacity to participate in BES scenario development and modelling. These differences are a reflection of political history, environmental variability, information and communications technology, economic capacity, population size and education, among many other factors. Differences in capacity are most noticeable when comparing infrastructure to support scenario analysis and modelling across nations and regions. Significant differences are apparent when comparing economic investment priorities by different governments, which include prioritization of research on BES (Figure 7.2A). Disparities in authorship of scientific papers on BES models highlight cross-regional and national differences, reflecting disparities in both human and technological capacity in BES modelling (Figure 7.2B). Unfortunately, biodiversity-rich countries and regions are not the major contributors to BES modelling and scenario analysis. Additionally, there are geographic inequalities in the ability to access information about BES scenarios and models, and datasets and software tools used to develop them, as approximated by relative internet usage (Figure 7.2C).

Innovations in BES models are often supported by government funding through academic and research institutions or through direct funding to government ministries to develop and implement management solutions. However a dependence exists on external organizations (e.g., environmental non-governmental organizations) to provide technical and financial resources in many nations with smaller economies, with resulting challenges with long-term viability and uptake by local stakeholders (Morrison *et al*. 2010; Horigue *et al*. 2012, Mills *et a*l. 2014).

There are also cultural differences at local, regional and national scales that need to be recognised for BES scenario and model planning processes. These include biases due to lack of cross-cultural engagement and understanding, and also biases where local or traditional management practices, customary and participatory decision making, and oral knowledge and data gathering are not integrated into policy and decision making. Cultural frameworks also guide taboos about types of management and decision-making frameworks that are acceptable, and methods to collect and share data. The separation of people and nature can result in discontinuities between local community priorities for biodiversity management, and those of government institutions.

Thematic biases are apparent at the ecosystem scale with BES models and scenarios more commonly used to support decision making in terrestrial ecosystems compared to marine and freshwater ecosystems (FRB 2013). Socio-economic drivers also result in differing capacity across topical issues, with model capacity biased toward resource-based modelling (e.g., fisheries, forestry, agriculture) and fewer resources allocated to models that have little underlying economic gain. Increased understanding and integrating of ecosystem service (ES) concepts into environmental policy, and recognition of ES concepts in international commitments at platforms such as IPCC and IPBES are resulting in models that are more holistic, and include environmental (e.g., water quality), climate (e.g., coastal inundation, sea level rise, ocean acidification) and biodiversity objectives alongside socio-economic, cultural and community objectives.

Finally, external drivers can influence the use of BES scenarios and modelling. Political agendas, which vary on temporal scales of political tenures, can provide impetus or hindrance for new innovations and decision making, and can also bring instability by causing reversals of existing decisions and environmental commitments (e.g., Australia's 2014 decision to repeal its carbon tax, and resulting changes in institutional support for climate-related research). National and regional environmental policies often have topical biases (e.g., biases toward terrestrial over marine and aquatic policies) that drive funding, data collection, and decision making. Similarly, non-governmental organizations have research priorities that may result in biases in research agendas, e.g., focus on protected area implementation rather than sustainable agriculture or water quality.

With an understanding of historical differences and similarities in capacity for BES modelling and scenario analysis, future strategies for capacity building can build on these existing capacities, and fill national and regional gaps. In the remainder of this chapter, we present strategies to develop capacity for effective participation in the development and use of scenarios and models in IPBES assessments, to access data, information and knowledge, to integrate BES models and scenarios into policy and decision-making frameworks, and to provide for meaningful multi-stakeholder engagement.

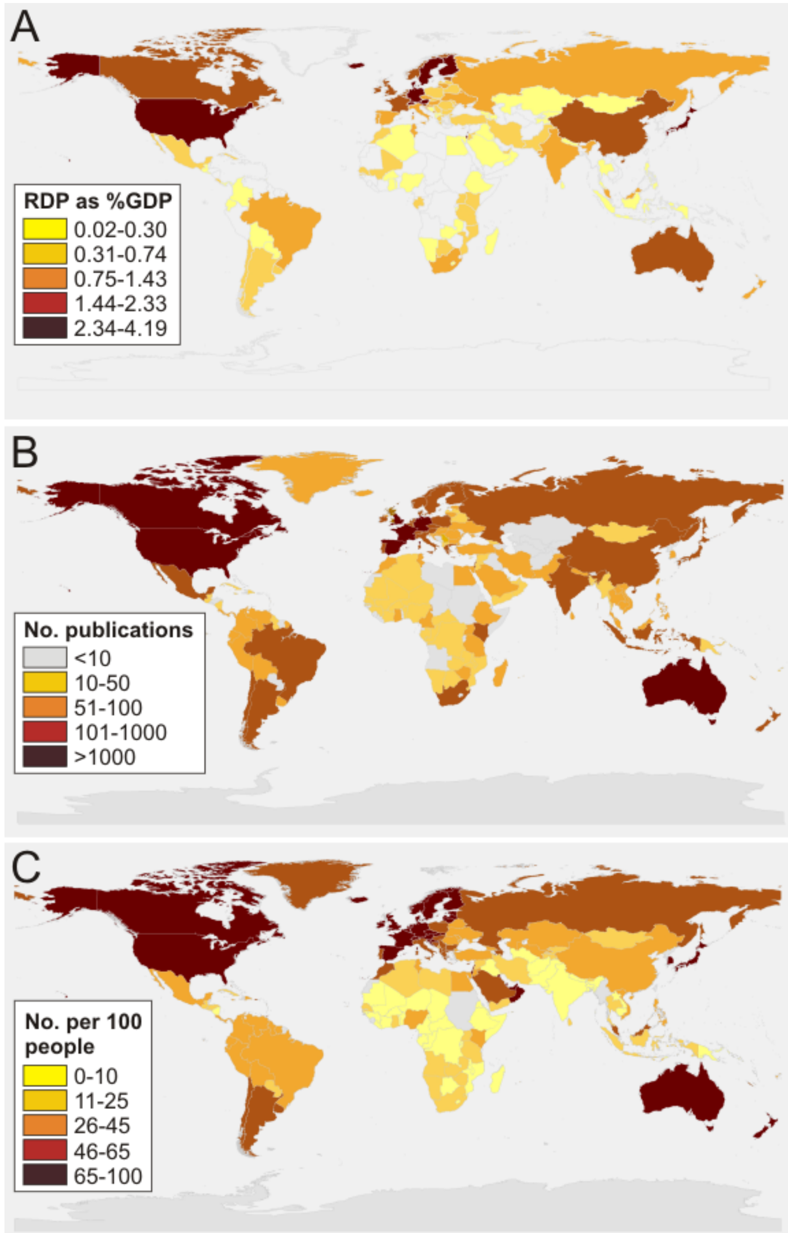

Figure 7.2. Regional differences in capacity to support BES modelling and scenario analysis. A. **Research and development expenditure (% of GDP)**. Current and capital expenditures (both public and private) on creative work undertaken systematically to increase knowledge, including knowledge of humanity, culture, and society, and the use of knowledge for new applications. Data source: United Nations Educational, Scientific, and Cultural Organization (UNESCO) Institute for Statistics http://databank.worldbank.org/data/views/reports/tableview.aspx; B. **Peer-reviewed publications of scientific and technical journal articles** based on search of ISI Web of Science citation database for all years (1900-current) for nationality of authors of publications with TOPIC: (ecosystem service*) OR TOPIC: (biodiversity*) AND TOPIC: (model* OR scenario*); C. **Internet users** per 100 people. Data source: World Bank/World Development Indicators (http://data.worldbank.org/indicator/IT.NET.USER)).

7.2 Enhancing capacity to effectively participate in the development and use of biodiversity and ecosystem services scenarios and models

A key capacity for the implementation of the IPBES Work Programme is to enhance people's capacity to effectively participate in the development and use of BES scenarios and models (Annex 4, IPBES Task Force on Capacity Building). Developing BES scenarios and models requires expertise in various fields such as ecology, modelling, economics, GIS, social sciences etc. for regional, global, and thematic assessments. The development of policy support tools and methodologies to integrate models and scenarios into national and regional decision making requires the expertise of ecologists, social scientists, economists, lawyers, and policy analysts. In addition, facilitators with experience in participatory approaches are needed to enable the incorporation of local and traditional knowledge and stakeholder input into scenarios, models, and decision-making processes.

7.2.1 Technical capacity for effective participation in models and scenarios

Key aspects of the technical capacity required for scenario analysis and modelling include improving access to, and guidelines for, user-friendly software tools for scenario analysis, modelling and decision-support systems. IPBES should provide guidelines and documentation for recommended tools for scenario development and modelling (models, software and databases) in the six UN languages, using clear terminology that the users and developers of models and scenarios can understand. IPBES should develop and support networks, workshops and user groups for people to ask questions and interact with other users of models and scenarios, and to promote knowledge exchange and development of capacity within and between regions.

The most important aspects for successful BES models and software tools are accessibility, user-friendliness and robustness. Models can be used individually or within scenario analyses to model relationships between indirect drivers, direct drivers, and BES, resulting in predictions that relate to nature's benefits to people. Software used in BES models ranges from standard applications such ArcGIS and other geospatial software, to specialist tools developed specifically to model ecosystem services (ES) (e.g., InVEST), to applications for mobile phones, such as those created to support taxonomic identification and geospatial recording of biodiversity records (Table 7.3; reviewed in Bagstad et al. 2013). There are also models specifically developed to suit local or regional situations.

While many tools are open source, and freely accessible, access to proprietary software can be attained through financial support from funding sources such as the United Nations, the World Bank, and CITES. Examples of open source biodiversity software tools include Waterworld and Costing Nature (Table 7.3). Costing Nature provides free web training for their user base, and includes links to most global datasets in their TERRASIM server; this software also provides the option to upload other databases if there is better data available.

Table 7.3.: Comparison of widely used software for biodiversity and ecosystem service models and scenario analysis (see also https://ebmtoolsdatabase.org, http://www.earthinc.org/earthinc.php?page=ecomodel)

Name	Tool Categories	Ecosystem Type(s) and Scale	Open source	Documentation and training	Additional software requirements	Data requirements
ARIES http://www.ariesonline.org/	Stakeholder engagement and outreach; Modelling and analysis; Visualisation; Decision support	Coastal; Estuarine; Freshwater; Terrestrial; Watershed; Wetland; River; National, regional and local scale	Yes	Online documentation; online training via webinars; technical support as needed	No resources required to use basic functionalities (data are included, tool is web-based). Detailed analysis may require data input for region of interest if not already available.	Probabilistic and capable of operating in conditions of data scarcity. No data will be required for basic analysis, but user data can be input to improve predictions.
ECOSERV http://www.durhamwt.com/wp-content/uploads/2012/06/EcoServ-GIS-Executive-Summary-Only-WildNET-Jan-2013-9-pages.pdf	Modelling and analysis; Decision support	Local scale	Free for Wildlife Trusts	Online documentation	ArcGIS 10 or higher software	Geospatial data
GLOBIO3 http://www.globio.info/	Modelling and analysis; Decision support	Terrestrial; Global, national and regional scale	No	Online documentation, in person training workshops	Specialist training and software required	Unspecified

INVEST http://www.naturalcapitalproject.org/	Modelling and analysis; Visualization; Decision support	Coastal; Freshwater; Marine; Terrestrial	Yes	Online user guide, in person and online training and webinars, online forum for troubleshooting	ArcGIS (ArcInfo 9.3 or higher)	Biophysical data (e.g., land cover, topography, precipitation); socio-economic data (e.g., population density, property values, operating costs, market prices of natural resources).
LUCI http://www.victoria.ac.nz/sgees/research/research-groups/enviro-modelling/ecosystem-service-modelling#lucideveloping	Stakeholder engagement and outreach; Modelling and analysis; Visualisation; Decision support	Flexible, user defined	No	No	ArcGIS	Geospatial data
SOLVES http://solves.cr.usgs.gov/	Stakeholder engagement and outreach; Modelling and analysis; Visualisation; Decision support	Regional to national scale	Yes	Online user guide and tutorials	ArcGIS 10, 10.1 or 10.2 software	ArcGIS supported formats for geospatial and tabular data
WATERWORLD/COSTING NATURE http://www.policysupport.org/waterworld, http://www.policysupport.org/costingnature	Data processing and management; Stakeholder engagement and outreach; Modelling and analysis; Decision support	Coastal; Estuarine; Freshwater; Terrestrial; Watershed; Wetland; River; Local to global scale	Free for non-commercial uses	Online documentation, in person and online training	GIS skills useful but not necessary	None - all data supplied

7.2.2 Developing capacity to participate in IPBES methodological assessments and in developing policy support tools and methodologies

Training programmes are an important part of building human capacity to support BES models and scenarios analysis. Currently, only two major global programmes exist. The UNEP-WCMC has a training programme that relates closely with a number of European and North American Universities through teaching and research supervision. UNEP-WCMC partners with the University of Cambridge to train the next generation of conservationists through an MPhil in conservation leadership, supervising students, project placements, and providing programme oversight and direction as a part of the Steering Committee (www.unep-wcmc.org/expertise). A second global training programme is the SGA Network (Sub-Global Assessments Network), which is implementing a mentoring scheme for early career scientists and researchers. This scheme seeks to facilitate the establishment of mentoring relationships between early-career scientists and researchers working in the field of ecosystem assessments/services, and to promote capacity development for undertaking and using current or upcoming ecosystem assessments (http://www.ecosystemassessments.net/network/mentoring-scheme.html). The recently established IPBES Mentoring programme will also mentor early career scientists in developing skills to participate in regional and national assessments and other aspects of the IPBES Work Programme.

Training is also an important component of software applications. Regular courses are run at global, regional, and national scales, including through online training and webinars, and provide guidance on use and application of different models and software tools (Table 7.3). Short-term training courses are also often held in association with meetings of scientific societies or through various regional and national projects. For example, projects such as CHIESA (Climate Change Impacts on Ecosystem Services and Food Security in Eastern Africa) under ICIPE (International Centre for Insect Physiology and Ecology) sponsored courses to train practitioners in some of the tools (such as InVEST) in BES scenario and modelling. To further provide training in BES models and scenario analysis, IPBES should develop and deliver short-term courses and workshops on a selection of key BES scenarios and model tools. Regular courses to support development of BES skills will enhance capacity of practitioners and early career researchers, especially from developing countries, in addition to sharing of knowledge and skills and establishing networks across geographical boundaries.

The development and interpretation of scenarios requires explicit acknowledgement of the interdependencies between system components and the uncertainties associated with ecosystem driver trajectories. To be the most effective for decision makers, an understanding of the different parameters that can produce a range of possible futures is also needed. This “what if” analysis (Costanza 2000, Watson & Freeman 2012) can be considered an extension of a sensitivity analysis, where all inputs are consistently modified against an overarching theme or narrative [Francis et al. 2011]. Scenario analysis should therefore ideally include detailed documentations of parameters and model inputs (if these are inbuilt in scenarios). In addition, information and training for scenario analyses should go hand in hand with the development of models and software tools.

7.2.3 Developing and utilising networks to enhance capacity to implement the IPBES work programme

International environmental governance literature generally conceives of 'networks' as the links created by and through social relations in economic, cultural, and political domains, with an emphasis on the materiality of the operation and practice of these networks (Bulkeley 2005). Using this definition to guide the development and utilisation of networks to enhance the capacity for implementing the IPBES work programme can focus attention on supporting various educational and development pathways at a range of interconnected scales.

For example, the IPBES Task Force on Capacity Building should partner with the many global programs, partnerships and initiatives that provide opportunities for human resource and skills development associated with BES through a wide range of training courses, workshops, internships and collaborative projects. Long-term partnerships need to be established with universities in developing and developed countries to train practitioners in tools and software for scenario development and modelling through the development of short courses and establishment of MPhil/research fellowships.

Similarly, another way to enhance capacities to use tools is the reinforcement and support of existing regional infrastructure for modelling ES. Such infrastructure is already present in many places but often lacks funding for training or is not well known. By developing a relationship with the agencies and institutions that have some ES modelling capacity already, it may be possible to implement a "train the trainer" programme that could exponentially enable capacities.

Creating a network and user forums that include scientific communities, stakeholders, decision makers, and policy makers can enable feedback at all stages of model development, including evaluating scenario and model outputs with empirical observations. Such network and forums are useful for people to ask questions, interact with other users, and exchange knowledge. For example, the Marxan forum at the University of Queensland serves a network of users from over one hundred countries, and answers queries from software applications to dataset requirements related to this software. While this process enhances the model through the feedback, it also creates capacity within stakeholders to familiarize with the model and how it works, which in turn enables easier integration and use of the model for planning and decision-making processes.

7.3 Improving capacity to access data, information and knowledge

Datasets are strong contributors to our understanding of biodiversity and ecosystem services. For example, the world's governments missed their target to reduce the rate of biodiversity loss by 2010

(Secretariat of the CBD 2010) and the progress so far toward 2020 Aichi targets is limited (Secretariat of the CBD 2014). These analyses were interpreted through existing datasets by utilising biodiversity and ecosystem service modelling and scenario development processes (e.g. Sala *et al*. 2000; Leadley 2010; Pereira *et al*. 2010). One of the many reasons for this global failure was the shortage of comprehensive indicators and associated accessible data (Butchart *et al*. 2010; Secretariat of the CBD 2010). To create appropriate policies to protect biodiversity we must understand what they contain, how the species interact, and how they might respond to changes and pressures, both natural and man-made (Mace *et al*. 2010).

7.3.1 Develop the capacity to gain access to data, information and knowledge managed by internationally active organizations and publishers

Realizing the importance of data, many global, regional and national initiatives have progressed to archive different forms of data for the use and applications on various decision-making processes (Table 7.4; MA 2005a; Chettri *et al*. 2008; Yahara *et al*. 2014; Viciani *et al*. 2014). This is true even at the global level where Multilateral Environmental Agreements such as UNFCCC, CBD, RAMSAR, CITES and Millennium Development Goals are supported by a range of primary and secondary data both at national and global levels to reach common conservation and development goals. Extensive use of global and regional datasets are also evident in the progressive and refined reporting from IPCC Report 4 (IPCC 2007) and IPCC Report 5 (IPCC 2014).

Table 7.4.: Types of platforms that support model and scenario datasets

Type of platform	Scale	Examples
Multilateral environmental agreements (MEAs) and Biodiversity-related Conventions	Global, regional	Convention on Biological Diversity (CBD), CBD), the Convention on International Trade in Endangered Species (CITES), Convention on Migratory Species (CMS), Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar Convention)
International Government Organizations (IGOs)	Global, regional	Food and Agriculture Organization (FAO), Global Environment Facility (GEF), Global Biodiversity Information Facility (GBIF), International Union for Conservation of Nature (IUCN), United Nations Environment Programme (UNEP)
Regionally hosted datasets	Regional, sub-regional	Pan-European Species-directories Infrastructure (PESI), Arctic Biodiversity Data Service, ASEAN Biodiversity Information Sharing Service (BISS), European Landscape Convention, The Alpine Convention

Global thematic datasets	Global, 'thematic'	Ocean Biogeographic Information System (OBIS), MarineBio Species Database (MarineBio), the Global Invasive Species Database (GISD), BirdLife International, FishBase, HerpNET, Integrated Botanical Information System (IBIS), Integrated Taxonomic Information System (ITIS)
Others	All scales	Global Biodiversity Informatics Outlook (GBIO), World Biodiversity Database (WBD), Natura 2000, NatureServe

Parties to such conventions are obliged to develop clearing housing mechanisms with established national level accessible datasets. These practices have significantly contributed to dataset development processes and accessibility. Thus, through such conservation and development processes, biodiversity and ecosystem data (among others) are becoming more extensive and accessible, and therefore more likely to be integrated into environmental assessments. Some of the promising efforts on developing global biodiversity databases include the Encyclopedia of Life (Parr *et al*. 2014) and the Global Biodiversity Information Facility (Robertson *et al*. 2014) among others. The GBIF database has made significant progress on publishing records of approximately 500 million species and 50 million geo-referenced data records worldwide (Figure 7.3). Efforts have also been made to develop thematic datasets on forests (Gilani *et al*. 2014; Pfeifer *et al*. 2014), wetlands (Lehner and Döll 2004; Chaudhary *et al*. 2014) and mountain ecosystems (Chettri *et al*. 2008; Guralnick and Neufeld 2005; Gurung *et al*. 2011).

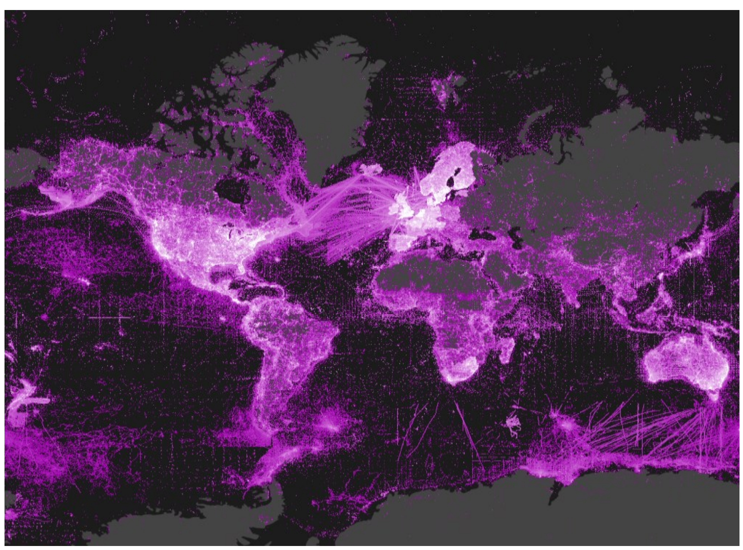

Figure 7.3.: Density of geo-referenced species occurrence records published through GBIF till July 2014. Top ten contributing countries of geo-referenced data include the United States, Sweden, United Kingdom, Australia, Netherlands, Germany, France, Finland, Norway, and Spain) (Source: http://www.gbif.org/ocuurange)

As new technologies and scientific approaches are evolving, modelling of both new and historical datasets can provide enhanced understanding of the role of biodiversity and ecosystem services in human health and well-being (Pimm *et al*. 2014). However, this can happen only if we are able to enrich, maintain and use quality data effectively (GBIF 2013). This is possible when data, old and new, are archived in a structured and standardized form to enable a diversity of uses, creating new opportunities for research and application, and supporting biodiversity-related policy making. Integration of biodiversity and ecosystem datasets into innovative modelling tools can enable us to understand the trends and projections with scenarios, and serve as building blocks for future conservation and development goals.

There are five broad groups of issues that are relevant to the access to and incorporation of data into BES models and scenarios (Arzberger *et al*. 2004).

1. Technological issues: Broad access to research data, and their optimal utilisation, requires appropriately designed technological infrastructure, broad international agreement on interoperability, and effective data quality controls (Table 7.5);
2. Institutional and managerial issues: While the core open access principle applies to all science communities, the diversity of the scientific enterprise suggests that a variety of institutional models and tailored data management approaches are most effective in meeting the needs of researchers;
3. Financial and budgetary issues: Scientific data infrastructure requires continued, and dedicated, budgetary planning and appropriate financial support. The use of research data cannot be maximized if access, management, and preservation costs are an add-on or after-thought in research projects;
4. Legal and policy issues: National laws and international agreements directly affect data access and sharing practices, despite the fact that they are often adopted without due consideration of the impact on the sharing of publicly funded research data;
5. Cultural and behavioural issues: Appropriate reward structures are a necessary component for promoting data access and sharing practices. These apply to those who produce and those who manage research data.

Table 7.5.: Technical requirements to improve data quality and compatibility

Issue	Specific technical requirements
Data quality	• Documentation of uncertainties surrounding data collection and measurement error • Authenticity and integrity of data source • Security against loss, destruction, modification, and unauthorized access • Taxonomic resolution and revision (e.g., Natvi *et al*. 2009). • Inter-operability across the temporal and geospatial scales (e.g., Edward *et al*. 2000)
Data format	• Compatibility with multiple analytical, reporting and publishing options • Compatibility for both spatial and temporal analysis as well as with available software • Geospatial grids and projections appropriate to geographic region and scale, including altitude • Use of commonly of recognized and widely used data standards such as Darwin core (e.g., Wieczorek *et al*. 2012)
Data inter-operability	• Compatibility of technical standards and protocols across software packages and data management organizations to ensure the access and usability of data
Accessibility	• Open access to data and software • Ability to combine data from multiple sources • Comprehensive documentation of data sets
Flexibility	• Flexibility to incorporate data management innovations • Flexibility to integrate across disciplines, scales and ecosystems
Long-term sustainability	• Financial sustainability to maintain infrastructure including publishing platforms and data hubs • Technological backups of both data and platforms

7.3.2 Developing capacity to enhance multi-disciplinary and cross-sectoral collaboration at the national and regional levels

Data collection and management are among the least priority areas leading to limited representation or participation in global database development discourse. The vast information available amongst the traditional and indigenous people and their fading knowledge has not been properly documented and archived. Many of the existing global datasets such as Global Circular Model for temperature and forest datasets such as HYDE (Klein *et al*. 2011) are with coarse resolution. They do not capture the true picture of varied landscapes such as that of mountains or small sized wetlands and fragmented forests (Chettri *et al*. 2010; Pfeifer *et al*. 2014; Svob *et al*. 2014).

Ironically, even the existing datasets maintained by Secretariats of multilateral agreements such as UNFCC, CBD, RAMSAR, the global commons on bioinformatics such as GBIF and IUCN Red List, and other datasets maintained by developed countries do not show complementarity to each other and duplication of work is prominent. Geospatial datasets for the same location may use different geospatial projections, making datasets incompatible (e.g., the numerous geospatial projections available for the Antarctic region, and lack of consistency in usage for Antarctic datasets). In addition, taxonomic inconsistencies, provision for inter-operability among the existing datasets and duplication of efforts in generating datasets and developing database infrastructure among the biodiversity research communities are bringing more complexities in database management domain rather than contributing to its resolution. There is also an ongoing need for balanced and representative national and regional centers contributing to the quality of open access databases.

Table 7.6.: Short- and long-term strategies to address gaps in data collection and management strategies to support BES modelling.

Short term strategies (1-2 years)	**Long term strategies (3-20 years)**
Incorporate SWOT (strengths, weaknesses, opportunities and threats) analysis	Establish/improve data base infrastructures (portals) and accessibility
Prepare database development and management outlook at national and regional levels	Strengthen regional network and cooperation (particularly in nations without culture of data sharing)
Develop database catalog and identification of gaps	Establish global and regional advisory platforms to certify the quality of the datasets in conformity with the adopted standards
Provide thematic modules for capacity development (training resources- online available)	Link results with policy development process
Provide training for database developers and users	Ensure mechanisms exist such that datasets are updated when new information is available
Promote data sharing and users policies	Ensure financial sustainability
Develop guidelines for habitat assessment to allow approximation of ecosystem services based on land-cover/biotypes, and guide data collection to validate model functional relationships	Develop priorities to enlarge data coverage of global datasets
Develop tools for down-scaling of common databases (e.g. GBIF, climate models)	
Develop queries to enable dataset transformations of popular global indices to seasonal-monthly-daily scales; spatial queries to enable regional, national or local scale analysis of global datasets	
Develop products using new technologies such as Android and iOS applications (e.g., Aichi Indicators Exploration application) and E-books (e.g., E-Handbook of the Convention on Biological Diversity) to communicate information from IPBES	

The existing data collection and management practices could be improved with emphasis on data quality, inter-operability, and institutionalization of data management processes through short and long term strategies. A number of recommendations can result in increased capacity to use Geographic Information System (GIS) databases and analytical and visualization tools for rapid production and access of information products (Table 7.6).

7.4 Integrating scenarios and models into policy and decision making

7.4.1 Strategies to mainstream scenarios into the Science-Policy interface

A scenario provides a platform or basis that allows decision units (governments, agencies) to reflect on how changes in their respective context i.e. BES (that is, developments beyond their immediate spheres of influence) may affect their decisions. Effective scenario building and model construction require expertise in several fields including management, development, ecology (terrestrial or marine), climate change, culture, agriculture, economics and mapping among others depending on the subject at hand (Mackenzie *et. al*. 2012).

Capacity building in BES requires strengthening or developing long-term relevant trans-disciplinary expertise, institutions, and organizational structures to carry out scenarios exercises and develop models within IPBES assessments (Ash *et al* 2010). These have been of relevance to decision makers with a key objective of allowing decision makers to act on findings of BES models. The purpose of using scenarios and developing stories is to encourage decision makers to consider certain positive and negative implications of different development trajectories (MA 2005a). The main effective strategies for mainstreaming scenarios and models into decision-making processes across scales (national, regional, global), and across different policy, planning and management contexts within the framework of IPBES are summarized in Table 7.1. The key steps to mainstream scenarios and modelling into Science-Policy interface may involve:

1. Engaging the policy makers and all other stakeholders from the beginning
2. Developing relevant BES scenarios and models that are easily understandable
3. Translating results into policy makers’ and stakeholders’ language
4. Using just ‘sufficient’ data (not too much) to convey a clear message
5. Using precise and credible information for BES scenarios and models

At the national scale, most governments recognize the social role of ecosystems and their biodiversity due to their influence on human health and quality of life, apart from their contribution to social and economic development through the supply of essential ecosystem services. This emphasizes the socio-cultural and economic value of ecosystem services and the importance of their inclusion in policies. As an example, the failure to meet the 2010 biodiversity targets (CBD, 2010) stimulated a set of new future targets for 2020 (the Aichi targets). As highlighted by Perrings *et al*. (2011), the first strategic goal to meet the 2020 targets is to "address underlying causes of biodiversity loss by mainstreaming biodiversity across government and society". The Millennium Ecosystem Assessment has shown that there is no clear institutional response to address these underlying causes (indirect drivers of change), and new sets of responses are necessary to meet the 2020 targets. This requires structural changes to recognize biodiversity as a global public service as well as to integrate biodiversity conservation into policies and decision frameworks (Rands *et al*. 2010) at local, regional and national scales. BES scenarios and models can help to fill this gap, but presently, there are very few scenarios that focus on BES and suit the policy decision makers. Costanza *et al*. 2014 reviewed various scenarios at a global and national scale (i.e., Australia) and most of the scenarios were related to businesses or economy, not to BES.

The current accelerated changes in economic, social and environmental aspects require flexible policies. Policy is subject not only to a political process but also to urgent or sudden calls for decisions, before any scientific result is available (Scheraga *et al*. 2003). The complexity of ecosystems and their services demands reliable data and analysis for policy decisions (UNEP 2012) (Figure 7.4). In addition, there is a growing need for scientific knowledge that is understandable across diverse stakeholder groups.

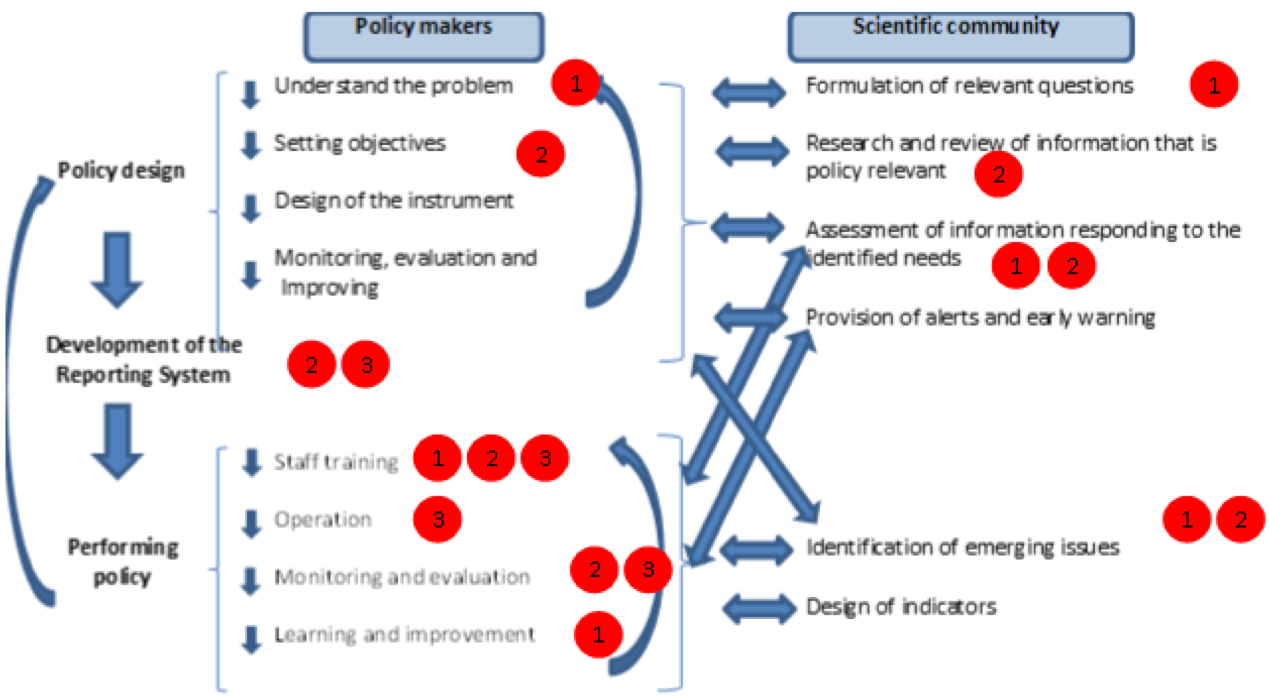

Figure 7.4.: Connection between policy makers and scientific community and scenario capacity needs objectives inter-linkages (red circle indicates Capacity Building objective as referenced in Table 7.6) (Source: Adapted from Swanson, D. and Bhadwal, S. (2009). Creating adaptive policies. IISD-TERI: Ottawa. IUCN (2010). Information Paper on IPBES.

There are at least two different ways in which scenarios and models could be useful for mainstreaming BES into policy at several scales of decision making:

- 'Scenarios based on models' could be developed to project possible futures where there is a greater degree of certainty in data. For example, population models could be used to develop scenarios on use of ES in a particular region.
- 'Models based on scenarios' could be used to project possible future options. A model can use different scenarios to suggest different options that may occur in the future. For example, a model can suggest the difference in values of ES over time based upon current use of ES as the scenarios based models used in the UK (Haines-Young et al 2014).

Either of the two methods mentioned above can be applied to project long-term impacts for future decision making. However, the second approach could be more appropriate in relation to BES assessment given the intangible nature of many ES as well as uncertainty in BES data. The experts, locals and other stakeholders can apply their common judgment to predict for future alternatives.

To mainstream scenarios and models into policy and decision making, it can be valuable to include people's wellbeing, economy and status and trends in BES as important domains in any BES scenario, to appropriately dialogue with policy makers. An example of a possible 'BES approach' is presented below (Figure 7.5.):

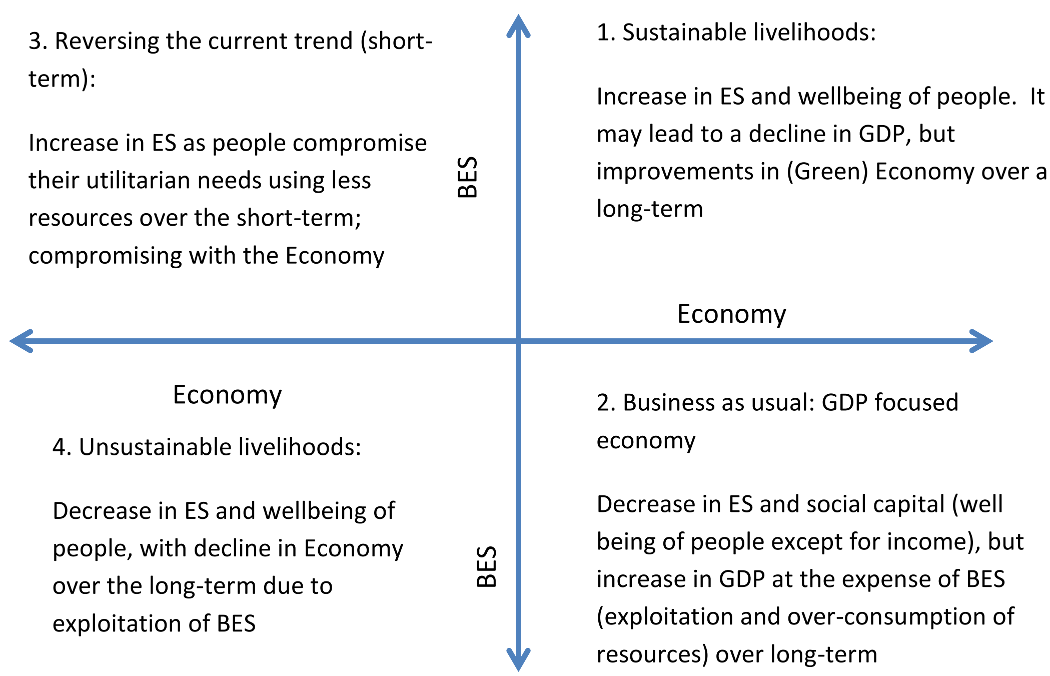

Figure 7.5.: Example of BES scenarios on linking BES with economy (focused on Gross Domestic Product (GDP)) and wellbeing of people (Sangha 2014).

Each type of scenario mentioned in Fig. 7.5 can further include studying the impacts of change in BES over a long-term on:

1. Government (development and policy sector)
2. Natural resources (capital)
3. Social values (capital)

A combined approach of scenario planning and modelling can be useful for the policy decision makers to comprehend various values and changes that may occur in a system over the long-term. However, it is important when working with local or indigenous communities to develop scenarios that suit people's values. This is one major difference from the modelling approach where pre-developed models are applied without including local values. Scenarios can help us exploring options from local perspectives, and can accommodate local knowledge, and this may prove very useful for IPBES assessments to demonstrate the role of ES in people's wellbeing, beyond the tangible measures and can significantly help to bridge the gap between local knowledge and policy decision making.

7.4.2 Recognition of the interdependence of knowledge systems, including traditional knowledge, to inform biodiversity and ecosystem services models and scenarios

"Traditional and local knowledge" refers to knowledge and 'know-how' accumulated by regional, indigenous or local communities over generations that guide human societies in their interactions with their environment (IPBES/2/17). The IPBES Conceptual Framework clearly recognizes the importance and interdependence of the knowledge across multiple systems (local, scientific, technical, educational and traditional) (IPBES/2/17), and that understanding of these complex knowledge systems is necessary to determine system feedbacks within modelling and scenarios. Folke *et al*. (2002) and Tengö *et al*. (2012) highlighted the importance of such knowledge systems to build resilience in a world of uncertainties.

Traditional and local knowledge offers us a vision of the world from a different epistemology, which provides a new perspective to define relationship between people and the environment and to construct "another possible world" (Leff 2011). Cultural understanding to develop scenarios or models (a common vision established in the Plan 2011-2020 in the frame of the CBD and for Aichi Biodiversity Targets) is a critical aspect of scenario analysis and modelling. For indigenous and local communities, environmental management decisions are intrinsically tied to culture and way of life, and their knowledge can enrich and inform scenarios and models (Feinsinger 2001). However, these systems are often quite complex due to multiple interactions between people and their environment. The main problem of such complex systems is limited skills to understand, to predict and to control socio-ecological systems (Pilkey and Pilkey-Jarvis 2007, Roe and Baker 2007, Eddy et al. 2014). There is a compelling need to develop an integrated system of western and traditional knowledge, and for this, decision making must engage with the most relevant users (Cortner & Moote 1999, Bocking 2004, MA 2005a & b).

Co-design and co-production of necessary knowledge in the process of modelling and building scenarios will strengthen human capacities. To develop effective BES scenarios and models for decision making, diverse forms of local knowledge must come together by transcending spatial and temporal scales. BES scenarios and models must integrate key aspects of local knowledge, including feedbacks between different scales and knowledge systems (Figure 7.5). The dialogue of knowledge can form the platform for scenarios and modelling, across the science exchange to strengthen the validation and the co-production of knowledge. This dialogue can integrate knowledge and world views from local and indigenous perspectives, including civil society, scientific experts, private and economic sectors, and the government. In this process, knowledge is achieved through a combination of rights, obligations and responsibilities, resulting in integral, just and sustainable management of resources (Pacheco 2013).

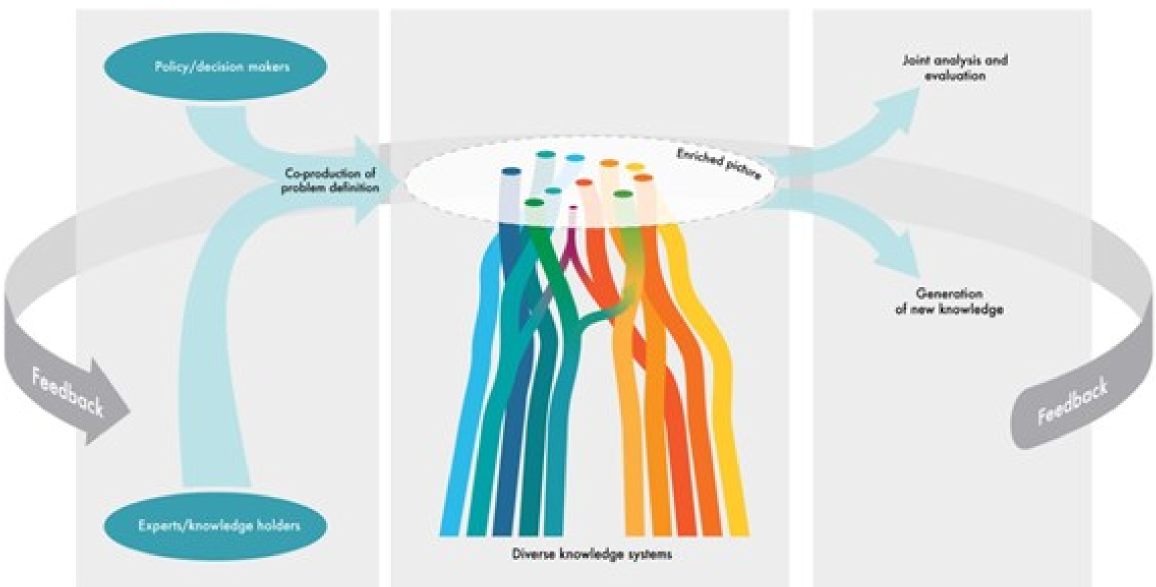

Figure 7.5.: Conceptual diagram on integration of local knowledge for developing BES scenarios and models for decision making (Tëngo et al. 2014).

7.4.3 Mechanisms to include indigenous and local knowledge in scenario analysis and modelling

To incorporate traditional knowledge systems into scenario analysis and modelling, the key mechanisms are to integrate knowledge, and enhance participation and dialogue between actors at national and regional scales (Key priorities of IPBES 3/3 (2014)). Some key aspects to develop efficient mechanisms on integrating traditional knowledge into BES scenarios/models are:

1. To develop a good understanding of indigenous knowledge systems and the ability to translate and integrate this knowledge, where possible, into conventional knowledge systems
2. To study beyond the set boundaries to embrace the holistic perspectives of living that are embedded in many indigenous knowledge systems (especially, for practitioners in conventional knowledge systems)
3. To develop a 'common' (integrated) knowledge base through shared traditional and conventional knowledge systems (e.g., a set of indicators)
4. To apply a trans-disciplinary approach on the role of BES in terms of people's livelihoods (wellbeing), where MA framework could be useful (but with local modifications)
5. To 'effectively' engage with the local and traditional societies from the earliest possible stages of scenario and model development

We also need to consider local and national politics that can significantly influence the possible BES scenarios. For scenarios across local scales, we should recognize commonalities between regions that are critical for determining actions and/or for developing policies. Alternatively, there should be specific local scenarios and models to appropriately address the main issues in a region.

Some examples of integration mechanisms include adaptive co-management, participation and ongoing collaboration with traditional and local societies (Folke *et al* 2002). Adaptive co-management incorporates traditional and modern knowledge, and encourages participation and collaboration amongst all the stakeholders. It is critical to effectively engage with local/indigenous knowledge from the first stage of planning scenarios in order to allow co-definition of the problem, to increase trust and understanding between participatory stakeholders, and to reduce uncertainty in the scenarios (Peterson *et al*. 2003). The long-term success of a particular scenario will depend on cooperation among various stakeholders through scenario refinement, testing and iterations, to ensure acceptance for evaluating policies and informing decision making. We emphasize that 'effective' engagement with traditional and local societies can be a key to develop appropriate BES scenarios.

Incorporation of traditional knowledge is a process that goes hand in hand with empowerment and strengthening of local communities, and is directly related to goal 19 of the Aichi Targets. One method to incorporate traditional knowledge is to develop an integrated set of BES indicators that are based on scientific and traditional knowledge. At a local scale, indicators that include or have links to local and regional traditional knowledge systems will better contribute to collaborative involvement and to enhance socio-ecological scenarios and models (IUCN, 2006). Robb *et al*. (2014) found that implementation of locally based indicators into biocultural conservation can be used to integrate local Māori knowledge and the western science. Other such example is the SESELP Program of Biocultural Subantarctica Conservation (Rozi *et al*. 2010) conducted at a local scale, and National Program of Conservation and Sustainable Utilization (PNCASL) for the caiman (*Caiman yacare*) in Bolivia, as presented in Box 7.1.

Another way to integrate indigenous knowledge for BES scenarios and models is to understand and evaluate the role of BES in people's well-being that further links well with the economics in the modern science. For this, there is need to develop and apply a holistic perspective of well-being for incorporating ES. Sangha *et al*. (2011) evaluated the role of ES from tropical rainforests in indigenous well-being in north Queensland, applying the Millennium Ecosystem Assessment (MA) approach (Figure 7.6). Each ES-well-being link highlighted the importance of an ES in terms of well-being of indigenous people that could be used in developing scenarios and models.

Box 7.1. Incorporation of local knowledge in the management and conservation of *Caiman yacare* (a crocodile species) in Bolivia

Bolivia developed a National Program of Conservation and Sustainable Utilization (PNCASL) for the caiman (*Caiman yacare*). Initially, the annual assignment of local harvest quota was estimated across the "Scientific Authority" based on random counts of relative abundance. With the increasing interest among local communities to be a part in the PNCASL, a need to strengthen the system was identified for incorporating new indicators. These included both biological indicators (based upon models of the species) as well as socioeconomic and cultural indicators of species health. One of the first trials under this new approach was done in the TIPNIS (Indigenous Territory and National Park Isiboro Sécure) where local knowledge was initially the most reliable source on the status of *Caiman yacare*. The quantitative indicators moved beyond quantitative measures to include qualitative indicators such as perceptions of increase in abundance of charismatic species, e.g. "there are a lot more caiman than before". This helped to develop robust indicators on estimation of population size. This was achieved as the traditional resource users participated in workshops where they informed resource quotas using traditional knowledge of caiman, defining concepts, harmonizing criteria, and defining the space and territory conceptualized across maps and knowledge of habitats where caiman live. From a scientific perspective, a population count was measured by the researchers involving indigenous techniques suggested by the communities. The process was repeated by the communities after an integration of knowledge systems and harvest estimates were developed based on local knowledge fortified with scientific concepts and criteria that were internalized (e.g., sizes of hunt allowed). These estimates were used to determine and manage abundance of caiman within the whole protected area. This participatory experience informed a national scale predictive model of abundance of *Caiman yacare*.

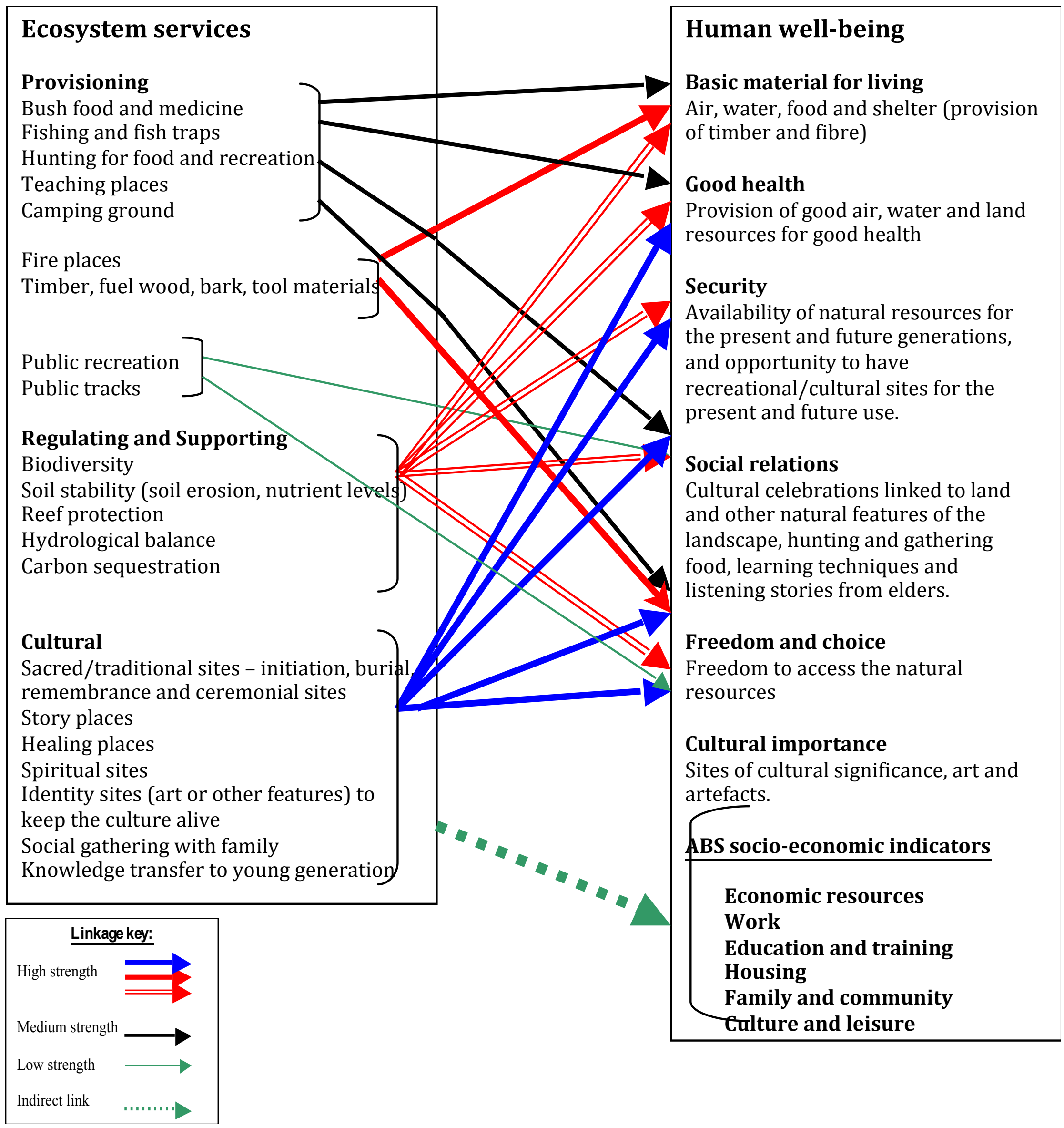

Figure 7.6.: Relationships between ES and the constituents of well-being identified by the Mullunburra-Yidinji community, north Queensland (Sangha *et. al*. 2011).

Indigenous knowledge of BES also links well with people's capabilities that are important when discussing people's development from a policy decision-making perspective. For example, knowledge of bush food and medicine of local plants benefits people's health and enables them to develop a capability to pass on this knowledge to the next generation. As Sen (1999) suggested, enhancing people's capabilities (e.g. health, education etc.) will enhance their well-being. This approach, linking BES with indigenous capabilities, requires a new perspective of thinking about development, economics of indigenous systems and related policies. Integration (co-perception) of knowledge from conventional and indigenous systems can help to consider the importance of BES for policy development decisions. For example, Sangha *et al*. (2014) proposed an integrated well-being framework (Figure 7.7) focusing on country (indigenous perception of land systems in Australia) that equates to ecosystems, which links and equates various ES from country (ecosystems) with the economic, cultural and social worlds of people. Such an integrated framework could be used as a tool to develop possible scenarios and models to suggest and analyze the role of BES in the economic and social living of indigenous and local communities.

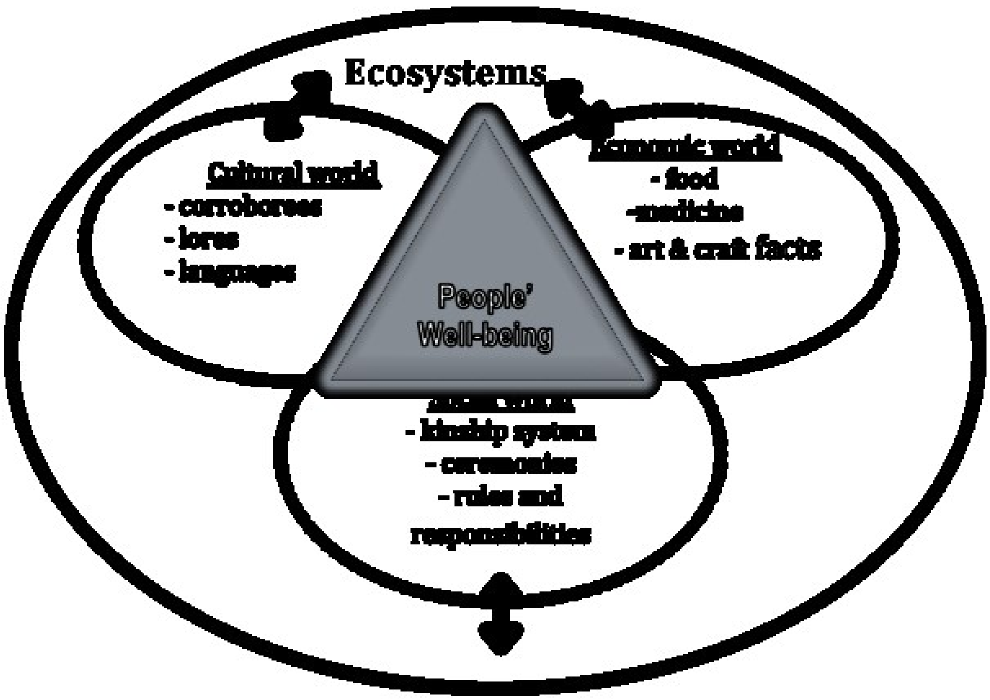

Figure 7.7 A proposed framework on how the ecosystems (i.e. country in indigenous value system) deliver various ES (in the form of social, economic and cultural values) that are vital for indigenous well-being (Sangha *et al.* 2014)

To support integration of traditional knowledge, people's capacities need to be identified through key stakeholders, their interests and powers, and feasibility of key stakeholders to participate in the development of relevant and inclusive BES scenarios and models (Table 7.1) (CONDESAN/UMBROL, 2014). By incorporating traditional knowledge, the BES scenarios and models can actually broaden the horizon, and strengthen our current knowledge systems.

7.5 Develop the capacity for enhanced and meaningful multi-stakeholder engagement

7.5.1 Develop the capacity for effective engagement of stakeholders in assessment and other related activities at the national

A wide range of qualitative and quantitative participatory methods have been used to facilitate engagement of stakeholders in scenario development. These include but are not restricted to: workshops; scenario-based stakeholder engagement; focus group meetings, questionnaire surveys, facilitated discussion and ranking; cooperative discourse; multi-criteria evaluation; conceptual system modelling; and dynamic systems modelling (Bousquet *et. al.* 2002; Madlener *et. al*. 2007; Magnuszewski *et. al*. 2005; Kowalski *et. al.* 2013; van den Belt 2004; Castella *et. al*. 2005; Renn 2006; Tompkins *et. al.* 2008 and others). The key steps to facilitate effective stakeholder participation in scenario development (Reed *et al.* (2013) are:

1. Define context (biophysical, socio-economic and political) and establish a basis for stakeholder engagement in scenario development.
2. Systematically identify and engage relevant stakeholders in the process.
3. Define clear objectives for scenario development including spatial and temporal boundaries.
4. Select relevant participatory methods for scenario development.

We summarise the capacities required to involve stakeholders, the kind of stakeholders and their levels of engagement in Table 7.7.

Learning must occur in both directions, with enhanced understanding of local stakeholders in regional, national and international policy and management goals, in addition to the incorporation of local knowledge into local, national and regional collaborative processes that support sustainable development and biocultural conservation. This requires collaborative dialogues between the stakeholders and decision makers (Rozi *et al*. 2010). Educational initiatives are valuable outlets for enhancing partnerships between the scientific community and local communities through universities and school centers.

Table 7.7 Capacities required to engage with stakeholders and levels of involvement to integrate knowledge for scenario analysis and modelling

Level	Involved	Capacities
Local stakeholders and organizations	Local stakeholders, national and regional organizations	Representation Leadership Inclusion of biodiversity use/value into policy decision making Adaptability to ecosystem and functional change Knowledge register Information from people' systems of life Feedback on indicators of direct drivers Lessons learnt Basics TLK integration Procedures and legal instruments for biodiversity value and conservation
Institutions	Public Regional associations Private	Transparency and credibility Measurement of indicators of indirect and direct drivers Interaction with local communities Organizational support for biodiversity and eco system services Transverse incorporation of Biodiversity knowledge in the educational system Generation of TICs in the form of Ecosystem Data Groups Exchange of information among Data Groups at regional level
Practice	Inter-scientific community Associations that work with local stakeholders	Active Participation Measurement across qualitative and quantitative indicators in relation to the direct drivers Technical integration and multilevel..? Recapitulation of lessons learned on managing and conservation Inter-scientific dialogue Establish and support networks on BES

7.5.2 Developing capacity for effective communication of the importance of biodiversity and ecosystem

Communication is crucial in dissemination of results of a scenario and modelling exercise. This requires clear communication goals for the target audiences through appropriate means of communication. For indigenous and local communities across the globe, scenarios can prove to be useful tools, as these can encompass indigenous/local perspectives of natural systems from a much broader perspective rather than just the biophysical or the economic perspectives that is commonly used in many models. Combining scenarios with modelling can also be an effective tool for decision makers for providing a long-term vision to support decisions. For example, each of the scenarios as mentioned in Figure 7.5

could be further processed using InVEST or any other such model, to project the outcomes over the long-term in the future.

A lack of communication in real time could be a main barrier for effective participation of the local communities which influences the dialogue between communities and decision-makers (Primack, 2001). The spread of knowledge is greatly important for the local actors to take suitable decisions regarding the management as part of the process of empowerment. Scientific research is more likely to be applied when there is an open dialogue between different parties (Mauser et al 2013).

7.5.3 Develop the capacity to effectively use the Platform's deliverables in implementing national obligations under biodiversity-related multilateral environmental agreements

Another important aspect for communication is that the BES scenarios and models must be freely accessible, and translated into products that are compatible with both local language and modern knowledge systems. The co-dissemination of the results may include publication of the acquired knowledge also in accessible language, and translation into comprehensible and usable information for different stakeholders. This sharing of knowledge leads to open discussion and future research actions to target sustainability, which will then jointly be framed and initiate a new trans-disciplinary research cycle (Mauser et al, 2013). A number of communication sources are available such as graphical pamphlets, television and print media, educational systems, and internet and social media. Choice of communication media will depend on the community of interest and their technical capacity. The communication materials must have key messages and presentation format that is of relevance to local communities (e.g. local language, drawings/printing, characters etc.), avoiding excessive technical information. For example, if one seeks to register data on a species from a local perspective, the graphical material must link this with the needs of the local people using agricultural calendars or cultural events. Highlighting the importance of a particular species in people's living based upon their current values and usages can also help to engage and communicate with the locals for future scenarios. An important part of information dissemination is that it should reach the different sectors including minorities, children, women, and aging populations.

7.5.4 Develop the capacity to strengthen networks and information sharing among different knowledge systems, including those of indigenous and local peoples

Long-term support for collaborative partnerships is important to ensure long-term survival of traditional methods of managing common property resources and integration of traditional knowledge into management decisions (Merino and Robson 2006). Global partnerships include organizations such as the Group on Earth Observations Biodiversity Observation Network (GEO BON) which coordinates activities relating to the Societal Benefit Area (SBA) or Biodiversity of the Global Earth Observation

System of Systems (GEOSS). Similarly, the UNEP - Sub Global Assessment network strengthens the regional and global networks among the scientists. Most of the networks exist for the practitioners – scientists, policy makers, but there are few existing networks for the local and indigenous communities. Similar networks need to be supported for indigenous and local communities at the local, regional and global scales and IPBES can provide such a platform.

7.6 Consolidation, strategy, recommendations

Based on the capacity building requirements identified for BES models and scenario analysis, the following broad recommendations are proposed that would improve the use and application of BES models and scenario analyses:

7.6.1 Closing capacity gaps for biodiversity and ecosystem services regional scenarios and models

IPBES could:

- Produce manuals and guidelines to improve common data users' understanding, possible methodologies and limitations of scenarios and models of BES which are adapted to the situation and capacities of the different UN regions.
- Develop brochures and booklets about scenarios and models of BES which are adapted to the different user groups and, as such, enable them to tailor and package their scenarios and models in ways that are more useful for decision makers.
- Establish international forums for scenarios and models of BES managed by highly qualified experts that have the needed skills to translate science concepts into those that users understand and can use, without distorting the concepts. These forums will serve as tools for people to ask questions and interact with other users of models and scenarios, to promote knowledge exchange and development of capacity within and between regions. The experts, who will manage these forums, should be equally chosen to represent the different UN regions that allow them to have in depth understanding of users’ needs and the potential opportunities for developing scenarios and models of BES in their regions.
- Use the lessons learned from previous global and regional assessments to define the other critical skills and expertise required to develop more integrated scenarios and models of BES in an effective way that will support decision makers.

7.6.2 Develop the capacity for effective participation in the IPBES assessments

IPBES could:

- Develop global, regional and national lists of open source and freely accessible software and tools (e.g., Deliverable 3d) that will support the development of successful scenarios and modelling of

BES. All tools (model, software and database) should be well documented, in an intelligible language so that the user base can understand. Metadata associated with models should be written following international standards, fully illustrated and intelligible by both specialists and non-specialists.

- Run and maintain regular in person and/or online courses at global and at regional/national scales, providing training on use and application of different models and software tools.
- Use and build upon the upcoming global, regional and sub-regional assessments to establish networks of mentoring schemes for early career scientists and researchers. This scheme will seek to facilitate the establishment of mentoring relationships between early-career scientists and researchers working in the field of ecosystem assessments/services, and established assessment practitioners, in order to promote capacity development for undertaking and using current or upcoming ecosystem assessments.
- Develop global and regional “fellows programs” for young scientists on integrated scenarios and models of BES to transfer the gained experience to the national levels.
- Build partnerships between the IPBES Task Force on Capacity Building and other global programmes and initiatives to provide a wide range of training courses, workshops, internships and collaborative projects with universities in developing and developed countries to train practitioners on tools and software for scenario development and modelling.
- Provide funds, in cooperation with other international and regional donors, to strengthen national institutions and infrastructure on biodiversity modelling and scenario usage through multidisciplinary research, activities, planning and budgeting.

7.6.3 Promote an inter-scientific dialogue between different world views and modern science systems

IPBES could:

- Encourage participation and contributions to the existing global scenarios, modelling, and database infrastructure to enhance their capacities instead of building new infrastructure, thus minimising duplication of efforts.
- Initiate development of an Android and/or iOS based free application about IPBES and the BES models and scenario analyses presented in Deliverable 3c to take advantage of new technologies to reach different stakeholder groups.
- Encourage IPBES to effectively engage local and indigenous knowledge from the first stage of planning scenarios in order to allow co-definition of the problem, to increase trust and understanding between participatory stakeholders, and to reduce uncertainty in the scenarios.
- Develop an integrated set of BES indicators that are based on scientific and traditional knowledge. These indicators could include or have links to local and regional traditional knowledge systems to enhance socio-ecological scenarios and models.

- Produce standardised training modules that are made available to government officials, decision makers and practitioners as a means of strengthening their capacity to draw appropriately on available data. The training modules could also raise awareness of the available data as it evolves.

7.6.4 Improving the capacity building relating to data management and infrastructure

IPBES could:

- Invite IPBES countries to participate in matchmaking projects, programmes and events, to enhance resource sharing for BES modelling and scenario development. Data sharing can demonstrate cost effectiveness of forecast-based-policy-making in resource management sectors such as agriculture and biotechnology, protected areas management, forestry, nature conservation, and coastal zone management.
- Develop tools to improve and adapt models of species occurrence data.
- In cooperation with existing regional and international institutional networks and respective human resources, cultivate cooperative web-based digital products on biodiversity, modelling, scenarios building, accuracy improvement, and implementation that are needed to support robust modelling outcomes.
- Initiate development of a set of BES indicators and indices where indirect statistics of existing biodiversity indicators/indices and platforms could serve as a starting guideline.

7.6.5 Incorporating traditional

To achieve an effective integration of traditional knowledge and socio-ecological feedbacks in models and scenarios for BES IPBES could:

- Work to identify universities, research institutions and NGOs with experience and/or with existing relationships that enable integration of traditional and local knowledge into development of BES scenarios or models over both short and long time scales.
- Build capacity of indigenous and local knowledge networks through the identification of leadership and educational opportunities and mechanisms to enhance communication between indigenous organisations and local governments.
- Establish agreements of cooperation between local governments and indigenous technical personnel and organisations for transfer of knowledge as well as for coordination with educational entities to promote incorporation of information on BES into educational curriculum.
- Develop policy relevant scenarios backed by rigorous scientific data and local knowledge to decision makers which involve ‘good’ integration of scientific, social, economic and local information, for telling a good storyline. Apply a balanced approach (just enough data to appropriately inform the stakeholders) to develop scenarios and sufficient scientific data that help policy makers comprehend the impacts or changes under a given scenario.

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