UNITED NATIONS

BES

IPBES/4/INF/9

Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services

Distr.: General
4 January 2016

English only

Plenary of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
Fourth session
Kuala Lumpur, 22–28 February 2016
Item 4 of the provisional agenda*

Report of the Executive Secretary on the implementation of the work programme 2014–2018

Guide on the production and integration of assessments from and across all scales (deliverable 2 (a))

Note by the secretariat

In paragraph 1 of section III of its decision IPBES-2/5, on the work programme for the period 2014–2018, the Plenary of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services requested the Multidisciplinary Expert Panel in consultation with the Bureau, supported by a time-bound and task-specific expert group, to implement deliverable 2 (a) of the work programme, on the development of a guide to the production and integration of assessments from and across all levels. According to the work programme,[1] the guide is intended to address the practical, procedural, conceptual and thematic aspects of undertaking assessments and to draw on the work of the task forces and other expert groups. In accordance with decision IPBES-2/5 an expert group was established to develop the guide in accordance with the procedures for the preparation of the Platform's deliverables adopted by the Plenary at its second meeting.[2]

In paragraph 1 of section III of its decision IPBES-3/1, the Plenary noted the development of a draft version of the guide[3] and requested that the guide be completed as provided in decision IPBES-2/5 with a view to it becoming a living document that would be regularly reviewed and updated as necessary, building on lessons learned and best practices from the implementation of the work programme of the Platform. The annex to the present note provides information on the membership of the expert group, on progress made in the development of the guide, on the review process and on next steps. The guide itself is set out in the appendix to the annex. The annex, including its appendix, is presented without formal editing.

[1] IPBES/2/17, annex, decision IPBES-2/5, annex I, para. 9 (a).

[2] IPBES/2/17, annex, decision IPBES-2/3, annex.

[3] IPBES/3/INF/4.

Annex

Report on the development of a guide on the production and integration of assessments from and across all levels

I. Membership of the Expert Group

1. Governments and other relevant stakeholders submitted 90 nominations for the expert group to prepare the draft of the Guide. The Multidisciplinary Expert Panel, at its third meeting, decided to select from this pool of nomination a small group of 9 experts, tasked, to develop the guide on assessments, together with members of the Multidisciplinary Expert Panel and the Bureau, as well as a larger group of 48 experts tasked to review the draft guide. The selection process involved members of the Multidisciplinary Expert Panel supported by members of the Bureau, together reviewing all nominations submitted, based on examination of nomination templates and curricula vitae for each nominee. Selections were made on the basis of excellence and relevance of candidates' expertise with respect to relevant areas of the work programme. Once selected on merit, further selection was focused on balancing disciplinary, regional and gender diversity, as well as sectoral aspects (i.e. government and stakeholder nominations).

2. The expert group selected included 22 percent of experts from Africa, 33 percent from Asia Pacific, 11 percent from Eastern Europe, 22 percent from Latin America and the Caribbean and 11 percent from Western European and Others Groups, with 89 percent nominations made by Governments and 11 percent by other Stakeholders, with 44 per cent males and 56 percent females. The expert group was co-chaired by Ivar Baste (Bureau) and Sebsebe Demissew (MEP). Ten other members of the Multidisciplinary Expert Panel and Bureau oversaw the work of this deliverable. The composition of the expert groups was presented to the third session of the Plenary in document IPBES/3/INF/4 and has remained unchanged.

3. The expert group had one final meeting during 2015 to revise and update the draft guide based on comments received. Relevant task forces and expert groups of IPBES contributed chapters in line with their work.

II. Progress and planned next steps in the development of the guide

4. A working draft version of the guide has been developed since the third session of the IPBES Plenary and is currently being utilised by the regional assessments and the land degradation and restoration assessment. Further developments and revision of the guide will be undertaken by the MEP in consultation with the Bureau and relevant task forces and expert groups, as knowledge and experience accumulate.

5. Following the third session of the Plenary, a draft was open for review by Governments and other stakeholders of IPBES. Comments were submitted to the IPBES Secretariat by 31 March 2015 using a standard format. Comments were received from 9 stakeholders and 5 experts from the larger expert group for the Guide. The expert group for the guide addressed the comments received from the peer review.

6. The Guide on the production and integration of assessments from and across all scales will be produced as an e-book, including an overarching diagrammatic summary, in 2016, following final agreement of content by the Multidisciplinary Expert Group. It will be made available on the IPBES website.

7. The Guide will be updated every 12 months allowing for new and relevant work from the IPBES task forces and expert groups to be incorporated. Feedback from experts involved in the IPBES assessments will be sought to ensure that the Guide remains relevant. Updating of the Guide will proceed under the guidance of the Multidisciplinary Expert Group and in consultations with the Bureau, as needed.

8. The task force on capacity building will utilise the Guide within its activities.

Appendix

IPBES Deliverable 2(a)

Guide on production and integration of assessments from and across all scales

Contents

Introduction **10**

The Intergovernmental Platform on Biodiversity ND Ecosystem Services (IPBES) **10**

What is an IPBES assessment? **11**

What are the IPBES assessment types? **11**

How to use this assessment guide **11**

Chapter 1: The IPBES Conceptual Framework and how to use it **13**
- 1.1. The IBES Conceptual Framework **13**
  - 1.1.1 The key elements of the IPBES Conceptual Framework 13
  - 1.1.2 Interlinkages between the elements of the conceptual framework 16
- 1.2 How to apply and adapt the conceptual framework **17**
- References consulted 21

Chapter 2: IPBES assessments across scales **27**
- 2.1. Scales in assessments - key terms and concepts **27**
- 2.2. Multi-scale and cross-scale considerations **30**
- 2.3. The types of assessment in IPBES and their scales **32**
  - 2.3.1. Global scale 33
  - 2.3.2. Regional and subregional scales 34
  - 2.3.3. National and subnational scales 34
- 2.4 A roadmap for IPBES assessments across scales **34**
- 2.5. Key resources **38**
- References **38**

Section II: Applying the IPBES Assessment Processes **41**

Chapter 3: The IPBES assessment process **41**
- 3.1 Introduction **41**
- 3.2 The Exploratory Stage **41**
  - 3.2.1 Scoping studies under IPBES 42
- 3.2 The Design Stage **43**
  - 3.2.1 Who's who in an IPBES assessment 44
- 3.3 The Implementation Stage **48**
  - 3.3.1 Developing an IPBES Assessment report 48
  - 3.3.2 Peer review process 50
  - 3.3.3 Preparing the final draft report 53
  - 3.3.4 Acceptance of reports by the plenary 56
- References **57**

Chapter 4: Using confidence terms **58**
- 4.1 What is confidence? **58**
  - 4.1.1 Why does our communication of confidence matter in IPBES assessments? 58
  - 4.1.2 Where to apply confidence terms 58
- 4.2 How to select confidence terms **58**
  - 4.2.1 Qualitative assessment of confidence 58
  - 4.2.2 Quantitative assessment of confidence 61
- 4.3. How to present confidence terms **62**
  - 4.3.1 Presenting confidence using the four-box model 62
  - 4.3.2 Presenting confidence using the likelihood scale 62

4.4 Traceability ... 62
4.5 Summary ... 63

Section III: Use of Methodologies in Assessments ... 66

Chapter 5: Values ... 66
5.1 Stepwise approach to "assessing diverse conceptualizations of multiple values of nature and its benefits, including biodiversity, ecosystem functions, and services": a summary and directions to the guidance document ... 66

Chapter 6: Role of scenarios and models in assessment and decision support ... 71
6.1 Overview ... 71
6.2 Assessment of status and trends ... 73
6.3 Scenario-based analysis of plausible futures ... 74
6.4 Decision support for policy and management ... 75
6.5 Specific recommendations for regional, global and thematic assessments ... 77
References ... 79

Chapter 7: Indigenous and Local Knowledge ... 82
7.1. Draft Approaches and Procedures for working with ILK ... 82
7.1.1 Introduction ... 82
7.1.2 Draft approaches for working with ILK systems ... 82
7.2 Draft procedures for working with ILK for the preparation of platform deliverables ... 85
7.3 Draft ILK specific mechanism for preparation of platform deliverables ... 88
References ... 93

Chapter 8: Data ... 99
8.1 Types and Sources ... 99
8.1.1 General guidance ... 99
8.1.2 Global sources ... 100
8.1.3 Regional and sub-regional sources ... 100
8.1.4 Source recommendations ... 101
8.2 Standards ... 103
8.2.1 Knowledge resources ... 103
8.2.2 Metadata ... 103
8.3 Data and Information Quality, Uncertainty and Representativeness ... 104
8.4 Data mobilization and archiving ... 105
8.5 Practical considerations regarding KID in IPBES assessments ... 106

Chapter 9: Knowledge, Information and Data (KID) Gaps ... 108
9.1 Background ... 108
9.2 Identifying Gaps ... 108
9.3 Prioritizing and Addressing Gaps ... 109
9.3.1 Prioritization ... 109
9.3.2 Determination of actions ... 110
9.3.3 Engagement of strategic research partners and funding bodies ... 110
9.3.4 Knowledge dialogues ... 111
9.4 Acknowledging the Variability of Knowledge Systems ... 111

Chapter 10: Biodiversity and Ecosystem Service Indicators ... 112
10.1 Introducing indicators of biodiversity and ecosystem services ... 112
10.2. The role of indicators in assessments ... 112
10.3. What makes a good indicator? ... 113
10.4. Indicator frameworks and approaches ... 114
10.4.1 Developing indicators of biodiversity ... 114
10.4.2 Developing indicators of ecosystem services. ... 114
10.4.3 Indicators of trade-offs and synergies of biodiversity and ecosystem services ... 116
10.4.4 Ecosystem Service models ... 116
10.5 Summary of current indicators ... 116
10.5.1 Indicators of biodiversity and ecosystem functioning ... 116
10.5.2 Indicators of benefits ... 117
10.5.3 Indicators of Nature's Contribution to Human Wellbeing ... 117
10.5.4 Value Indicators (also see Chapter 5 of Assessment Guide) ... 118

10.6 A Shortlist of Indicators for Regional IPBES Assessments 118
Appendix 1. Biodiversity Data and Metadata Standards, Terms and 126

Section V: Enhancing the Utility of Assessments for Decision Makers and Practitioners 129

Chapter 11: Policy support tools and methodologies [GUIDANCE TO UPDATED FOLLOWING BUDAPEST MEETING] 129
11.1 IPBES and policy support tools and methodologies 129
11.1.1 What are policy support tools and methodologies? 129
11.1.2 What role do assessments play in relation to policy support tools and methodologies? 131
11.2 Guidance on identifying and assessing policy support tools and methodologies 131
Key resources 132

Chapter 12: Communication and stakeholder engagement 133
12.1 Communication 133
12.2 Stakeholder engagement 135
References 136

Section VI Strengthening Capacities in the Science - Policy interface 137

Chapter 13 Identifying and addressing Capacity-building Needs through Assessments 137
13.1 The capacity-building function of IPBES 137
13.2 Issues, concepts and definitions of key terms 137
13.2.1 Capacity-building in IPBES 137
13.2.2 Priority capacity-building needs 138
13.2.3 Access to technical and financial resources 141
13.2.4 Integrating capacity-building into assessments 141
13.3 Roadmap with recommended practical steps to be followed for different IPBES related assessments 142
13.4 References 144
Glossary 145

Table of Boxes

Box No.	Title	Page
A	The Four Key Functions of IPBES	10
B	The IPBES Catalogue of Assessments and other key IPBES resources	12
1.1	Example of application of the CF to assessments – Marine wild fisheries	20
1.2	Example of application of the CF to assessments – Terrestrial invasive species	22
1.3	Example of application of the CF to assessments – The benefits of pollinators in food production	24
2.1	Upscaling and downscaling methods for estimating species diversity	40
2.2	GEO Amazonia: challenges for an ecosystem multi scale assessment	46
3.1	Scoping study for a National Ecosystem Assessment in Germany	53
3.2	Key Audience groups	55
3.3	Selection of report co-chairs, coordinating lead authors, lead authors and review editors	56
3.4	Some useful writing suggestions for assessment reports	60
4.1	Examples of the use of confidence terms	78
4.2	Summary of steps recommended for assessing and communicating confidence for Executive Summaries and Summaries for Policy Makers	79
5.1	Some useful search terms for literature search	84
7.1	An illustration of experience gained from the fast track pollination assessment	118
10.1	Questions used to direct the Millennium Ecosystem Assessment and the development of indicators and measures used in the global and sub-global assessments	140
10.2	Principles for choosing indicators	142
11.1	Proposed families of policy support tools and methodologies with examples	166
12.1	Target groups and report style	168
12.2	Developing a comprehensive communications plan ensures effective outreach	168
12.3	UK National Ecosystem Assessment Follow-on Phase Knowledge Exchange Strategy	170
12.4	The Spanish National Ecosystem Assessment's (EME) Communication Strategy	170

Table of Figures

Figure No.	Title	Page
1.1	The analytical Conceptual Framework of IPBES	15
2.1	Part of the IPBES conceptual framework with the components extended to the three scales of IPBES assessments to depict cross-scale interlinkages between components	38
2.2	Nested ecological and institutional scales that determine human-ecosystem interactions and thereby flows of benefits from nature to societies	39
2.2A	Ecological, hydrographic and political/administrative criteria used to reach an agreement amongst parties on the definition of the greater and the lesser Amazonia	47
2.3	Relationships between spatial and temporal scales, institutional scales and scales of different types of IPBES assessments	42
3.1	The IPBES assessment process	52
3.2	IPBES assessment scoping process	54
3.3	Three principles of Platform report review processes	64
4.1	The four-box model for the qualitative communication of confidence. Confidence increases towards the top-right corner as suggested by the increasing strength of shading.	75
4.2	Likelihood scale for the quantitative communication of the probability of an outcome occurring.	77
6.1	Interaction between modelling, assessment and decision support	89
6.2	General characteristics of scenarios and their relationships to IPBES assessments	90
6.3	Example application of modelling to status-and-trend assessment	92
6.4	Example of scenario-based risk analysis employing species distribution modelling	94
6.5	Example of decision support employing scenarios that are designed achieve future global targets on climate change, biodiversity and human development	96
8.1	Conceptual connection among knowledge resources	124
8.2	Example data and information addressing the different IPBES foci and potential sources at global and regional level	127
8.3	Steps in the IPBES process as triggered by an inquiry	133
8.4	Knowledge, information, and data (KID) resource considerations at each stage in the IPBES assessment process	134
11.1	Schematic representation of the context of policy support tools and methodologies	165

Table of Tables

Table No.	Title	Page
2.1	Scope of IPBES assessments of biodiversity and ecosystem services and their characteristic (‘core’) spatial scale, temporal process and social/institutional scales	33
2.2A	Amazonia area for ATCO countries based on ecological, hydrographic and political-administrative criteria	47
3.1	Summary of the different roles within an IPBES Assessment process	57
3.2	Steps in preparation of Platform assessment report(s) following acceptance of the Scoping document by Plenary	61
3.3	Example of a review template	64
3.4	Example of the key findings and key messages of the UK NEA	68
4.1	Sources of low confidence	80
7.1	Draft Approaches for working with indigenous and local knowledge in assessments	105
7.2	Draft Procedures for working with indigenous and local knowledge in assessments	109
8.1	Examples of key global information sources and layers for IPBES Regional Assessments	128
8.2	Hypothetical examples of metadata that may arise in the assessment process and associated Dublin Core Terms	131
9.1	Determinants of Completeness of Biodiversity Data	136
9.2	Various sources of requests for new knowledge generation by approximate order of priority	137
9.3	Example Data and Information Gaps and Access Barriers and potential actions.	138
10.1	Categories of biodiversity indicators and some examples of indicators from each category for use in assessments	144
10.2	Examples of ecosystem service indicators capturing the series of ecosystem and social system components necessary to reflect the links between ecosystems and society	146
10.3	A Shortlist of Indicators for Regional IPBES Assessments	152
13.1	Capacity-building needs identified by members and other stakeholders, and potential sources of support for addressing their needs	176

List of Acronyms

ARIES	Artificial Intelligence for Ecosystem Services
ASA	Analytic Species Accumulation
ASEAN	Association of South East Asian Nations
ATCO	Amazonian Treaty for Cooperation
AU	African Union
BD	Biodiversity
BES	Biodiversity and Ecosystem Services
BII	Biodiversity Intactness Index
BIP	Biodiversity Indicators Partnership
BPI	Brazilian Pollinator Initiative
CARICOM	Caribbean Community
CAs	Contributing Authors
CBD	Convention on Biological Diversity
CCD	Colony Collapse Disorder
CF	Conceptual Framework
CHANS	Coupled human and natural systems
CIS	Commonwealth of Independent States
CLAs	Coordinating Lead Authors
DIK	Data, Information and Knowledge
DPSIR	Drivers-Pressures-State-Impact-Response
EBSAs	Ecologically or Biologically Significant marine Areas
EEA	European Economic Area
EEMBizkaia	Millennium Ecosystem Assessment in Biscay
EME	Spanish Ecosystem Assessment’s
ES	Ecosystem Services
ESA	European Space Agency
EU	European Union
FAM	First Author’s Meeting
FAO	Food and Agriculture Organization of the UN
FOD	First order draft
FPIC	Free and prior informed consent
FSC	Forest Stewardship Council
GBIF	Global Biodiversity Information Facility
GBO	Global Biodiversity Outlook
GEO BON	Group on Earth Observations Biodiversity Observation Network
GLORIA	Global Observation Research Initiative in Alpine Environments
HANPP	Human Appropriated Net Primary Productivity
HWB	Human Well Being
ICCA	Indigenous and Community Conserved Area
IEA	Integrated Environmental Assessment
IISD	International Institute for Sustainable Development
ILK	Indigenous and Local Knowledge
InVEST	Integrated Valuation of Ecosystem Services and Tradeoffs
IOC	Intergovernmental Oceanographic Commission
ILTER	International Long Term Ecological Research
IPBES	Intergovernmental Platform on Biodiversity and Ecosystem Services
IPCC	Intergovernmental Panel on Climate Change
IPCC-SRES	Intergovernmental Panel on Climate Change Special Report on Emissions Scenarios
IPLC	Indigenous Peoples and Local Communities
ISO	International Organization for Standardization
IUCN	International Union for Conservation of Nature
IUCN ISSG	IUCN Invasive Species Specialist Group
JRC	Joint Research Center
KID	Knowledge, Information and Data
LAs	Lead Authors
LINKS	Local Indigenous Knowledge Systems
LPI	Living Planet Index

LPJmL	Land Dynamic Global Vegetation and Water Balance Model
MA	Millennium Ecosystem Assessment
MEA	Multilateral Environment Agreement
MEB	Multiple evidence base
MEP	Multidisciplinary Expert Panel
MERCOSUR	Southern Common Market
MIMES	Multiscale Integrated Models of Ecosystem Services
MOL	Ministry of Labour
MRV	Monitoring , Reporting and Verification
MSA	Mean Species Abundance
MSC	Marine Stewardship Council
MTI	Marine Trophic Integrity
NAFTA	North American Free Trade Agreement
NASA	Nation Aeronautics and Space Administration
NCI	Natural Capital Index
NEA-DE	National Assessment of Ecosystems and their Services for the Economy and Society in Germany
NGO	Non-Governmental Organisation
NIE	National Institute of Ecology
NPP	Net Primary Production
OAS	Organization of American States
OBIS	Ocean Biogeographic Information System
PBL Netherlands	Planbureau voor de Leefomgeving Netherlands
RCPs	Representative Concentration Pathways
REF	Research Excellence Framework
REPOL	Rede Baiana de Polinizadores
REs	Review Editors
RLI	Red List Index
SAARC	South Asian Association for Regional Cooperation
SAfMA	Southern African Millennium Ecosystem Assessment
SAM	Second Author’s Meeting
SAR	Species-Area Relationship
SDGs	Sustainable Development Goals
South Korean NIE	The South Korean National Institute of Environment
SSPs	Shared Socio-economic Pathways
TEEB	The Economics of Ecosystems and Biodiversity
TF DIK	The Task Force on Data, Information and Knowledge
TNC	The Nature Conservancy
TSU	Technical Support Unit
UBC	University of British Columbia
UCSB	University of California, Santa Barbara
UFZ	Helmholtz Centre for Environmental Research
UK NEA	UK National Ecosystem Assessment
UK NEAFO	UK National Ecosystem Assessment Follow-On Phase
UN	United Nations
UNCCD	United Nations Convention to Combat Desertification
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNEP-WCMC	United Nations Environment Programme World Conservation Monitoring Centre
UNESCO	United Nations Education, Scientific and Cultural Organization
UNICEF	United Nations Children’s Fund
UNSD	United Nations Statistics Division
WCS	Wildlife Conservation Society
WRI	World Resources Institute
WWF	World Wide Fund for Nature

Introduction

The Intergovernmental Platform on Biodiversity ND Ecosystem Services (IPBES)

Societies are faced with threats to long-term human well-being from the loss of biodiversity and degradation of ecosystem services. Invigorated responses to the challenge among public and private sector at local, national and international levels include multiple efforts for conservation and sustainable use of biodiversity. Examples at international level include the Strategic Plan for Biodiversity 2011-2020 and its Aichi Targets prepared under the auspices of the Convention on biological Diversity, the 10-year strategic plan and framework (2008-2018) of the United Nations Convention to Combat Desertification (UNCCD), and the development by the UN General Assembly of the post-2015 Development Agenda and a set of sustainable development goals (SDGs). However, a steadily strengthened environmental governance system has to date not been sufficient to stem the increasing human pressures on the biosphere.

The situation calls for an improved understanding of the kind of ecosystem degradation that is undermining long-term human wellbeing. Decision makers need scientifically credible, legitimate and relevant information on the often complex interactions between biodiversity and society that defines nature's benefits to people. They also need effective methods to interpret this scientific information in order to make informed decisions. The scientific community on the other hand needs to understand the needs of decision makers better in order to provide them with the relevant information. These needs can be met by strengthening the science policy interface and enhancing the dialogue between the scientific community, governments, and other stakeholders on biodiversity and ecosystem services.

Science-policy interfaces are critical forces in shaping the environmental governance system. The system can be seen as a polycentric one consisting of nested public, private and non-governmental decision-making units operating at multiple scales within rule and value systems that differ from one another to some extent. Interactions between science and policy are challenged by the complexity of the environmental governance system and of the problems it seeks to address. The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) is a structured formal response to this challenge.

IPBES was established in April 2012 as an independent intergovernmental body whose objective is "to strengthen the science-policy interface for biodiversity and ecosystem services for the conservation and sustainable use of biodiversity, long-term human well-being and sustainable development". In order to achieve this objective, IPBES performs four key functions (Box A).

Box A: The Four Key Functions of IPBES

1. Facilitate access to the scientific information needs of policymakers, promoting and facilitating the generation of new knowledge where this is necessary;
2. Deliver global, regional, sub-regional and thematic assessments as requested, and at the same time promote and facilitate assessments at the national level;
3. Promote the development and use of policy support tools and methodologies so that the results of assessments can be more effectively applied; and
4. Identify and prioritize capacity building needs for improving the science-policy interface at appropriate levels, and provide, call for and facilitate access to the necessary resources for addressing the highest priority needs directly relating to its activities.

Source: UNEP/IPBES.MI/2/9

This Guide[4] aims to help address conceptual, procedural and practical aspects of IPBES assessments at all scales, and to promote consistency across different scales. The Guide serves as a 'Roadmap' and focuses on key elements assessment practitioners may want to take into account when undertaking an assessment within the context of IPBES.

The Guide has been developed for experts who are taking part in assessments approved under IPBES be they thematic, methodological or general assessments of biodiversity and ecosystems at global, regional and sub-regional level. The Guide is also meant to assist those who might want to undertake IPBES inspired assessment at sub-regional, national and local level and to help facilitate that such assessments are compatible with larger scale IPBES approved assessments.

[4] The first IPBES programme of work 2014-2018 was agreed in December 2013 setting out a number of deliverables, including the development of guidance materials and the scoping and completion of thematic and regional assessments. This Guide is deliverable 2(a) of the first work programme of IPBES.

What is an IPBES assessment?

An IPBES assessment is a critical evaluation of the state of knowledge in biodiversity and ecosystem services. It is based on existing peer-reviewed literature, grey literature and other knowledge systems such as indigenous and local knowledge. It does not involve the undertaking of original research. The assessment may involve a literature review, but is not limited to such a review. The process of evaluating the state of knowledge involves the analysis, synthesis and critical judgement of information by experts and the presentation of such findings to governments and relevant stakeholders on their request.

IPBES assessments need to be credible, legitimate and relevant. They typically:

- Involve governments and other stakeholders in the initiation, scoping, review and adoption of the assessment reports (this involvement promotes credibility, legitimacy and relevance at policy level);
- Operate through an open and transparent process, run by a group of experts that has a balance of disciplines, geography and gender. They use agreed conceptual frameworks, methodologies, and support tools and are subject to independent peer review (this process promotes credibility, legitimacy and relevance at scientific level); and
- Present findings and knowledge gaps that are policy relevant but not policy prescriptive, where the level of confidence and the range of available views are presented in an unbiased way (this approach promotes relevance at both scientific and policy level).

IPBES assessments focus on what is known, but also what is currently uncertain. Assessments play an important role in guiding policy through identifying areas of broad scientific agreement as well as areas of scientific uncertainty that may need further knowledge generation such as through scientific research.

What are the IPBES assessment types?

IPBES will undertake a number of different types of assessments at sub-regional, regional and global levels. It will also encourage and help catalyse other assessments at lower scales such as those with a local, national and a more limited sub-regional scope. IPBES is currently engaged in or has planned to undertake:

- **Global assessments** to assess biodiversity and ecosystem services and their interlinkages at the global scales. The global assessments will draw upon the work undertaken by the regional assessments.
- **Regional assessments** to assess biodiversity and ecosystem services and their interlinkages at the regional and, as necessary, sub regional levels. Regional assessments will provide the building blocks for the global assessments.
- **Thematic assessments** that is, assessments that address a particular theme at an appropriate scale or a new topic.
- **Methodological assessments** to conduct a rapid methodological evaluation of a topic (e.g. valuation) and how the methods can be taken into account in the Platform’s activities.

How to use this assessment guide

The assessment guide is divided into six sections (each containing a number of chapters) covering conceptual issues, assessment processes, methodologies, knowledge resources, utilising assessments and capacity building.

Each chapter of the Guide first sets out the issues and concepts and defines key terms. Second, the chapters provide a roadmap with recommended practical steps to be followed for different IPBES related assessments, indicating amongst others where there is flexibility in application. Finally, the chapters lists key resources, including by pointing to other guidelines, plans, strategies and approaches that could be of use to practitioners (Box B).

It is anticipated that as the work of the Platform progresses, chapters could be updated or new ones added, in particular within the methodological section. This guide is a living document and will be updated periodically. Users should always ensure that they have the latest version of the guide, which is downloadable from the IPBES website.

Box B: The IPBES Catalogue of Assessments and other key IPBES resources

Development of a "Catalogue of Assessments on Biodiversity and Ecosystem services" was called for in 2012 at the meeting that established IPBES. Deliverable 4b of the Work Programme 2014-2018 requests the continued maintenance and enhancement of this online Catalogue, which can be found at http://catalog.ipbes.net/. The Catalogue brings together information on and experiences from undertaking assessments of biodiversity and ecosystem services from the global to the sub-national scale. It offers direct access to assessment reports, and supporting technical documents as a resource for assessment practitioners and policy makers. Containing over 200 assessments, the Catalogue provides a platform from which lessons can be learnt from existing and ongoing assessment processes so as to inform the future development of IPBES. The inclusion of IPBES assessments in the Catalogue is encouraged in order to keep the Catalogue up-to-date and to guide future IPBES assessments. The Catalogue is managed by UNEP World Conservation Monitoring Centre (UNEP-WCMC) on behalf of the IPBES Secretariat and maintained with the direct involvement of assessment practitioners within existing networks and initiatives, including the Sub-Global Assessment Network (www.ecosystemassessments.net).

Other key IPBES resources include:

- Procedures, approaches and participatory processes for working with indigenous and local knowledge systems (Deliverable 1c)
- A guide for scenario analysis and modelling of biodiversity and ecosystem services (Deliverable 3c)
- A guide for the diverse conceptualisation of values of biodiversity and nature's benefits to people including ecosystem services (Deliverable 3d)
- Information and data management plan (Deliverable 4b)
- Catalogue of policy support tools and methodologies (Deliverable 4c)

Section I: Addressing Conceptual issues

This section considers how to use the IPBES Conceptual Framework and how to deal with the question of scale in assessments. There are several other considerations that should be taken into account in the scoping processes and these are also dealt with here.

Chapter 1: The IPBES Conceptual Framework and how to use it

Coordinating Author: Sandra Díaz

Authors: Sebsebe Demissew, Julia Carabias, Sandra Lavorel, Berta Martín-López, Rosemary Hill

1.1. The IBES Conceptual Framework

All assessments carried out by IPBES are expected to be based on the IPBES Conceptual Framework (hereafter CF[5]). This is important to give structure to the assessments' analytical and synthetic work, to interpret the information that forms their basis, and to facilitate consistency and comparability across various assessments (different spatial scales, different themes, and different regions). The CF is a highly simplified model of the complex interactions within and between the natural world and human societies. The model identifies the main elements, together with their interactions, that are most relevant to the Platform's goal and should therefore be the focus for assessments and knowledge generation to inform policy and the required capacity building.

IPBES embraces different disciplines (e.g. natural, social, and engineering sciences), stakeholders (e.g. the scientific community, governments, international institutions, civil society organisations at different levels, the private sector), and knowledge systems (western science, indigenous knowledge, local and practitioners' knowledge). Accordingly, the CF explicitly incorporates all these aspects. Rather than a comprehensive model of how the world works, the CF should be seen as a tool for achieving a shared working understanding across the different disciplines, knowledge systems and stakeholders that are expected to be active participants in the Platform. While a single CF has been retained for the practical purposes of IPBES assessments (as explained in the text), it is recognized that representations of human-nature relationships (i.e. conceptual frameworks) may vary from culture to culture in relation to specific worldviews/cosmologies, including between scientific and indigenous knowledge systems, as well as among indigenous cultures.

1.1.1 The key elements of the IPBES Conceptual Framework

The CF includes six interlinked elements constituting a social-ecological system that operates at various scales in time and space (Figure 1.1): nature; nature's benefits to people; anthropogenic assets; institutions and governance systems and other indirect drivers of change; direct drivers of change; and good quality of life. These elements are general and comprehensive enough to resonate with the categories of different knowledge systems, and of different disciplines within western science. In Figure 1.1, categories in black and bold font are inclusive, whereas categories in green and blue illustrate the concepts used by Western science and other knowledge systems respectively. Within these broad and cross-cultural categories, different assessments are invited to identify more specific subcategories, associated with knowledge systems and disciplines relevant to the task at hand, without losing view of their placement within the general picture. For example, there is a large gap between the ways in which ecosystem goods and services ("green" category) and gifts of nature ("blue" category) in Figure 1.1 are conceptualized, valued and used according to different world views, but both categories are concerned with the things that societies obtain from the natural world, which are collectively represented by the inclusive category nature's benefits to people ("bold and black" category). For consistency across assessments, and to follow the spirit of the CF, authors of assessments are encouraged to use the inclusive "bold and black" categories as the starting point of their task, and then refer back to them in the conclusions, although more specific categories, strongly dependent on discipline, knowledge system and purpose are likely to be used in their analytical work during the assessment.

[5] For full description of the IPBES Conceptual Framework see Díaz S., Demissew, S., Carabias, J., et al. 2015. The IPBES Conceptual Framework - Connecting nature and people. Current Opinion in Environmental Sustainability. In Press.

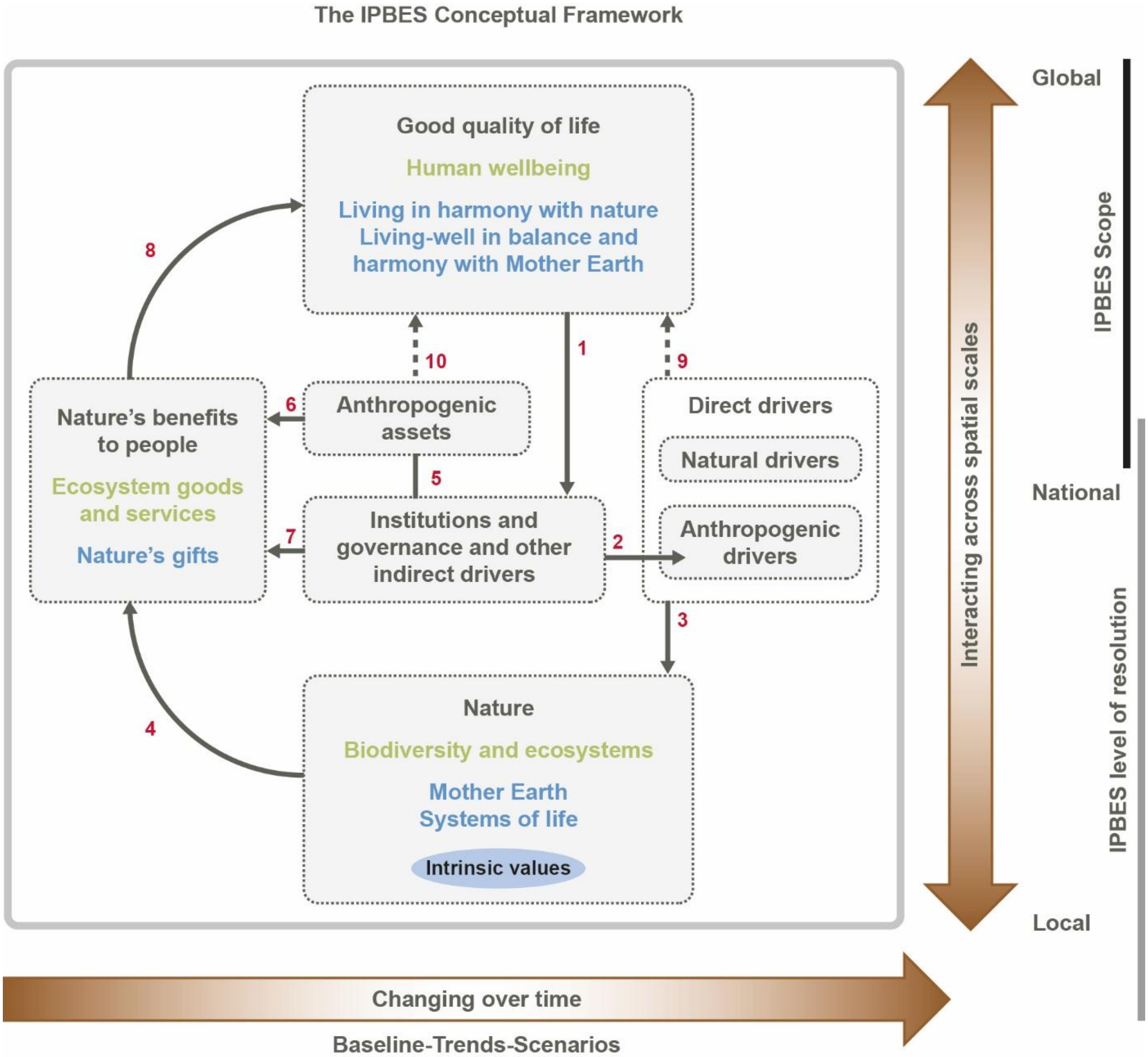


Figure 1.1: The analytical Conceptual framework of IPBES (CF). In the main panel, delimited in grey, boxes and arrows denote the elements of nature and society that are the main focus of the Platform. In each of the boxes, the headlines in black are inclusive categories that should be intelligible and relevant to all stakeholders involved in IPBES and embrace the categories of western science (in green) and equivalent or similar categories according to other knowledge systems (in blue). The blue and green categories mentioned here are illustrative, not exhaustive, and are further explained in the main text. Solid arrows in the main panel denote influence between elements; the dotted arrows denote links that are acknowledged as important, but are not the main focus of the Platform. Links indicated by a numbered arrow are described in the main text and illustrated in the boxed examples. The thick coloured arrows below and to the right of the central panel indicate that the interactions between the elements change over time (horizontal bottom arrow) and occur at various scales in space (vertical arrow). The vertical lines to the right of the time arrow indicate that, although IPBES assessments will be at the supranational (subregional to global) geographical scales (scope), they will in part build on properties and relationships acting at finer (national and subnational) scales (resolution). This figure (extracted from Díaz et al. 2014 and Diaz et al. 2015) is a simplified version of that adopted by the Second Plenary of IPBES (IPBES-2/4), it retains all its essential elements but some of the detailed wording explaining each of the elements has been eliminated within the boxes to improve readability.

"*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. Other components of nature (non-living natural resources), such as deep aquifers, mineral and fossil reserves, wind, solar, geothermal and wave power, are not the focus of the Platform. *Nature* contributes to societies through the provision of benefits to people (instrumental and relational values, see below) and has its own intrinsic values, that is, the value inherent to *nature*, independent of human experience and evaluation and thus beyond the scope of anthropocentric valuation approaches (represented by an oval at the bottom of the *nature* box in Figure 1.1).

"*Anthropogenic assets*" refers to built-up infrastructure, health facilities, knowledge -including indigenous and local knowledge (ILK) systems and technical or scientific knowledge-, as well as formal and non-formal education), technology (both physical objects and procedures), and financial assets, among others. *Anthropogenic assets* have been highlighted to emphasize that *a good life* is achieved by a coproduction of benefits between nature and societies (see *Nature's benefits to people* for further explanation).

"*Nature's benefits to people*" refers to all the benefits that humanity obtains from *nature*. Ecosystem goods and services are included in this category. Within other knowledge systems, nature's gifts and similar concepts refer to the benefits of *nature* from which people derive *a good quality of life*. The notion of *nature's benefits to people* includes detrimental as well as beneficial effects of *nature* on the achievement of a *good quality of life* by different people and in different contexts. Trade-offs between the beneficial and detrimental effects of organisms and ecosystems are not unusual and they need to be understood within the context of the bundles of multiple effects provided by a given ecosystem within specific contexts. For example, wetland ecosystems provide water purification and flood regulation but they can also be a source of vector-borne disease. In addition, the relative contribution of *nature* and *anthropogenic assets* to a *good quality of life* varies according to the context. For example, the level at which water filtration by the vegetation and soils of watersheds contributes to quality of life in the form of improved health or reduced treatment costs is based in part on the availability of water filtration by other means, for example, buying bottled water from another location, or treating water in a built facility.

Nature provides a number of *benefits to people* directly without the intervention of society, for example the production of oxygen and the regulation of the Earth's temperature by photosynthetic organisms; the regulation of the quantity and quality of water resources by vegetation; coastal protection by coral reefs and mangroves; and the direct provision of food or medicines by wild animals, plants and microorganisms. Many benefits, however, depend on or can be enhanced by the joint contribution of *nature* and *anthropogenic assets*. For example, some agricultural goods such as food or fibre crops depend on ecosystem processes such as soil formation, nutrient cycling, or primary production as well as on social intervention such as farm labour, knowledge of genetic variety selection/modern breeding and farming techniques, machinery, storage facilities and transportation.

The importance of **nature's benefits to people** can be expressed through a diverse set of valuation approaches and methods (briefly presented in Chapter 2 and discussed in further detail in Chapter 5).

Drivers of change refers to all those external factors (i.e. generated outside the CF element in question) that affect *nature*, *anthropogenic assets*, *nature's benefits to people* and a *good quality of life*. *Drivers of change* include *institutions and governance systems and other indirect drivers*, and *direct drivers* -both natural and anthropogenic (see below)**.**

"Institutions and governance systems and other indirect drivers" are the ways in which societies organize themselves (and their interaction with nature), and the resulting influences on other components. They are underlying causes of change that do not get in direct contact with the portion of nature in question; rather, they impact it – positively or negatively- through *direct anthropogenic drivers*. 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*. Examples of institutions are systems of property and access rights to land (e.g. public, common pool, or private), legislative arrangements, customary laws, treaties, informal social norms and rules, and international regimes such as agreements for the protection of endangered species of wild fauna and flora, or against the stratospheric ozone depletion. Economic policies, including macroeconomic, fiscal, monetary or agricultural policies, play a significant role in influencing people's decisions and behaviour and the way in which they relate to nature in the pursuit of benefits. Many drivers of human behaviour and preferences, however, which reflect different perspectives on a *good quality of life*, work largely outside the market system.

"Direct drivers", both natural and anthropogenic, affect *nature* directly. ***"Natural direct drivers"*** are those that are not the result of human activities and whose occurrence is beyond human control (e.g. natural climate and weather patterns, extreme events such as prolonged drought or cold periods, cyclones and floods, earthquakes, volcanic eruptions). ***"Anthropogenic direct drivers"*** are those that are the result of human decisions and actions, namely, of *institutions and governance systems and other indirect drivers*. (e.g. land degradation and restoration, freshwater pollution, ocean acidification, climate change produced by anthropogenic carbon emissions, species introductions). Some of these drivers, such as pollution, can have negative impacts on *nature*; others, as in the case of habitat restoration, can have positive effects.

"Good quality of life" is the achievement of a fulfilled human life, a notion which varies strongly across different societies and groups within societies. It is a context-dependent state of individuals and human groups, comprising 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. From virtually all standpoints, a *good quality of life* is multidimensional, having material as well as immaterial and spiritual components. What a *good quality of life* entails, however, is highly dependent on place, time and culture, with different societies espousing different views of their relationships with nature and placing different levels of importance on collective versus individual rights, the material versus the spiritual domain, intrinsic versus instrumental values, and the present time versus the past or the future. The concept of human well-being used in many western societies and its variants, together with those of living in harmony with nature and living well in balance and harmony with Mother Earth, are examples of different perspectives on a *good quality of life*.

1.1.2 Interlinkages between the elements of the conceptual framework

A society's achievement of *good quality of life* and the vision of what this entails directly influence institutions and governance systems and other indirect drivers (arrow 1 in Figure 1.1) and, through them, they influence all other elements. For example, to the extent that a good life refers to an individual's immediate material satisfaction and individual rights, or to the collective needs and rights of present and future generations, it affects institutions that operate from the subnational scale, such as land and water use rights, pollution control, and traditional arrangements for hunting and extraction, to the global scale, as in subscription to international treaties. The views of what constitutes a *good quality of life* also indirectly shape, via institutions, the ways in which individuals and groups relate to nature. Perceptions of *nature* range from *nature* being considered as a separate entity to be exploited for the benefit of human societies to *nature* being seen as a sacred living entity of which humans are only one part.

Institutions and governance systems and other indirect drivers affect all elements and are the root causes of the *direct anthropogenic drivers* that directly affect *nature* (arrow 2 in Figure 1.1). For example, economic and demographic growth and lifestyle choices (*indirect drivers*) influence the amount of land that is converted and allocated to food crops, plantations or energy crops; accelerated carbon-based industrial growth over the past two centuries has led to anthropogenic climate change at the global scale; synthetic fertilizer subsidy policies have greatly contributed to the detrimental nutrient loading of freshwater and coastal ecosystems. All of these have strong effects on biodiversity, ecosystem functioning and their derived benefits and, in turn, influence different social arrangements intended to deal with these problems. This may be seen, for example, at the global level, with institutions such as the United Nations Framework Convention on Climate Change, the Convention on Biological Diversity, the Convention on the Conservation of Migratory Species of Wild Animals or, at the national and subnational levels, arrangements in ministries or laws that have effectively contributed to the protection, restoration and sustainable management of biodiversity.

Institutions and governance systems and other indirect drivers also affect the interactions and balance between *nature* and *human assets* (arrows 5, 6, 7) in the co-production of *nature's benefits to people*, for example by regulating urban sprawl over agricultural or recreational areas. This element also modulates the link between *nature's benefits to people* and the achievement of *a good quality of life* (arrow 8), for example, by different regimes of property and access to land and goods and services; transport and circulation policies; and economic incentives as taxations or subsidies. For each of *nature's benefits* that contribute to a *good quality of life*, the contribution of institutions can be understood in terms of instrumental value, such as access to land that enables the achievement of particular dimensions of human wellbeing such as food, water or energy, or in terms of relational values, spiritual beliefs and regimes of property that both represent and allow human lives deemed to be in harmony with nature. The links between *nature* and *anthropogenic assets* are not by definition negative and they do not necessary trade off in every case. Different bio-cultural systems are living examples of how different knowledge systems and physical practices create and maintain biodiversity (e.g. the many cultivated varieties of rice, potatoes, maize and other crops obtained from wild relatives and maintained by ancestral and contemporary agricultural societies; the highly diverse meadows and pasturelands maintained by traditional pastoral use). Many cultures around the world also have spiritual and religious practices in which certain places, water bodies, forests, animals, trees are considered sacred, serve as totems, are protected by rituals and taboos, and/or are revered as gifts imbued with ancestral and divine presence and significance. *Nature* and *good quality of life* influence each other. Different societies experience different elements of the natural world (different animals, different vegetation types, different seasonal and decadal cycles); and they do so with different immediacy (from everyday intimate contact to sporadic contact through the mass communication media). These are important factors shaping their perspectives on a *good quality of life*.

Direct drivers cause a change directly in *nature* (arrow 3) and, as a consequence, in the supply of *nature's benefits to people* (arrow 4). *Natural drivers* of change affect *nature* directly, for example, the impact by a massive meteorite is believed to have triggered one of the mass extinctions of plants and animals in the history of life on Earth. Furthermore, a volcanic eruption can cause ecosystem destruction, at the same time serving as a source of new rock materials for fertile soils. These drivers also affect *anthropogenic assets* directly (arrow not shown), such as the destruction of housing and supply systems by earthquakes or hurricanes; they can also have direct impacts on *quality of life* (arrow 9), as may be seen with heat stroke as a result of climate warming or poisoning as a result of pollution.

In addition, *anthropogenic assets* directly affect the possibility of leading a *good quality of life* through the provision of and access to material wealth, shelter, health, education, satisfactory human relationships, freedom of choice and action, and sense of cultural identity and security (arrow 10). These linkages are acknowledged in Figure 1.1 but not addressed in depth because they are not the main focus of the Platform.

1.2 How to apply and adapt the conceptual framework

In order to follow the general goal and spirit of IPBES, each assessment should follow the steps set out below. Three case studies demonstrating the application of the CF can be found in Boxes 1.1-1.3.

Step 1. Use the CF as theoretical and methodological scaffolding

Consider all the different elements (boxes) of the CF and the interlinkages between them (arrows). The inclusive categories (black and bold font in Figure 1.1) should be used at least at the starting point and in the synthesis stage, to ensure general consistency across IPBES products. An effective way of doing this is through a "mapping out" exercise, in which specific content is assigned to the different boxes and arrows of Figure 1.1 within the context of the assessment. For example, in the case of the thematic assessment of the impacts of pollination and pollinators on food production, pollinator networks could embody the *nature* box, pollination services in the production of food would be the focal aspect within the *nature's benefits to people* box, although other benefits could also be considered, such as the cultural values derived from the pollinated plants or from the pollinators themselves.

Step 2. Consider the broadest possible set of values of nature and its benefits to people.

The CF encourages broad consideration of the full suite of values in all IPBES assessments. A major distinction adopted in the CF is between intrinsic values and anthropocentric values, including instrumental and relational values. Intrinsic values are those inherent to *nature*, independent of human judgement, such as non-human species' inherent rights to exist. Intrinsic values of *nature* as defined here thus fall outside the scope of anthropocentric values and valuation methods. Within anthropocentric values, instrumental values are closely associated with the notion of *nature's benefits* as far as they allow people to achieve a *good quality of life*, be it through spiritual enlightenment, aesthetic pleasure or the production or consumption of a commodity. They are generally linked to economic values (including, but not restricted to monetary valuation) as they reflect the extent to which they confer satisfaction to humans either directly or indirectly. Relational values therefore they depart from an economic valuation framework; they are imbedded in desirable (sought after) relationships, including those between people and *nature* (as in 'living in harmony with nature'), regardless of whether those relationships imply trade-offs to obtain nature's benefits. Relational values are also related to the notion of held values because specific principles or moral duties can determine how individuals relate with nature and with other individuals. Therefore, all *nature's benefits to people* have instrumental values and relational values, and often a given aspect of *nature* (a species, an ecosystem, a network of ecological interactions) can provide more than one *benefit to people*, with different instrumental and relational values (see Box 1.1). These two broad categories of values can be expressed in diverse ways within the CF as they can be experienced in a non-consumptive way (both relational and instrumental values) or through consumption (specific instrumental values), and they can range from spiritual inspiration (both relational and instrumental values) to market-based values (specific instrumental values). They also include existence value (the satisfaction obtained from knowing that nature continues to be there) and future-oriented values. These future-oriented values include bequest value (the preservation of nature for future generations) or the option values of biodiversity as a reservoir of yet-to-be discovered uses from known and still unknown species and biological processes, or as a constant source, through evolutionary processes, of novel biological solutions to the challenges of a changing environment (see Chapter 5).

Step 3. Contemplate different disciplines, knowledge systems and stakeholders right from the start

Different disciplines, knowledge systems and stakeholders should be considered throughout an assessment: in the definition of the major questions to be addressed, the collection of evidence, and the synthesis of findings and options for policy and practice. It is essential to engage indigenous and local peoples, as well as sciences from different disciplines, from the earliest stages of an assessment. This gives the opportunity for their perspectives to influence the framing of the assessment as well as contributing information. Most importantly, a dialogue between knowledge holders is the basis for fruitful engagement.

The first step is to identify relevant ILK networks (see e.g. Box 1.1). ILK may be held '*ex-situ*', for example in books, videos and collections; and '*in-situ*' in the living cultural systems based on oral traditions and performances. Dialogue workshops between scientists help to identify ILK relevant to various boxes and arrows in the CF in a 'mapping out' exercise. Holding dialogue workshops between scientists and ILK holders can enable the diverse perspectives to influence the framing, such as through assigning content, and identifying examples of high quality *in-situ* ILK, as mentioned above. After initial dialogue, relevant information can be gathered through engaging concurrently with collection and draft syntheses of *ex-situ* and high-quality examples of *in-situ* knowledge. Finally, catalysing the synergies between the ILK and western science contributions requires further dialogue focused on synthesis. For a discussion of approaches to these dialogues, and to issues of validity and recognition of the evidence coming from different streams of knowledge, see Chapter 7.

Box 1.1: Example of application of the CF to assessments – Marine wild fisheries

There are more than 28,000 fish species recorded in 43 ecoregions in the world's marine ecosystems and probably still many more to be discovered (*nature*). With a worldwide network of infrastructure such as ports and processing industries, and several million vessels (*anthropogenic assets*), about 78 million tons of fish are caught every year (arrow 6). Fish are predicted to become one of the most important items in the food supply of over 7 billion people (*nature's benefits*). This is an important contribution to the animal protein required to achieve food security and livelihood security (*good quality of life*), especially within the subsistence sector of developing countries.

Campaigns and promotion of the benefits of fish protein have induced changes in consumption patterns (arrow 8) and have brought about an increased demand for fish in the global markets with an improvement in the diet (*good quality of life*). This, together with the dominance of private short-term interests over collective long-term interests, weak regulation and enforcement of fishing operations, and perverse subsidies for diesel, are *indirect drivers* underlying (arrow 2) the overexploitation of fisheries by fishing practices (*anthropogenic direct drivers*) that, because of their technology or spatial scope or time scale of deployment, are destructive to fish populations and their associated ecosystems. In many case, lack of recognition of the *formal and informal institutions* of indigenous and local peoples and their customary marine tenure systems is a further *indirect driver*, that allows their sustainable knowledge and use systems to be over-ridden by the practices of actors that carry out larger-scale commercial operations to supply fish into the global economy. The impacts of these practices are combined with those of chemical pollution associated with agriculture and aquiculture runoff, the introduction of invasive species, diversions and obstructions of freshwater flows into rivers and estuaries, the mechanical destruction of habitats, such as coral reefs and mangroves, and climate and atmosphere change, including ocean warming and acidification. All *anthropogenic direct drivers* affect marine biodiversity directly (arrow 3).

The steep decline in fish populations can dramatically affect nature, in the form of wildlife, ecological food webs, including those of marine mammals and seabirds, and ecosystems from the deep sea to the coast (*nature*). Increasingly, depleted fisheries have also had a negative effect on *nature's benefits to people* and the *good quality of life* that many societies derive from them, in the form of decreases in catches (*nature's benefits to people*; arrow 4), reduced access (arrow 8), and the impaired viability of commercial and recreational fishing fleets and associated industries across the globe *(anthropogenic assets*). In the case of many small-scale fisheries in less developed countries, this disproportionally affects the poor and women (*quality of life)*, either through direct displacement by industrial and commercial fishers, or by declines in harvests in their areas (*nature's benefits to people)* due to industrial pressure elsewhere (*indirect divers*). In some cases it also affects *nature* and its *benefits to people* well beyond coastal areas, for example by increasing bushmeat harvest in forest areas and thus affecting populations of wild mammals such as primates, and posing threats to human health (*good quality of life*).

Institutions and governance systems and other indirect drivers at the root of the present crisis can be mobilized to halt these negative trends and aid the recovery of many depleted marine ecosystems (*nature*), fisheries (*nature's benefits to people*) and their associated food security and lifestyles (*good quality of life*). Examples include strengthening and enforcement of existing fishing regulations, such as the Code of Conduct for Responsible Fisheries of the Food and Agriculture Organization of the United Nations (FAO), the zoning of the oceans into reserves and areas with different levels of catch effort, enhanced control of quotas and pollution, recognition of indigenous and local peoples' customary marine tenures and sustainable use systems. In addition, anthropogenic assets could be mobilized towards this end in the form of the development and implementation of new critical knowledge, such as fishing gear and procedures that minimize by-catch, or a better understanding of the role of no-catch areas in the long-term resilience of exploited fisheries.

Step 4. Identify relevant scales for the assessment

Scale should be considered both in terms of the scope of reporting and of the information used as raw material for the assessment. The Platform will focus on supranational (from subregional to global) geographical scales for assessment. The properties and relationships that occur at these coarser spatial scales will, however, be partially linked to properties and relationships occurring at finer scales. For example, the thematic assessment on the impacts of pollination and pollinators on food production is to report at the regional to global scales, but can usefully use case studies at the landscape scale, including those with indigenous and local peoples, as raw material. The most relevant time scales are years to decades, with trends over millennia mostly beyond the scope of the assessment.

Identify the possibly different scales of the elements and linkages that affect the focal issue of the assessment. For example, possible declining trends in pollinators in a region may be related to direct drivers at the regional scale (e.g. agricultural intensification), which in turn could be driven by institutions and socio-economic trends at the same scale, as well as much larger scales, such as global demand for grains, or institutions favouring the use of pesticides. For further details see Chapter 2.

Step 5. Carefully consider institutions, governance systems and other indirect drivers and their close links with visions of a good quality of life.

These drivers are given high prominence in the CF as root causes of the present state of *nature* and *nature's benefits to people*, and are perceived as key points of action in order to improve trends. They therefore need to be considered in detail. Focusing predominantly on *direct drivers* without a proper consideration of the indirect drivers that underpin them often leads to ineffective or incomplete solutions.

Step 6. Identify options for policy and practice, as well as state, trends and scenarios for the future.

These options should also have an identifiable scale, and be assigned to specific boxes and arrows of the CF. Options can be clearly related to policy-relevant findings and contexts. For example, take a possible measure aimed at improving pollinator health. Is it based on changes in how much unploughed land is left in agricultural landscapes (arrow 3); does it consist of changes in technology and/or the way in which farmers handle pollinators nesting sites (arrow 6); or is it related to changes in international and national regulation of trade in bees or in bee products (arrow 7). Consider carefully distinguishing the findings and related options to address it (usually there will be more than one). Identify the specific arrow that a proposed policy or practice option targets. Consider whether there are policy relevant findings that would enable identification of where the problem is primarily located, and therefore which are the priority interventions. However, recognise that often further information about the policy context and policy windows that are outside the scope of these assessments will be needed for effective prioritisation.

Box 1.2: Example of application of the CF to assessments – Terrestrial invasive species

Invasions by alien species, whether transported unintentionally from other regions or intentionally introduced for agriculture, forestry, horticulture or other human activities produce critical changes in biodiversity and ecosystems (*nature*). Alien species invasions have increased exponentially over the last decades due to increased globalization and associated transport of goods, trade in agricultural products or wood, and demand for exotic horticultural species and pets *(institutions and governance systems and other indirect drivers*; arrow 2*)*. These introduced species meet favourable conditions for their expansion as a result of a number of *direct anthropogenic drivers* that modify the availability of resources or the capacity of native communities and food webs to resist invasion (arrow 3). Examples of these *direct anthropogenic drivers* are forest clearing, physical disturbance of soils, increased nitrogen deposition, widespread pesticide use, and changes in temperature and rainfall and extreme events (floods, cyclones, fires).

Invasions are estimated to have caused average local declines of almost 25% of species richness across taxa and biomes (*nature;* arrow 3). In Boreal and Northern temperate forests, the impact of biological invasions are stronger than those of other causes of biodiversity loss, such as habitat loss and land-use change (which are prevalent causes of species loss in the tropics). For instance, in the case of plants, introduced species tend to exclude native plant and animal species, increase biomass production, accelerate nutrient cycling, decrease water run-off and promote more frequent fires. Introduced vertebrates modify habitat structure by consuming vegetation (e.g. introduced deer deeply affect forest structure on islands), are predators of native species (e.g. foxes and stoats in Australia and New Zealand), and can be dispersers of invasive plants (e.g. introduced frugivorous birds spreading *Rubus* species and guava in Indian Ocean island forests). Alien arthropods and pathogens directly affect crop and forest production and can also disrupt native food webs. Ants, for example, have led to the decimation of crab populations on Christmas Island in the Indian Ocean and the loss of seabird populations on many islands; avian malaria is one of the factors responsible for the extinction of endemic birds in Hawai'i; and taro leaf blight has been responsible for the cessation of a multi-million dollar loss of taro production, the main staple food and export crop in Samoa. An estimated cost to the global economy of $1.4 trillion a year results from invasive species management costs plus direct negative impacts of invasive species on multiple *nature's benefits to people*, such as crop or wood production, and availability of drinking water and hydropower, and on human health and security (*good quality of life*) (arrow 4).

The assessment and management of alien species invasions (arrow 3) therefore is a critical challenge for the maintenance or improvement of human well-being (arrow 8). The first priority must be to prevent invasions by addressing the demand for exotic species (visions of a good *quality of life*), strengthening the *institutions* around the trade and transport of potential invaders, and for the detection of potentially invasive species and the detection and monitoring of their spread once introduced. Community-based monitoring by indigenous and local peoples is a key front-line opportunity in this context. For already established invaders, control by biological agents can be an efficient solution, where risks to non-target species are low, and where eradication processes are designed together with indigenous and local peoples to respect customary institutions and values associated with the target species. Native predators or pathogens of the problem species may be available and have been weakened by past or ongoing management. Then, restoration of suitable habitat for source populations or engineering of green infrastructure will facilitate control of problem species such as crop weeds and pests (*nature*, arrow 3). Introduction of control agents has also been successful in some instances, although unintended cascading effects are a strong risk. This has been the case for the cane toad introduced to Australia to control pests decreasing sugar cane production, but which has turned into a major pest itself spreading to natural ecosystems, killing native reptiles and upsetting associated food webs (*nature*). In all cases, it is most likely that successful control of introductions and invasions will require a combination of *institutional* change (arrow 2), management of natural or modified ecosystems (arrow 3), understanding of different views and priorities concerning invasive species, careful manipulation of control agents and possible innovations such as genetic change, all of which must be supported by the continued development of knowledge and financial and human resources (*anthropogenic assets*).

Also, beyond the intended *benefits to people* of intentionally introduced species, in some cases alien species can also provide unintentional or unforeseen benefits. First, introduced species may provide biodiversity conservation benefits by providing habitat or food resources to rare species, serving as functional substitutes for extinct taxa (*nature*), and providing *benefits to people* such as soil retention in areas submitted to increasing intense rainfall events, or increased soil fertility by nitrogen fixation. Perceptions about whether an alien species is a pest or an asset are highly influenced by world-views and experiences (arrow 5); for example Martu people in western Australia value non-native cats as a food source, and have incorporated them into their systems of customary law and lore. Evidence suggests that cats arrived several centuries before British occupation of Australia, perhaps from visiting Dutch boats. Second, it has been speculated that alien species might contribute to achieving conservation goals in the future because they may be more likely than native species to persist and provide *benefits to people* in areas where climate and land use are changing rapidly (*natural and anthropogenic drivers*). In general, the emergence of so-called 'novel ecosystems' (*nature*) assembled around alien species may be an inevitable feature of the future, and welcomed by some as sources of *nature's benefits to people*. Community-based monitoring by indigenous and local peoples is a key front-line option that also enables identification of cases where novel ecosystems are considered from the perspective of both their benefits and disbenefits (losses) to various sectors of society. In this context, changes in societal values (*visions of a good quality of life*) and a renewal in *institutions* may need to be better understood and supported in order to foster adaptation to such changes.

Box 1.3: Example of application of the CF to assessments – The benefits of pollinators in food production

Many animals are considered important pollinators: bats, butterflies, moths, birds, flies, ants, non-flying mammals and beetles. Bees are the most important of these. There are approximately 20,000 identified bee species worldwide, inhabiting every continent except Antarctica (*nature*).

Pollination is important for maintaining the populations of many plants, including wild and cultivated species considered useful or important by people (*nature's benefits to people*, arrow 4). It is critical in agricultural systems; ~75% of our global crops are pollinator-dependent. The global value of pollination for commercial food production has been estimated at approximately $351 billion (USD)/yr; in addition it contributes to the subsistence agricultural production that feeds many millions of people worldwide (arrows 4 and 8). Therefore, a substantial decline in pollinator populations threatens food production for both local consumption and global food markets.

Aside from pollination benefits, there are also products directly produced from some species of bees such as honey, pollen, wax, propolis, resin, royal jelly and bee venom (*nature's benefits to people*), which are important for nutrition, health, medicine, cosmetics, religion and cultural identity (*good quality of life*, arrow 8). There are some societies that are particularly vulnerable to pollinator declines such as indigenous communities and/or local subsistence farmers, whose *quality of life* will be disproportionally affected by a decrease in pollinator communities. For example, indigenous communities that rely on stingless bee honey, as both a sweetener and medicine, would be more affected than people in urban centres with access to an array of alternative sweeteners, medicines and remedies in the case of a local stingless bee population decline. There are also many links between bee populations, the honey they produce and cultural values. For example, in the case of the Tagbanua people of the Philippines, honey collecting is tightly linked to their community's cultural belief system (i.e. bee deities and spirits) and traditional swidden farming practices. If bee populations were to decline in these areas, aspects of the Tagbanua culture and farming practices may be lost.

Pollination benefits will become increasingly more important as the demand for pollinator-dependent crops increases with growing human populations (*good quality of life and indirect drivers*, arrow 1). For example, in the United States, fruit and vegetable imports (representing demand) has tripled in the last two decades. Many of these products include pollinator-dependent crops such as citrus fruits, strawberries, berries, tropical fruits, peaches, pears, and apples.

Land use change (i.e. habitat loss, fragmentation, conversion, agricultural intensification, urbanization etc.), pollution, pesticides, pathogens, climate change and competing alien species are *direct anthropogenic drivers* that threaten pollinator populations (*direct drivers*, arrow 3). Some potential indirect drivers behind them include human population growth, global economic activity, and science and technology. For instance, large-scale agricultural production involving the combined use of genetically modified crops, new pesticides and agricultural machinery reduce food resources and nesting habitats for pollinators. *Direct drivers* can act in tandem, for example, the phenomenon of Colony Collapse Disorder (CCD) describes the effect of several combined factors (i.e.

pesticides, disease, and mites) causing losses of approximately 30-35% of hives of managed honey bee (*Apis mellifera*) in the United States and some European countries (arrows 3 and 4), which has affected some sectors of their agricultural economies (arrow 8). It is not only managed honey bees that are declining, but there is strong evidence that wild bee populations are also decreasing in some regions, many of which are efficient crop pollinators.

Besides affecting the *nature's benefits to people* described above, the adverse effects of pollinator declines can affect nature in other ways; for example loss of pollinators can cause changes in wild plant diversity (arrow 3) which might in turn can impact on animal communities, including birds, mammals and insects, dependent on these plants for food, shelter and other resources.

Institutions and governance, and other indirect drivers, affecting pollinators and pollination benefits include policies for agri-environmental schemes, environmental stewardship schemes, and conservation and trade policy for honey bee hive transport (arrows 2, 7). For instance, in some parts of Europe agri-environment and stewardship schemes provide monetary incentives to farmers who adopt biodiversity- and environmentally-friendly management practices. A specific example comes from Switzerland, where an agri-environment scheme called 'ecological compensation areas' (wildflower strips, hedges or orchards etc.) maintained at a minimum of 7% of the land, were found to house a significantly higher pollinator community compared to farms without 'ecological compensation areas'. Two international efforts, the Indigenous Pollinators Network and the Sentimiel Program, aim to construct a network of cooperative initiatives, traditional beekeepers and honey harvesters, farmers, and indigenous and local people to strengthen knowledge concerning pollination by sharing and engaging with the scientific community, hence strengthening *anthropogenic assets* and *institutional arrangements* that contribute to bees' diverse *benefits to people* (arrows 5, 6, 7).

There are a number of regional and national initiatives specifically focused on pollinators, targeting all types of communities on different scales, (visions of a *good quality of life*) that play an important role in connecting people, encouraging knowledge and data sharing, and mainstreaming pollination and biodiversity towards conservation (*institutions and governance and other indirect drivers, nature's benefits to people* and *good quality of life*, arrows 7 and 8). For example, the Pollinator Partnership, which is a nonprofit organization focused on the protection of pollinators in North America, initiated National Pollinator Week. This national celebration aims to raise awareness and educate citizens on issues related to pollinator conservation. Another example is the Brazilian Pollinator Initiative (BPI) and the Rede Baiana de Polinizadores (REPOL) organizing the International Pollinator Field Course, which trains and educates researchers, teachers and conservationists on the topic of pollination and pollinator conservation.

References consulted

Agarwala, M. (2012). *Inclusive wealth report 2012*. Cambridge: Cambridge University Press.

Albrecht, M., Duelli, P., Muller, C., Kleijn, D., & Schmid, B. (2007). The swiss agri-environment scheme enhances pollinator diversity and plant reproductive success in nearby intensively managed farmland. *Journal of Applied Ecology 44*(4): 813-822.

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(3), pp. 317–353.

Asah, S., Blahna, D. & Ryan, C. (2012). Involving forest communities in identifying and constructing ecosystem services: millennium assessment and place specificity. *Journal of Forestry*, 110 (3), pp. 149-156.

Balmford, A. & Whitten, T. (2003). Who should pay for tropical conservation, and how could the costs be met? *Oryx*, 37 (02), pp. 238-250.

Bandot, B. (2012). Approaching harmony with nature, In: Nicklin, S. and Cornwell, B. 2012. *Future Perfect*. England: Tudor Rose.

Barrett, C., Travis, A. & Dasgupta, P. (2011). On biodiversity conservation and poverty traps. *Proceedings of the National Academy of Sciences*, 108 (34), pp. 13907-13912.

Bateman, I., Harwood, A., Mace, G., Watson, R., Abson, D., Andrews, B., Binner, A., Crowe, A., Day, B., Dugdale, S., Fezzi, C., Foden, J., Hadley, D., Haines-Young, R., Hulme, M., Kontloeon, A., Lovett, A. A., Munday, P., Pascual, U., Paterson, J., Perino, G., Sen, A., Siriwardena, van Soest, D. & Termansen, M. (2013). Bringing ecosystem services into economic decision-making: land use in the United Kingdom. *Science*, 341 (6141), pp. 45-50.

Berkes, F., Folke, C. & Gadgil, M. (1994). Traditional ecological knowledge, biodiversity, resilience and sustainability. *Biodiversity Conservation – Ecology, Economy & Environment*, 4, pp. 269-287.

Brashares, J., Arcese, P., Sam, M., Coppolillo, P., Sinclair, A. & Balmford, A. (2004). Bushmeat hunting, wildlife declines, and fish supply in West Africa. *Science*, 306 (5699), pp. 1180-1183.

Brondizio, E. S., Ostrom, E. & Young, O. (2009). Connectivity and the Governance of Multilevel Socioecological Systems: The Role of Social Capital. *Annual Review of Environment and Resources*, 34, pp. 253–78.

Brown, T. (1984). The concept of value in resource allocation. *Land Economics*, 60 (3), pp. 231-246.

Carpenter, S., Mooney, H., Agard, J., Capistrano, D., Defries, R., Diaz, S., Dietz, T., Duraiappah, A., 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*, 106 (5), pp. 1305-1312.

Chan, K.M.A., Guerry, A., Balvanera, P., Klain, S., Satterfield, T., Basurto, X., Bostrom, A., Chuenpagdee, R., Gould, R., Halpern, B. Hannahs, N., Levine, J., Norton, B., Ruckelshaus, M., Russell, R., Tam, J. & Woodside, U.(2012). Where are cultural and social in ecosystem services? A framework for constructive engagement. *BioScience*, 62 (8), pp. 744-756.

Chan, K.M.A., Satterfield, T. & Goldstein, J. (2012). Rethinking ecosystem services to better address and navigate cultural values. *Ecological Economics*, 74, pp. 8-18.

Cinner, J. E., & Aswani, S. (2007). Integrating customary management into marine conservation. *Biological Conservation 140*:201-216.

Cowling, R., Egoh, B., Knight, A., O'Farrell, P., Reyers, B., Rouget, M., Roux, D., Welz, A. & WilhelmRechman, A. (2008). An operational model for mainstreaming ecosystem services for implementation. *Proceedings of the National Academy of Sciences*, 105 (28), pp. 9483-9488.

Daniel, T., Muhar, A., Arnberger, A., Aznar, O., Boyd, J., Chan, K., Costanza, R., Elmqvist, T., Flint, C., Gobster, P. H., Gret-Regamey, A., Lave, R., Muhar, S., Penker, M., Ribe, R. G., Schauppenlehner, T., Sikor, T., Soloviy, I., Spierenburg, M., Taczanowska, K., Tam, J. & von der Dunk, A. (2012). Contributions of cultural services to the ecosystem services agenda. *Proceedings of the National Academy of Sciences*, 109 (23), pp. 8812-8819.

Danielsen, F., Burgess, N. D., & Balmford, A. (2005). Monitoring matters: examining the potential of locally-based approaches. *Biodiversity and Conservation 14*: 2507-2542.

Díaz, S. & Cabido, M. (2001). Vive la différence: plant functional diversity matters to ecosystem processes. *Trends in Ecology & Evolution, 16* (11), pp. 646-655.

Diaz, S., Quétier, F., Caceres, D.M., Trainor, S.F., Perez-Harguindeguy, N., Bret-Harte, M.S., Finegan, B., Pena-Claros, M. & Poorter, L. (2011). Linking functional diversity and social actor strategies in a framework for interdisciplinary analysis of nature’s benefits to society. 2011. *Proceedings of the National Academy of Sciences of the United States of* America, 108 (3), pp. 895-902.

Díaz, S., Demissew, S., Joly, C., Lonsdale, W., & Larigauderie, A. (2014). *Plos Biology*, **in press**.

Díaz, S., Demissew, S., Carabias, J., Joly, C., Lonsdale, W., Ash, N., Larigauderie, A., et al. (2015). The IPBES Conceptual Framework – connecting nature and people. *Current Opinion in Environmental Sustainability*, **in press**.

Dietz, T., Fitzgerald, A., & Shwom, R. (2005). Environmental Values. *Annual Review of Environment and Resources*, 30 (1), pp. 335–372.

Dressler, W. (2005). Disentangling Tagbanua Lifeways, Swidden and Conservation on Palawan Island. *Human Ecology Review 12(*1): 21-29

Duraiappah, A. (2011). Ecosystem services and human well-being: Do global findings make any sense? *BioScience*, 61 (1), pp. 7-8.

Duraiappah, A. (2012). *Satoyama-Satoumi Ecosystems and Human Well-Being: Socio-Ecological Production Landscapes of Japan*. United Nations University Press.

Duraiappah, A. & Rogers, D. (2011). The Intergovernmental Platform on Biodiversity and Ecosystem Services: opportunities for the social sciences. *Innovation: The European Journal of Social Science Research*, 24 (3), pp. 217-224.

Faith, D., Magallon, S., Hendry, A., Conti, E., Yahara, T., & Donoghue, M. (2010). Evosystem services: an evolutionary perspective on the links between biodiversity and human well-being. *Current Opinion in Environmental Sustainability*, 2 (1), pp. 66-74.

Franklin, D. C., A. M. Petty, G. J. Williamson, B. W. Brook, & Bowman, D. M. J. S. (2008). Monitoring contrasting land management in the savanna landscapes of northern Australia. *Environmental Management 41*: 501-515.

Garmendia, E. & Pascual, U. (2013). A justice critique of environmental valuation for ecosystem governance. In: Sikor, T. eds. 2013. *Justices and Injustices of Ecosystem Services*. London: Routledge.

Gregory, R., Failing, L., Harstone, M., Long, G., Mcdaniels, T. & Ohlson, D. (2012). *Structured Decision Making.* Hoboken: Wiley.

Harrington, R., Anton, C., Dawson, T., De Bello, F., Feld, C., Haslett, J., Kluvankova-Oravska, T., Kontogianni, A., Lavorel, S., Luck, G.W. Rounsevell, M. D. A., Samways, M. J., Settele, J., Skourtos, M., Spangenberg, J. H., Vandewalle, M., Zobel, M. & Harrison, P. A. (2010). Ecosystem services and biodiversity conservation: concepts and a glossary. *Biodiversity and Conservation, 19* (10): 2773-2790.

Hill, R., D. Buchanan, & Baird, A. (1999). Aborigines & Fires in the Wet Tropics of Queensland, Australia: Ecosystem Management Across Cultures. *Society and Natural Resources 12*:205-223.

Hill, R., C. Grant, M. George, C. J. Robinson, S. Jackson, & Abel, N. (2012). A typology of Indigenous engagement in Australian environmental management: Implications for knowledge integration and social-ecological system sustainability. *Ecology and Society 17*:23

Hobbs R.J., Higgs, E. & Harris, J.A. (2009) Novel ecosystems: implications for conservation and restoration. *Trends in Ecology & Evolution,* 25, 599-605.

IPBES Task Force on indigenous and local knowledge systems (ILK). (2014). *A global dialogue workshop to strengthen the synergies between ILK and science in the assessment on pollination and pollinators associated with food production. Internal working document: proposal to IPBES Bureau and MEP.* Technical Support Unit for the IPBES Taskforce on ILK, United Nations Educational, Scientific and Cultural Organization Paris.

Ishak, I. & Alias, R. (2005). Designing a Strategic Information Systems Planning Methodology for Malaysian Institutes of Higher Learning (isp- ipta). *Information System,* 6(1), pp. 325-331.

Jahn, T., Becker, E., Keil, F., & Schramm. E. (2009). *Understanding Social-Ecological Systems: Frontier Research for Sustainable Development. Implications for European Research Policy.* Institute for Social-Ecological Research (ISOE), Frankfurt/Main, Germany.

Jax, K., Barton, D., 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: pp. 260-268.

Johnson, R. (2014). *The U.S. Trade Situation for Fruit and Vegetable Products. Congressional Research Service Report. Report 7-5700*. http://fas.org/sgp/crs/misc/RL34468.pdf (accessed September 18, 2014).

Klein, A.-M., Vaissiere, B. E., Cane, J. H., Steffan-Dewenter, I., Cunningham, S., Kremen, C., & Tscharntke, T. (2007). Importance of pollinators in changing landscapes for world crops. *Proceedings of the Royal Society B 274* (1608): 303-313.

Larigauderie, A., Prieur-Richard, A., Mace, G., Lonsdale, M., Mooney, H., Brussaard, L., Cooper, D., Cramer, W., Daszak, P., Díaz, S., Duraiappah, A., Elmqvist, T., Faith, D. P., Jackson, L. E., Krug, C., Leadley, P. w., Le Prestre, P., Matsuda, H., Palmer, M., Perrings, C., Pulleman, M., Reyers, B., Rosa, E. A., Scholes, R. J., Spehn, E., Turner II, B. L. & Yahara, T. (2012). Biodiversity and ecosystem services science for a sustainable planet: The DIVERSITAS vision for 2012-20. *Current opinion in environmental sustainability,* 4 (1), pp. 101-105.

Lautenbach, S., Seppelt, R., Liebscher, J., & Dormann, C. F. (2012). Spatial and temporal trends of global pollination benefits. *PLoS ONE 7*(4): e35954

Lenzer, M., Moran, D., Kanemoto, K., Foran, B., Lobefaro, L. & Geschke, A. (2012). International trade drives biodiversity threats in developing nations. *Nature,* 486, pp. 109-112.

Liu, S., Gallois, C. & Volčič, Z. (2011). *Introducing intercultural communication*. London: SAGE.

Luck, G.W, Harrington, R., Harrison, P., Kremen, C., Berry, P., Bugter, R., Dawson, T., De Bello, F., Diaz, S., Feld, C. Haslett, J. R., Hering, D., Kontogianni, A., Lavorel, S., Rounsevell, M., Samways, M. J., Sandin, L., Settele, J., Sykes, M. T., van den Hove, S., Vandewalle, M. & Zobel, M. (2009). Quantifying the contribution of organisms to the provision of ecosystem services. *Bioscience*, 59 (3), pp. 223-235.

Mace, G., Norris, K. & Fitter, A. (2012). Biodiversity and ecosystem services: a multilayered relationship. *Trends in Ecology & Evolution,* 27 (1), pp. 19-26.

Millennium Ecosystem Assessment. (2005). *Ecosystems and human well-being: biodiversity synthesis*. World Resources Institute, Washington, DC.

Murphy, G. E. P. & Romanuk, T.N. (2014) A meta-analysis of declines in local species richness from human disturbances. *Ecology and Evolution,* 4, 91-103.

O'Neill, J., Holland, A. & Light, A. (2008). *Environmental Values.* New York: Routledge.

Ostrom, E. (2005). *Understanding institutional diversity*. Princeton: Princeton University Press.

Pascual, U., Muradian, R., Brander, L., Gómez-Baggethun, E., Martín-López, B, Verman, M., Armsworth, P., Christie, M., Cornelissen, H., Eppink, F., Farley, J., Loomis, J., Pearson, L., Perrings, C. & Polasky, S. (2010). The economics of valuing ecosystem services and biodiversity. In: Kumar, P. eds. 2010. *The Economics of Ecosystems and Biodiversity Ecological and Economic Foundations*. pp. 183-256. Earthscan.

Pascual, U., Phelps, J., Garmendia, E., Brown, K., Corbera, E., Martin, A., Gomez-Baggethun, E. & Muradian, R. (2014). Social Equity matters in Payments for Ecosystem Services. *Bioscience* , **in press**.

Pereira, H.M., Leadley, P., Proença, V., Alkemade, R., Scharlemann, J., Fernandez-Manjarrés, J., Araújo, M., Balvanera, P., Biggs, R., Cheung, W. Chini, L., Cooper, H. D., Gilman, E. L., Guenette, S., Hurtt, G. C., Huntington, H. P., Mace, G. M., Oberhdorff, T., Revenga, C., Rodrigues, P., Scholes, R. J., Sumaila, U. R. & Walpole, M. (2010). Scenarios for global biodiversity in the 21st century. *Science*, 330 (6010), pp. 1496-1501.

Perrings, C., Duraiappah, A., Larigauderie, A. & Mooney, H. (2011). The biodiversity and ecosystem services science-policy interface. *Science*, 331 (6021), pp. 1139-1140.

Plurinational State of Bolivia. (2013). *Submission by the Plurinational State of Bolivia on the conceptual framework of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services.* Available from www.ipbes.net/images/documents/Bolivia_comments%20on%20background%20document%20on%20IPBES%20Conceptual%20Framework.pdf.

Pyšek, P., Jarošík, V., Hulme, P.E., Pergl, J., Hejda, M., Schaffner, U. & Vilà, M. (2012). A global assessment of invasive plant impacts on resident species, communities and ecosystems: the interaction of impact measures, invading species' traits and environment. *Global Change Biology,* 18, 1725-1737.

Pyšek, P., Jarošík, V.C., Hulme, P.E Kuhn, I., Wild, J., Arianoutsou, M., Bacher, S., Chiron, F., Didziulis, V., Essl, F., Genovesi, P., Gherardi, F., Hejda, M., Kark, S., Lambdon, P. W., Desprez-Loustau, M-L., Nentwig, W., Pergl, J., Poboljsaj, K., Rabitsch, W., Roques, A., Roy, D. B., Shirley, S., Solarz, W., Vila, M. & Winter, M. (2010). Disentangling the role of environmental and human pressures on biological invasions across Europe. *Proceedings of the National Academy of Sciences*, 107, 12157-12162.

Reid, W.V., Berkes, F., Wilbanks, T.J. & Capistrano, D. (2006). *Bridging Scales and Knowledge Systems: Concepts and Applications in Ecosystem Assessment*. Washington D.C. Island Press.

Reyers, B., Biggs, R., Cumming, G.S., Elmqvist, T., Hejnowicz, A.P. & Polasky, S. (2013). Getting the measure of ecosystem services: a social-ecological approach. *Frontiers in Ecology and the Environment,*11, 268-273.

Reyers, B., O'Farrell, P.J., Cowling, R.M., Egoh, B.N., Le Maitre, D. C. & Vlok, J. H. J. (2009). Ecosystem services, land-cover change, and stakeholders: finding a sustainable foothold for a semiarid biodiversity hotspot. *Ecology and Society*, 14(1), pp. 38. Published under license by the Resilience Alliance.

Robinson, C., J., & Wallington, T. (2012). Boundary Work: Engaging Knowledge Systems in Co-management of Feral Animals on Indigenous Lands. *Ecology and Society* 17: http://dx.doi.org/10.5751/ES-04836-170216.

Rohan, M. J. (2000). A rose by any name? The values construct. *Personality and Social Psychology Review*, 4 (3): 255-277.

Sagoff, M. (1998). Aggregation and deliberation in valuing environmental public goods: A look beyond contingent pricing. *Ecological Economics*, 24 (2), pp. 213-230.

Satterfield, T., Gregory, R., Klain, S., Roberts, M. & Chan, K. (2013). Culture, intangibles and metrics in environmental management. *Journal of environmental management*, 117, pp. 103-114.

Schlaepfer, M.A., Sax, D.F. & Olden, J.D. (2011). The Potential Conservation Value of Non-Native Species. *Conservation Biology,* 25, 428-437.

Scholes, R.J., Reyers, B., Biggs, R., Spierenburg, M.J. & Duriappah, A. (2013). Multi-scale and cross-scale assessments of social–ecological systems and their ecosystem services. *Current Opinion in Environmental Sustainability,* 5, 16-25.

Secretariat of the Convention on Biological Diversity. (2010). *Global Biodiversity Outlook 3.* Montréal. Available from http://www.cbd.int/doc/publications/gbo/gbo3-final-en.pdf.

Secretariat of the Convention on Biological Diversity. (2010). *The Strategic Plan for Biodiversity 20112020 and the Aichi Biodiversity Targets* (Decision X/2, of 29 October 2010, of the Conference of the Parties to the Convention on Biological Diversity at its tenth meeting). Available from www.cbd.int/decision/cop/default.shtml?id=12268/.

Sen, A. (2009). *The idea of justice*. The Belknap Press of Harvard University Press, Cambridge, Massachusetts.

Simberloff, D., Martin, J-L., Genovesi, P., Maris, V., Wardle, D. A., Aronson, J., Courchamp, F., Galil, B., Garcia-Berthou, E., Pascal, M., Pysek, P., Sousa, R., Tabacchi, E. & Vila, M. (2013). Impacts of biological invasions: what's what and the way forward. *Trends in Ecology & Evolution*,28, 58-66.

Smith, L., Case, J., Smith, H., Harwell, L. & Summers, J. (2013). Relating ecoystem services to domains of human well-being: Foundation for a US index. *Ecological Indicators*, 28, pp. 79-90.

Sutherland, W.J., Gardner, T.A., Haider, L.J. & Dicks, L.V. (2013). How can local and traditional knowledge be effectively incorporated into international assessments? *Oryx,* 48**,** 1-2.

Tëngo, M., Brondizio, E.S., Elmqvist, T., Malmer, P. & Spierenburg, M. (2014). Connecting diverse knowledge systems for enhanced ecosystem governance: the multiple evidence base approach. *Ambio* doi: 10.1007/s13280-014-0501-3.

Thaman, R.R. (2009). Sustainability. In Gillespie, R.G. and Clague (eds.). *Encyclopedia of Islands*, University of California Press, Berkeley, pp. 888-896.

Trainor, S. (2006). Realms of value: Conflicting natural resource values and incommensurability. *Environmental Values*, pp. 3-29.

UK National Ecosystem Assessment. (2011). *The UK National Ecosystem Assessment: Synthesis of the Key Findings.* UNEP WCMC, Cambridge.

UNEP/CBD/AHTEG-SP-Ind/1/3. Report of the Ad Hoc Technical Expert Group on Indicators for the Strategic Plan for Biodiversity 2011-2020.

UNEP/GC.27/17 (Nairobi, 2013). Decision 27/8: Green economy in the context of sustainable development and poverty eradication.

UNEP/IPBES.MI/1/INF/11 (Nairobi 2011): Considering the generation of knowledge function of IPBES: Recommendations from a meeting of scientific organizations interested in IPBES convened by ICSU, and hosted by UNESCO (Paris, France, 10 June 2011).

UNEP/IPBES.MI/1/INF/12 (Nairobi 2011): Report of an international science workshop on assessments for an intergovernmental science-policy platform on biodiversity and ecosystem services, held in Tokyo from 25 to 29 July 2011.

UNEP/IPBES.MI/2/INF/10 (Panama 2012): Report of the scientific workshop on assessments for an intergovernmental science-policy platform on biodiversity and ecosystem services.

UNEP/IPBES.MI/2/INF/11 (Panama 2012): Report of the workshop on the theme “Considering further the intergovernmental science-policy platform on biodiversity and ecosystem services knowledge-generation function.

United Nations. (1982). World Charter for Nature, adopted by the General Assembly, 48th plenary meeting, 28 October 1982, A/Res/37/7. (http://www.un.org/documents/ga/res/37/a37r007.htm))

United Nations (UN). (2009). General Assembly Resolution 63/278 of 22 April 2009, by which the Assembly designated 22 April “International Mother Earth Day” (A/RES/63/278).

United Nations (UN). (2012). United Nations Conference on Sustainable Development, The future we want. Available from www.uncsd2012.org/content/documents/727The%20Future%20We%20Want%2019%20June%201230pm.pdf (accessed 1 October 2013).

United Nations (UN). UN World Ocean Assessment (http://www.worldoceanassessment.org/) (accessed November 2013).

United Nations Educational, Scientific and Cultural Organization (UNESCO). (2010). A proposed joint programme of work on biological and cultural diversity lead by the secretariat of the Convention on Biodiversity and UNESCO, working document prepared for the International Conference on Biological and Cultural Diversity: Diversity for Development – Development for Diversity, Montreal, Canada, June 2010. Available from www.unesco.org/mab/doc/iyb/icbcd_working_doc.pdf.

Universcience Glossary. Available from www.cite-sciences.fr/en/lexique/definition/c/1248117917733/-/p/1239026795199/ (accessed September 2013).

Walsh, F. (2008). To hunt and to hold : Martu Aboriginal people's uses and knowledge of their country, with implications for co-management in Karlamilyi (Rudall River) National Park and the Great Sandy Desert, Western Australia. Doctoral thesis presented in the School of social and Cultural Studies and School of Plant Biology, University of Western Australia, Perth.

Wegner, G. & Pascual, U. (2011). Cost-benefit analysis in the context of ecosystem services for human well-being: A multidisciplinary critique. *Global Environmental Change*, 21 (2), pp. 492-504.

World Bank. (2012). *Hidden harvest: the global contribution of capture fisheries*. Agriculture and Rural Development Series, ISBN: 978-0-8213-8844-0.

Chapter 2: IPBES assessments across scales

Coordinating Author: Dolors Armenteras

Authors: Sandra Lavorel, Szabolcs Lengyel, CAs: Marc Metzger, Bob Scholes, Fernando Santos, Reinette Biggs, Ben ten Brink, Patricia Koleff, Klaus Henle, Wolfgang Cramer, Vania Proenca, Henrique Pereira, Rosario Gómez

2.1. Scales in assessments - key terms and concepts

In a general sense, “scale” means a reference system of measurements to compare quantities. In this guide, scale is defined in both a spatial and a temporal sense. In a spatial sense, scale can refer either to the (i) extent of study, which is the physical size (e.g. area) of the entity under inquiry or to the (ii) grain of study, which is the size of the smallest unit for which unique information is available. In ecology, these dimensions are defined by the physical boundaries of the area (e.g. an ecosystem, a watershed or a biome) and the size of the biological units under study (e.g. an individual or the entire population of a species). In social sciences, these dimensions refer to units of governance (e.g. administrative boundaries of countries and regions) and/or social organisation (e.g. household, local community, nation etc.). Here we use “social/institutional scale” to reflect the extent of the organisation of societies. In a temporal sense, “extent” means the time period over which a process operates and observations or measurements are collected and “grain” means the time period which is necessary to collect one observation or measurement.

IPBES undertakes assessments at the global and near-global level and at different regional and subregional levels. The global, regional and subregional assessment levels have characteristic spatial scale, temporal process and social/institutional scales, (Table 2.1). These specific scales are referred to as ‘core’ scales in this guide.

Table 2.1

Scope of IPBES assessments of biodiversity and ecosystem services and their characteristic (‘core’) spatial scale, temporal process and social/institutional scales.

	Scales		
Scope	**Spatial (extent)**	**Temporal[a]**	**Social/institutional**
Global	very large (Earth)	long	global (≈ UN)
Regional	large (≈ continental)	medium	continental (e.g. AU, EU/EEA, OAS)
Subregional	medium (≈ supranational)	short	supranational (e.g. ASEAN, CARICOM, CIS, MERCOSUR, NAFTA, SAARC)
National[b]	local - national	very short/short	national (e.g. ministry, government agencies)

[a] While spatial and institutional scales are directly linked with the assessment scope, the same is not true for the temporal scale (i.e., more than one temporal scale may fit a particular scope, depending on the focus of the assessment and data availability e.g. Global assessments often use short-term data from local studies, whereas National assessments may use long-term data such as historical records of land cover).

[b] The national level is added here to highlight that many goods and services are related to local biodiversity and that the large-scale focus of IPBES is deeply rooted in a synthesis of information across scales including local scales.

Biodiversity, and, as a consequence, ecosystem services provided by components of biodiversity, are intrinsically ***scale-dependent*** concepts. Biodiversity encompasses several entities at each level of the hierarchy of biological organisation from genes through individuals, populations, species and communities to habitats/ecosystems. ***Biodiversity patterns*** arise by the interaction of different components in different quantities in various spatiotemporal organization. For example, “patterns in species diversity” encompass the list of species, the quantity of all species and their spatiotemporal organisation. ***Biodiversity processes*** encompass all the past, present and future temporal changes in the identity, quantity and structure of components of biodiversity. The quantification of ***biodiversity patterns and processes*** will depend not only on the level of biological organisation studied but also on the ***spatial and temporal scales*** at which they are measured. For example, the species diversity can be considered at small spatial scales (e.g. diversity of macroscopic invertebrates in a stream) and large ones (e.g. diversity of macroscopic invertebrates in European river systems) and at small temporal scales (e.g. few days) to large ones (e.g. evolutionary times). Similarly, ***ecosystem services*** provided by the components of biodiversity will also depend on the spatial and temporal scales at which they are viewed and on the social/institutional scale as well (e.g., household vs. national) – that affects the demand side.

Assessments of biodiversity patterns and processes and ecosystem services thus need to consider the ***spatial and temporal scales at which biodiversity patterns and processes operate***. When small-scale patterns and processes are assessed at broad scales, or, when large-scale patterns and processes are addressed at small scales, ***scale mismatches*** occur, which can greatly undermine the efficiency of assessments and conservation actions (Cumming et al., 2006). Scale mismatches can also occur when ***coarse-grained ecosystems***, characterised by a few large components, are assessed at a grain size too small relative to the large components, which can result in superfluous measurements, too detailed information and in statistical non-independence of the measurements. Similarly, scale mismatches can occur when ***fine-grained ecosystems***, characterised by a larger number of smaller components, are assessed at a grain size too large relative to the smaller components, which can result in missing information on important small-scale variation within and among the components, overlooking key small-scale processes and biased estimates for the assessment. Although the concept of ***granularity*** of the studied ecosystem is relative, it needs to be considered when determining the grain size of the assessment to avoid mismatches. Thus, there is a ***need to match the scales***, both in terms of extent and grain size, at which (i) the drivers shaping biodiversity patterns and processes operate, (ii) the ecosystems to be assessed function, provide services, and respond to drivers, and (iii) the assessment is carried out.

The IPBES Conceptual Framework classifies social-ecological systems that operate at various scales in space and time into six interlinked elements (see Chapter 1). Because the scope of IPBES assessments ranges from global to regional and, if necessary, subregional, these three spatial scales are given priority in this guide (Table 2.1), although many of the considerations are also valid at smaller scales (national, landscape, local).

"Nature" encompasses the natural world with a focus on biodiversity patterns and processes as well as ecosystem structure and functioning. There is increasing scientific knowledge regarding the scale-dependence of biodiversity patterns

"Anthropogenic assets" encompass infrastructure, knowledge systems, including indigenous and local knowledge (ILK), technology and financial assets, among others. The importance of each of these components will vary across scales ranging from global, through regional and subregional. For example, there will be different levels of infrastructure, e.g. roads and built-up areas, in different regions, which may have a bearing on biodiversity and ecosystem services. Similarly, financial assets are not distributed equally globally or regionally, whereas ILK will vary at even smaller scales (often locally). The scale-dependence of these assets thus need to be considered in assessments.

"Nature's benefits to people" encompasses all benefits that humanity obtains from the living natural world. Because these benefits are often delivered and perceived at the local scale (individuals, families, local communities), it is very important to assess both the scale at which benefits originate and the possibly multiple scales at which benefits are received. Moreover, in many cases, benefits will be reaped by people in other regions or subregions than those from where they are produced. A classic example for this is that of mountain regions which act as key sources of benefits for surrounding regions through their role of water towers and through cultural services. Therefore, there is a need for upscaling in assessments, i.e., to consider benefits arising at scales larger than the focal scale. It is also possible that nature's benefits are reaped by several different groups. For example, climate regulation by carbon sequestration e.g. by afforestation, may benefit people both at large and local scales.

"Drivers" may be direct and indirect ones as defined in the CF. ***"Direct drivers"*** encompass both natural drivers and anthropogenic drivers that affect nature and its processes. ***Natural drivers*** such as volcano eruptions, tsunamis etc. usually happen at small scales but can affect people over large scales through indirect effects (e.g. climate modification from volcanic ash). Other natural drivers such as solar storms can influence people over large scales. However, due to the unpredictable frequency and uncontrollability of such events, they are usually not considered in assessments.

"Anthropogenic drivers", on the other hand, should always be explored in assessments at any scale. Many drivers, such as ecosystem conversion, logging and fishing are self-evident, but one should be aware of drivers that act insidiously, for example, pollution and climate change. ***"Indirect or underlying drivers"*** operate by altering the level or rate of change of one or more direct drivers. It is important to take into account the accumulation of drivers on the same space and in the long time.

Drivers may be scale-invariant or scale-sensitive. ***Scale-sensitive*** means that the intensity and spatial or temporal heterogeneity/variability of the driver change with the scale at which the driver is assessed. Scale-sensitive drivers and the corresponding ecosystem impacts operate at different spatial and temporal scales. For example, habitat loss and degradation and fire have instant local impacts on biodiversity, e.g. a decreasing area of ecosystems, reduced abundance of populations and reduced migration, which may in turn result in local extinction and declining species richness. In contrast, climate change has a long-term, more gradually accumulating impact (decennia) on a much wider, continental and global scale. In general, drivers characterised by high impact, large scale and persistence have the largest share in total impact. The MA (2005) identified habitat loss and fragmentation, invasive species, population growth, pollution, over-exploitation and consumption, climate change and fire as the main direct and indirect drivers of ecosystem change at the global scale.

In terms of ***temporal scales***, it is important to consider how rapidly drivers and the biodiversity and ecosystem features change and account for uncertainty in the time span and frequency of measurements (Magurran et al., 2010). For example, it may suffice to monitor long-lived species on a less frequent basis than short-lived one, although monitoring change generally requires long-term data sets to be able to detect any change of low to moderate degree. Further, the uncertainty of distinguishing what is natural variability from anthropogenic change needs to be acknowledged (Magurran et al., 2010).

Lastly, there are interactions among drivers operating at different scales. Climate change (slow, large scale) results in changes in local fire regimes with potentially fast switches from fire free to fire prone ecosystems. One particularly important interaction and feedbacks in this case takes place between climate change and land use change. Conversely, effects of locally acting drivers may accumulate across spatial and temporal scales (Leadley et al., 2014). For example, incremental, small-scale habitat loss has accumulated and exceeded a threshold in many parts of the world, beyond which species that depend on that habitat rapidly decline to regional and even global extinction.

Ultimately, the appropriate spatial and temporal scales for each driver are ***specific*** to the context and the assessment. For instance, natural forest regeneration may be positive for biodiversity in one part of Europe (Proença et al., 2010), but negative in another (Eriksson et al., 2002). Similarly, ***different drivers*** may act at on biodiversity and ecosystem services ***at different scales*** (e.g. Tzanopoulos et al., 2013). For example, the primary driver for the diversity of a garden can be the diligence of its owner, for a park it can be the spreading of invasive plants, for a city the proportion of green infrastructure, and for a region the agricultural subsidy system. Moreover, there is no one single right spatial or temporal scale for each driver. However, scale-sensitive drivers generally require more spatially explicit data and more data for upscaling from local to regional or global levels. In addition, one needs to be aware of effects across the boundary of the study area as these may originate quite far from the study area. For example, upstream events, such as erosion, water regulation (dams, irrigation) and pollution will affect ecosystems, biodiversity and humans downstream.

Because assessment studies ultimately aim to analyse the role of ***nature*** for ***good quality of life***, it is necessary to understand the interrelationships of all the ecological and social components to define appropriate response options at different spatial and temporal scales (Liu et al., 2007). Therefore social scales also need to be defined for ecosystem services assessment (Martin-López et al., 2012). Social, political, and economic processes can be more readily observed at some scales than others, and these may vary widely in terms of duration and extent. Furthermore, social organisation scales have more or less discrete levels, such as the individuals, household, community, and higher levels groups that correspond broadly to particular scale domains in time and space.

"Institutions and governance systems and other indirect drivers" encompass the ways societies organise and regulate themselves and they influence all aspects of human relationships with nature. Institutions, their governance and their instruments (e.g. policies) have a hierarchy both within and above the level of nations, which need to be considered in assessments at any scale. The scale-dependence of institutions and governance systems is unique because the interactions across scales are often and increasingly regulated in a top-down way, i.e., larger-scale (e.g. global) institutions and governance systems likely influence smaller-scale (e.g. regional) institutions and governance systems. However, increasing attention is also being paid to the role of local scale governance in generating innovative solutions that can have large scale impacts (Ostrom et al., 1999). Local governance is relevant since it is based on cultural traditions related with nature and its social benefits.

The relevant institutions will obviously ***change with spatial scale*** from global through regional to subregional. In general, the institutions and governance systems at smaller scales are likely to differ more because smaller administrative levels will have institutions and governance systems developed for their local needs. However, because the institutions and governance systems of countries geographically closer to one another (e.g. countries of Europe vs. those of Africa) will likely be more similar, assessments at smaller, e.g. subregional, scales are also likely to encounter ***more similar institutions and governance systems*** than assessments at a larger, e.g. regional and global, scale. These differences and similarities may represent an increased risk of mismatches between the scales of institutions/governance systems and the scales of the biodiversity patterns and ecosystem services under assessment. Typical examples for increased risks of mismatches are watersheds stretching over administrative boundaries or ecosystems that span across several institutional units. Moreover, it is very typical that small-scale patterns in biodiversity and ecosystem services are influenced by larger-scale institutions and policies, for example, the number of African Grey Parrots in the wild can be closely linked to the limitations and restrictions set forth in the global Convention on International Trade in Endangered Species of Wild Fauna and Flora. Therefore, as a general rule, assessments at a certain scale need to consider the institutional/governance settings from higher scales.

"Good quality of life" is a multidimensional concept that has both material and immaterial/spiritual components to describe human well-being. Global scale assessment uses easily-accessible large-scale indicators. However, such indicators may not reflect what is considered good quality of life by people because this will be highly dependent on place, time, culture and society and thus there will be substantial variation related to the concept at smaller scales. This will also cause difficulties when aggregating from small to large scales, which involves integrating very heterogeneous elements such as different cultures, value systems etc. However, working at small scales enables the assessment to include specific views on what is considered as a good quality of life by different cultures and societal groups. This is particularly relevant for the successful integration of indigenous and local knowledge on the framework to access food, education, health and nature of good quality.

Interactions and interlinkages across CF components − In addition to the inherent scale-dependence of the six elements of the CF described above, there are scale-sensitive interlinkages among the elements. These interlinkages across scales can be visualised as arrows between scale-layers of the six elements of the CF (Figure 2.1). In many cases, drivers and institutions from multiple scales will influence local, small-scale biodiversity and related local benefits of nature and quality of life. It is also possible that benefits from smaller-scale ecosystems will flow from the local to global scales. These cross-scale ***interlinkages need to be carefully explored, mapped and quantified*** in assessments carried out at any scale. The importance of such cross-scale linkages often justifies ***multi-scale assessments***.

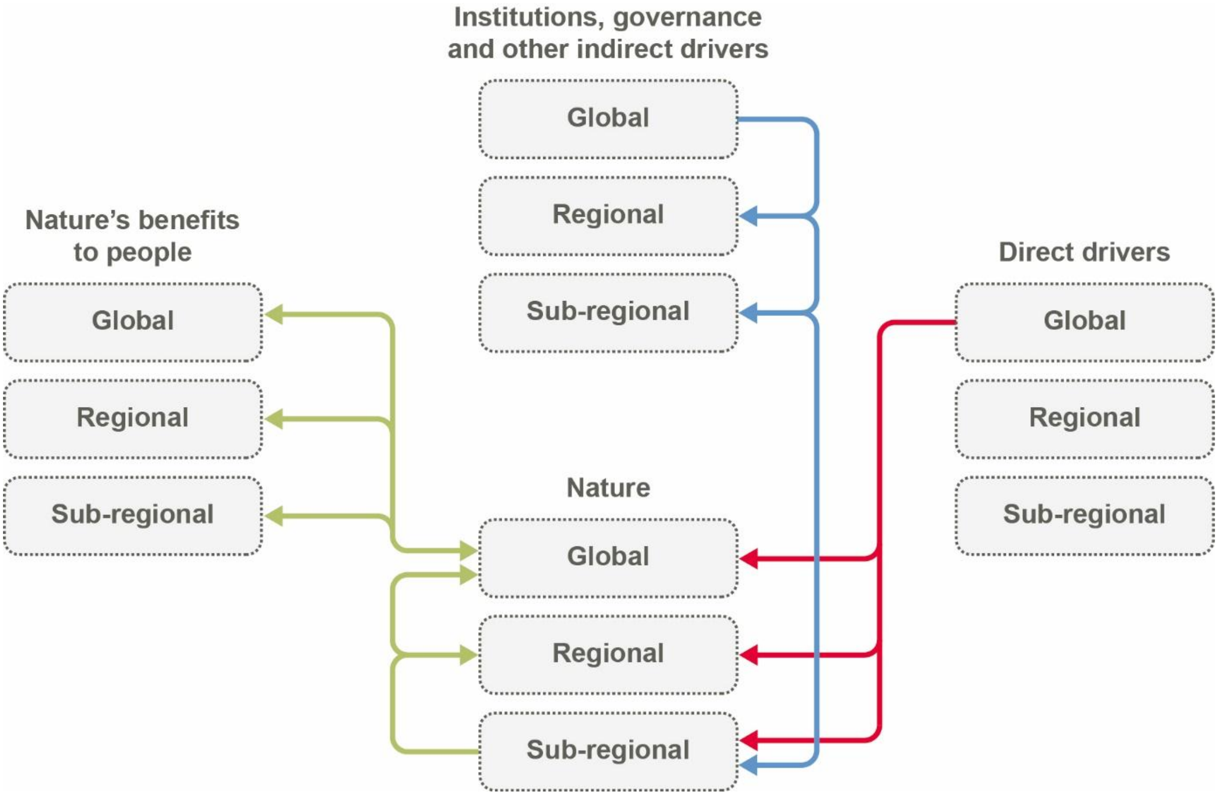


Figure 2.1: An example of interlinkages across scales using a simplified version of the IPBES conceptual framework with the components extended to the three scales of IPBES assessments. A global anthropogenic driver such as climate change will influence nature at each scale (global, regional, sub-regional, red arrows). In response, institutions and policy instruments may coordinate small-scale action to address global drivers such as climate change (blue arrows). In an ideal case, small-scale positive effects on nature will scale up to global levels, which will then influence nature's benefits to people at each scale (green arrows).

2.2. Multi-scale and cross-scale considerations

Assessments usually cover many issues; one scale may not be appropriate for all of them (Scholes et al., 2003; 2010; 2013). Both human and natural systems tend to have hierarchically nested subsystems (Kolasa & Pickett, 1991; Ostrom et al., 1999): a broad 'forest biome' contains many specific sorts of forests, within each there are patches of different history or environmental circumstances. Economic regions contain nation-states which contain provinces and local authorities, while values defining the criteria for a good life are constructed through the interactions between individual, household, local community and broader scales. In addition, it is critical in every assessment that mismatches are avoided between the scale at which ecological processes occur and the scale at which decisions on them are made. However, at this level of complexity, mismatches might still occur, given the lack of knowledge on all components and scales. Thus, the adoption of a single scale of assessment limits the types of problems that can be addressed, the modes of explanations that are allowed, and the generalizations that are likely to be used in analysis. This leads naturally to the adoption of multi-scale and cross-scale assessments.

A multi-scale approach, defined as a structured hierarchical approach where individual assessments are performed at several scales and then integrated, is preferred for IPBES assessments if at all feasible. Multi-scale assessments have several benefits because they allow to uncover and understand the dynamics occurring at each scale and the complex cross-scale spatial and temporal linkages, they allow to engage stakeholders at different scales, and they can provide policy recommendations at the appropriate scale (Pereira, Domingos & Vicente, 2006; Carpenter et al., 2009). The implicit multi-scaling in the original Millennium Assessment conceptual framework was actually cross-scaling, considering that human wellbeing and biodiversity typically manifest themselves locally, but ecosystem services are often delivered at a larger scale, and indirect drivers and direct drivers mostly operate at even larger scales (Carpenter et al., 2006). Wisely choosing the scales associated with the various levels in the hierarchy for each of nature, anthropogenic assets benefits, drivers, institutions, and good life (see section 2.1) clarifies the core scale of interest for each level.

It is desirable to identify interlinked scales, to map out how they nest within each other spatially or temporally and integrate them upfront in the assessment design. This requires a hierarchical design centred on the core scale of the assessment, which encompasses the other scales relevant to explain the condition and trends observed at that scale. Figure 2.2 illustrates the respective nesting of scales for ecological systems and institutions, whose interactions underpin the dynamics of socio-ecosystems. One may also consider how the dynamics at the core scale spread to other scales and potential feedback mechanisms. A full cross-scale assessment (Scholes et al., 2013) asks questions such as: ‘what is the effect of this at larger (or smaller) scales?’ and ‘how is this affected by processes at larger or smaller scales?’ It enables in particular to account for ‘slow variables’, which typically operate at larger scales, and are especially important in controlling resilience properties (Biggs et al., 2012).

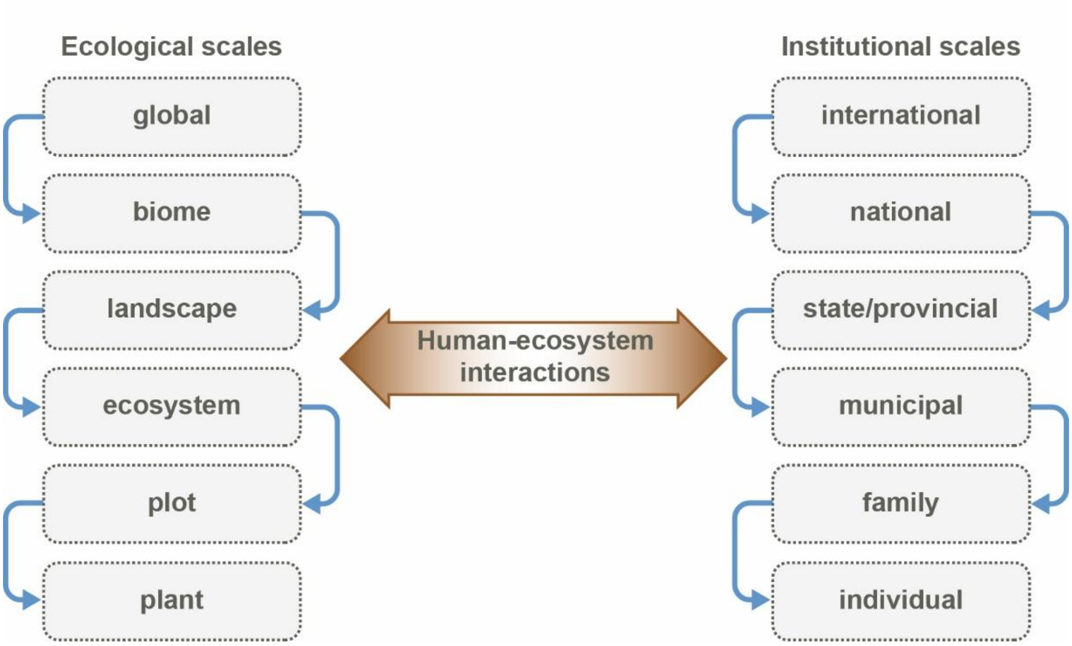


Figure 2.2: Nested ecological and institutional scales that determine human-ecosystem interactions and thereby flows of benefits from nature to societies (from Hein et al., 2006, adapted from Leemans, 2000)

Such structured multi-scale assessments are more likely to deliver clear and robust information for designing integrated response options, from local management approaches to sectorial policies. On the other hand, they are more demanding in terms of data needs, so that practical constraints mean not all biodiversity patterns or ecosystem services can be addressed at every assessment scale (MA, 2005). A judgement should be made about how much information is useful to the assessment’s users.

Once a multi-scale assessment has been chosen, it is crucial to think carefully about common characteristics of the entire assessment area to allow comparison across scales or between assessments. A first step is to recognize and describe the socio-ecological context of the assessment (Redman, Grove, & Kuby, 2004; Seppelt et al., 2012) and explicitly think about the scale at which the assessment operates and can provide valid findings. A second step is to select a set of common biodiversity indicators and ecosystem services to assess in conceptually comparable ways across different scales or assessments. For instance, in the Southern African Millennium Ecosystem Assessment (SAfMA), which comprised separate assessments at three different spatial scales, each of these scales agreed to assess a common set of three services: cereal production, freshwater, and biodiversity (Biggs et al., 2004; van Jaarsveld et al., 2005). Each of the common services linked to food production and freshwater was assessed in terms of the difference between minimum per capita requirements and supply in each region, so that although these were assessed using completely different datasets and methods, they could be compared across scales (Biggs et al., 2004, van Jaarsveld et al., 2005). In addition to the common services, the assessment at each scale incorporated additional services of specific relevance or interest to the particular assessment region or scale, for instance medicinal plant use in local communities or air quality at the regional scale.

Cross-scale assessments will require upscaling and downscaling approaches. One of the greatest challenges is how to extrapolate or draw conclusions at large scales from estimates obtained at small scales, an approach called upscaling. Upscaling is in some cases quite straightforward, by aggregating with some weighting rule (for instance area occupied by terrestrial ecosystem; or number of people in a social system). In this instance, it is recommended to preserve both the averages and the distributional characteristics of data. Upscaling can for example enable the estimation of species richness in poorly sampled regions and taxa (Box 2.1), can be used to monitor biodiversity change across multiple scales, and can allow the inference of coarse-scale environmental or management changes from fine-scale observations and experiments. Downscaling, the opposite approach, is a promising way to extrapolate data from assessments conducted at different spatial scales. For example, downscaling can be applied when some parts of a large area are sampled, whereas others are not. Downscaling from the larger-scale study (sampled areas) to unsampled areas can provide reasonable estimates on whether a species is present or absent in the unsampled areas and these estimates can be projected as valid across the entire focal region. Disaggregating downwards is more tricky, as it is based on probabilistic estimates rather than deterministic ones, but is routinely done using some covariate for which a high-resolution coverage is available (such as altitude, for climate variables; Scholes, 2009). In some cases, scale translation is not at all straightforward, since the scaling rule may be non-linear, or the meaning or power of the variable may change between scales. For instance, transpiration is controlled by stomatal conductivity at the leaf scale, but by energy balance at the regional scale. These cases are interesting but relatively rare; they should be dealt with on a case-by-case basis using expert input.

Box 2.1: Upscaling and downscaling methods for estimating species diversity

Current upscaling approaches estimate the species-area relationship (SAR) for a larger geographical unit from small-scale measurements and then use the overall SAR to estimate total species richness at large scales. SARs arise partly because species composition will differ more among geographically more distant communities (similarity decay). The rate at which similarity declines with distance can be estimated from empirical samples, and this rate is closely associated with the slope of the SAR. Therefore, if we know the similarity decay and the species richness of samples collected at different distance classes, we can reasonably estimate species richness at larger scales. Several recent modelling approaches have been developed beyond this theoretical logic, and these models are now flexible enough to allow anthropogenic shifts in biodiversity scaling (e.g. the SAR will increase more slowly when the area is degraded) to be reflected in their results. A recent comparison of upscaling methods in the project SCALES (Kunin et al., 2012) suggested that the models with the best predictive accuracy are the ones that use incidence-based parametric richness estimator (Shen & He, 2008) or the analytic species accumulation (ASA) approach (Ugland et al., 2003).

Downscaling methods at present are confined to cases when information available at a large scale is used to predict the presence or absence (occupancy) of species at finer scales. A recent study (Azaele, Cornell & Kunin, 2012) showed that some methods can produce highly accurate estimates of fine-scale species occupancy, i.e., presence or absence of a species in a region, from large-scale patterns.

2.3. The types of assessment in IPBES and their scales

IPBES encompasses ***thematic assessments*** on specific questions such as pollination, land degradation, invasive alien species and sustainable use as well as ***methodological assessments*** on issues such as scenarios and valuation**.** IPBES also conducts ***comprehensive assessments of biodiversity and ecosystem services***. These reflect issues at global, regional and subregional scales. Regional and subregional boundaries of such IPBES assessments do not necessarily follow the geopolitically defined UN regions that underpin the composition of membership in bodies under IPBES such as its Bureau and its Multidisciplinary Expert Panel (MEP). In defining such boundaries IPBES are exploring the following criteria, amongst others (Deliverable 2(b) scoping of regional assessments; IPBES/3/6):

(a) Biogeographic characteristics;

(b) Geographic proximity;

(c) Ecological and climatic similarities and barriers;

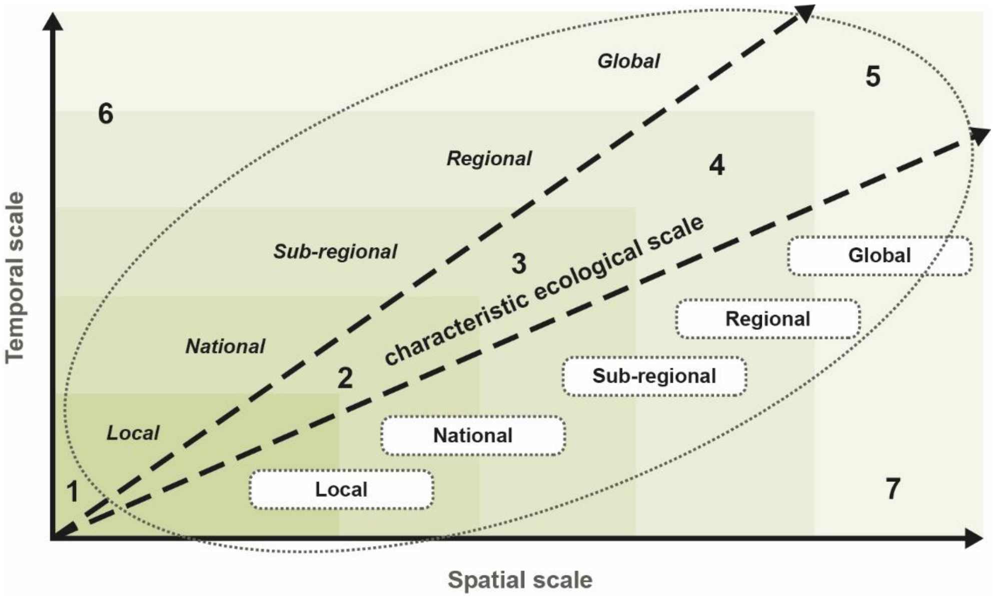
(d) Shared terrestrial and aquatic ecosystems and ecological features, such as migrating species;

(e) Interdependencies on ecosystem services, such as water catchments and food production;

(f) Social, economic, political, cultural, historical and linguistic similarities including existing regional mechanisms, institutions and processes.

Many ecosystem assessments are undertaken wither globally or at the spatial scales defined by administrative boundaries (i.e. regional, subregional, national and local). In these cases, the definition of the spatial scale is fixed for political reasons and it will influence the outputs and methodological approach of the assessment. It is important to reflect on the consequences of selecting administrative spatial scales to understand how this type of assessment might contribute to decision making and public policy processes at various levels (MA, 2005). Sometimes it is necessary to assess a specific ecosystem or ecological units. In these cases, the assessment would use different ecological spatial scales such as biogeographic regions (i.e. temperate forest), or a watershed (e.g. Amazonia). These ***focused assessments*** will be oriented towards the understanding of ecosystem processes that have the capacity to supply ecosystem services in a given area (Díaz et al., 2007) and can consider how trade-offs vary from ecosystems to benefits (Lavorel & Grigulis, 2012). Although the selection of ecological spatial units will generally ensure a better matching of the different spatial and temporal scales at which ecosystems operate, this is not necessarily the case for socio-economic systems, which have historically developed within and across ecological units and are better adjusted to cultural and/or administrative borders of regions.

Given the prerequisites described above beginning any assessment, it is essential to explicitly identify the scales for which the study is valid, because ultimately it will define the type of assessment (Figure. 2.3).



1. Soil C (Microbial)
2. Primary productivity (Ecosystem)
3 Soil development (Landscape)
4 Climate Regulation(Biome)
5 Biogeochemistry cycle (Global)
6. ????
7 Increased extreme weather events. Altered frequency, climate regulation

Figure. 2.3: Relationships between spatial and temporal scales, institutional scales (in white boxes) and scales of different types of IPBES assessments (in italics, local and national are incorporated here because they might provide input to larger scale assessments). The dotted line encompasses where thematic and methodological assessments can be found. The area between the dotted arrows reflects the range of characteristic ecological scales. Numbers illustrate some examples of combinations of ecosystem services and organizational levels of biodiversity which typically fall into the range of characteristic ecological scales (1-5) and those that do not fall into this range ('exceptions' that do not follow the regular pattern: 6, 7).

In the following, the Guide highlights the key features for the different scales of assessment of IPBES: global, regional and subregional, considering also recommendations for national and local assessments.

2.3.1. Global scale

Global-scale assessments are, by definition, carried out at a very large spatial scale and ideally over very long temporal scales. Assessments applicable to large spatial scales however generally use spatially explicit data at low resolutions, which may hinder the detection of fine-scale patterns and processes. Even if data are collected at a fine level of detail, the aggregation of the findings at a larger scale means that local patterns and constraints may disappear (MA, 2005). Furthermore, large-scale assessments frequently use very large spatial and social/institutional scales but do not necessarily use long-term temporal scales. Thus there can be a potential mismatch between the ecologically relevant (long) time scale for large-scale processes and the small time scale of the assessment, which is often based on a snapshot of current biodiversity patterns and ecosystem services. An implication is that global scale assessments, in particular, may need to consider historical data in order to gain the deeper time perspective necessary for a robust understanding of some large-scale processes. Additionally, the relationships between large-scale processes means there will always be some unpredictability that makes it difficult to answer questions about future long-term processes and their interaction with behaviour on shorter time scales.

A global or regional ecosystem services assessment's methods will need to consider that most of the services are actually delivered at the local scale, although the results are often expressed over large scales such as nations. Thus, there is a need to aggregate information on local processes to the larger scale of the assessment. To deal with such issues the assessment would need to use some specific scaling rules, as for example up-scaling the ecosystem service demand (such as for cultural services) or down-scaling the impacts on ecosystems (such as by regionalizing the estimates of global climate change).

2.3.2. Regional and subregional scales

Regional and subregional scales differ from the global scale in several important aspects. The spatial scale for regional assessments is still relatively large (i.e., continental) and encompasses a wide range of environmental and biogeographical settings. Nevertheless, the regional scale offers an opportunity for a better understanding of the role that historical environmental and biogeographical factors played in shaping current patterns in biodiversity and ecosystem services than does the global level. For example, the impact of Ice Ages and the postglacial periods are now much better understood for some continents than for the entire globe. Thus, there is usually higher data availability and better opportunities for the use of temporal comparisons and longer time scales and for studying changes along temporal scales at the regional than at the global scale. However, in some cases, a global-scale assessment based on biogeographical units (e.g. zonobiomes or ecozones) may be less complex and/or more elucidating than a continental assessment that combines a range of different biomes as well as socio-economic interactions and situations. At the institutional/social scale, assessment units will likely be more similar at the regional than at the global scale (c.f. regional political organisations such as the AU, EU, OAS etc.), although heterogeneities may still be an issue.

At the subregional scale, variation in the non-living environment including geography and climate is further reduced. The subregional assessment units share a common history and are likely to be environmentally and biogeographically more homogeneous than regions. Therefore, patterns in their biodiversity and ecosystem services are also likely to be more similar, for example, many of the subregional assessment units will correspond to the level of biomes in the biological organisation. These similarities make it likely that there is higher data availability for the assessments, or, when this is not the case, up- and downscaling methods and other techniques (e.g. species distribution modelling) will provide more reliable results and data for the assessments than at higher (regional, global) assessment scales. Although the subregional scale can still represent an enormous range of different scales and levels of complexity, assessments can usually be more detailed, and can build on national, subnational and local scales. There will also be higher similarity among assessment units along the social/institutional scales in subregions where countries share at least some of their socio-economic development and where countries have similar socio-economic systems. This scale offers the best opportunities for the integration of ILK and other knowledge systems.

2.3.3. National and subnational scales

Although IPBES assessments are intended to be carried out primarily at the global and regional, and, as necessary, at the subregional levels, IPBES also helps to catalyse support for subregional and national assessments, as appropriate (UNEP/IPBES.MI/2/9). In general, assessments of biodiversity and ecosystem services at the national scale are mainly based on the identification of indicators from available databases and through the use of expert judgment. In contrast, local case studies attempt to address trade-offs in ecosystem services at a finer level of detail using different methodologies, such as participatory assessment techniques based on the social perception of local actors, modelling of future scenarios, and biophysical evaluations of services and trends through local-scale indicators (Mouchet et al., 2014). On a national scale, most of the completed assessments have focused on explaining the relationship between the state of their ecosystem services and the direct causes of degradation. In many cases, other components such as indirect drivers of change or their implications for human wellbeing have been empirically excluded from the analysis because their relations with ecosystem services are not obvious, and time series data at the scale of assessment are often absent (Santos-Martín et al., 2013).

Local assessments are framed from the point of view of local stakeholders and therefore need to consider local constraints and processes as well as decisions and actions taken at that level (Resilience Alliance, 2007). However, to be effective, local assessments must adequately include relevant factors and determinants from larger scales in which they are embedded.

Moving towards national policies to implement actions at local scales for biodiversity management is a major challenge, since a national assessment can provide valuable insight at a broad scale that needs refinement to be relevant for a smaller domain. Whether it is possible to conduct a comparable assessment for local actions depends on (i) the application of explicit and compatible (or at least comparable) methods for the domain of interest, (ii) a good understanding of large-scale patterns and temporal trends of change in biodiversity and ecosystem services (Booney et al., 2009) and (iii) ensuring that information needed for the local analysis is adequate to solve the problems identified for multiple decision-making scales. To influence policies and their implementation at national scales, it is thus essential to combine broad assessments with finer-scale research to be able to attend to environmental problems at different levels of governance (Soberon & Sarukhan, 2010).

2.4 A roadmap for IPBES assessments across scales

The design of an ecosystem assessment should emerge from a collaborative process involving scientists, stakeholders and assessment users (MA 2005). User information needs, including information to guide policy making, should define the scope of the assessment. The selection of the scale or scales to be assessed should take into consideration data availability and/or the feasibility of obtaining new data, such as time, human resources, and monetary costs. This is particularly relevant in the design of multi-scale assessments as typically each new scale requires at least the doubling of resources needed. The roadmap below presents four main steps to be considered and re-iterated as necessary in order to identify the appropriate spatial, temporal and social/institutional scales for an assessment. Box 2.2 illustrates some of the challenges faced for some of the steps described here.

Step 1. Given the key questions and target stakeholders of the assessment, select appropriate scales for drivers, ecosystems, and institutions and governance

(a) Use existing knowledge, publications, expert judgement to identify the core temporal and spatial scale for each of: biodiversity and ecosystems, nature’s benefits, drivers, institutions and governance, and quality of life.

(b) Some of these scales might be prescribed by the nature of the assessment such as the extent (global, regional, sub-regional) for ecosystems and political jurisdiction, which can be supported by maps. The grain for these should still be identified beforehand based on existing knowledge and adjusted to data availability.

(c) For drivers and institutions, carefully consider the multiple scales that are relevant for the focus of the assessment.

(d) Try as far as possible to rationalise these into one or a few scales, with matching boundaries.

(e) It is usually more practical to match ecological scales to administrative regions, than vice versa, since the decisions are based on the latter. However, from an ecological perspective ecologically defined assessment units may be more meaningful (e.g. watersheds, biomes).

(f) Example: a regional assessment may comprise a mosaic of ecosystems distributed across several nations. The spatial extent of the region is prescribed for the assessment and defines that of biodiversity and ecosystems to be included. It is reasonable to first consider the resolution of data availability for biodiversity inventories and compare that to that of land use maps in order to identify the preferable grain for the quantification of ecosystem processes. If available historical biodiversity and land use data should be incorporated in order to document ecosystem trends and possible past legacies. Nature’s benefit will be quantified for people living in the region (extent of the assessment), however it is also important to consider first how these benefits are distributed spatially across smaller traditional or administrative units where they translate into quality of life, and second whether benefits are derived to larger scales outside the region. Examples of the latter could be climate regulation or exported agricultural or forest commodities. The identification of drivers at the regional scale often starts with a land use map whose resolution determines the quantification of habitat extent and conversion (if time series are available) and of fragmentation. Survey data can provide maps of sources and extent of exotic species invasions, while climate change will be quantified from regional data sets and models whose resolution is often coarser than that of land use and biodiversity data.

Step 2: Decide if it is possible and necessary to carry out a multi-scale assessment

(a) Use the above analysis (step 1) along with existing knowledge, publications and expert judgement to identify relevant adjacent temporal and spatial scales at which assessments should be carried out using a multi-scale nested approach (hierarchical design):

(b) At sub-regional scale the assessment of biodiversity and ecosystem processes can be improved by first analysing watershed or landscape scales. At regional scale the overall analysis might proceed by up-scaling analyses of individual ecosystems.

(c) Quality of life at regional scale might be best assessed by first analysing ecosystem benefits and their translation to quality of life for different cultural groups. Here, the identification of the relevant units for analyses might benefit from the knowledge of cultural landscapes and by integrating ILK on their definition.

(d) As for step 1, for each of the smaller scales to be considered ecological and administrative or cultural boundaries need to be matched as best as possible so as to define the units of smaller scale assessment.

(e) Example: a multi-scale assessment for a geographically diverse region could be designed based on the map of main ecosystems. Combining this with a map of cultural groups could be used to identify one option for the smaller scale of assessment. In case the resulting boundaries encompass several nations or autonomous administrative regions, sub-dividing these may be meaningful for the adequate assessment of anthropogenic assets and quality of life.

(f) Evaluate benefits vs. difficulties (including data availability) and costs of a multi-scale assessment.

Step 3. If using a multi-scale assessment, this consists in first conducting the assessment at each of the selected lower scales (e.g. different ecosystem types of cultural areas) and second upscaling the resulting information

This implies the following additional elements:

(a) To allow for comparison across scales or between assessments it is crucial to think carefully about common characteristics of the assessment area, in addition to focusing on unique or special features of the region. A first step is therefore to recognize and describe the socio-ecological context of the assessment (Redman, Grove, & Kuby, 2004; Seppelt et al., 2012)

(b) Identify a core set of variables for each of biodiversity, benefits and drivers that should be documented at each spatial scale.

(c) Use an expert thinking process (including scientists and stakeholders) to identify which ecological and social processes may operate cross-scale, and design a way of collecting information to understand and model such processes.

(d) Depending on the important ecological processes of response to drivers and effects on benefits identify appropriate up-scaling methods of biodiversity and ecosystem functioning. Likewise for social processes identify up-scaling methods for benefits and quality of life.

(e) Still take special care to consider benefits and impacts on quality of life beyond boundaries of the higher assessment scale considering off-site or downstream effects.

Step 4. Discuss with stakeholders your scale-related decisions, preferably by an iterative process (i.e. go back to step 1 if necessary)

It is important to note that if you involve additional scales (space or time) the stakeholder group may need to be adjusted to incorporate new stakeholders

Box 2.2: GEO Amazonia: challenges for an ecosystem multi scale assessment

GEO Amazonia was the first integrated environmental assessment for the region that took an ecosystem approach with the goal to contribute to policymaking and development planning. The assessment focused on biodiversity, forest, hydrological resources, aquatic ecosystems, agro-productive ecosystems and human settlements (UNEP 2009). The assessment reinforces the perception that the Amazonia is a region of great contrasts, not only considering physical- geographical aspects and its megadiversity, but also socio-culturally, economically, politically and institutionally.

This challenging project was organised by the United Nations Environmental Program (UNEP) and the Amazonian Treaty for Cooperation (ATCO). The technical coordination and execution of the process was led by Universidad del Pacífico (Lima-Perú). The countries involved in the GEO Amazonia process were those that belong to ATCO: Bolivia, Brazil, Colombia, Ecuador, Guyana, Peru, Suriname and Venezuela.

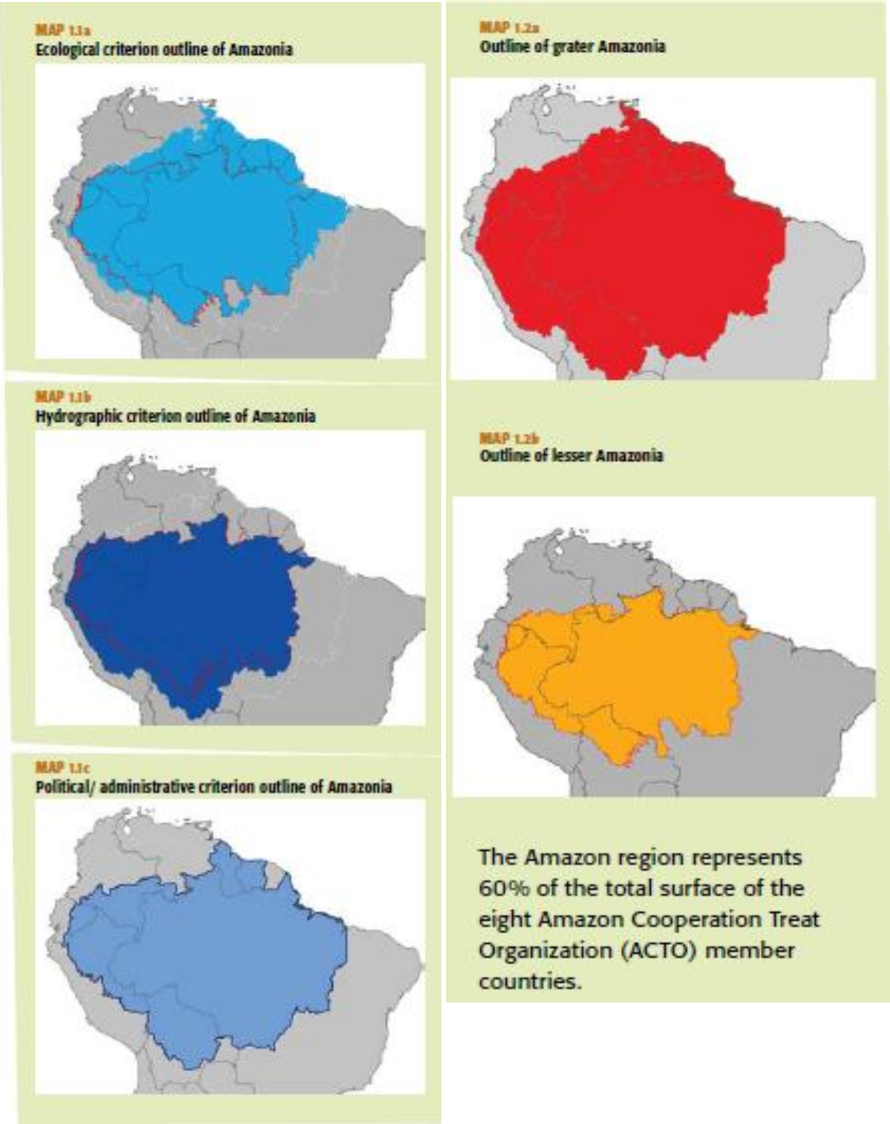


Figure 2.2A. Ecological (Map 1.1), hydrographic (Map 1.2) and political/administrative (1.3) criteria used to reach an agreement amongst parties on the definition of the greater (Map 1.2[a]) and the lesser Amazonia (Map 1.2b).

The GEO Amazonia process faced different challenges: to agree on the boundary of the Amazonia region; to establish criteria for selecting particular important issues with regional relevance, and handling country differences in data availability, among others. In the first case, three criteria were used to define the boundaries: ecological, hydrographic and political-administrative (Figure 2.2A). These criteria were used to define a Major Amazonia and a Minor Amazonia. Major Amazonia is the maximum area based on at least one of the criteria. Minor Amazonia is the minimum area generated by the three criteria combined (Table 2.2A). The Amazonian countries considered this approach appropriate.

Table 2.2A.

Amazonia area for ATCO countries based on ecological, hydrographic and political-administrative criteria Source: UNEP (2009)

Amazonia	Total area	Conservation area	
	Km^2	**Km^2**	**%**
Major Amazonia	8,187,965	1,713,494	20.9
Minor Amazonia	5,147,970	1,159,387	22.5
World	134,914,000	13,626,314	10.1

The other challenge was to select specific examples that were relevant at the sub-national level, as well as the regional level. This selection was based on scientific information and experts' contributions. To do this, GEO

Amazonia organized a group of researchers, Amazonia experts and policy makers to identify key examples of environmental degradation and ecosystem services conservation in Amazonia. It was very important to balance the representation of countries, given their great differences in size. Finally, differences in data availability, time frames and methodologies between countries limited the comparative analysis.

Despite the complexity involved, the preparation of GEO Amazonia was well managed because we shared a comprehensive, logical and easily understood framework. The framework is based on analysing the pressures and driving forces that affect the state of the main ecosystems. The key questions that organized the integrated environmental assessment were:

- What is happening with the environment in the Amazonia and why?
- What are the impacts of the environmental degradation on the human well-being?
- What actions are being taken to address the driving forces that affect the environment as well as the impacts on human well-being?
- What are the perspectives from and emerging issues in Amazonia?
- What are the proposals to drive a sustainable development in the Amazonia?

Like other GEO processes, GEO Amazonia is based on stakeholder participation, and is interdisciplinary and multi-sectorial. The development of GEO Amazonia took two years and finished with the publication of the report in three languages (Spanish, English and Portuguese). More than 150 scientists, researchers and policy makers from the Amazonian countries were part of the process.

2.5. Key resources

A current overview of scale issues in ecology and conservation is presented in Henle et al. (2014). A general introduction in scale issues and a useful dictionary for the meaning of scale-related terms is provided at the SCALETOOL portal (http://scales.ckff.si/scaletool). A seminal work on mismatches between ecological and societal scales is Cumming et al. (2006), while classic references for the hierarchical organisation of biodiversity is Noss (1990) and for environmental heterogeneity Kolasa & Pickett (1991). A worked example for both a multi-scale regional and a subregional assessment is provided by the South African Millennium Ecosystem Assessment (Scholes & Biggs, 2004; van Jaarsveld et al., 2005). Hein et al. (2006) provides a framework for the scaling of ecosystem services.

References

Azaele, S., Cornell, S. J., & Kunin, W. E. (2012). Downscaling species occupancy from coarse spatial scales. *Ecological Applications*, *22*, 1004–1014.

Biggs, R., Bohensky, E., Desanker, P.V., Fabricius, C., Lynam, T., Misselhorn, A.A., Musvoto, C., Mutale, M., Reyers, B., Scholes, R.J., Shikongo, S., & van Jaarsveld, A.S. (2004). *Nature supporting people: The Southern African Millennium Ecosystem Assessment.* Pretoria, South Africa: Council for Scientific and Industrial Research.

Biggs, R., Schlüter, M., Biggs, D., Bohensky, E. L., BurnSilver, S., Cundill, G., Dakos, V., Daw, T. M., Evans, L. S., Kotschy, K., Leitch, A. M., Meek, C., Quinlan, A., Raudsepp-Hearne, C., Robards, M. D., Schoon, M. L., Scultz, L. & West, P. C. (2012). Toward Principles for Enhancing the Resilience of Ecosystem Services. *Annual Review of Environment and Resources*, *37*, 421–448.

Bonney, R., Cooper, C.B., Dickinson, J., Kelling, S., Phillips, T., Rosenberg, K.V., & Shirk, J. (2009). Citizen science: A developing tool for expanding science knowledge and scientific literacy. *BioScience*, *59*, 977–984.

Carpenter, S. R., DeFries, R., Dietz, T., Mooney, H.A, Polasky, S., Reid, W. V, & Scholes, R. J. (2006). Ecology. Millennium ecosystem assessment: research needs. *Science*, *314*, 257–258.

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*, 1305–1312.

Cumming, G. S., Cumming, D. H. M., & Redman, C. L. (2006). Scale mismatches in social-ecological systems: Causes, consequences, and solutions. *Ecology and Society*, 11.

Díaz, S., Lavorel, S., de Bello, F., Quétier, F., Grigulis, K., & Robson, T. M. (2007). Incorporating plant functional diversity effects in ecosystem service assessments. *Proceedings of the National Academy of Sciences of the United States of America*, *104*, 20684–9.

Eriksson, O., Cousins, S.A.O. & Bruun, H.H. (2002). Land-use history and fragmentation of traditionally managed grasslands in Scandinavia. *Journal of Vegetation Science*, *13*(5), 743–748.

Hein, L., van Koppen, K., de Groot, R.S., & van Ierland, E.C. (2006). Spatial scales, stakeholders and the valuation of ecosystem services. *Ecological Economics*, *57*, 209-228.

Henle, K., Potts, S.G., Kunin, W.E., Matsinos, Y.G., Similä, J., Pantis, J.D., Grobelnik, V., Penev, L., & Settele, J. (Eds.). (2014). *Scaling in Ecology and Biodiversity Conservation* (p. 206). Sofia, Bulgaria: Pensoft Publishers.

Kolasa, J., & Pickett, S.T.A. (1991). *Ecological heterogeneity.* New York, NY: Springer-Verlag.

Kunin, W.E., Harte, J., He, F.L., Jobe, R.T., Polce, C., Sizling, A., Smith, A., Smith, K., Smart, S. & Storch, D. (2012). *Up-scaling biodiversity estimates from point records: a comparative test.* Deliverable 3.3b of project "SCALES". University of Leeds, Leeds.

Lavorel, S., & Grigulis, K. (2012). How fundamental plant functional trait relationships scale-up to tradeoffs and synergies in ecosystem services. *Journal of Ecology, 100*, 128–140.

Leadley, P., Proença, V., Fernandez-Manjarrés, J., Pereira, H. M., Alkemade, R., Biggs, R., Bruley, E., Cheung, W., Cooper, D., Figueiredo, J., Gilman, E., Guenette, S., Hurtt, G., Mbow, C., Oberdorff, T., Revenga, C., Scharlemann, J. P. W., Scholes, R., Stafford Smith, M., Sumalia, U. R. & Walpole, M. (2014). Interacting Regional Scale Regime Shifts for Biodiversity and Ecosystem Services. *BioScience, 64*, 665-679.

Liu, J., Dietz, T., Carpenter, S.R., Alberti, M., Folke, C., Moran, E., Pell, A. N., Deadman, P., Kratz, T., Lubchenco, J., Ostrom, E., Ouyang, Z., Provencher, W., Redman, C. L., Schneider, S. H. & Taylor, W.W. (2007). Complexity of coupled human and natural systems. *Science*, *317*, 1513–1516.

Magurran, A.E., Baillie, S.R., Buckland, S.T., Dick, J.M., Elston, D.A., Scott, E.M., Watt, A.D. (2010). Long-term datasets in biodiversity research and monitoring: assessing change in ecological communities through time. *Trends in Ecology & Evolution, 25*(10), 574–82.

Martín-López, B., Iniesta-Arandia, I., García-Llorente, M., Palomo, I., Casado-Arzuaga, I., Del Amo, D. G., Gomez-Baggethun, E., Oteros-Rozas, E., Palacios-Agundez, I., Willaarts, B., Gonzalez, J. A., Santos-Martin, F., Onaindia, M., Lopez-Santiago, C. & Montes, C. (2012). Uncovering ecosystem service bundles through social preferences. *PLoS ONE*, 7.

Martín-López, B., Gómez-Baggethun, E., González, J.A., Lomas, P.L. & Montes, C. (2009). The assessment of ecosystem services provided by biodiversity: re-thinking concepts and research needs. Editors: Jason B. Aronoff, pp. Chapter 9 In: *Handbook of Nature Conservation*. Nova Science Publishers, Inc. ISBN 978-1-60692-993-3

MA (Millennium Ecosystem Assessment). (2005). *Ecosystems and human wellbeing: A framework for assessment.* Washington, D.C.: World Resources Institute.

Mouchet, M., Lamarque, P., Martin Lopez, B., Gos, P., Byczek, C., & Lavorel, S. (2014) An interdisciplinary methodological guide for quantifying associations between ecosystem services. *Global Environmental Change*, in press.

Noss, R.F. (1990). *Indicators for Monitoring Biodiversity: A Hierarchical Approach*. Conservation Biology, 4: 355–364.

Ostrom, E., Burger, J., Field, C. B., Norgaard, R. B., & Policansky, D. (1999). Revisiting the commons: local lessons, global challenges. *Science*, *284*, 278–282.

Pereira, H.M., Domingos, T., & Vicente, L. (2006). Chapter 4. Assessing Ecosystem Services at Different Scales in the Portugal Millennium Ecosystem Assessment. In W. Reid, F. Berkes, T.J. Wilbanks & D. Capristano (Eds.), *Bridging Scales and Epistemologies: Linking Local Knowledge and Global Science* (pp. 59–79). Island Press.

Proença, V. M., Pereira, H. M., Guilherme, J. & Vicente, L. (2010). Plant and bird diversity in natural forests and in native and exotic plantations in NW Portugal. *Acta Oecologica*, *36*, 219-226.

Redman, C.L., Morgan Grove, J. & Kuby, L.H. (2004). Integrating social science into the Long-Term Ecological Research (LTER) network: social dimensions of ecological change and ecological dimensions of social change. *Ecosystems 7*, 161-171.

Resilience Alliance. (2007). *Assessing and managing resilience in social-ecological systems: Volume 2. Supplementary notes to the practitioners workbook*. Available from: http://www.resalliance.org/files/1190318371_practitioner_workbook_suppl_notes_1.0.pdf

Santos-Martín, F., Martín-López, B., García-Llorente, M., Aguado, M., Benayas, J., & Montes, C. (2013). Unraveling the Relationships between Ecosystems and Human Wellbeing in Spain. *PloS ONE, 8*(9).

Scholes, R.J., & Biggs, R. (Eds.). (2004). *Ecosystem services in southern Africa: a regional assessment. Millennium Ecosystem Assessment*. Council for Scientific and Industrial Research, Pretoria, South Africa

Scholes, R.J., Biggs, R., Palm, C., & Duraiappah, A. (2010). Assessing state and trends in ecosystem services and human well-being. In N. Ash, H. Blanco, C. Brown, K. Garcia, T. Henrichs, N. Lucas, C. Raudsepp-Hearne, R.D. Simpson, R. Scholes, T. Tomich, B. Vira and M. Zurek (Eds.), *Ecosystems and human well-being: a manual for assessment practitioners* (pp. 115-150). Washington DC: Island Press.

Scholes, R.J. (2009). Ecosystem services: issues of scale and trade-offs. In S.A. Levin (Ed.), *The Princeton Guide to Ecology* (pp. 579-583). Princeton, NJ: Princeton University Press.

Scholes, R.J., Reyers, B., Biggs, R., Spierenburg, M.J. & Duriappah, A. (2013). Multi-scale and cross-scale assessments of social–ecological systems and their ecosystem services. *Current Opinion in Environmental Sustainability, 5*, 1-10.

Scholes, R.J., Walters, M., Turak, E., Saarenmaa, H., Heip, C.H.R., Tuama, É.Ó., Faith, D.P., Mooney, H.A., Ferrier, S., Jongman, R.H.G., Harrison, I.J., Yahara, T., Pereira, H.M., Larigauderie, A., & Geller, G. (2012). Building a global observing system for biodiversity. *Current Opinion in Environmental Sustainability, 4*, 139–146.

Scholes, R.J., Capistrano, D., Lebel, L., Samper, C., Wilbanks, T.J., Biggs, R., Lee, M.J., Petschel-Held, G. (2003). Dealing with Scale. In G. Gallopin, R. Kasperson, M. Munasingbe, L. Olive, C. Padoch, J. Romm, & J. Vessuri (Eds.). *Millennium Ecosystem Assessment: Ecosystems and Human Well-Being. A framework for Assessment* (Chapter 5). Washington DC: Island Press.

Seppelt, R., Fath, B., Burkhard, B., Fisher, J.L., Grêt-Regamey, A., Lautenbach, S., Perth, P., Hotes, S., Spangenberg, J., Verburgl, P.H., & Van Oudenhoven, A.P.E. (2012). Form follows function? Proposing a blueprint for ecosystem service assessments based on reviews and case studies. *Ecological Indicators, 21*, 145-154.

Shen, T., & He, F. (2008). An incidence-based richness estimator for quadrats sampled without replacement. *Ecology, 89*, 2052-2060.

Soberon, J. M. & Sarukhan, J. K. (2010). A new mechanism for science-policy transfer and biodiversity governance. *Environmental Conservation, 36*, 265 – 267.

Tzanopoulos, J., Mouttet, R., Letourneau, A., Vogiatzakis, I.N., Potts, S.G., Henle, K., Mathevet, R., Marty, P. (2013). Scale sensitivity of drivers of environmental change across Europe. *Global Environmental Change, 23*, 167-178.

Ugland, K.J., Gray, J.S., & Ellingsen, K.E. (2003). The species-accumulation curve and estimation of species richness. *Journal of Animal Ecology, 72*, 888-897.

Van Jaarsveld, A.S., Biggs, R., Scholes, R.J., Bohensky, E., Reyers, B., Lynam, T., Msuvuto, C., & Fabricius, C. (2005). Measuring conditions and trends in ecosystem services at multiple scales: The Southern African Assessment (SAfMA) experience. *Philosophical Transactions of the Royal Society of London, Biological Sciences, 360,* 425-441.

Section II: Applying the IPBES Assessment Processes

This section is a guide to applying the IPBES Assessment Process. The overall structure for the IPBES Assessment Process has been agreed in Plenary and is set out in the IPBES Rules of Procedure (IPBES 2/17). The following chapters summarise this process in an accessible format and include further information to enhance this process, such as the use of uncertainty terms.

Chapter 3: The IPBES assessment process

3.1 Introduction

The IPBES plenary plans to make regular and timely assessments of knowledge on biodiversity and ecosystem services and their interlinkages. These assessments should include comprehensive global, regional and, as necessary, sub-regional assessments and thematic issues at appropriate scales and new topics identified by science and as decided upon by the plenary.

IPBES/2/17 states that assessment reports should be published assessments of scientific, technical and socio-economic issues that take into account different approaches, visions and knowledge systems. There are four types of assessment (See Introduction): global, regional, thematic and methodological. They are to be composed of two or more sections including a summary for policymakers, an optional technical summary, individual chapters, and executive summary.

A full ecosystem assessment should generally comprise of four stages: exploratory; design; implementation; and communication and outreach (Figure 3.1). Throughout the process, there should be continuous communication, capacity building and stakeholder engagement strategies. This section of the report discusses the process for undertaking an assessment, from its conception and initial scoping through to the presentation of the assessments findings.

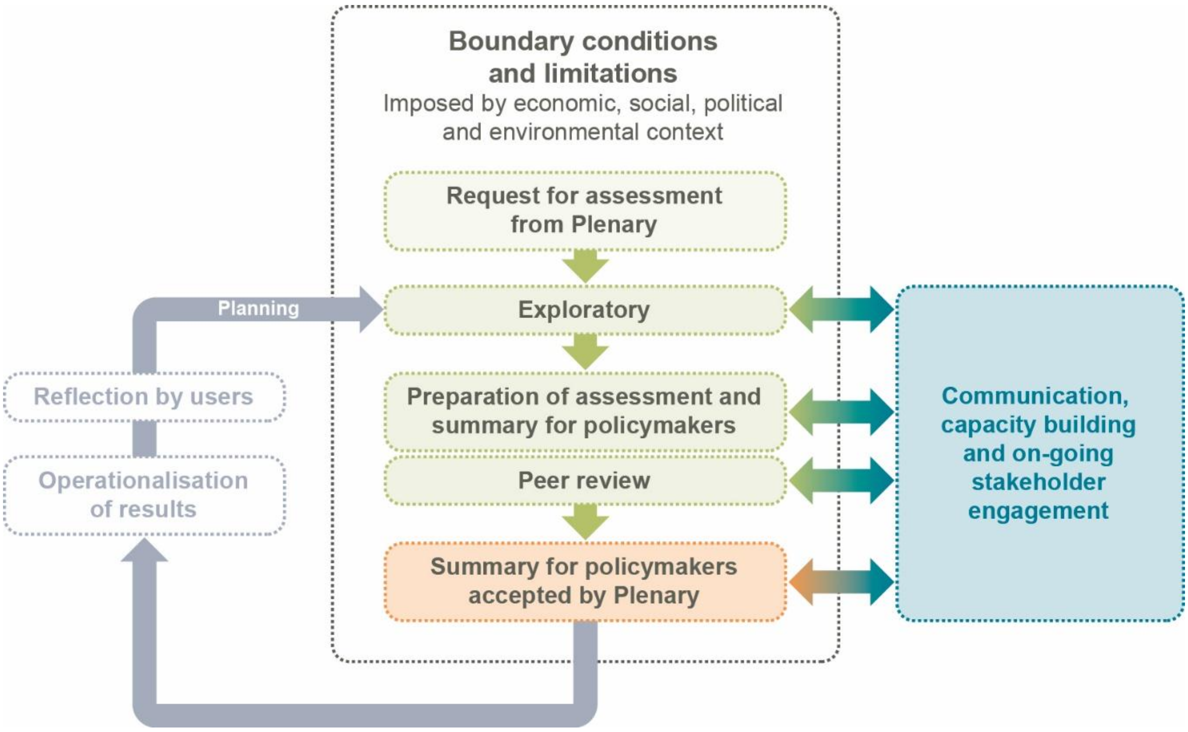


Figure 3.1. The IPBES assessment process. Source: adapted from Ash et al. 2010

3.2 The Exploratory Stage

The exploratory stage or scoping stage of an assessment investigates how and why an ecosystem assessment might be undertaken and generally has three main components:

1. Determining the need for an assessment
2. Defining the key questions the assessment will be designed to answer
3. Initial examination of potential design constraints

It can be helpful to convene a technical and user planning group to address these issues and clarify the direction and applicability of applicability of assessment outputs (Box 3.1). The scoping process aims to define the scope and objectives of an assessment and evaluate the necessary information, human and financial requirements to achieve that objective. The scoping process should also consider the type and availability of knowledge, including local and indigenous knowledge (ILK) that is required to address the policy questions that have been identified. The scoping study should consider how this knowledge will be accessed and by whom. Identification of knowledge gaps is an important part of the assessment process that should also be considered during the scoping process. Mobilisation of indigenous and local knowledge holders and contributions to the scoping through co-design is important at this stage (see Chapter 7).

Box 3.1: Scoping study for a National Ecosystem Assessment in Germany

In 2014, an interdisciplinary team at the Helmholtz Centre for Environmental Research (UFZ), in collaboration with external scientists, undertook a scoping study to investigate implementation options for a National Assessment of Ecosystems and their Services for the Economy and Society in Germany (NEA-DE).

The study identified the needs of potential assessment stakeholders and addressed the political questions around the validity of outputs from a NEA-DE. Further conclusions to arise from this study include:

- identification of the social, political and economic context that NEA-DE could contribute to;
- objectives and potential research questions of a NEA-DE;
- modular implementation concept for the NEA-DE; and
- analysis of current data availability for a NEA-DE.

Two possible implementation concepts were presented: a complete assessment; or a more scaled down, focused assessment. The project team is planning a strategic workshop to take this information forward and develop a conceptual framework.

Source: Albert et al. 2014

3.2.1 Scoping studies under IPBES

The first stage in the IPBES assessment process is for requests, inputs and suggestions to be submitted to the IPBES Secretariat consistent with decision IPBES/1/3.These inputs and suggestions are then considered by the Multidisciplinary Expert Panel (MEP) and the Bureau[6].

The procedure for the scoping process of an IPBES assessment is shown in Figure 3.2. As part of the initial evaluation and prioritisation process, the MEP and Bureau will undertake an initial scoping of an assessment, including examining feasibility and estimated costs. This initial scoping study may also contain pre-scoping material, usually provided by the body making the original request for the assessment. Using this information the MEP, in conjunction with the Bureau, will prepare a report containing a prioritised list of requested assessments to be submitted to the Plenary. The report will contain an analysis of the scientific and policy relevance of the requests, including the implication of the requests for the Platform’s work programme and resources requirements. The Plenary has two options: fast-track or detailed scoping. A fast-track assessment can go ahead with the detailed scoping study and proceeds to implementation without the need to further consider the outcomes of the scoping exercise. In other cases, the Plenary will request a detailed scoping before agreeing an assessment following recommendation by the MEP and the Bureau.

[6] See paragraph 7 and 9 of decision IPBES/1/3.

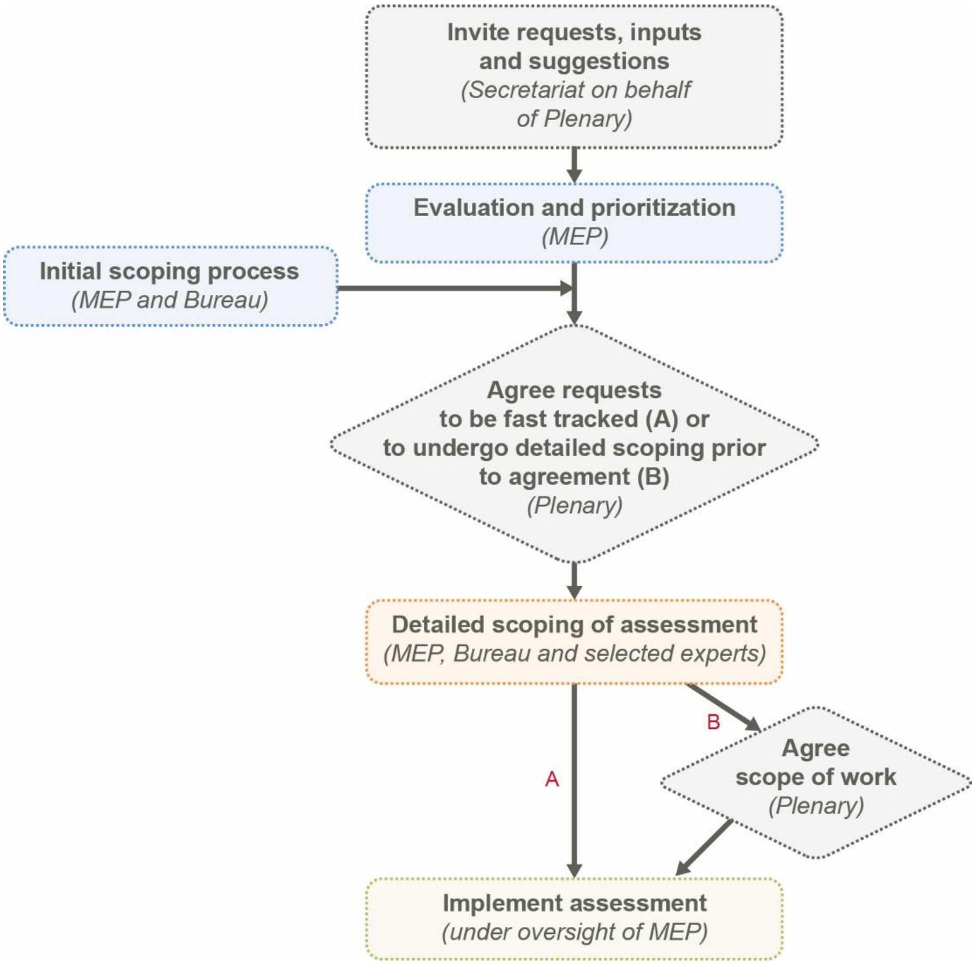


Figure 3.2: IPBES assessment scoping process (blue outline = Exploratory stage; orange outline = Design stage; green outline = Implementation stage). Source: adapted from IPBES/2/9.

The detailed scoping study will be conducted by experts selected from nominations from Governments and invited relevant stakeholders and will be overseen by the MEP and Bureau.

Following the scoping stage, and assuming acceptance by the Plenary, the Plenary will then formally request the MEP to proceed with an assessment. The detailed scoping report that was produced as part of the scoping stage is then sent to members of the Platform for review and comment over a four-week period and made available on the Platform website. Based on the results of the detailed scoping exercise and comments received from members of the Platform and other stakeholders, the MEP and the Bureau then decide whether to proceed with the assessment, working under the assumption that it could be conducted within the budget and timetable approved by the Plenary.

3.2 The Design Stage

A work plan with clearly defined timelines and milestones makes it easier to monitor progress. Setting out a clear work plan can minimise problems by allowing for conflict resolution, providing a mechanism to monitor progress and enabling integration of the work into a single product.

The design stage explores the key features of the assessment including:

1. Governance Structure (who and how)
2. Conceptual Framework (assessment aims; see Chapter 1)
3. Scale (temporal/spatial; see Chapter 2)
4. Knowledge Sources (scientific, traditional; see Section IV)
5. Processes for engaging indigenous and local knowledge (ILK) holders (see Chapter 7)

Defining who will be involved in an assessment, and what their respective roles and functions will be, is critical for ensuring user engagement, raising funds, and overseeing assessment progress. Effective governance provides leadership and can ensure the relevance, legitimacy and credibility of the assessment process and its findings. The governance structure is dependent upon the size and scope of the assessment at hand, and can be made up of representatives from key audience groups such as community leaders, scientists and scientific institutions, technical experts, political leaders and other stakeholders (see Box 3.2).

Box 3.2: Key audience groups

The scoping phase should identify key audience groups. Early and consistent stakeholder engagement will help those conducting the assessment understand stakeholders' needs and priorities and so help to shape the production of relevant assessment outputs. The type and scale of the assessment will determine these key audience groups, however time and budget constraints may also influence the ultimate decision on where to target communication of the key messages. There may be a need to utilise different media for diverse audiences, e.g. articles, leaflets or workshops, and the increased costs of producing these varying outputs may be a limiting factor in achieving far-reaching dissemination across multiple audience groups.

Common audiences for assessment information include:

- Governments (various levels and various departments)
- Planners
- Politicians
- Researchers and analysts
- Non-governmental organizations
- General public
- Schools and universities
- Industries and business
- Women's groups
- Indigenous peoples' and local communities' groups
- Media

Source: Ash et al., 2010

3.2.1 Who's who in an IPBES assessment

The Rules of Procedure[7] set out the function and nomination process for the different roles with in an IPBES assessment. From the nominations received The MEP will select the report co-chairs, coordinating lead authors, lead authors and review editors from nominations it receives, using the selection criteria set out in Box 3.3. The proportion of stakeholder-nominated experts should not exceed twenty percent[8]. The functions of these roles is summarised in Table 3.1.

Box 3.3: Selection of report co-chairs, coordinating lead authors, lead authors and review editors

The composition of the group of coordinating lead authors and lead authors for a given chapter, report or its summary should reflect the range of scientific, technical and socio-economic views and expertise; geographical representation, with appropriate representation of experts from developing and developed countries and countries with economies in transition; the diversity of knowledge systems that exist; and gender balance. The Multidisciplinary Expert Panel will inform the Plenary on the selection process and the extent to which the above-mentioned considerations were achieved therein, and on the persons appointed to the positions of report co-chairs, coordinating lead authors, lead authors and review editors for the various chapters. Every effort should be made to engage experts from the relevant region on the author teams for chapters that deal with specific regions, but experts from other regions can be engaged when they can provide an important contribution to the assessment.

The coordinating lead authors and lead authors selected by the Multidisciplinary Expert Panel may enlist other experts as contributing authors to assist with the work.

Source: IPBES/2/17

[7] IPBES2/3.
[8] IPBES/2/17.

Table 3.1

Summary of the different roles within an IPBES Assessment process

Role	Function	Nomination Process
Assessment co-chair	An assessments co-chair's role is to assume responsibility for overseeing the preparation of an assessment report or synthesis report and ensuring that the report is completed to a high standard.	Governments, the scientific community and other stakeholders are able to nominate appropriate experts for the roles of Co-chairs, CLAs and LAs in response to requests from the Chair of IPBES. In addition to a call for nominations Members of the Multidisciplinary Expert Panel and the Bureau will contribute, as necessary, to identifying relevant experts to ensure appropriate representation from developing and developed countries and countries with economies in transition as well as an appropriate diversity of expertise and disciplines, gender balance and representation from ILK holders. Such nominations will be compiled in lists that are made available to all Platform members and other stakeholders and maintained by the Platform secretariat. Experts with the most relevant knowledge, expertise and experience may only be chosen once an assessment topic has been fully scoped. Every effort should be made to engage experts from the relevant region on the author teams for chapters that deal with specific regions, but experts from countries outside the region should be engaged when they can provide an important contribution to the assessment. The nomination process will follow these steps: 1. Nominees will be invited to fill out an Application form and attach their Curricula Vitae through the dedicated web portal (www.ipbes.net/applicationform.html)
Coordinating Lead Authors (CLAs)	A coordinating lead author's role within an assessment is to assume overall responsibility for coordinating the major sections and/or chapters of an assessment report. Coordinating lead authors are lead authors who, in addition to their responsibilities of a lead author, have the responsibility of ensuring that the major sections and/or chapters of a report are completed to a high standard and are collated and delivered to the report co-chairs in a timely manner and conform to any overall standards of style set for the document. Coordinating lead authors also play a leading role in ensuring that any cross-cutting scientific, technical or socio-economic issues of significance to more than one section of a report are addressed in a complete and coherent manner and reflect the latest information available.	
Lead Authors (LAs)	The role of a lead author is to assume the responsibility of producing designated sections or parts of chapters that respond to the work programme of the Platform on the basis of the best scientific, technical and socio-economic information available.	

Role	Function	Nomination Process
	Lead authors typically work in small groups that together are responsible for ensuring that the various components of their sections are put together on time, are of a uniformly high quality and conform to any overall standards of style set for the document. The essence of the lead authors' role is to synthesize material drawn from the available literature, fully-justified unpublished sources, contributing author's stakeholders and experts where appropriate.	2. The Application Form will automatically be sent to the Nominating Government or Organisation (Nominator) indicated by the Nominees with an email which will provide a link to a Nomination Form inviting the Nominators to approve and submit their nominations. 3. Nominators and Nominees will receive an acknowledgement message once the Nomination Form confirming the nomination is submitted.
Contributing Authors (CAs)	A contributing author's role is to prepare technical information in the form of text, graphs or data for inclusion by the lead authors in the relevant section or part of a chapter. Input from a wide range of contributors is key to the success of Platform assessments. Contributions are sometimes solicited by lead authors but spontaneous contributions also encouraged. Contributions should be supported, as far as possible, with references from the peer reviewed and internationally available literature.	The coordinating lead authors and lead authors selected by the MEP may enlist other experts as contributing authors to assist with the work.
Review Editors (REs)	Review Editors carry out the following activities: (i) to assist the Multidisciplinary Expert Panel in identifying reviewers for the expert review process, (ii) ensure that all substantive expert and government review comments are afforded appropriate consideration, (iii) advise lead authors on how to handle contentious or controversial issues and (iv) ensure that genuine controversies are adequately reflected in the text of the report concerned. Responsibility for the final text of the report remains with the relevant CLAs. In general, there will be two review editors per chapter, including its executive summary. Review editors are not actively engaged in drafting reports and may not serve as reviewers for text that they have been involved in writing. Review editors may be drawn from among members of the Multidisciplinary Expert Panel, the Bureau or other experts as agreed by the Panel.	REs are nominated through the same process as authors.

Role	Function	Nomination Process
	Review editors must submit a written report to the Multidisciplinary Expert Panel and, where appropriate, will be requested to attend a meeting convened by the Multidisciplinary Expert Panel to communicate their findings from the review process and to assist in finalizing summaries for policymakers and, as necessary, synthesis reports. The names of all review editors will be acknowledged in the reports.	
Expert Reviewers	Expert reviewers are to comment on the accuracy and completeness of the scientific technical and socio-economic content and the overall balance between the scientific, technical and socio-economic aspects of the drafts according to their knowledge and experience.	Expert reviewers are identified by the MEP
Technical Support Unit (TSU)	Although the IPBES Secretariat is mandated to provide technical support to the expert working groups, it is probable that the technical support required will outstrip the capacity available. A number of solutions to this have been proposed including the creation of expert group specific technical support units: whose task is to coordinate and support the activities of working groups and task forces. Dedicated technical support units under the oversight of the Secretariat to coordinate and administer specific activities of expert groups, networks etc. Actual functions would vary depending on activities being undertaken by the body being supported. The IPCC runs under such a distributed model for technical support to its assessment working groups.	One possible mechanism for managing technical support may be through strategic partnerships which aim to use the expertise and experience of other organizations where this is relevant to supporting delivery of the work programme, in anticipation that this will provide a cost-effective approach if implemented in an appropriate manner.

3.3 The Implementation Stage

This is the technical stage of the assessment, which undertakes preliminary assessments of each of the focus areas identified in the scoping study. Work undertaken at this stage can include consideration of:

1. The **status and trends** of priority ecosystems and services and the associated drivers of change
2. **Scenarios** – development of descriptive story lines to illustrate the consequences of different plausible kinds of change in drivers, ecosystems and their services and human well-being (see Chapter 6)
3. **Valuation** of services – present and future; monetary and non-monetary
4. Mobilisation of **indigenous and local knowledge**, both *in-situ* (living knowledge systems in the communities) and *ex-situ* (in scientific and grey literature; see Chapter 7)
5. Analysing **response options** – i.e. Examining past and current actions that have been taken to enhance contribution of ecosystem services to human well-being

For most assessments, the key output will be a report detailing the methodological processes and technical findings of the assessment. However, in some cases the production of a series of tailored reports may be necessary in order to communicate effectively to all intended audience groups.

The first draft of this report should be prepared by the report co-chairs, coordinating lead authors and lead authors, with the secretariat maintaining communication between the authors and experts on assessment themes and expected timeframe. Lead authors must work on the basis of contributions submitted by experts. Peer-reviewed and publically available literature should underpin these contributions and any unpublished materials, including indigenous and local knowledge, must be cited accordingly (see Chapter 7). Assessment authors should be mindful of the language used in the preparation of the first draft and the range of scientific, technical and socio-economic evidence should be presented clearly and concisely (Box 3.4).

Box 3.4: Some useful writing suggestions for assessment reports

These suggestions are based on comments received during the Millennium Ecosystem Assessment peer review process.

- Discuss the problems and actions first. Any necessary background can come later, in an appendix or in references to other sources.
- Focus on definable measures and actions and avoid the passive voice. For example, policy professional are likely to ignore statements like "there are reasons to believe some trends can be slowed or even reversed". If there are some opportunities for reversal, state precisely what we believe they are, as best we know.
- Statements like "...might have enormous ramifications for health and productivity...," while they seem to the scientist to be strong because of the word "enormous" are actually politically impotent because of the word "might." If data were used in the assessment, what do they say about what "is" happening? What can we recommend, based on best knowledge, about what actions would be effective?
- Statements like "There is a long history of concern over the environmental effects of fishing in coastal habitats, but the vast scope of ecological degradation is only recently becoming apparent (citation)" is a case where something strong could be said, but it is weakened by putting the emphasis on the late arrival of this information and knowledge "becoming apparent." It does not matter so much when the degradation was discovered, what matters is that it was. Cite the source and say "fishing practices are causing wide-spread destruction."
- Do not use value-laden, flowery, or colloquial language (e.g. "sleeping dragon," "elephant in the room," etc.).
- Statements like "we do not yet have clear guidelines for achieving responsible, effective management of natural resources" could result in a legitimate policy response of "OK, so we'll wait until we do." Instead, the statement could be changed to recommend what needs to be done, such as "if clear guidelines were developed, then..."
- Diverse formats and modes of communication, for example participatory maps, artwork and visual imagery, will be important for working with indigenous and local knowledge (see Chapter 7).

Source: Ash et al., 2010

3.3.1 Developing an IPBES Assessment report

Assessment reports and synthesis reports prepared for the Platform require the report co-chairs, coordinating lead authors, lead authors, reviewers and review editors to produce "technically and scientifically balanced assessments" (IPBES 2/3). Following the relevant scoping study or studies, approval process, and selection of experts and authors, there are a number of steps to be carried out in the preparation of the Platform assessment report(s).These steps are dependent upon the type of assessment being undertaken (Table 3.2).

Table 3.2

Steps in preparation of Platform assessment report(s) following acceptance of the Scoping document by Plenary

Step	Standard–thematic or methodological assessments	Fast Track–thematic or methodological assessments	Regional, subregional or global assessments
1	The report co-chairs, coordinating lead authors and lead authors prepare the first draft of the report. ILK is mobilized for inclusion in the first draft.	The report co-chairs, coordinating lead authors and lead authors prepare first drafts of the report and the summary for policymakers. ILK is mobilized for inclusion in the first draft.	The report co-chairs, coordinating lead authors and lead authors prepare the first draft of the report. ILK is mobilized for inclusion in the first draft.
2	The first draft of the report is peer reviewed by experts in an open and transparent process. ILK-holders engage in reviewing and validation inclusion of their knowledge in the draft.	The first drafts of the report and the summary for policymakers are reviewed by Governments and experts in an open and transparent process. ILK-holders engage in reviewing and validation inclusion of their knowledge in the draft.	The first draft of the report is peer reviewed by experts in an open and transparent process. The review of regional and subregional reports will emphasize the use of expertise from, as well as relevant to, the geographic region under consideration. ILK-holders engage in reviewing and validation inclusion of their knowledge in the draft.
3	The report co-chairs, coordinating lead authors and lead authors prepare the second draft of the report and the first draft of the summary for policymakers under the guidance of the review editors and the Multidisciplinary Expert Panel.	The report co-chairs, coordinating lead authors and lead authors revise the first drafts of the report and the summary for policymakers with the guidance of the review editors and the Multidisciplinary Expert Panel.	The report co-chairs, coordinating lead authors and lead authors prepare the second draft of the report and the first draft of the summary for policymakers under the guidance of the review editors and the Multidisciplinary Expert Panel.
4	The second draft of the report and the first draft of the summary for policymakers are reviewed concurrently by both Governments and experts in an open and transparent process. ILK-holders engage in reviewing and validation inclusion of their knowledge in the draft.	The summary for policymakers is translated into the six official languages of the United Nations and prior to distribution is checked for accuracy by the experts involved in the Assessments. ILK-holders engage in reviewing and validation inclusion of their knowledge in the draft.	The second draft of the report and the first draft of the summary for policymakers are reviewed concurrently by both Governments and experts in an open and transparent process. ILK-holders engage in reviewing and validation inclusion of their knowledge in the draft.

Step	Standard–thematic or methodological assessments	Fast Track–thematic or methodological assessments	Regional, subregional or global assessments
5	The report co-chairs, coordinating lead authors and lead authors prepare final drafts of the report and the summary for policymakers under the guidance of the review editors and the Multidisciplinary Expert Panel	The final drafts of the report and the summary for policymakers are sent to Governments for final review and made available on the Platform website	The report co-chairs, coordinating lead authors and lead authors prepare final drafts of the report and the summary for policymakers under the guidance of the review editors and the Multidisciplinary Expert Panel
6	The summary for policymakers is translated into the six official languages of the United Nations and prior to distribution is checked for accuracy by the experts involved in the assessments. The summary for policy-makers is prepared in formats suitable for ILK-holders.	Plenary reviews and may accept the report and agree the summary for policymakers. The summary for policy-makers is prepared in formats suitable for ILK-holders.	The summary for policymakers is translated into the six official languages of the United Nations and prior to distribution is checked for accuracy by the experts involved in the assessments. The summary for policy-makers is prepared in formats suitable for ILK-holders.
7	The final drafts of the report and the summary for policymakers are sent to Governments for final review and made available on the Platform website		The final drafts of the report and the summary for policymakers are sent to Governments for final review and made available on the Platform website
8	Governments are strongly encouraged to submit written comments to the secretariat at least two weeks prior to any session of the Plenary		Governments are strongly encouraged to submit written comments to the secretariat at least two weeks prior to any session of the Plenary
9	The Plenary reviews and may accept the report and agree the summary for policymakers.		The Plenary reviews and may accept the report and agree the summary for policymakers.

3.3.2 Peer review process

The peer-review stage is a vital element in the assessment process, and should be given careful consideration from the outset. Comprehensive review processes can (as indicated in TEEB, 2013):

- provide guidance
- ensure robustness
- provide a fresh perspective
- augment results
- add legitimacy
- help to ensure greater buy-in to the findings

The selection of suitable peer-reviewers should not be restricted to scientists and assessment practitioners, but involve a range of assessment users. This will contribute further to stakeholder engagement while providing a broader set of comments through which to enhance the assessment's perceived legitimacy (Ash et al., 2010).

The logistical side of peer review can be complicated so you need to allocate adequate time and resources for this process during the design stage. It is advised that one or two members of the assessment team are designated as a central contact point in order to deal with administrative tasks, such as the distribution of assessment materials and collation of review comments. Select peer-reviewers as early as possible and tell them: when the assessment outputs will be available; what the format and size of outputs will be (e.g. number of chapters and/or pages); what sections they are expected to comment on; and deadlines for submission of comments. This will allow them to prepare their own time schedules and maximize their engagement in the process.

It is crucial that peer-reviewers are given clear guidance, including:

- a background to the assessment;
- the timeline for peer-review;
- what reviewers are expected to comment on e.g.
    - the overall direction and content of the report
    - methods and analysis
    - overarching conclusions
    - whether there is any additional material that should be considered for inclusion;
- how to submit comments (i.e. email, post or online);
- how the reviewer will be acknowledged in the report (if applicable);
- how their comments will be addressed by the respective authors; and
- when outputs are expected to be disseminated.

A review template can be provided to all peer-reviewers to make it easier to collate comments submitted (see Table 3.3). When preparing the documents for peer review, consider including section, page and line numbers so that these can be recorded by the reviewer in the review template.

Table 3.3
Example of a review template

Section number	Page number	Line number	Comment
1	2	3	xxxxx

3.3.2.1 IPBES peer review process

The MEP and Bureau will assist the authors in ensuring the reports are peer-reviewed in accordance with the present procedures (IPBES2/3). This includes ensuring adherence to the three governing principles of Platform report peer-review: the provision of preeminent expert advice; ensuring comprehensive independent representation; and following a transparent and open process (Figure 3.3).

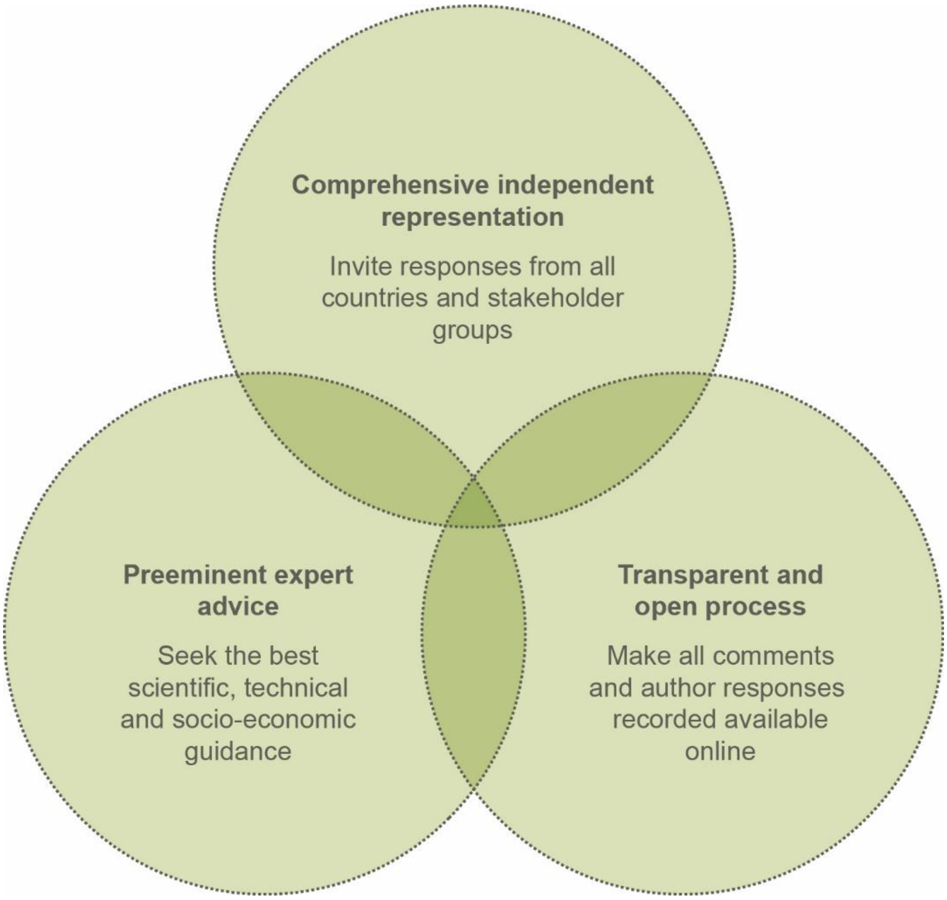


Figure 3.3: Three principles of Platform report review processes

The review process for Platform reports normally consists of three stages, which should be coordinated in a timely manner according to the type of assessment undertaken (IPBES2/3):

1. Review by experts(first review);
2. Review by Governments and experts(second review);
3. Review by Governments of summaries for policymakers and/or synthesis reports.

All written review comments by experts and Governments will be made available on the Platform website during the review process. The draft Platform reports and author responses to review comments will be made available as soon as possible following the finalization of the report.

First review (by experts)

The MEP circulates the first draft of a report for review, through the secretariat,.

Governments should be notified of the start of the first review process. The first draft of a report should be sent by the secretariat to government-designated national focal points for information purposes. A full list of reviewers should be made available on the Platform's website.

On request, the secretariat should make available any material that is referenced in the document being reviewed that is not available in the international published literature.

Expert reviewers should provide the comments to the appropriate lead authors through the secretariat.

Second review (by Governments &experts)

The Platform secretariat should distribute the second draft of the report and the first draft of the summary for policymakers to Governments through the government-designated national focal points, the Bureau of the Plenary, the Multidisciplinary Expert Panel and the report co-chairs, coordinating lead authors, lead authors, contributing authors and expert reviewers.

Government focal points should be notified of the start of the second review process some six to eight weeks in advance. Governments should send one integrated set of comments for each report to the secretariat through their designated national focal points. Experts should send their comments to the secretariat.

3.3.3 Preparing the final draft report

Report co-chairs, coordinating lead authors and lead authors, in consultation with the review editors, should prepare a final draft for submission to the Plenary. The final draft should reflect comments made by Governments and experts. If necessary, the MEP working with authors, review editors and reviewers can try to resolve areas of major differences of opinion.

Reports should describe different, possibly controversial, scientific, technical and socio-economic views on a given subject, particularly if they are relevant to the policy debate. The final draft of a report should credit all report co-chairs, coordinating lead authors, lead authors, contributing authors, reviewers and review editors and other contributors, as appropriate, by name and affiliation, at the end of the report.

3.3.3.1 Summary for Policy Makers

What is a Summary for Policy Makers?

A Summary for Policy Makers (SPM) is a short document that highlights the main findings of an assessment responding to its scoping report and tailored to the needs of policy makers. It consists of a limited number of key findings which is followed by more detailed findings and graphics. Findings are usually formulated in one or two bolded sentences each which is further substantiated or explained in a paragraph which follows from the main message. Findings are given with confidence levels and references which makes them traceable back to the main report.

Responsibility for preparing first drafts and revised drafts of SPMs lies with the report co-chairs and an appropriate representation of coordinating lead authors and lead authors, overseen by the Multidisciplinary Expert Panel and the Bureau.

The first review of a SPM will take place during the same period as the review of the second draft of a report by Governments and experts in an open and transparent manner. The final draft of a summary for policymakers will be circulated for a final round of comments by Governments in preparation for the session of the Plenary at which it will be considered for approval.

The SPMs of each IPBES assessment will be approved by the IPBES plenary. “Approval” of the Platform’s summaries for policymakers signifies that the material has been subject to detailed, line-by-line discussion and agreement by consensus at a session of the Plenary. Approval of a summary for policymakers signifies that it is consistent with the factual material contained in the full scientific, technical and socioeconomic assessment accepted by the Plenary. Report co-chairs and coordinating lead authors should be present at sessions of the Plenary at which the relevant summary for policymakers is to be considered in order to ensure that changes made by the Plenary to the summary are consistent with the findings in the main report.

The summaries for policymakers is formally and prominently described as reports of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services.

The features of an SPM are:

- sets out policy relevant messages from the assessment while not being policy prescriptive
- builds on the executive summaries (key findings) from each chapter from the technical assessment report

The development of an SPM is an iterative process as explained in the steps below (see Figure X.1). You will need to move constantly checking information in the Chapter Executive Summaries contain the information that underpins the messages set out in the SPM. And that the analysis set out in the assessment chapters supports the findings in the Chapter Executive Summary. Fundamentally, no information, data or knowledge should appear in the SPM that does not appear in the technical assessment report.

Steps to developing an SPM

Step 1: Developing chapter executive summaries

The first step in developing an SPM, is the development of an Executive Summary for each chapter. The Executive Summaries set out the key findings with the appropriate confidence terms for a particular chapter (see Chapter 4 for further guidance on applying Confidence Terms). The content of the Executive Summary should be technical in nature and be based on the analysis set out in the chapter.

Step 2: Identify the policy relevant messages

One of the key differences between the Executive Summaries and the SPM is moving from setting out the technical facts to blending and synthesising the findings from different chapters into policy relevant messages. Each message should be referenced to where the supporting evidence can be found in the assessment chapters.

To start with you might like to begin by envisaging the different decision makers receiving the SPM and assessment report. And then ask the following questions:

- What information would the decision maker expect or be surprised by from the assessment report?
- What would the questions be that the decision makers want most answered? (these are set out in the approved Scoping Document for an IPBES assessment)
- What information does the decision makers need in order to implement change?
- What information would help a decision maker convince others of the rationale for further action?

There is a tendency to make very general comments when aggregating key findings together and which are often not relevant for the policy agenda. It is therefore important to keep in mind who you are writing the SPM for. The importance of the IPBES review process should be highlighted here as it gives the opportunity for governments as members of the Platform to provide comment on the SPM. These insights might be helpful to continue the shaping of the SPM.

Step 3: Revisit chapters in light of the identified policy relevant messages

Remember that developing an SPM is an iterative process. Once you have identified the key policy relevant messages, it is important to revisit the technical assessment report and ask the following questions:

- Have we undertaken the analysis that would support the messages set out in the SPM and are they central to the arguments set out in the chapter?
- Have we pulled out and brought forward the necessary facts and figures that can substantiate and exemplify the findings?
- Have we identified the uncertainties and range of views that a policy maker needs to be aware of?

Step 4: Drafting the SPM

At this point you will need to think about structure of the SPM. The structure should follow the key messages identified in step 2. At this point you should reflect again on the storyline for the SPM (e.g. if you were to read only the key messages does it tell the story/macro-story you want policy makers to understand). It is important to identify facts and figures that can be used to illustrate, exemplify and help tell the story.

You might consider presenting the policy relevant key messages as a set on the first page of the SPM. This set of short and succinct key messages should then be backed up with a more detailed summary (8-15 pages) which substantiate the key messages. The main message should be the first sentence of a paragraph and be bolded. This should be followed by text including key facts and figures and examples. Confidence terms should by applied and the range of views on a topic that a policy maker should be aware of presented. If appropriate then use bullet points to present lists and also include key graphics or develop graphic synthesis that help to illustrate the key messages of the assessment. The context of the assessment should also be included in the SPM. Once you have drafted the SPM it is suggested that you reflect once again on the questions posed by the assessment and ensure that the SPM addresses these.

Remember that the SPM for IPBES assessments will be approved line by line within the Plenary, therefore it is important to develop a succinct summary based upon the analysis of the assessment. Use confidence terminology to ensure that no ambiguity appear in regards to the messages and analysis in the SPM. Each finding should also contain a footnote with a reference back to the number of the section or sections of the main report that the finding is drawn from.

<Structure and text Example from the SPM of the pollination assessment to be included once it is approved.>

3.3.3.2 Language and translation

We advise that translation be considered as early in the process as possible. Experience from the MA showed that translation of the final outputs into the official UN languages proved to be more complicated than expected. Translation processes proved to be time-consuming as multiple reviews of translated texts were necessary to ensure quality (Ash et al., 2010).

The working language of IPBES assessment meetings will normally be English. Subregional and regional assessment reports may be produced in the most relevant of the six official languages of the United Nations. All summaries for policymakers presented to the Plenary will be made available in the six official languages of the United Nations and checked for accuracy prior to distribution by the experts involved in the assessments.

3.3.3.3 Key messages and key findings

While the full assessment reports are useful reference documents, it is important to synthesise this information into targeted key messages for interested parties who may have little time to fully engage. Often, these ‘Key messages’ are confused with the 'Key findings' of an assessment and are therefore do not adequately convey the content and conclusions in a way that will resonate with key audiences. Key findings are defined as the facts and information drawn directly from the technical chapters, while key messages are a "strategic culling of the points most relevant to each audience, presented in a way that promotes the credibility of the findings" (Ash et al., 2010; Table 3.4).

Table 3.4

Example of the key findings and key messages of the UKNEA (2011)

Key Findings	Key messages
The economic, human health and social benefits that we derive from ecosystem services are critically important to human well-being and the UK economy, and each should be considered when evaluating the implications of changes in ecosystems and their services.	The natural world, its biodiversity and its constituent ecosystems are critically important to our well-being and economic prosperity, but are consistently undervalued in conventional economic analyses and decision-making.
The landscape of the UK has changed markedly during the last 60 years with the expansion of Enclosed Farmlands, Woodlands and Urban areas, and the contraction and fragmentation of Semi-natural Grasslands, upland and lowland Heaths, Freshwater wetlands and Coastal Margin habitats.	Ecosystems and ecosystem services, and the ways people benefit from them, have changed markedly in the past 60 years, driven by changes in society.
• The expansion of Woodlands has contributed to both improved climate regulation, through greater carbon sequestration, and air quality, while at the same time increased timber supply. More recent changes in forest policy and woodland management have enhanced general amenity value and wild species diversity. • Expansion of Urban areas has degraded regulating services for climate, hazards, soil and water quality, and noise. • Fragmentation and deterioration of wetlands, and in particular these parathion of rivers from their floodplains, has compromised hazard (flood) regulation and many other ecosystem services.	The UK's ecosystems are currently delivering some services well, but others are still in long-term decline.
Contemporary society is less sustainable than it could be. Responding to the pressures to provide food, water and energy security, while at the same time conserving biodiversity and adapting to rapid environmental change, will require getting the valuation right, creating functioning markets for ecosystem services, improving the use of our resources and adopting new ways of managing those resources.	The UK population will continue to grow, and its demands and expectations continue to evolve. This is likely to increase pressures on ecosystem services in a future where climate change will have an accelerating impact both here and in the world at large.
In future, the management of ecosystem services will need to be resilient and adaptive to societal (e.g. demographic), environmental (e.g. climate change) and land use (e.g. increased use of bio-energy) changes. Therefore the underlying indirect and direct drivers of change must be considered.	Actions taken and decisions made now will have consequences far into the future for ecosystems, ecosystem services and human well-being. It is important that these are understood, so that we can make the best possible choices, not just for society now but also for future generations.
The transition to a more sustainable use of ecosystems and their services can be facilitated by taking a more integrated, rather than conventional sectoral, approach to their management, recognizing that some difficult trade-offs will have to be made between individual ecosystem services.	A move to sustainable development will require an appropriate mixture of regulations, technology, financial investment and education, as well as changes in individual and societal behavior and adoption of a more integrated, rather than conventional sectoral, approach to ecosystem management.

3.3.3.4 Addressing possible errors and complaints

The review processes described above should ensure that errors are eliminated well before the publication of Platform reports and technical papers. However, if a reader of an agreed Platform report, accepted summary for policymakers or finalized technical paper finds a possible error (e.g., a miscalculation or the omission of critically important information) or has a complaint relating to a report or technical paper (e.g., a claim to authorship, an issue of possible plagiarism or of falsification of data) the issue should be brought to the attention of the secretariat, which will implement the process for error correction or complaint resolution as set out in decision IPBES 2/3.

3.3.3.5 Conflicts of interest

Highly participatory processes, such as the conducting of ecosystem assessments, will always carry a risk of conflicts of interest among stakeholders. The assessment team, and various governance groups, should be prepared to deal with these issues pro-actively in order to minimize any interruptions to the process. Ash et al. (2010) suggest that some ways of dealing with these issues could be to:

- Establish by consensus clear, but flexible, rules of participation;
- Have an agenda and clear objectives for each meeting that is convened;
- Promote communication among members in between meetings; and
- If the governing body is a large one, create a committee to deal with operative issues between meetings.

3.3.4 Acceptance of reports by the plenary

Reports presented at sessions of the Plenary are the full scientific, technical and socio-economic assessment reports. The subject matter of these reports shall conform to the terms of reference and to the work plan approved by the Plenary or the MEP as requested. Reports presented to the Plenary will have undergone review by Governments and experts. The purpose of these reviews is to ensure that the reports present a comprehensive and balanced view of the subjects they cover. While the large volume and technical detail of this material places practical limitations upon the extent to which changes to the reports can be made at sessions of the Plenary, “acceptance” signifies the view of the Plenary that this purpose has been achieved. The content of the chapters is the responsibility of the coordinating lead authors and is subject to Plenary ‘acceptance’. Other than grammatical or minor editorial changes, after ‘acceptance’ by the Plenary only changes required to ensure consistency with the summary for policymakers shall be accepted. Such changes shall be identified by the lead author in writing and submitted to the Plenary at the time it is asked to accept the summary for policymakers.

Reports accepted by the Plenary should be formally and prominently described on the front and other introductory covers as a report accepted by IPBES.

3.3.4.1 Approval and adoption of synthesis reports by the Plenary

Synthesis reports integrate materials contained in the assessment reports. They should be written in a non-technical style suitable for policymakers and address a broad range of policy-relevant questions as approved by the Plenary. A synthesis report comprises two sections, (a) summary for policymakers, and (b) full report.

There are five steps, as outlined in IPBES 2/3, to the approval and adoption of synthesis reports by the Plenary:

Step 1: The full report (30–50 pages) and the summary for policymakers (5–10 pages) of the synthesis report are prepared by the writing team.

Step 2: The full report and the summary for policymakers of the synthesis report undergo simultaneous review by Governments, experts and other stakeholders.

Step 3: The full report and the summary for policymakers of the synthesis report are revised by the report co-chairs and lead authors with the assistance of the review editors.

Step 4: The revised drafts of the full report and the summary for policymakers of the synthesis report are submitted to Governments and observer organizations eight weeks before a session of the Plenary.

Step 5: The full report and the summary for policymakers of the synthesis report are submitted for discussion by the Plenary:

1. At its session, the Plenary will provisionally accept the summary for policymakers on a line-by-line basis.

2. The Plenary will then review and adopt the full report of the synthesis report on a section-by-section basis in the following manner:

    - When changes in the full report of the synthesis report are required, either for the purpose of conforming to the summary for policymakers or to ensure consistency with the underlying assessment reports, the Plenary and the authors will note where such changes are required to ensure consistency in tone and content.

- The authors of the full report or the synthesis report will then make the required changes, which will be presented for consideration by the Plenary for review and possible adoption of the revised sections on a section-by-section basis. If further inconsistencies are identified by the Plenary, the full report or the synthesis report will be further refined by its authors with the assistance of the review editors for subsequent review on a section-by-section basis and possible adoption by the Plenary.

3. The Plenary will, as appropriate, agree the final text of the full report of the synthesis report and agree the summary for policymakers.

The synthesis report consisting of the full report and the summary for policymakers should be formally and prominently described as a report of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services.

References

Albert, C., Neßhöver, C., Wittmer, H., Hinzmann, M., Görg, C. (2014). *Sondierungsstudie für ein*

Nationales Assessment von Ökosystemen und ihren Leistungen für Wirtschaft und Gesellschaft in

Deutschland. Helmholtz-Zentrum für Umweltforschung – UFZ, unter Mitarbeit von K. Grunewald und

O. Bastian (IÖR), Leipzig. ISBN 978-3-00-046830-8.

Ash, N., Blanco, H., Brown, C., Garcia, K., Henrichs, T., Lucas, N., Raudsepp-Hearne, C., Simpson, R.D., Scholes, R., Tomich, T.P., Vira, B., and Zurek, M. (Eds). (2010). *Ecosystems and Human Well-being: A Manual for Assessment Practitioners*. Washington DC: Island Press.

Booth, H., Simpson, L., Ling, M., Mohammed, O., Brown, C., Garcia, K. & Walpole, M. (2012). *Lessons learned from carrying out ecosystem assessments: Experiences from members of the Sub Global Assessment Network.* Cambridge, UK: UNEP-WCMC.

EME (2014). Communication and education. Retrieved from: http://www.ecomilenio.es/comunicacion

Spanish National Ecosystem Assessment (2013). *Ecosystems and biodiversity for human wellbeing. Synthesis of the key findings* (p. 90). Madrid, Spain: Biodiversity Foundation of the Spanish Ministry of Agriculture, Food and Environment.

TEEB (2013). Guidance Manual for TEEB Country Studies. Version 1.0.

UK National Ecosystem Assessment. (2011). *The UK National Ecosystem Assessment: Synthesis of the key findings*. UNEP-WCMC: Cambridge.

UK National Ecosystem Assessment. (2014). *UK National Ecosystem Assessment Follow on Synthesis Report.* London, UK.

UNEP (2007). *Global Environment Outlook 4.* London, UK: Earthscan Publications.

Chapter 4: Using confidence terms

4.1 What is confidence?

In assessments when we talk about confidence in relation to knowledge, we are referring to how certain experts are about the findings (data and information) presented within their chapters. Low confidence describes a situation where we have incomplete knowledge and therefore cannot fully explain an outcome or reliably predict a future outcome, whereas high confidence conveys that we have extensive knowledge and are able to explain an outcome or predict a future outcome with much greater certainty.

4.1.1 Why does our communication of confidence matter in IPBES assessments?

Knowledge and scientific data about the natural world and the influence of human activities are complex. There is a need to communicate what the assessment author teams have high confidence in as well as what requires further investigation to allow decision makers to make informed decisions. Furthermore, by following a common approach to applying confidence terminology within an assessment, authors are able to increase consistency and transparency.

IPBES assessments will use specific phrases known as “confidence terms” in order to ensure consistency in the communication of confidence by author teams. What confidence term is used will depend on the whether the author team’s expert judgement on the quantity and quality of the supporting evidence and the level of scientific agreement. IPBES assessments will use a four-box model of confidence (Figure 4.1) based on evidence and agreement that gives four main confidence terms: “well established” (much evidence and high agreement), “unresolved” (much evidence but low agreement), “established but incomplete” (limited evidence but good agreement) and “speculative” (limited or no evidence and little agreement).

The following guidance will discuss where confidence terms must be applied in IPBES assessment reports, how to select the appropriate term to communicate the author team’s confidence and to present the confidence terms in the text.

4.1.2 Where to apply confidence terms

Confidence terms should always be used in two key parts of an assessment:

1. They should be assigned to the key findings in **Executive Summaries** of the technical chapters in an assessment report.
2. Within the **Summary for Policymakers.**

4.2 How to select confidence terms

Once the author team has identified the chapter’s key messages and findings, in order to present these in the **Executive Summary** or **Summary for Policymakers**, it is mandatory to evaluate the quality and quantity of associated evidence and scientific agreement. Author teams will always be required to make **qualitative assessments** of confidence based on expert estimates of agreement and evidence.

Depending on the nature of the evidence supporting the key message or finding, **quantitative assessments** of confidence may also be possible. Quantitative assessments of confidence are estimates of the likelihood (probability) that a well-defined outcome will occur in the future. Probabilistic estimates are based on statistical analysis of observations or model results, or both, combined with expert judgment. However, it may be that quantitative assessments of confidence are not possible in all assessments due to the nature of the evidence available.

It is not mandatory to apply confidence terms throughout the main text of the assessment report. However, in some parts of the main text, in areas where there are a range of views that need to be described, confidence terms may be applied where considered appropriate by the author team. In no case should the terms in Figure 4.1 (qualitative terms) or Figure 4.2 (quantitative terms) be used colloquially or casually to void confusing readers. Only use these terms if you have followed the recommended steps for assessing confidence.

4.2.1 Qualitative assessment of confidence

This section discusses the process and language that all author teams must apply to evaluate and communicate confidence qualitatively. The following factors should be considered to evaluate the validity of the message or finding: the type, quantity, quality and consistency of evidence (the existing peer-reviewed literature, grey literature and other knowledge systems such as indigenous and local knowledge[9]), and the level of agreement (the level of concurrence in the data, literature and amongst experts, not just across the author team). The author team's expert judgement on the level of evidence and agreement should then be used to apply a confidence term (Figure 4.1):

- ***Speculative*** – existing as or based on a suggestion or speculation; no or limited evidence.
- ***Unresolved*** – multiple independent studies exist but conclusions do not agree.
- ***Established but incomplete*** – general agreement although only a limited number of studies exist but no comprehensive synthesis and, or the studies that exist imprecisely address the question.
- ***Well established*** – comprehensive meta-analysis or other synthesis or multiple independent studies that agree.

  The ***well established*** box in Figure 1 is further subdivided in order to give author teams the flexibility to emphasise key messages and findings that the author team have very high confidence in:

- ***Very well established*** – very comprehensive evidence base and very low amount of disagreement.
- ***Virtually certain*** –very robust data covering multiple temporal and spatial scales and almost no disagreement.

The qualitative confidence terms discussed in this section should not be interpreted probabilistically and are distinct from "statistical significance".

Virtually certain will not be used by the author teams frequently in the assessment report. The confidence terms used to communicate high confidence are intended to provide authors with the flexibility to emphasise issues that may be considered as fact by the scientific community but not by the non-scientific community (decision makers, media, general public). In most cases it may be appropriate to describe these findings with overwhelming evidence and agreement as statements of fact without using confidence qualifiers.

Similarly, ***speculative*** may also be used infrequently, but is intended to provide authors with the flexibility to emphasise issues that are not established in science but that are important to policy makers or might have been highlighted by a different audience.

The degree of confidence in findings that are conditional on other findings should be evaluated and reported separately.

[9] Note: The Indigenous and Local Knowledge Task Force will provide recommendations on the use of confidence terms with indigenous and local knowledge.

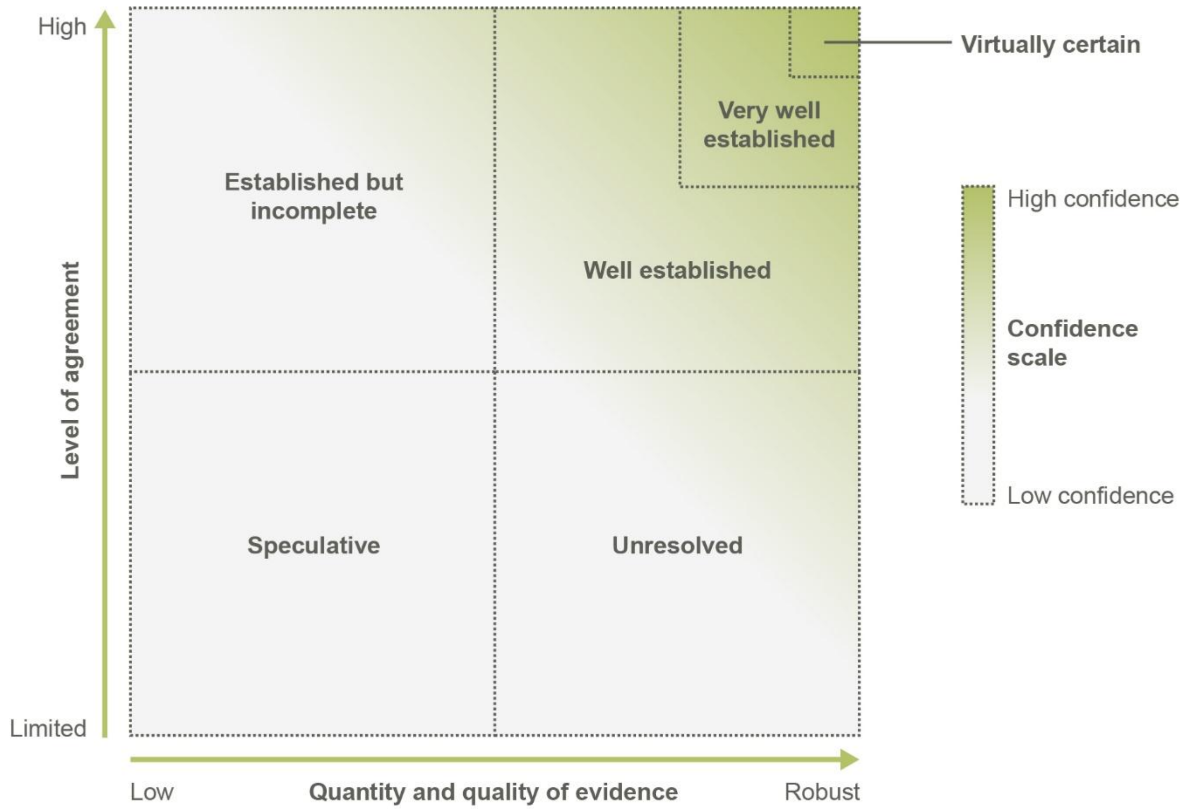


Figure 4.1: The four-box model for the qualitative communication of confidence. Confidence increases towards the top-right corner as suggested by the increasing strength of shading. Source: modified from Moss and Schneider (2000).

When evaluating the level of evidence and agreement for a statement, it is important to standardise the use of the terms within and across the author teams, and when possible, across the assessment, to ensure their consistent use. The use of the above confidence terms can be standardised by taking key messages and findings in the **Executive Summaries** and discussing, as an author team, what terms should be applied and the reasons why. When appropriate, consider using formal elicitation methods to organise and quantify the selection of confidence terms.

Be aware of the tendency for a group to converge on an expressed view and become over confident in it. One method to avoid this would be to ask each member of the author team to write down his or her individual assessment of the level of confidence before entering into a group discussion. If this is not done before group discussion, important views and ranges of confidence may be inadequately discussed and assessed. It is important to recognize when individual views are adjusting as a result of group interactions and allow adequate time for such changes in viewpoint to be reviewed (Mastrandrea et al. 2010). Whichever approach is taken, traceable accounts should be produced and recorded to demonstrate how confidence was evaluated (see section on Traceability).

It is important to carefully consider how the sentences in the key messages and findings are structured because it will influence the clarity with which we communicate our understanding of the level of confidence. For example, sometimes the key finding combines an element that is ***well established*** with one that is ***established but incomplete***. In this case it can be helpful to arrange the phrasing so that the ***well established*** element comes first, and the ***established but incomplete*** element comes second, or as a separate sentence. Where possible avoid the use of the ***unresolved*** and ***established but incomplete*** by writing or rewording key messages and findings in terms of what is known rather than unknown. Author teams should focus on presenting what is ***well established*** as far as possible in order to make it clear to decision makers what is known. Assigning confidence terms to our key findings will therefore often require that we re-write sentences, rather than simply adding the terms to existing text.

ILK-holders are responsible for validating their own knowledge through Approaches and Procedures in Chapter 7. Where statements that are assigned confidence measures include ILK, the steps in Stage 5 of the Procedures (Chapter 7) should be followed. ILK-holders will provide ongoing advice about the development and use of confidence and validity terms that fit with their knowledge systems.

4.2.2 Quantitative assessment of confidence

This section discusses the process and language that author teams may wish to apply in order to evaluate and communicate the confidence that an outcome will occur quantitatively. Likelihood expresses a probabilistic estimate of the occurrence of a single event or of an outcome within a given range. Probabilistic estimates are based on statistical analysis of observations or model results, or both, combined with expert judgment.

When sufficient probabilistic information is available, consider ranges of outcomes and their associated probabilities with attention to outcomes of potential high consequence. The author team's expert judgement on the magnitude of the probability should then be used to apply a likelihood term from Figure 4.2.

Categories in Figure 4.2 can be considered to have nested boundaries. For example, describing an outcome as ***likely*** or ***very likely*** conveys in both cases that the probability of this outcome could fall within the range of 95% to 100% probability, but in the case of ***likely***, the larger range (66-100%) indicates a higher degree of confidence than ***very likely*** (90-100%). In making their expert judgement, author teams should start at ***about as likely as not*** and consider whether there is sufficient quantitative information available to assign either a ***likely*** or ***unlikely*** probability range. Only after thinking about this initial range should the author teams consider whether there is sufficient evidence to move to more extreme levels of probability.

Author teams should note that using a likelihood term for a specific outcome implies that alternative outcomes have the inverse likelihood e.g., if an outcome is ***likely*** (a range of 66-100%) than that would imply that other outcomes are ***unlikely*** (0-33% probability).

If the author team consider that sufficiently robust information is available with which to make a 'best estimate' of the probability of the occurrence of an event, then it is preferable to specify the full probability range (e.g. 90-95%) in the text without using the terms in Figure 2. Also, ***about as likely as not*** should not be used to communicate a lack of knowledge, only an estimate of probability based on the available information.

Author teams should be aware of the way in which key messages and findings are phrased. The way in which a statement is framed will have an effect on how it is interpreted e.g., a 10% chance of dying is interpreted more negatively than a 90% chance of surviving. Consider reciprocal statements to avoid value-laden interpretations e.g., report chances both of dying and of surviving (Mastrandrea et al. 2010).

Finally, author teams should try not to avoid controversial events, such as impacts or events with high consequence but extremely low probability, in their effort to achieve consensus within an author team.

Figure 4.2. Likelihood scale for the quantitative communication of the probability of an outcome occurring. Note that the extreme levels of probability are nested within the broader levels of "likely" and "unlikely". Source: modified from Mastrandrea et al. 2010.

4.3. How to present confidence terms

4.3.1 Presenting confidence using the four-box model

Confidence terms are communicated as part of the key findings of an assessment. The key findings are set out in the **Executive Summaries** for each of the assessment's chapters in the full technical report. The key findings are the facts and information drawn directly from the chapter. It is recommended that key findings should be set out as follows.

The first sentence of the finding should be bolded and contain a confidence term from the four-box model in italics and brackets at the end of the sentence. This first sentence is followed by two to four sentences which then supports the information contained in this first sentence. Subsequent sentences may contain confidence terms within brackets where appropriate. It is not necessary to include confidence terms with each sentence if the whole paragraph falls under the same confidence term.

The words that make up the four-box model and likelihood scale should <u>not</u> be used in the text of the assessment except when formally assigning confidence. If, for example, there was a sentence that used the word "likely" but not with the intended meaning from the likelihood scale, then the word should be replaced with another (e.g. probably).

Box 4.1: Examples of the use of confidence terms

Example 1:

Biodiversity underpins all ecosystem services. Biodiversity plays a wide range of functional roles in ecosystems and, therefore, in the processes that underpin ecosystem services *(well established){1.1}.* Examples range from the roles bacteria and fungi play in nutrient cycles which are fundamental processes in all ecosystems, to particular animal groups, such as birds and mammals, which are culturally important to many people. Ecosystem functions are more stable through time in experimental ecosystems with relatively high levels of biodiversity (*established but incomplete*){1.3}; and there are comparable effects in natural ecosystems. Taken together, this evidence shows that, in general terms, the level and stability of ecosystem services tend to improve with increasing biodiversity. (Source: Norris et al. 2011)

Example 2:

Many organisms create living habitats such as reefs and seagrass meadows. These can provide essential feeding, breeding and nursery space that can be particularly important for commercial fish species (*well established){1.3}*. Such habitats play a critical role in species interactions and the regulation of population dynamics, and are a prerequisite for the provision of many goods and services. Fishing at the seabed with trawl nets and dredging fishing gears severely damages living reefs and deep sea corals, which are very slow-growing and, consequently, take a long time to recover. Boat anchoring, propeller scarring and channel dredging can damage shallow water and intertidal habitats. However, building coastal defences and offshore structures, such as wind turbines, oil platforms and reefs, provides artificial habitats which can have positive impacts, particularly for species usually associated with rocky environments. (Source: Austin & Malcom et al. 2011)

4.3.2 Presenting confidence using the likelihood scale

In some instances, as above, author teams may wish to complement the use of the ***well established*** confidence term with a term from the likelihood scale. If terms from the likelihood scale are used than they should be incorporated into the text and italicised prior to the impact or outcome the probability of which they are describing.

4.4 Traceability

The author team's expert judgment of their confidence in the key messages and findings should be explained by providing a clear traceable account. A traceable account is a description in the chapter of the evaluation of the type, quantity, quality and consistency of the evidence and level of agreement that forms the basis for the given key message or finding (Mastrandrea et al. 2010). Where possible, the description should identify and discuss the sources of confidence. In order to ensure consistency in how the author teams classify sources of confidence within and across IPBES assessments, author teams should use the typology shown in Table 1 below.

A key statement in the **Summary for Policy Makers** should be readily traceable back to an **Executive Summary** statement(s) that in turn should be readily traceable back to a section(s) of the chapter text, which in turn should be traceable where appropriate to the primary literature through references.

References to the relevant **Executive Summary** statement should be included in curly brackets (e.g. {1.2}).

4.5 Summary

A summary of the steps for assessing confidence and selecting a confidence term can be found in Box 4.2 below.

Box 4.2: Summary of steps recommended for assessing and communicating confidence for Executive Summaries and Summaries for Policy Makers

1. Identify the chapter's key messages and findings.
2. Evaluate the supporting evidence and the level of scientific agreement.
3. Engage ILK-holders in validating and evaluating the in-situ and ex-situ ILK included in statements about confidence (Stage 5 in ILK Procedures).
4. Establish whether the evidence is probabilistic or not (e.g. from model predictions).
5. Where the evidence is qualitative instead or probabilistic, select a confidence term from the **four-box model** (Figure 1) to communicate the author team's confidence in the key message or finding.
    a. Assess the quantity and quality of evidence and the level of agreement in the scientific community.
    b. Establish how confident the author team is and select the appropriate term.
6. Where quantitative estimates of the probability of an outcome or impact occurring are available (e.g. from model predictions), select a likelihood term from the **likelihood scale** (Figure 2) to communicate the author teams expert judgement of the range of the probability of occurrence.
7. Ensure that there is always a 'traceable account' in the main text describing how the author team adopted the specific level of confidence, including the important lines of evidence used, standard of evidence applied and approaches to combine/reconcile multiple lines of evidence. Where specific sources of confidence are prominent for a key finding, the terms used in left hand column of Table 1 should be included in the traceable account.
8. OPTIONAL: Consider using formal frameworks for assessing expert judgement for each author team.

Table 4.1

Sources of low confidence.

Source of low confidence	Definition & examples	Qualities	Means of dealing with low confidence
Imprecise meanings of words (Linguistic uncertainty)	Vagueness and ambiguity of terms EXAMPLE: When terms such as human welfare, risks, plant reproductive success, pollination deficits are central to the finding.	Reducible Not quantifiable	• Clear, common definition of terms (IPBES Common Glossary). • Protocols as used in agent based modelling to deal with context dependence
Inherently unpredictable systems (Stochastic uncertainty)	Low confidence due to the chaotic nature of complex natural, social or economic systems (sometimes known as 'aleatory' uncertainty). Findings that depend on weather or climate variables, or market prices, will be subject to this low confidence. EXAMPLE: Pollination deficits and values measured at local scales.	Not reducible Quantifiable	• Clear communication. • Using probabilistic approaches. • Support large scale, long term multi-site studies to quantify the variation over space and time to characterise the low confidence. • Evidence synthesis. • Capacity building for researchers and decision makers
Limits of methods and data (Scientific uncertainty)	Where there is insufficient data to fully answer the question, due to unsatisfactory methods, statistical tools, experimental design or data quality (also referred to as epistemic uncertainty). EXAMPLE: Impacts of pesticides on pollinator populations in the field, trends in pollinator abundance, estimations of ecosystem service delivery.	Reducible Quantifiable	• Acknowledge differences in conceptual frameworks (within and between knowledge systems). • Improve experimental design • Expand data collection. • Support detailed, methodological research. • Knowledge quality asessment. • Evidence synthesis. • Capacity building for scientists.
Differences in understanding of the world (Decision uncertainty)	Low confidence that is caused by variation in subjective human judgments, beliefs, world views and conceptual frameworks (sometimes called epistemic uncertainty). In terms of policy decisions, low confidence is due to preferences and attitudes that may vary with social and political contexts. This can mean a finding looks different in different knowledge systems that cannot easily be aligned. EXAMPLES: Effects of organic farming look	Sometimes reducible Not quantifiable	• Acknowledge differences in conceptual frameworks (within and between knowledge systems). • Document, map and integrate where possible. • Acknowledge existence of biases. • Multi-criteria analysis, decision support tools. • Capacity building for decision makers.

Source of low confidence	Definition & examples	Qualities	Means of dealing with low confidence
	different if you take the view that wild nature beyond farmland has a higher value than farmland biodiversity, and overall food production at a large scale is more important than local impacts. There are divergent interpretations/perceptions of well-being.		

Section III: Use of Methodologies in Assessments

This section is a guide to the use of methodologies in IPBES assessments. This section does not contain all the possible methods which can be or should be employed when undertaking an IPBES assessment at any scale. The chapters included here summaries of methods which have been requested by the Plenary for further assessment and have their own comprehensive guides.

There are a number of other methods, approaches and tools which are essential to undertaking an assessment. For example: systematic reviews form an important step in gathering evidence[10]. Other methods and tools which might be used within an assessment process include trade-off analysis, risk assessments, ecosystem services mapping, participatory approaches, and multi-criteria analysis.

Chapter 5: Values

5.1 Stepwise approach to "assessing diverse conceptualizations of multiple values of nature and its benefits, including biodiversity, ecosystem functions, and services": a summary and directions to the guidance document

This summary provides an introduction to the guidance document and illustrates how it can be used within the context of IPBES work. It contains a stepwise approach to

1. identify the range of dimensions of values and their scopes;
2. find information on values in the literature ;
3. categorise and assess values data and methods involved ;
4. synthesize and then integrate the values in the wider assessment and communicate results.

For each step we outline who within the assessment team should be involved, how to go about the step, referring to relevant sections of the full guidance document or other IPBES documents that provide further detail and illustrations and finally what to document and make transparent about how values were assessed.

Step 1: Identifying value dimensions and understanding where values play a role in your assessment

This step concerns the co-chairs, CLAs and value experts of the assessment team.

The word "value" has interrelated but distinct dimensions and is understood and analysed differently in the biophysical sciences, social sciences, economics, and ILK. It is therefore essential that an assessment team tasked to address diverse values be broadly interdisciplinary and come to a shared understanding of terminology. For example, value can refer to:

- a **measure** (for example the number of species);
- **usefulness or importance** (referred to as assigned values);
- **principles** (referred to as individually or socially held values)
- **preference** (for something or for a particular state of the world)

In the IPBES conceptual framework these dimensions of value are focused on:

- nature (non-anthropocentric or intrinsic values)
- nature's benefits to people (anthropocentric values: instrumental and relational)
- good quality of life (anthropocentric values: instrumental and relational)

In IPBES assessments biophysical measures of nature will be used in different ways. They will play a decisive role in analysing e.g. status and trends of species or ecosystem services, these topics are not addressed here but in xxx. This guide focuses on the values that people associate with nature (principles, importance, and preference). These values can be assessed from sources of ILK, economic analysis, and social sciences analysis (e.g. ethnography) which reflect different worldviews but also by using biophysical measures. A broad range of different methods are used that elicit complementary or conflicting results for the documentation of nature's benefits in different formats.

IPBES assessments should address the values attributed to nature, nature's benefits and a good quality of life. The values are individual or shared, context and scale sensitive, influenced by personal experiences, social norms the socio-cultural and political environment (called institutions in the conceptual framework) and by the biophysical environment itself. Many values change through time, influenced for example by environmental changes, social

[10] www.cebc.bangor.ac.uk/Documents/CEBC%20Systematic%20Review%20Guidelines%20Version%202.0.pdf.

learning and institutional dynamics. Values influence behaviour at individual, institutional and societal levels. Values are influenced by institutional settings that shape issues such as distributional justice and equity, power relations and inclusiveness across stakeholders.

Identify where values are relevant to your assessment:

Each IPBES assessment has a defined purpose (including a set of policy relevant questions and issues) and identifying and assessing values plays a key role in this context. Based on your scoping document, analyse where values, nature's benefits and /or good quality of life are referred to or play a role?

Within the scoping document the sections on utility, policy-relevant questions, all the chapters but particularly those on benefits, scenarios or response options will likely contain relevant information and require some assessment of values.

➢ Ensure valuation/value experts are included in the relevant chapter teams. Economists and social scientists should be adequately represented in the overall team; if this is not the case make sure you identify relevant contributing authors early in the process (or ask the expert group on diverse values for support).

Addressing the following questions can help to scope the values aspect of your assessment:

A. What worldviews are involved, and what issues are at stake, in the mandate of the assessment?

B. What scale or scales are relevant and how do they interact?

C. Does the assessment team have the needed expertise to address the worldviews and scale issues involved? *Following the IPBES conceptual framework, the team may be most effective if it integrates contextually relevant expertise from ILK, ecological science, economics, and other social sciences such as anthropology and human geography.*

D. How are values associated with nature, nature's benefits to people and a good quality of life relevant for the assessment?

E. Considering the diverse conceptualizations of nature, and nature's multiple benefits, what is the possible scope of values that may be relevant in the assessment? *It is useful to first identify all potentially relevant values.*

Step 2: Searching the literature

This step concerns mainly the value experts within the assessment team

Once the team has clarified which chapters of your assessment require addressing values and what value dimensions might be concerned, the next step is to screen the literature to identify relevant studies that report on such values. In searching for relevant literature the team should be deliberative and expansive searching for research that includes diverse values and worldviews, including those associated with or coming directly from ILK holders, going beyond standard peer-reviewed papers. IPBES experts could also utilise workshops to gather relevant information.

Table 5.1 guides you through the search process and can also help with the assessment of the results you find (see step 3), be sure to include the policy-relevant questions of your assessment and identify which values are most appropriate to informing these.

Box 5.1: Some useful search terms for literature search

TEK – traditional ecological knowledge, ILK – indigenous and local knowledge, Worldviews on nature, Worldviews on benefits from nature, Sacred ecology, Good quality of life, Ecological knowledge, Traditional knowledge, Multiple values, Plural values, Socio-ecological systems, Coupled human and natural systems (CHANS), Institutions, IPLC – indigenous peoples and local communities,

Bio-cultural diversity, Integrated valuation, Bridging worldviews, Transdisciplinary approaches, Interdisciplinary approaches, Multi-stakeholder perspectives, Social engagement, Equity, Cultural values/ services, Socio cultural values, Value mismatches, Resilience, Sustainability, Socio-ecological resilience, Shared values

➢ Document the literature search process and make the arguments for your approach explicit.

Step 3: Categorizing, sorting and assessing values – which values have been elicited (in the literature) and how?

This step concerns mainly the value experts within the assessment team

In carrying out an IPBES-based assessment to identify impacts on biodiversity and ecosystem services, and associated threats to human well-being, and effectiveness of responses, an assessment should explore diverse values, world views, valuation methods and their findings. In order to achieve this, assessors should examine how diverse values have been elicited and reflected in the literature.

Table 5.1 provides a heuristic for this step. The following questions can help to collect relevant information and analyse it:

Collecting information about values included in the information sources

A. What dimensions and types of values related to nature, nature's benefit to people and good quality of life have been captured in the study (e.g. article/thesis/report/indigenous research papers)?

Collecting information about valuation perspectives included in the information sources.

B. What world views are reflected in the study? e.g. Western, Indigenous, which ones?

C. How have values of different worldviews at different scales been explicitly discussed?

D. What levels of social, spatial, temporal, and decision-making scales have been covered in the study?

E. To what extent were social engagement or participatory processes involved in the identification and documenting of values in the existing data sources, which social groups were included, which were left out? What types/levels of social engagement are reflected in the study?

F. To what extent is ILK represented? Have ILK holders been involved in the research? Is this representation sufficient? What are the implications?

Collecting information about valuation methods included in the information sources.

G. What types of valuation methods have been used to identify/elicit values?

  a. Biophysical and ecological

  b. Cultural and social

  c. Economic

  d. Public health

  e. Holistic, Indigenous, and local knowledge-based

Information addressing synthesis or integration of diversity of values and/or value perspectives

H. Have values have been aggregated/up-scaled? If so, how and by whom? Has upscaling created double counting problems?

I. Has the study attempted to integrate and bridge different types of values, where relevant?

Gaps in information in individual information sources.

J. What are the gaps in value formation, value elicitation, and value articulation (interpretation and discussion) processes in the study?

K. Is the study (article/reports/thesis) explicit about the limitations of the valuation approach chosen?

L. What are the limitations in the research findings, including uncertainty associated with values, methods used, and probable scenarios (where relevant)?

Gaps in information based on the collected body of knowledge

M. What gaps are there in the existing data on values (dimensions and types of values)? To what extent can the causes of the gaps be identified? What are the implications of these gaps?

Information about interpretation of values in the information sources

N. Is the study relevant to answering policy questions at different scales (e.g. local, landscape, national, regional)?

O. What types of policy implications are derived from the values documented in the existing data? How does the lack of bridging and not-reporting certain value dimensions/types affect the policy implications?

P. Has the study considered implications of findings at a broader social context (i.e. equity, distributive effects etc.)?

Q. Have the studies predicted future scenarios of development trajectories and their implications on different types of values? If values are extrapolated, have confidence limits (or associated uncertainty) been explicitly stated in relevant studies, and if so how?

➢ Synthesize and evaluate what you have found in each of the studies.

Try to fill gaps as possible within the time and financial restrictions of an assessment process, for example, consider using Delphi Questionnaires (experts) or ethnographic interviews.

- **A first result** is to present a summary of your findings, addressing what sorts of values, (worldviews, types, foci, scales, regions, social groups) addressing what sorts of questions have been predominantly studied, and to identify and describe where current gaps lie. For this systematically document the missing data on values, e.g certain types of values for certain ecosystem services in certain biomes and give an expert estimation, how relevant these missing parts are for the purpose of assessing the plurality of values. Such an overview already is a type of assessment of values and provides helpful and important additional information to any IPBES assessment.
- *Make transparent who did this assessment and how you approached this step*

Step 4: Synthesis, up-scaling and integration

This step concerns the value experts and CLAs of the assessment team

The type(s) of synthesis, bridging or integration of values needed depend on the purpose(s) of the assessment including the policy-relevant questions as outlined in the IPBES scoping document and clarified in Step 1.

Addressing the following questions would help clarify the purpose and methods for this step:

(a) Who is the likely end-user of the synthesis outcomes?

(b) Are there specific policy or management contexts wherein the synthesis would be relevant?

(c) At what (political, geographical and temporal) scales should the synthesis be reported?

(d) What are the synthesis needs at different scales?

(e) Are the full range of values available at all scales for synthesis? If not, what are the gaps and what are the implications for synthesis?

(f) What confidence can be attached to the synthesis outcomes?

While an assessment does not entail original data collection (e.g. conducting valuation studies), synthesis is an original task of an assessment. Sometimes this can be done based on the literature or on previous assessments. Otherwise the assessment team may employ methods for this that can include the ones listed below. These methods mostly help to present diversity in a well-structured manner, making the diverse values accessible to decision-makers, rather than coming up with one unified value.

Step 4 builds on the reflection and compilation done in Step 3 and the documentation of gaps in the current literature. This should also include an estimation of the experts doing the assessment, how relevant these missing parts are for the purpose of assessing values and what the implications of incomplete information regarding the responses to the policy-relevant questions are.

Approaches an assessment team can use to synthesize information on diverse values and to relate it to other results of the assessment process:

- Narratives. Story-telling, scenarios, graphs, sketches are a form of synthesis. Qualitative, based on the evolution of value-drivers, but may include quantitative references. Likely all assessments will include this approach.
- Integrated modeling is mostly a numerical approach to quantify the system-wide effects of interacting biophysical and socio-economic realities and values across time and space, and to assess outcomes of policy or management scenarios. Depending on the purpose(s) of the valuation assessment, methods may be required that involve actors (e.g. stakeholders, organizations, people). These include the following:
- Multi-criteria analysis is a method capable of embracing, combining and structuring often incommensurable diversity: diversity of information (such as different types of data, e.g. qualitative and quantitative data, as well as uncertainty), diversity of opinion (also amongst experts), diversity in actor perspectives (stakes), and diversity in assessment/decision making criteria.
- Deliberative valuation is a social process with the purpose of discovering, constructing and reflecting values in a dialogue with others.
    - Synthesis needs differ with scales. Up-scaling of values in space or time may be desirable, if studies are available only for specific places or periods in time. However, it is not always feasible, as different scales may require different valuation methods and available data may be deemed too coarse for meaningful upscaling. Implication for synthesis and integration: take into account that different valuation studies may refer to different scenarios of the future; perhaps you can use

scenarios also for temporal up-scaling. Again, consider options feasible within the restrictions of an assessments, e.g., consider using online Delphi Questionnaires with relevant experts for example to address confidence limits as outlined below. It can be very informative to policy makers to know how stakeholder groups interpret this valuation step quite differently and to learn about their argumentation behind this. Stakeholder groups involved in the IPBES framework can be considered for this, but perhaps a broader diversity of stakeholder groups need to be considered too.

Synthesis may lead to identification of values which co-vary negatively in response to policy choices and management decisions under consideration. Such value trade-offs need to be carefully elicited in the synthesis process for informing decision makers.

However, assessment teams may face a trade-off between “getting it right” vs. “getting it relevant”. A way to deal with this is to focus on getting it relevant, and to report confidence limits in a transparent way; but some serious errors cannot be solved this way. Confidence limits to the assessment and synthesis of values refer to three levels

1. the level of values available in the literature
2. the level of synthesis, taking into account the number of studies available
3. the limits of scope with respect to the scoping considerations (world views, foci of value, types of value), and scale of values.

➢ Make transparent who did the synthesis and how you approached this step, make confidence limits explicit.

Step 5: Deriving and communicating results

This step concerns the co-chairs, CLAs and value experts of the assessment team

The process of communicating assessment results consist in synthesizing and contextualizing diverse results so that they can contribute to “mainstreaming biodiversity management into decision making at all levels”. Some results arise directly from the value assessments (particularly step 3 and 4) and can be communicated as such, while others will have to be brought together with the results from other components of the assessments and tailored to communication formats that can easily be understood and acted upon by policy makers/decision makers.

Addressing the following questions can effectively guide communication:

- What are the implications of the value assessments on the policy relevant questions your assessment is addressing?
- How do results of the value assessment inform scenarios and scenario analysis?
- What are the implications of having incomplete/biased information on values?
- What are the confidence limits of the results both from the existing body of literature and from the incomplete coverage of diverse values and conceptualizations?

Link to overall communication of results section of general assessment document. One point we came up with that concerns assessment overall rather than just value assessment: Show what governments could do with the results of scenarios and how they can promote the options outlined in the scenarios.

➢ Be explicit about how you derive results and where in the assessment more background information can be found.

Chapter 6: Role of scenarios and models in assessment and decision support

Coordinating Authors: Paul Leadley, Simon Ferrier

Authors: K.N. Ninan and Rob Alkemade

6.1 Overview

Scenarios and models offer the means of formalizing and quantifying interactions between the major elements of the IPBES conceptual framework, thereby providing an objective and highly flexible foundation for responding to assessment and decision-making needs across multiple spatial scales (Figure 6.1). In this guide and in the Methodological Assessment of Scenarios and Models (IPBES Deliverable 3c), the term "scenarios" refers either to plausible futures of indirect and direct drivers of nature and nature's benefits to people, or to potential policy and management interventions, or to a combination of these. The term "models" refers to qualitative, or more often quantitative, descriptions of the links between any two elements of the framework that provide the means to relate changes in one element to estimates, or projections, of changes in the other. When coupled with scenarios, models enable plausible futures of drivers, or policy and management interventions to be evaluated in terms of potential consequences for nature and nature's benefits to people. Note that this terminology is not consistently followed in the literature since the term "scenarios" is often used to refer to the combination of scenarios and models.

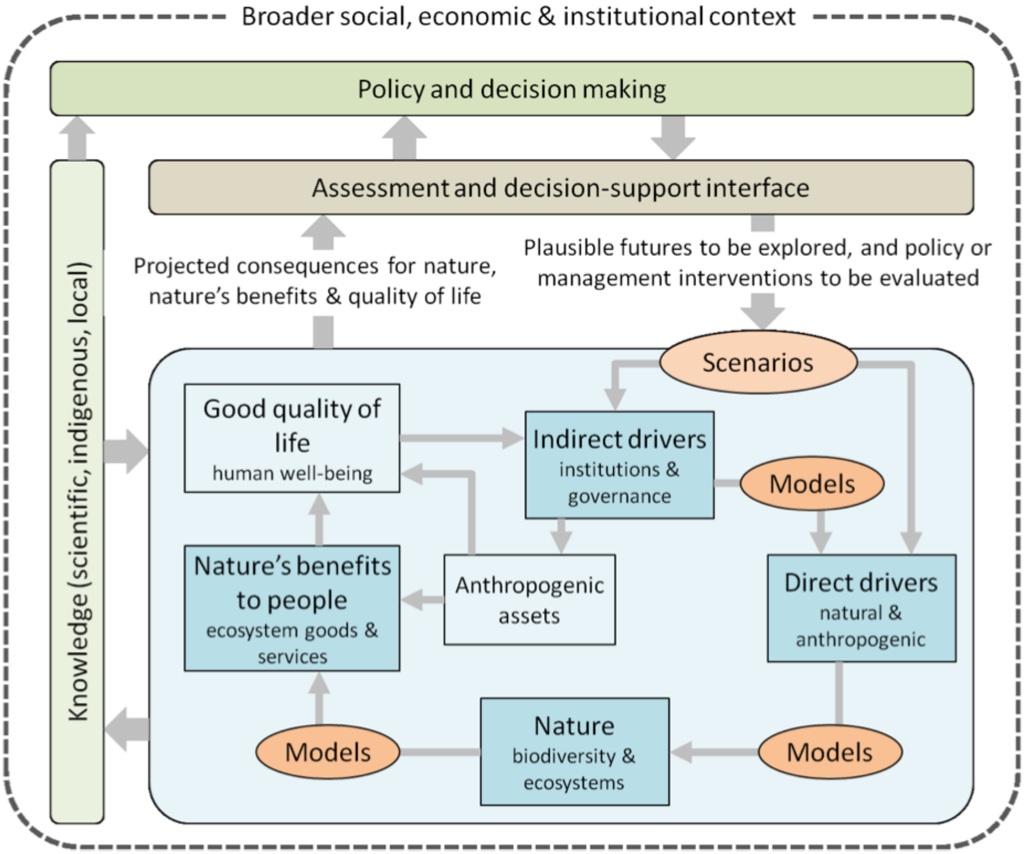


Figure 6.1. Illustration of the relationships between scenarios, models, knowledge, assessments and decision support. The diagram represents the role of scenarios and models (orange ovals) in a simplified version of the IPBES conceptual framework (outlined in blue) and its relationships with knowledge; assessments and other decision support; and policy and decision making (boxes in shades of green). Within the blue boxes the large font indicates the universal terms and the smaller font indicates the scientific terms associated with each component of the conceptual framework. (Figure reproduced from the IPBES Methodological Assessment of Scenarios and Models).

Scenarios cover a wide spectrum of applications, but can be broadly classified by the role they play in the decision making cycle: i) agenda setting and review, ii) policy design, and iii) policy implementation. Agenda setting and high-level strategy development based on assessments typically rely on "explorative scenarios" that examine a range of plausible futures based on assumptions about a range of trajectories of indirect and direct drivers. Explorative scenarios have been widely used in regional and global assessments (Figure 6.2). Policy design and policy implementation make use of "policy or intervention scenarios" in which specific policy choices or management interventions are tested to inform decisions regarding the design or implementation of particular policies. Policy and intervention scenarios have most frequently been used in support of local and national scale decision-making (Figure

6.2). Scenario development is more frequently based on participation of stakeholders at local scales, while stakeholder participation is frequently absent or very limited for global scale scenarios.

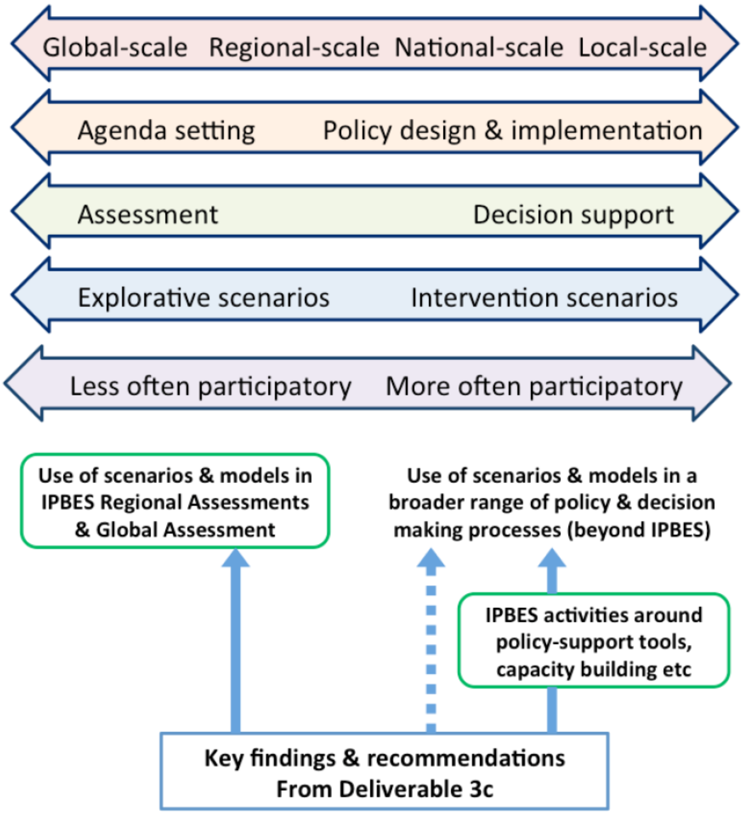


Figure 6.2. General characteristics of scenarios and their relationships to IPBES assessments and use in other IPBES activities as covered in detail in the Methodological Assessment of Scenarios and Models (Deliverable 3c).

Most of the modelling approaches considered by the Methodological Assessment of Scenarios and Models focus on three particular linkages within the IPBES framework (Figure 6.1):

- effects of changes in indirect drivers (e.g. socio-economic, technological and cultural factors) on direct drivers (e.g. habitat conversion, over-exploitation, climate change, pollution, species introductions) of change in biodiversity and ecosystems;
- impacts of changes in direct drivers – both negative and positive – on nature, including various dimensions and levels of biodiversity, and ecosystem properties and processes; and
- consequences of changes in biodiversity and ecosystems for the benefits that people derive from nature including, but not limited to, ecosystem goods and services. This includes in some cases models of monetary valuation of ecosystem goods and services.

Many types of models can be used to describe and explore the above linkages. Depending on the particular needs of any given application, models will often vary markedly in:

- *Geographical extent and resolution* – ranging from global models operating at relatively coarse spatial resolutions, through to finer-scaled regional, sub-regional and local (e.g., farm-level) models.
- *Scope of considered drivers and components of nature and nature's benefits to people* – ranging from models focusing very specifically on the effects of one, or a small number of drivers (e.g., habitat conversion, climate change), on particular biological entities (e.g., individual species; Feeley & Silman, 2010), through to whole-ecosystem models dealing with a broad array of ecosystem properties and processes (Fulton, 2010), or integrated assessment models (IAMs) that couple scenarios and a wide range of models to simulate the dynamics of complex social-economic-ecological systems (Harfoot et al. 2014a).
- *Source and form of information defining modelled relationships* – ranging from simple semi-quantitative approaches to capturing, and representing, stakeholder knowledge (e.g. using participatory techniques; Walz et al. 2007, Priess & Hauck, 2014), through to correlative (statistical) analysis of empirical data (e.g. species distribution modeling; Elith & Leathwick, 2009), or more mechanistic approaches based on established

scientific understanding and mathematical formulation of relevant underlying processes (e.g. meta-population modeling; Gordon et al. 2012; mechanistic models of ecosystem function Harfoot et al. 2014b).

Scenarios coupled with models can inform three broad areas of assessment and decision-making (Cook et al., 2014). These three areas are strongly linked and interdependent so it is best to think of the models informing them as serving complementary needs within an overarching policy or decision cycle: 1) assessment of status and trends, 2) scenario-based analysis of plausible futures and 3) decision support for policy and management. These three broad areas of application are described in more detail below.

6.2 Assessment of status and trends

Modelling can add considerable value to assessments of status and trends in two important ways:

- *Filling gaps in data needed to underpin key indicators.* Data are much easier or less costly to obtain for some elements of the IPBES conceptual framework than for others. For example, advances in remote sensing have made it possible to track temporal changes in a number of direct drivers, including habitat conversion and climate change, at relatively fine spatial resolutions across extensive regions. On the other hand, most components of biodiversity, particularly at the species and genetic levels, are not detectable through remote sensing, and changes in their state can be observed only through direct field survey. Such data therefore tend to be sparsely and unevenly distributed across both space and time. While this clearly highlights the need to reinforce field survey data collection, modelling offers a cost-effective means of filling gaps in this coverage. For example, remotely sensed information on drivers can be used to estimate changes in the trends and status of biodiversity expected across unsurveyed areas (Ferrier, 2011). Using modelling to fill gaps in information can play an equally valuable role in assessing status and trends in nature's benefits to people – e.g., by estimating changes in the supply of ecosystem services from remotely-sensed land cover classes and structural or functional ecosystem attributes (biomass, net primary production etc.; Tallis et al., 2012; Andrew, Wulder & Nelson, 2014; Figure 6.3).

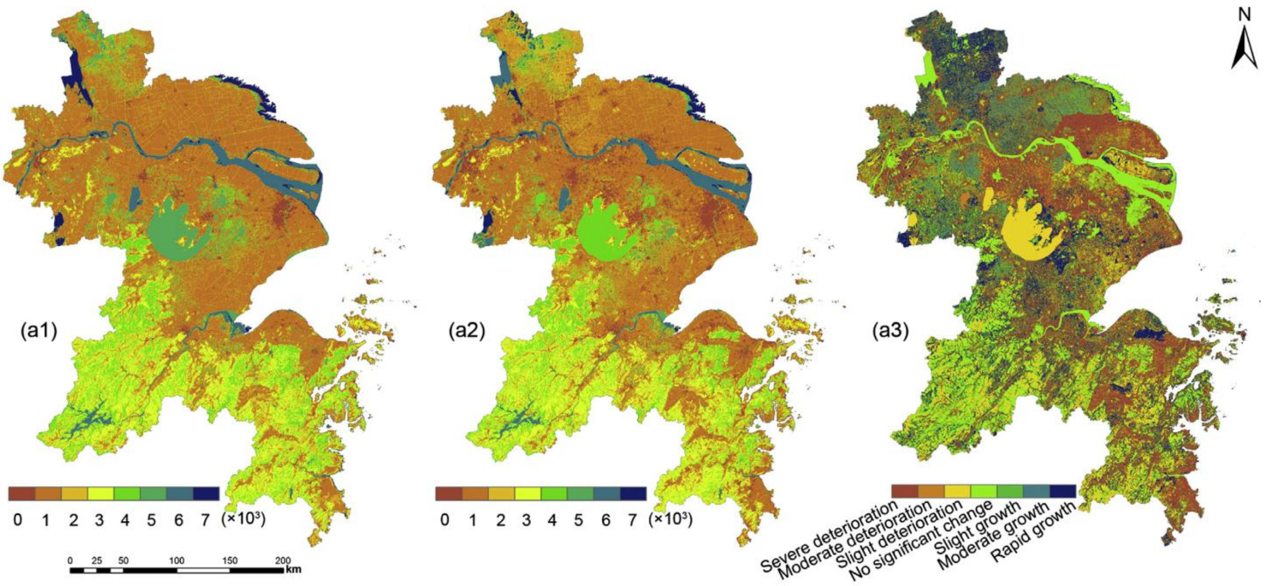


Figure 6.3: Example application of modelling to status-and-trend assessment – change in natural capital from ecosystem services related to carbon sequestration, grain production and water supply in the Yangtze River Delta from 2000 to 2010. The Yangtze River crosses from East to West on the upper portion of the delta and Shanghai is located south of the river mouth (dark orange splotch). Estimates of natural capital were derived from model-based analysis of remote sensing data; field-based measurements of water flow and quality; and meteorological data. Monetary value was then estimated for each of the ecosystem services using structured questionnaires of 700 experts (color bars in panels a1 and a2 are in 1000 yuan per year). Values of (a1) natural capital in 2000 and (a2) natural capital in 2010. Spatial change in natural capital in 2000–2010 (a3). The highest values correspond to rivers, lakes and wetlands (the large green area in the centre is Lake Taihu). Moderate values of natural capital in the South are forested areas, lower values in the centre and north are associated with farmlands and very low values with highly urbanized areas. Degradation of natural capital in many area of this region is related to very rapid urbanisation. Xu et al. (2014)

- *Integrating multiple pressure-state-response indicators.* High level assessments of status-and-trends typically rely on multiple indicators (Butchart et al., 2010; Sparks et al., 2011). To provide a better sense of the overall status of, and trends in, the condition or "health" of the system these individual indicators are sometimes aggregated to produce one, or a small number of, composite indicators or indices (Halpern et al., 2012). Aggregation can often be achieved through some form of simple arithmetic manipulation (e.g. as a scaled and/or weighted average of individual values; Butchart et al., 2010). However, such an approach may fail to adequately address the often complex, non-additive, and highly dynamic, nature of interactions between multiple pressure, state and response elements in real-world systems. Modelling offers an alternative means of integrating data, and indicators, describing past-to-present changes across multiple system elements, and thereby better accounting for complexities and dynamics in these interactions (Vackar *et al.* 2012; Pereira *et al.* 2013; Tett *et al.* 2013).

6.3 Scenario-based analysis of plausible futures

The role of scenarios and models in this second broad area of application is intermediate between, and therefore bridges, the roles played in status-and-trend assessment (section 6.2) and in decision support (section 6.4). While often sharing with status-and-trend assessment the general purpose of informing problem identification and agenda setting, scenario analysis shifts the focus of assessment from changes that have already occurred to changes that might occur into the future. Using scenarios and models to project possible changes beyond the present provides a powerful means of assessing future risks and opportunities for biodiversity, ecosystem properties and processes, and nature's benefits to people, and therefore the need for action (Pereira et al., 2010). Scenario analysis explores possible future developments of human society and the potential consequences of these developments. The IPCC defines scenarios to be *"… coherent, internally consistent and plausible descriptions of a possible future state … they are not a forecast and this is an important attribute; rather, each scenario is one alternative image of how the future can unfold"* (IPCC-SRES, 2000).

Any future projection involves high levels of uncertainty, particularly around indirect socio-political, economic, technological and cultural drivers of change in biodiversity and ecosystems. Scenario-based analyses of future risk typically attempt to accommodate these uncertainties by exploring a range of plausible socio-economic scenarios, each based on a different set of assumptions about future trajectories in key factors (e.g. population, income, technology development). Many such scenarios have been developed, and applied extensively and successfully by other major global assessments prior to the establishment of IPBES. The most prominent of these are the global scenarios developed by the climate science community, including the IPCC's Special Report on Emission Scenarios (SRES) from 2000, and the more recently adopted scenario framework comprising two elements: Representative Concentration Pathways (RCPs) describing different trajectories for emissions and concentrations of atmospheric constituents affecting the climate system over time; and Shared Socio-economic Pathways (SSPs) providing narrative descriptions and quantifications of plausible developments of socio-economic variables characterizing challenges to climate-change mitigation and adaptation (van Vuuren & Carter, 2014). The Millennium Ecosystem Assessment (MA) set another prominent precedent, from more of an ecosystem-service perspective, with its construction of global storyline scenarios representing different combinations of possible paths for world development, and reactive versus proactive approaches to ecosystem management (Cork et al., 2006). More recently, increasing effort is being directed towards developing socio-economic scenarios at regional or national scales, tailored specifically to the needs of biodiversity and ecosystem-service assessment – e.g. the ALARM project in Europe (Spangenberg et al., 2012), and the Australian National Outlook initiative (Bryan, Nolan & Harwood, 2014). The trend towards application of scenario analysis at more local scales is also being accompanied by increasing adoption of participatory approaches to the development of scenarios, tapping directly into local stakeholder knowledge of how the system of interest works (Walz et al., 2007; Priess & Hauck, 2014).

Commonly, the first step in assessing the implications of socio-economic scenarios for nature and nature's benefits to people is to model the effect that these scenarios are expected to have on direct drivers of biodiversity and ecosystem change (Figure 6.1) under each of the scenarios. For example, one might model spatially- and temporally-explicit changes in climate, or land use (Hurtt et al., 2011). An additional level of modelling is then used to project, in turn, the impact that these changes (in direct drivers) are expected to have on biodiversity and ecosystem properties and processes, and resulting consequences for benefits to people (Figure 6.1). In addition to more qualitative modelling approaches (e.g. arising through participatory scenario development), quantitative techniques commonly used to model, and thereby project, impacts of direct drivers on biodiversity and ecosystems include:

- species distribution modelling (Elith & Leathwick, 2009);
- population and meta-population modelling (Gordon et al., 2012);
- dose-response modelling (Alkemade et al., 2009);
- macroecological (e.g. species-area) and meta-community modelling (Mokany et al., 2012);
- trait-based modeling (Lamarque et al., 2014), and
- process-based ecosystem modelling (e.g. marine trophic models, dynamic vegetation models; Fulton, 2010; Hartig, et al., 2012).

A wide range of models of ecosystem services are reviewed in detail in the Methodological Assessment of Scenarios and Models. Models of ecosystem services typically focus on landscape to national scales and therefore may present difficulties in scaling up to regional and global scales. Models of ecosystem services at large regional and global scales have not been thoroughly vetted, so considerable caution should be exercised when using these models. The ability of ecosystem services models to treat a range of ecosystem services varies greatly. In many cases it is advisable to examine multiple ecosystem services in order to explore tradeoffs between them. Unfortunately, the connection between models of ecosystem services and models of biodiversity is currently weak, so authors must be prepared to make rather qualitative evaluations of the relationships between projections from these two classes of models.

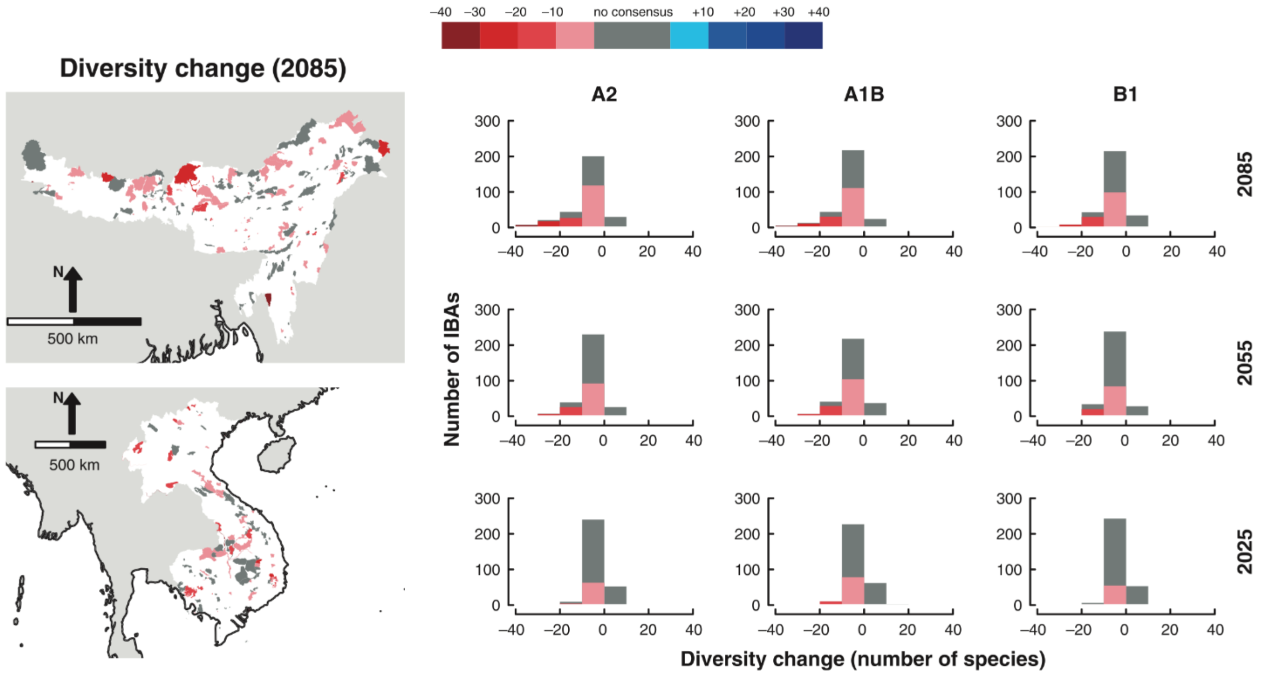


Figure 6.4. Example of scenario-based risk analysis employing species distribution modelling – projected impacts of climate change on species richness in Important Bird Areas (IBAs) in the Eastern Himalaya (top left) and the Lower Mekong (bottom left). The maps show projected changes in the number of species of conservation concern. Greenhouse gas emissions are based on the IPBES SRES scenarios. Climate projections are based on three General Circulation Models (GCMs) for each of the emissions scenarios. Climate impacts on bird species ranges were modelled using four different correlative species distribution models. Future climates in red coloured IBAs are 'extremely likely' to be suitable for fewer species. The histograms show the projected distribution of changes in species richness for the IBAs across combinations of three time periods (rows) and SRES scenarios (columns). **Source: Bagchi et al. (2013).**

Scenario-based risk analysis can set the scene for subsequent decision support (application 3 below) by exploring, and assessing potential impacts of, a broad range of socio-economic futures. An example could be through provision of valuable information on the relative importance of different drivers in shaping future risks to biodiversity and ecosystems, and the amount of change that might be required in important drivers to reduce these risks to an acceptable level.

6.4 Decision support for policy and management

This third, and arguably most crucial application of modelling, extends the use of scenario analysis (section 6.3) by exploring the effect that alternative, and explicitly defined, policy and/or management interventions are expected to have on future outcomes for nature and nature's benefits to people. The type and scale of interventions potentially considered by this approach can vary greatly, thereby allowing applicability across a wide range of decision-making contexts. For example, the intervention options requiring assessment might be aimed at addressing either indirect drivers (e.g. reduction of fossil-fuel use to slow the rate of climate change) or direct drivers (e.g. habitat protection or restoration to counter the impacts of habitat loss). These options may also involve either the formulation of whole policies (e.g. regulation of vegetation clearing) or programs (e.g. establishment of an environmental-stewardship funding scheme) across entire countries or other jurisdictions, or the implementation of specific spatially-explicit management actions (e.g. reservation of a particular patch of forest; or introduced-species control within a particular estuary).

Where the interventions of interest are aimed primarily at addressing indirect drivers, and/or involve high-level policy formulation, established approaches to scenario-based risk analysis (section 6.3) may need only modest extension to effectively support decision-making. The same models used to evaluative the consequences of a plausible range of futures in analysis of risks and opportunities – i.e. so-called "explorative scenarios" – are now applied to "policy scenarios" (also known as "intervention scenarios" or "normative scenarios"), purposely tailored to assess the extent to which different policy interventions might move the system of interest in a desired direction (van Vuuren et al, 2012). Depending on the context, such modelling may also be required to consider options from a "backcasting", rather than a forecasting, perspective by finding combinations of policy and/or management interventions that can deliver an agreed future end-point for nature, or its benefits to people – e.g. as applied recently in the Rio+20 scenarios (PBL 2012; Figure 6.5).

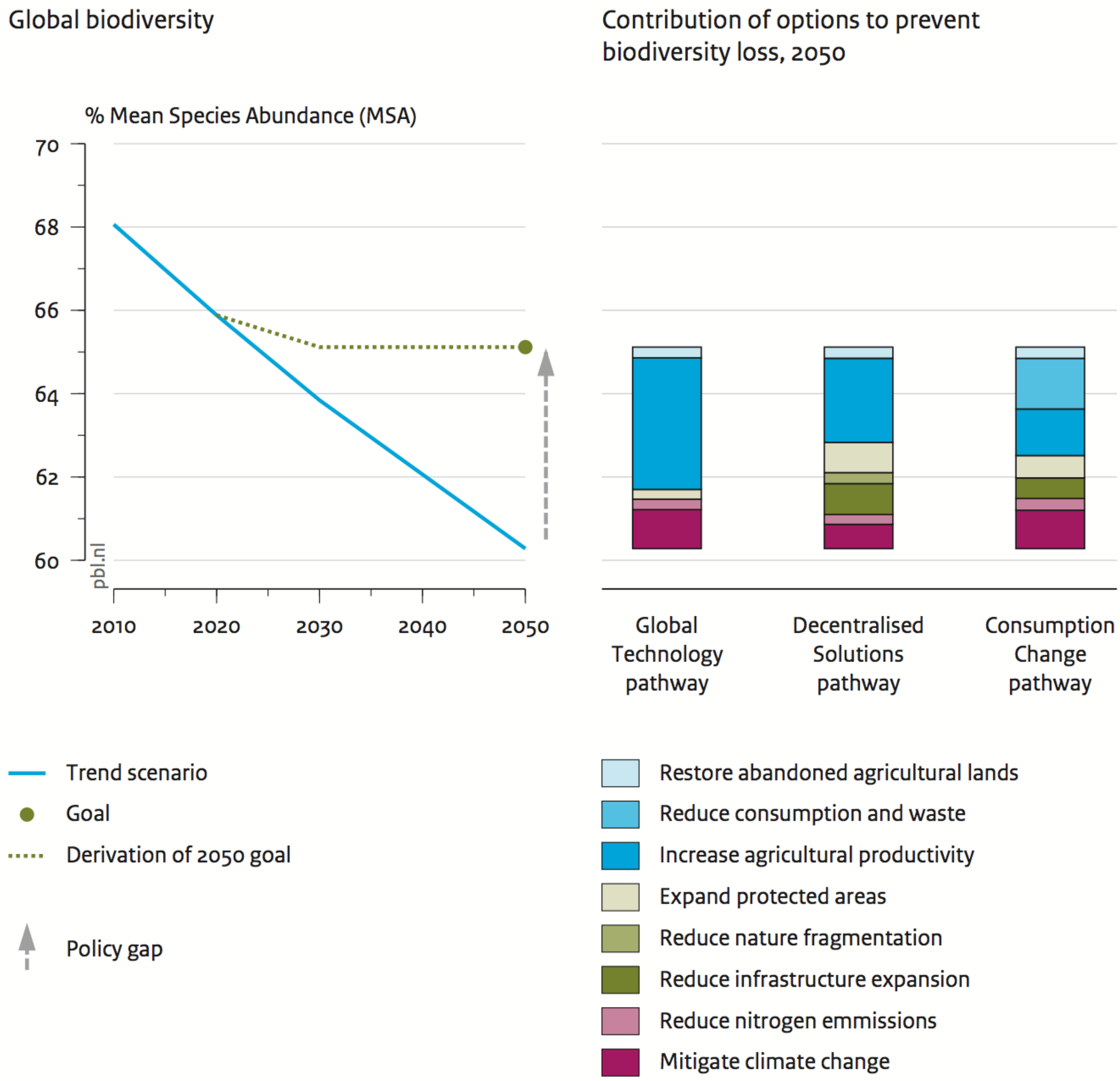


Figure 6.5: Example of decision support employing scenarios that are designed to achieve desirable future global goals on climate change, biodiversity and human development. This type of analysis is known as "backcasting" because it relies on first setting future goals and then determining the pathways that can lead to these goals from the current state. Biodiversity goals set by the Convention on Biological Diversity (CBD) have been interpreted in terms of the biodiversity indicator "Mean Species Abundance" (MSA). The IMAGE integrated assessment model was used to create the scenarios of direct and indirect drivers. The GLOBIO3 model was then used to evaluate the effects on biodiversity of via three contrasting development pathways. Based on this indicator, the goal of halting biodiversity loss as set out in the CBD 2050 Vision can be achieved by 2030 in the sustainable pathways (green dotted line in the left-hand panel), whereas biodiversity loss continues unabated in the "business-as-usual" scenario (i.e., "Trend" line in the left-hand panel). The climate change goal was based on the UNFCCC target under discussion of keeping global warming below 2°C and the human development targets were based on the Millennium Development Goals (results not shown). The analysis suggests that achieving these goals would take a large effort for each pathway and would require a combination of policies including extension of protected area networks, sustainable intensification of

agriculture, climate mitigation and changes in life style. The relative contribution of these efforts to achieving these goals is indicated in the left-hand panel. For example, in order to feed a growing population and at the same time minimize land use change the "Global Technology" pathway relies strongly on technology to greatly improve crop yields per unit area, while the "Consumption Change" pathway relies more heavily on changes in diet and reduction in waste. Source: PBL, 2012.

Where the interventions under consideration are more specific, the basic idea of informing decision-making by modelling the expected consequences (for biodiversity or ecosystems) of alternative actions, is already well established across a number of methodological paradigms, or frameworks – e.g. Structured Decision Making (Addison et al., 2013), and Management Strategy Evaluation (Mapstone et al., 2008). Depending on the decision-making context, these frameworks typically call upon modelling to either: 1) assess a discrete set of policy or management options (arising, for example, from a participatory planning process); or 2) consider all possible options for achieving a specified goal, thereby identifying the “best” solution, subject to any relevant constraints (e.g. cost of implementation), through some form of optimization. Assessment and decision-making often need to focus on multiple rather than single criteria, e.g. multiple dimensions of biodiversity and ecosystem services (e.g. provisioning services, or climate regulation). This will require the use of multiple models and/or models that can produce projections for multiple criteria; the examination of trade-offs in outputs for alternative scenarios; the use of aggregation methods such as multi-criteria decision analysis or other participatory methods for decision support.

Participatory approaches – including the use of agent-based modelling to capture stakeholder knowledge and learning – are, again, playing an increasingly important role in the development and application of scenarios for decision support. These approaches can be applied either in place of, or in combination with, more quantitative techniques such as those described above (Castella, Trung & Boissau, 2005; Sandker et al., 2010).

6.5 Specific recommendations for regional, global and thematic assessments

Some assessments have relied primarily on analyses of tailor-made socio-economics scenarios (e.g., MA, 2005; GEO4, 2007; UK NEA, 2011), while others have been based almost exclusively on assessment of previously published material (e.g., GBO3, 2010). We recommend a mixture of these approaches where possible; i.e., that assessments include relevant published work and, where available, analyses that have been developed to match IPBES assessment objectives. Several of the IPBES task forces will encourage the development of tailor-made scenarios and models by working in close collaboration with the scientific community. The recently released Global Biodiversity Outlook 4 (GBO4, 2014) is one example of an assessment that combines analyses of published and bespoke scenarios and models. The evaluation of a wide range of scenarios and models has some drawbacks, one of the most important being that it complicates comparisons of scenarios and models. However, basing IPBES assessments on a wide range of published material will have the great benefit of allowing exploration of a much greater diversity of models and scenarios than in assessments that have relied on a single set of scenarios and models. Examples of the use of a broad range of scenarios and models in assessments can be found in several of the most recent IPCC chapters on climate change impacts (IPCC AR4 WG2, 2014) and in the technical reports that are the basis of the Global Biodiversity Outlooks 3 & 4 (GBO3, 2010; GBO4, 2014).

This reliance of IPBES assessments on a wide range of published material and, when available, bespoke scenarios and models has a number of important consequences:

- Models and scenarios have been used to understand and quantify past trends, current status and possible future trajectories of nature and nature's benefits to people. As such, they provide important contributions to all components of assessments. The incorporation of scenarios and models in the overall structure of assessments has varied greatly. Some assessments have grouped most of the evaluation of scenarios and models to specifically dedicated chapters (e.g., MA, 2005; GBO3, 2010; UK NEA, 2011), while others have woven the evaluation of scenarios and models much more broadly into chapters (IPCC AR5 WG2, 2014; GBO4, 2014). The use of specifically dedicated chapters makes good sense for assessments that are primarily based on analyses of tailor-made socio-economic scenarios. Weaving scenarios and models more widely into chapters makes good sense when relying on a broad evaluation of published material. The authors of this chapter strongly encourage IPBES experts to consider a combination of these approaches when developing the overall structure of assessments during scoping and when writing assessments. For example, this would mean grouping analyses of scenarios and models into a single chapter when this is helpful for providing a synthetic overview of future projections of a wide range of indicators, while also integrating scenarios and models throughout chapters to provide a coherent vision of past, present and possible future dynamics of individual indicators. An example of this combined approach is the Global Biodiversity Outlook 4 (GBO4, 2014) in which past, present and future dynamics of a wide range of indicators were assessed for each of the twenty Aichi targets, and then the overall picture emerging from these scenarios and models was synthesized in a dedicated chapter.
- Assessment authors need to access, synthesize and assess a very large number of scenarios and modeling studies. This is particularly true for the regional and global assessments, although less so for the thematic

assessments. Sorting through the literature on models and scenarios is challenging, so one of the main objectives of the Methodological Assessment of Scenarios and Models and subsequent activities of the follow-up task force is to provide guidance on how to search for, interpret, synthesize and assess published work. When carrying out literature searches and their analyses, authors should keep in mind the role of each of the scenarios and modeling components and their contribution to policy and decision-making (Figure 6.1).

- Considerable attention needs to be paid to the capacity of authors to find, interpret and assess scenarios and models. Many IPBES authors will be less familiar with scenarios and models than with analyses of data on status and trends. This means that attention must be paid to the backgrounds of assessment authors, and that assessments should include a reasonable number of authors with experience in interpreting scenarios and models. The Technical Support Unit for the Methodological Assessment of Scenarios and Models (TSU-IPBES.scenarios@pbl.nl as of June 2015) can help guide authors to resources persons who can serve as contributing authors where needed and desired. Over the longer term, efforts within the capacity building components of IPBES will be required to encourage the development of a broader capacity to develop, use and interpret scenarios and models among scientists and decision makers.

- Assessment authors will need to evaluate scenarios and models that cover a wide range of temporal scales (see also Chapter 2). Many previous assessments have focused on scenarios and models examining future risk in the 2050-2100 time horizon (e.g., IPCC AR5 WG2, 2014; MA, 2005; UK NEA, 2011). As outlined above, scenarios and models for analysis of status and trends, shorter time horizons, or without explicit reference to time horizon (e.g., many management scenarios) are abundant in the literature. In many cases, these scenarios and models are easier for policy makers and other stakeholders to incorporate in their decision making than those that explore distant future time horizons, and therefore, should play an important role in IPBES assessment activities.

- Particular attention must also be paid to using scenarios and models at an appropriate spatial extent and resolution (see also Chapter 2). The IPBES global assessment will, by its very nature, rely heavily on global and regional scale scenarios and models (Figure 6.2). However, national and local scale scenarios and models can be extremely useful in helping to inform and enrich analyses at global scales. Methods for scaling up are outlined in Chapter 6 of the Methodological Assessment of Scenarios and Models. The simplest use of these scenarios and models at these scales may be case studies to illustrate key points. IPBES regional assessments will logically rely more heavily on regional, national and local scenarios and models; however, evaluating how these compare and contrast with global scenarios and models will aide considerably in making cross-regional comparisons. Again, Chapter 6 of the Methodological Assessment of Scenarios and Models provides an overview of methods for these types of comparisons. Thematic assessments are likely to exploit scenarios and models across a broad spectrum of spatial scales. In all cases, it should be kept in mind that many decision makers often seek scenarios and models at relatively fine spatial resolution.

- Scenarios and models vary substantially in the degree of uncertainty associated with their projections. Some have been extensively validated and widely used in decision-making. Many others have undergone little or no validation, and in some cases may suffer from serious flaws. Because the IPBES assessments will not rely on a single set of scenarios or modeling framework, assessment authors will need to evaluate the sources and levels of uncertainty associated with projections based on general scientific knowledge of key processes, the degree to which models compare favorably with observations, and the extent to which projections of a wide range of models are coherent (although multi-model comparisons are relatively rare). The Methodological Assessment of Scenarios and Models provides guidance on evaluating quality, as well as on methods for assessing uncertainty (e.g., comparison of projections of several types of models; Pereira et al., 2010).

- The choice of indicators used for scenarios and models is a key element in 1) linking them to assessments of status and trends, 2) making sure that they are policy relevant and 3) carrying out comparisons across regions and sub-regions in the regional assessment activities. In addition, indicators produced by models frequently do not align with indicators used for status and trends (GBO4, 2014). As such, discussions concerning the choice of indicators need to be carried out in advance of assessment activities, and authors of assessments, particularly the regional assessments, dialog needs to be encouraged across sub-regions and regions to harmonize use of indicators to the maximum extent feasible.

- Previous global and regional assessments have paid little or no attention to the role of indigenous and local knowledge (ILK) in scenarios and models. The rapid growth of participatory methods in scenario and model development (see above) has opened the door to greater inclusion of ILK. The Methodological Assessment of Scenarios and Models includes specific guidance on the inclusion of ILK.

IPBES will stimulate the development of new scenarios and models that target IPBES objectives through its interactions with the scientific and policy communities. The timing of the assessments should make the development of tailor-made scenarios and models a reasonable objective for the global assessment, but the earlier completion dates of the regional and currently planned thematic assessments may make it more difficult to integrate work specifically addressing IPBES objectives. The experts involved in the Methodological Assessment of Scenarios and Models will work closely with the Data, Information and Knowledge task force, and with the authors of assessments to ensure a coherent approach to dialoging with the scientific community and incorporating new scenarios work in assessments.

In addition to this guide and the IPBES Methodological Assessment of Scenarios and Models, the following resources may be helpful in understanding the role of scenarios and models in assessment activities: Scholes & Biggs (2004); an excellent example of the use of multiscale scenarios and models in a regional assessment), Kok et al. (2008; a short paper covering issues related to spatial scale and the use of scenarios and models in assessments); Ash et al. (2010; chapter 5 provides a broad overview of scenario development in the context of the Millennium Assessment follow-up), Spangenberg et al. (2012; describes the development of scenarios for Europe and modeled impacts on biodiversity), the Global Biodiversity Outlook 4 (GBO4, 2014; the introductory chapter provides an overview of types of scenarios and models used to assess progress towards the CBD Aichi targets). Some effort will be required to use these resources, since terminology differs among them and is not fully aligned with this guide.

References

Addison, P. F. E., Rumpff, L., Bau, S. S., Carey, J. M., Chee, Y. E., Jarrad, F. C., McBride, M. F. & Burgman, M. A. (2013). Practical solutions for making models indispensable in conservation decision-making. *Diversity and Distributions*, *19*(5-6), 490-502.

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*, 374–390.

Andrew, M. E., Wulder, M. A., & Nelson, T. A. (2014). Potential contributions of remote sensing to ecosystem service assessments. *Progress in Physical Geography*, *38*, 328–353.

Ash, N., Blanco, H., Brown C. et al. (2010). Ecosystems and Human Well-Being: A Manual for Assessment Practitioners. Island Press, Washington, DC, USA. 264 pages.

Bagchi, R., Crosby, M., Huntley, B., Hole, D. G., Butchart, S. H. M., Collingham, Y., Kalra, M., Rajkumar, J., Rahmani, A., Pandey, M., Gurung, H., Trong Trai, L., Van Quang, N. & Willis, S. G. (2013). Evaluating the effectiveness of conservation site networks under climate change: Accounting for uncertainty. *Global Change Biology, 19*, 1236–1248.

Bryan, B. A., Nolan, M., & Harwood, T. D. (2014). Supply of carbon sequestration and biodiversity services from Australia's agricultural land under global change. *Global Environmental Change, 28*, 166-181.

Butchart, S. H. M., Walpole, M., Collen, B., van Strien, A., Scharlemann, J. P. W., Almond, R. E. A., Baillie, J. E. M., Bomhard, B., Brown, C., Bruno, J., Carpenter K., Carr, G., Chanson, J., Chenery, A.M., Csirke, J., Davidson, N., Dentener, F., Foster, M., Galli, A., Galloway, J., Genovesi, P., Gregory, R., Hockings, M., Kapos, V., Lamarque, J., Leverington, F., Loh, J., McGeoch, M., McRae, L., Minasyan, A., Hernández, M., Thomasina, M., Oldfield, E., Pauly, P., Quader, S., Revenga, C., Sauer, J., Skolnik, B., Spear, D., Stanwell-Smith, D., Stuart, S., Symes, A., Tierney, M., Tyrrell, T., Vié, J. & Watson, R. (2010). Global biodiversity: indicators of recent declines. *Science, 328*, 1164–1168.

Castella, J.C., Trung, T. N., & Boissau, S. (2005). Participatory simulation of land-use changes in the northern mountains of Vietnam: the combined use of an agent-based model, a role-playing game, and a geographic information system. *Ecology and Society, 10*(1), 32.

Cook, C. N., Inayatullah, S., Burgman, M.A., Sutherland, W.J., & Wintle, B.A. (2014). Strategic foresight: how planning for the unpredictable can improve environmental decision-making. *Trends in Ecology & Evolution, 29*(9), 531-541.

Cork, S.J., Peterson, G.D., Bennett, E.M., Petschel-Held, G., & Zurek, M. (2006). Synthesis of the storylines. *Ecology and Society, 11*(2), 14.

Elith, J. & Leathwick, J.R. (2009). Species distribution models: ecological explanation and prediction across space and time. *Annual Review of Ecology Evolution and Systematics, 40*, 677-697.

Feeley, K. J. & Silman, M.R. (2010). Land-use and climate change effects on population size and extinction risk of Andean plants. *Global Change Biology, 16*(12), 3215-3222.

Feld, C. K., Sousa, J.P., da Silva, P.M., & Dawson, T.P. (2010). Indicators for biodiversity and ecosystem services: towards an improved framework for ecosystems assessment. *Biodiversity and Conservation, 19*(10), 2895-2919.

Ferrier, S. (2011). Extracting More Value from Biodiversity Change Observations through Integrated Modeling. *Bioscience, 61*(2), 96-97.

Fulton, E.A. (2010). Approaches to end-to-end ecosystem models. *Journal of Marine Systems, 81*(1-2), 171-183.

Global Biodiversity Outlook 3. (2010). Leadley P., Pereira H.M., Alkemade R., Fernandez-Manjarrés J.F., Proença V., Scharlemann J.P.W., Walpole M.J. *Biodiversity Scenarios: Projections of 21st century change in biodiversity and associated ecosystem services*. Secretariat of the Convention on Biological Diversity. CBD Technical Series no. 50.

Global Biodiversity Outlook 4. (2014). Leadley, P.W., Krug, C.B., Alkemade, R., Pereira, H.M., Sumaila U.R., Walpole, M., Marques, A., Newbold, T., Teh, L.S.L, van Kolck, J., Bellard, C., Januchowski-Hartley, S.R. and Mumby, P.J. *Progress towards the Aichi Biodiversity Targets: An Assessment of Biodiversity Trends, Policy Scenarios and Key Actions.* Secretariat of the Convention on Biological Diversity. CBD Technical Series no. 78.

Gordon, A., Wintle, B.A., Bekessy, S.A., Pearce, J.L., Venier, L.A., & Wilson, J.N. (2012). The use of dynamic landscape metapopulation models for forest management: a case study of the red-backed salamander. *Canadian Journal of Forest Research, 42*(6), 1091-1106.

Halpern, B.S., Longo, C., Hardy, D., McLeod, K.L., Samhouri, J.F., Katona, S.K., Kleisner, K., Lester, S. E., O'Leary, J., Ranelletti, M., Rosenberg, A. A., Scarborough, C., Selig, E. R., Best, B. D., Brumbaugh, D. R., Chaoin, F. S., Crowder, L. B., Daly, K. L., Doney, S. C., Elfes, C., Fogarty, M. J., Gaines, S. D., Jacobsen, K. I., Bunce Karrer, L., Leslie, H. M., Neeley, E., Pauly, D., Polasky, S., Ris, B., St Martin, K., Stone, G. S., Sumalia, U. R. & Zeller, D. (2012). An index to assess the health and benefits of the global ocean. *Nature, 488*(7413), 615-620.

Harfoot, M., Tittensor, D.P., Newbold, T., McInerny, G., Smith, M.J., & Scharlemann, J.P.W. (2014a). Integrated assessment models for ecologists: the present and the future. *Global Ecology and Biogeography, 23*(2), 124-143.

Harfoot, M.B.J., Newbold, T., Tittensor, D.P., Emmott, S., Hutton, J., Lyutsarev, V., Smith, M.J., Scharlemann, J.P.W., & Purves, D.W. (2014b). Emergent Global Patterns of Ecosystem Structure and Function from a Mechanistic General Ecosystem Model. *PLoS Biol, 12*(4).

Hartig, F., Dyke, J., Hickler, T., Higgins, S.I., O'Hara, R.B., Scheiter, S., & Huth, A. (2012). Connecting dynamic vegetation models to data - an inverse perspective. *Journal of Biogeography, 39*(12), 2240-2252.

Hurtt, G.C., Chini, L.P., Frolking, S., Betts, R.A., Feddema, J., Fischer, G., Fischer, G., Fisk, J. P., Hibbard, K., Houghton, R. A., Janetos, A., Jones, C. D., Kindermann, G., Kinoshita, T., Goldewijk, K. K., Riahi, K., Shevliakova, E., Smith, S., Stehfest, E., Thomson, A., Thornton, P., van Vuuren, D. P. & Wang, Y.P. (2011). Harmonization of land-use scenarios for the period 1500-2100: 600 years of global gridded annual land-use transitions, wood harvest, and resulting secondary lands. *Climatic Change, 109*(1-2), 117-161.

IPCC. (2000). *IPCC Special report: Emissions Scenarios*. IPCC

IPCC. (2014). *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. Cambridge, UK: Cambridge University Press.

Kok, K., R. Biggs, and M. Zurek. (2007). Methods for developing multiscale participatory scenarios: insights from southern Africa and Europe. *Ecology and Society* **13**(1): 8. [online] URL: http://www.ecologyandsociety.org/vol12/iss1/art8/

Lamarque, P., Lavorel, S., Mouchet, M., Quétier, F. (2014). Plant trait-based models identify direct and indirect effects of climate change on bundles of grassland ecosystem services. *Proceedings of the National Academy of Sciences.* **In press.**

Mapstone, B.D., Little, L.R., Punt, A.E., Davies, C.R., Smith, A.D.M., Pantus, F., McDonald, A.D., Williams, A.J., & Jones, A. (2008). Management strategy evaluation for line fishing in the Great Barrier Reef: Balancing conservation and multi-sector fishery objectives. *Fisheries Research, 94*(3), 315-329.

Millennium Ecosystem Assessment. (2005). *Ecosystems and Human Well-being: Biodiversity Synthesis*. Washington, DC: World Resources Institute.

Mokany, K., Harwood, T.D., Williams, K.J., & Ferrier, S. (2012). Dynamic macroecology and the future for biodiversity. *Global Change Biology, 18*(10), 3149-3159.

PBL. (2012). *Roads from Rio+20: pathways to achieve global sustainability goals by 2050*. PBL Netherlands Environmental Assessment Agency.

Pereira, H. M., Ferrier, S., Walters, M., Geller, G. N., Jongman, R. H. G., Scholes, R. J., Bruford, M. W., Brummit, N., Butchart, S. H. M., Cardso, A. C., Coops, N. C., Dulloo, E., Faith, D. P., Freyhof, J., Gregory, R. D., Heip, C., Hoft, R., Hurtt, G., Jetz, W., Karp, D., McGeoch, M. A., Obura, D, Onoda, Y., Pettorelli, N., reyers, B., Sayre, R., Scharlemann, J. P. W., Stuart, S. N., Turak, E., Walpole, M. & Wegmann, M. (2013). Essential biodiversity variables. *Science, 339*, 277–278.

Pereira, H.M., Leadley, P., Proença, V., Alkemade, R., Scharlemann, J., Fernandez-Manjarrés, J., Araújo, M., Balvanera, P., Biggs, R., Cheung, W. Chini, L., Cooper, H. D., Gilman, E. L., Guenette, S., Hurtt, G. C., Huntington, H. P., Mace, G. M., Oberhdorff, T., Revenga, C., Rodrigues, P., Scholes, R. J., Sumaila, U. R. & Walpole, M. (2010). Scenarios for global biodiversity in the 21st century. *Science*, 330 (6010), pp. 1496-1501.

Priess, J.A., & Hauck, J. (2014). Integrative Scenario Development. *Ecology and Society, 19*(1), 14.

Sandker, M., Campbell, B.M., Ruiz-Perez, M., Sayer, J. A., Cowling, R., Kassa, H., & Knight, A.T. (2010). The Role of Participatory Modeling in Landscape Approaches to Reconcile Conservation and Development. *Ecology and Society, 15*(2), 16.Scholes, R.J., Biggs, R. 2004. Ecosystem Services in Southern Africa: A regional assessment. Council for Scientific and Industrial Research, Pretoria, South Africa

Scholes, R. J., Biggs R. (2004). *Ecosystem services in southern Africa: a regional assessment.* Council for Scientific and Industrial Research, Pretoria, South Africa

Spangenberg, J.H., Bondeau, A., Carter, T.R., Fronzek, S., Jaeger, J., Jylha, K., Kuhn, I., Omann, I., Paul, A., Reginster, I., Rounsevell, M., Schweiger, O., Stocker, A., Sykes, M. T. & Settele, J. (2012). Scenarios for investigating risks to biodiversity. *Global Ecology and Biogeography, 21*(1), 5-18.

Sparks, T.H., Butchart, S.H.M., Balmford, A., Bennun, L., Stanwell-Smith, D., Walpole, M., Bates, N. R., Bomhard, B., Buchanan, G. M., Chenery, A. M., Collen, B., Csirke, J., Diaz, R. J., Dulvy, N. K., Fitzgerald, C., Kapos, V., Mayaux, P., Tierney, M., Waycott, M., Wood, L. & Green, R.E. (2011). Linked indicator sets for addressing biodiversity loss. *Oryx, 45*(3), 411-419.

Tallis, H., Mooney, H., Andelman, S., Balvanera, P., Cramer, W., Karp, D., Polasky, S., Reyers, B., Ricketts, T., Running, S., Thonicke, K., Tietjen, B. & Walz, A. (2012). A Global System for Monitoring Ecosystem Service Change. *Bioscience, 62*(11), 977-986.

Tett, P., Gowen, R.J., Painting, S. J., Elliott, M., Forster, R., Mills, D.K., Bresnan, E., Capuzzo, E., Fernandes, T., Foden, J., Geider, R., Gilpin, L., Huxham, M., McQuatters-Gollop, A., Malcolm, S., Saux Picart, S., Platt, T., R, M-F., Sathendranath, S., van der Molen, J. & Wilkinson, M. (2013). Framework for understanding marine ecosystem health. *Marine Ecology Progress Series, 494*, 1-27.

UK National Ecosystem Assessment. (2011). *The UK National Ecosystem Assessment: Synthesis of the Key Findings*. Cambridge, UK: UNEP-WCMC.

UNEP. (2007). *GEO4: Global Environmental Outlook 4*. Nairobi, Kenya: UNEP.

Vackar, D., ten Brink, B., Loh, J., Baillie, J.E.M., & Reyers, B. (2012). Review of multispecies indices for monitoring human impacts on biodiversity. *Ecological Indicators, 17*, 58-67.

van Vuuren, D.P., & Carter, T.R. (2014). Climate and socio-economic scenarios for climate change research and assessment: reconciling the new with the old. *Climatic Change, 122*(3), 415-429.

van Vuuren, D.P., Kok, M.T.J., Girod, B., Lucas, P.L., & de Vries, B. (2012). Scenarios in Global Environmental Assessments: Key characteristics and lessons for future use. *Global Environmental Change, 22*(4), 884-895.

Walz, A., Lardelli, C., Behrendt, H., Gret-Regamey, A., Lundstrom, C., Kytzia, S., & Bebi, P. (2007). Participatory scenario analysis for integrated regional modelling. *Landscape and Urban Planning, 81*(1-2), 114-131.

Xu, X. B., Tan, Y., Chen, S., & Yang, G.S. (2014). Changing patterns and determinants of natural capital in the Yangtze River Delta of China 2000-2010. *Science of the Total Environment, 466*, 326-337.

Chapter 7: Indigenous and Local Knowledge

At the second meeting of the Plenary of IPBES, it was agreed to establish an IPBES task force to address issues related to bringing indigenous and local knowledge systems (ILK) into IPBES assessments and other processes. This task force was specifically mandated to develop procedures and approaches for ILK in IPBES. The task force has prepared a decision document for consideration at the fourth meeting of the Plenary. This Chapter presents guidance based on that current version, which is a draft in progress and will change through the process of review by the MEP and Bureau, and through consideration, revision and adoption by the Plenary

7.1. Draft Approaches and Procedures for working with ILK

7.1.1 Introduction

What is ILK? Grounded in territory, indigenous and local knowledge systems (ILK) are defined as dynamic bodies of integrated, holistic, social-ecological knowledge, practices and beliefs, about the relationship of living beings, including humans, with one another and with their environment. ILK is highly diverse, produced in a collective manner and reproduced at the interface between the diversity of ecosystems, cultural systems and co-evolved bio-cultural diversity. ILK is thus shaped by diverse ontologies and historico-cultural contexts. ILK is continuously evolving through the interaction of grounded experiences and different types of knowledge (written, oral, tacit, practical, and scientific) that are empirically-tested, applied and validated by indigenous peoples and local communities.

The **Approaches and Procedures** outlined below are thus informed by the nature of ILK systems.

7.1.2 Draft approaches for working with ILK systems

The draft approaches are key principles that underpin all aspects of working with ILK. Draft procedures, presented in the next section, focus on bringing ILK into IPBES assessments. They are practical actions that enable these principles to be implemented that guide the appropriate inclusion of ILK from indigenous people and local communities (IPLCs) and from experts[11], in assessment processes and outcomes..

The approaches provide seven principles that underpin all aspects of IPBES work with ILK in order to enable a meaningful and active engagement of ILK in IPBES (Table 1). In the text following Table 1, the bolded material provides the agreed explanation of each principle. Non-bolded material provides further examples and explanation. The principles may amongst others, provide the basis for the development of indicators for monitoring and evaluating the progress made towards fulfilling the IPBES operating principle on ILK.

Table 1

Draft Approaches for working with indigenous and local knowledge in assessments of biodiversity and ecosystem services

1.	**Acknowledging and respecting diverse worldviews**
2	**Recognizing the importance of direct dialogue with indigenous peoples and local communities**
3	**Building synergies and addressing gaps between ILK and science**
4	**Establishing mutual trust and respecting intercultural differences**
5	**Practicing reciprocity, giving back and building capacity**
6	**Respecting rights and interests**
7.	**Defining mutual goals, benefits and benefit-sharing**

1. Acknowledging and respecting diverse worldviews

The diverse socio-cultural contexts and worldviews of IPLCs, regarding nature, its benefits to people and their links with a good quality of life, as reflected in the IPBES conceptual framework, should be acknowledged and respected in all IPBES work.

[11] ILK will be contributed by experts working on ILK (e.g. in research institutions), and by ILK holders from indigenous people and local communities.

In Bolivia, for example, Mother Earth is held as a sacred and living being and the foundation of the approach of living-well in balance and harmony for the construction of a contemporary society based on a cosmocentric, polycentric, and non-commercial vision (Bolivia 2013, Díaz et al. 2015). In other parts of the world, cultural hybridity has produced unique mixtures, for example different faith and ideology-based indigenous world views (Berkes 2012). These differences require attention in the work of IPBES assessments.

2. Recognizing the importance of direct dialogue with indigenous peoples and local communities

While literature reviews of *ex-situ* ILK are central to IPBES assessments, direct dialogue with ILK holders from IPLCs is required to bring ILK into IPBES assessments. The priority for working with ILK should be to strengthen the *in-situ* knowledge systems with and within communities where it is governed, gathered, used, applied, renewed, tested and validated.

Valid knowledge in ILK systems is tested through practice e.g. application of medicinal plants, conduct of ceremonies (Wilson 2008). Accessing valid ILK usually requires engagement with specific persons: highly skilled, hunters, gatherers, agriculturalists, fishers, craft-makers, artists, practitioners of traditional medicines and those with deep knowledge of the past or rare events (e.g. severe cyclones). Culturally designated ILK holders may be those with lineages and connections to specific places and institutions; with a character that is respected (e.g. fulfil community responsibilities, are truthful); seen to be living the knowledge; and with language skills, appropriate to the context of the people and places. ILK specialists for some places may include people in urban areas away from where it evolved, either part-time or full-time (Thaman *et al.* 2013). ILK holders need to ensure that the inclusion and interpretation of their knowledge in assessments is robust and appropriate in terms of their own validation methods. Mobilising key ILK holders can occur through networking between ILK holders and partners with relevant expertise at the global, regional, national, sub-regional and local levels (Berkes 2012).

Some ILK communities are now publishing their own knowledge, validated through their own processes using diverse media including books, films, web sites; this ex-situ knowledge can make valuable contribution to assessments. Other ILK existing as *ex-situ* knowledge in books, libraries, museums, films and data bases away from where they originated may have been collected without consent or validation of the ILK holders. Understanding *ex-situ* knowledge is best supported through repatriation and checking with indigenous peoples and local communities so it can be reinterpreted, re-applied and validated (Legrady *et al.* 2013).

Local studies and assessments, grounded in territory at the scale at which ILK holders are organized, assist to engage geographically specific ILK. Those who range over large territories, or whose homeland includes migratory species, may have knowledge that cuts across one or more national boundaries (Lyver *et al.* 1999, Perez *et al.* 2007). Traditional territories of others may cross political boundaries; in this case and their ILK and linguistic heritage will be relevant to several regional assessments, and to providing cross-scale linkages (Duraiappah *et al.* 2014). Activating ILK networks can help identify inherent solutions to cross-scale issues, through processes like knowledge-brokering and collaboration (Hill *et al.* 2015).

Women and men commonly fulfil different, responsibilities for biodiversity and may have different knowledge systems. In many coastal countries, for example, women generally have greater knowledge of medicinal plants, near shore small finfish, marine invertebrates, and handicraft plants, whereas men commonly have greater knowledge of hunting, timber and woodcarving resources, larger fish and offshore marine resources (Thaman *et al.* 2013). Assessments will need to pay special attention to the gender-based and other specific requirements (e.g. ethnicity, rights-holding groups, people living elsewhere), such as providing opportunities for separate work and for bringing together knowledge-holders from urban settings (Pfeiffer and Butz 2005).

3. Building synergies and addressing gaps between ILK and science

Bringing ILK and science into dialogue can result in a convergence of ideas and views, or may identify differences and gaps in understanding. Building synergies between ILK and science communities in IPBES should be pursued through a dynamic and interactive cycle that includes working in culturally-appropriate environments, respecting diverse styles of engagement and the use of effective tools and strategies that bridge knowledge systems (e.g. joint learning opportunities).

Fostering dialogue and building synergies between ILK and contemporary sciences will require some format for connecting different knowledge systems, through approaches including the Multiple Evidence Base (MEB), participatory scenarios and modelling, and other forms of knowledge co-production (Berkes 2012, Tengö *et al.* 2014). Bringing multiple knowledge systems together can result in diverse outcomes for levels of confidence such as: (i) being neutral in terms of providing a rich picture without affecting levels of confidence; (2) raising confidence levels when the bodies of evidence converge and support each other; or (ii) lowering confidence levels when the bodies of knowledge do not support each other.

ILK systems recognise that uncertainty and unpredictability are characteristics of all life, and use feedback, through individual, social, and institutional learning as the way to deal with and lower uncertainty over time (Berkes *et al.* 2000). Indigenous peoples and local communities have their own approaches for monitoring environmental and social conditions (Parlee *et al.* 2014) that can be supported through community-based monitoring and knowledge co-production (Berkes *et al.* 2007)

A goal in IPBES assessments is to provide a culturally acceptable environment for knowledge claims and sources of uncertainty to be considered. Visually powerful tools such as maps, art, diagrams, participatory scenarios and models can provide effective boundary objects that allow these differences to be explored and negotiated (Robinson *et al.* 2015). In some circumstances, indigenous peoples and local communities themselves seek validation of their knowledge by scientific practices, perhaps in the context of potential commercial opportunities in medicinal products, co-management or other enterprises (Evans *et al.* 2009, Gratani *et al.* 2011).

4. Establishing mutual trust and respecting intercultural differences

Working with ILK communities requires the building of two-way trust and confidence among ILK-holders from IPLCs and scientists through the demonstration of cultural respect and sensitivity.

Mutual respect and trust need to be established, nurtured, and maintained. An investment of time and energy is needed to build mutual acceptance and understanding of each other's observations, interpretations, values, worldviews and priorities. Intercultural respect and sensitivity nurture an equitable intercultural space for ongoing authentic dialogue and negotiation (Hill 2011).

5. Practicing reciprocity, giving back and building capacity

Reciprocity means that knowledge-sharing and capacity-building are a two-way process, resulting in the contribution of ILK to IPBES assessments, and the return of IPBES assessment results, knowledge and skills to indigenous people and local communities who are ILK holders in meaningful and useful forms.

ILK has many audiences but giving back the findings to the community should be a priority (Johnson *et al.* 2013). Sharing the co-produced knowledge, empowering with training, and capacity, and providing forums to raise their voices are some of the `giving back' responsibilities that should be provided to the communities in the context of IPBES assessments. Access to garnered information needs to respect confidentiality and agreement for knowledge transmission in accordance with culturally appropriate protocols; ILK communities need clarity on where the shared knowledge is stored, under whose custodianship, and how and by whom it can be accessed. Much information today can be accessible online, but the places where Indigenous and local peoples live often have poor internet connections, so there remains a critical need for the continued production of printed outputs, DVDs or outputs in other forms that are accessible and useful for such communities.

6. Respecting rights and interests

IPBES will in working with indigenous people and local communities who are ILK holders adhere to principles of non-discrimination, inclusiveness, affirmative action, recognition of traditional land tenure, seeking prior and informed consent, and respect for agreements, conventions and settlements existing within the UN framework and within countries, as appropriate. Prior agreements (seeking prior and informed consent or approval) are essential to protect intellectual and cultural rights of indigenous people and local communities who are ILK holders when documenting indigenous and local knowledge.

Indigenous peoples and local communities have rights established under multiple United Nations instruments including rights to self-determination, to maintain their social and cultural institutions, to practice and revitalise their cultural traditions and customs, for States to respect their intellectual property and to respect free, prior and informed consent. Indigenous peoples and local communities deserve respect and support as active agents with freedom and the capability to exercise their rights, freedoms and their customary governance (Ostrom 2012, Sen 2013). Partners should adhere to principles of non-discrimination, affirmative action, recognition of traditional land tenure, and respect for existing agreements and settlements. Experiences in the application of FPIC processes highlight the need to ensure people represent themselves through their own institutions and make decisions according to procedures and rhythms of their choosing (Carino and Colchester 2010).

Intellectual and cultural rights exist in relation to tangible heritage (human and genetic resources, seeds, and medicines), traditional and cultural expressions and practices (dance, language, music, and art), innovations (techniques, narratives) and individual, collective, gendered and other ownership systems. A large number of instruments can be used to protect intellectual and cultural rights including patents, copyright, trademarks, secrecy, confidentiality agreements and treaty settlement processes (Drahos 2014). Nevertheless, the World Intellectual Property Organisation recognises that significant (and challenging) legal reforms are needed to overcome gaps; and agreements are usually essential because the default position often transfers rights over knowledge to the recorder (Antons 2013).

7. *Defining mutual goals, benefits and benefit-sharing*

Identifying mutual goals in assessments and other work programmes through dialogue and partnerships and ensuring uninterrupted access and equitable sharing of benefits are critically important. Dialogues to identify common goals need to occur as early as possible in assessments and other IPBES work in order to allow for decision-making through customary and traditional institutions.

Indigenous peoples and local communities' goals may be strengthened through engagement with IPBES, for example by: supporting ILK transfer within and between generations; creating new opportunities to share ILK in language education, tourism and other businesses; demonstrating how ILK relates to management of and rights to foods and land; accessing scientific knowledge relevant to new threats such as climate change and invasive species; providing information to tailor government regulations to suit local contexts; and building alliances (Coombes *et al.* 2013). Benefit-sharing for IPBES assessments can involve actions such as provision of resources for ILK-holders to: engage in assessments through community-based compilations using their own indicators and modes such as art, video-recording; enable specific community activities during assessments such as inter-generational knowledge transfer; prepare new materials such as a tourism-educational booklet including the ILK and science mobilised in the assessment; or extend networks and connections through global meetings. Dialogues to identify common goals need to occur early to enable decision-making through customary institutions, which often requires community consensus, and liaison with a council of elders or other senior leadership group (Fenelon and Hall 2008). The Nagoya Protocol regulates access to genetic resources and provides useful guidance on equitable sharing of benefits associated with accessing traditional knowledge of genetic resources (Kamau *et al.* 2012).

While formal written agreements about mutual consent can help ensure a clear understanding of how ILK is shared, some communities may prefer to work on more informal, customary or community protocols that have to be followed. Formal written agreements can provide clarity about objectives, methods, possible benefits and benefit-sharing arrangements, protection for intellectual and cultural rights, review of drafts, arrangements for information release and are required to meet ethics guidelines in some contexts (Wilson 2008).

7.2 Draft procedures for working with ILK for the preparation of platform deliverables

Procedures for working with ILK for the preparation of platform deliverables involves specific attention to ILK in series of six stages, starting with prioritising requests, and continuing through the preparation of reports, including the nomination and selection of author teams, the preparation of draft reports and the review (Table 2).

An ILK-specific procedure involving an ILK workshop, community dialogues and literature review has been piloted for the Pollination Thematic Assessment, and the African and Europe-central Asia Regional Assessment. This ILK-specific procedure will be further enriched with ongoing thematic, and regional assessments and proposed to the Plenary at its fifth session.

Table 2

Stages that required specific attention to procedures for working with indigenous and local knowledge in preparation of platform

Stage 1	Receiving and prioritizing requests to the Platform
Stage 2	Scoping for Platform deliverables
Stage 3	Preparation of reports • The ILK-specific mechanism currently under piloting forms part of this stage, and overlaps with other stages
Stage 4	Preparation and approval of summaries for policy makers
Stage 5	Preparation, approval and adoption of synthesis reports by the Plenary
Stage 6	Dissemination of outputs and monitoring and evaluation of the procedures

Stage 1 Receiving and prioritising requests to the platform

When submitting inputs, requests and suggestions for Platform attention and action in line with the *Procedure for receiving and prioritizing requests put to the Platform* (IPBES/1/3), Governments, MEAs, UN bodies and other stakeholders are encouraged to take into account relevant ILK and the concerns and priorities of ILK holders from IPLCs and ILK experts.

Decision IPBES/1/3 sets out the procedure for receiving and prioritizing requests put to the Platform. These requests should also where relevant be accompanied by information about the availability of relevant ILK and the potential contribution of ILK holders from IPLCs and ILK experts.

Stage 2 Scoping for Platform deliverables

Decision IPBES/3/3 on Procedures for the preparation of Platform deliverables[12] includes guidance on defining the scope and objective of a deliverable and the information, human and financial requirements to achieve the objective. The MEP selects experts to carry out the scoping, including determination of the outline, costs and feasibility. In order for ILK to be appropriately included in IPBES assessments, it is important that the requisite ILK experience and expertise are available during the scoping phase in order to allow for the co-design of the assessment based on diverse knowledge systems. In particular this requires attention to:

- Nomination of experts:

  The Multidisciplinary Expert Panel, when requesting nominations of experts for a detailed scoping, should encourage governments and stakeholders to utilize the roster of ILK holders and experts.

- Selection of experts:

  The composition of the group of experts for the scoping should reflect the diversity of knowledge systems that exists (IPBES/3/18, 3.6.2). When making its selections for a detailed scoping, the Multidisciplinary Expert Panel should ensure that the scoping team includes an appropriate number of experts who are ILK holders from IPLCs or ILK experts. In the event that the composition falls short of expectations, the Multidisciplinary Expert Panel, advised, as appropriate, by the task force on ILK, could consult the roster of ILK holders and experts in order to identify additional individuals who can fill the gap in ILK experience and expertise in the scoping team. The proposed procedure to fill gaps in experts for thematic or methodological assessments (IPBES/4/15) could be followed, if approved by the Plenary.

  Members of the ILK task force can be nominated and potentially selected following accepted procedures, to join the expert team for the scoping.

Stage 3 Preparation of reports

The document "Procedures for the preparation of Platform deliverables"[13] contains a series of steps for the preparation of reports, including the nomination and selection of author teams, the preparation of draft reports and the review. Each of these steps requires attention to ILK:

- Nomination and selection of experts for assessment teams
  - Nomination of experts:

    The Multidisciplinary Expert Panel, when requesting nominations through the Platform secretariat of experts to act as Coordinating Lead Authors (CLAs), Lead Authors (LAs) or Review Editors (REs), could encourage governments and stakeholders to nominate ILK holders from IPLCs or ILK experts and/or to utilize the roster of ILK holders from IPLCs and ILK experts.

  - Selection of experts:

    The composition of the group of CLAs and LAs for a given chapter, report or summary, should reflect the diversity of knowledge systems as appropriate (IPBES/3/18, 3.6.2). When making its selection, the MEP should aim to include within the author team of relevant chapters, an appropriate number of authors who are ILK holders from IPLCs or ILK experts. If there are gaps in ILK expertise, the MEP in collaboration with the assessment Co-chairs, advised, as appropriate, by the task force on ILK, could consult the roster of ILK holders from IPLCs and ILK experts. The proposed procedure to fill gaps in experts for thematic or

[12] Items 3.1, paras. e and f; Item 3.2, para. c; Item 3.3, paras. e and f; and Item 3,4; in Decision IPBES-3/3 Procedures for the preparation of Platform deliverables, in the Report of the Plenary of IPBES on the work of its third session (IPBES/3/18) http://ipbes.net/images/documents/plenary/third/working/3_18/IPBES_3_18_EN.pdf.

[13] Items 3.5 and 3.6 in Annex I to Decision IPBES-3/3 in IPBES 3/18 Procedures for the preparation of Platform deliverables, Report of the Plenary of IPBES on the work of its third session (pp 80-83) http://ipbes.net/images/documents/plenary/third/working/3_18/IPBES_3_18_EN.pdf.

methodological assessments (IPBES/4/15) could be followed, if approved by the Plenary. Non-MEP Members of the ILK task force can be nominated and potentially selected following accepted procedures, to join the assessment author team as CLAs or LAs.

- Preparation of draft reports
    - Identification of relevant published sources of ILK

    While mainstream scientific resources provide access to some ILK literature, the ILK field also has its own dedicated journals, search engines, databases and networks, which differ from those generally consulted in the fields of ecology, biodiversity and economics. ILK holders and experts on the author team, will identify the ILK- resources that are most relevant to their assessment. They will also be invited to use, as an additional resource, an initial annotated list of key ILK-relevant resources prepared by the task force on ILK.

    ILK holders and experts or contributing authors could provide translations of material if not available in English. However in most instances, these arrangements will not provide adequate opportunities for ILK literature in languages other than English to be brought into the assessment process.

- ILK-specific procedure to reinforce ILK in IPBES assessments
    - Current draft procedure is in next section
- Review
    - Expert Reviews:

    Existing procedures for the review of report drafts pose unintentional but significant barriers to the participation of ILK holders from IPLCs. Efforts should be made to render review processes more user-friendly, including by allowing for the submission of comments from IPLCs in flexible formats.

    The MEP, the task force on ILK, and the secretariat should encourage ILK holders from IPLCs, IPLCs and ILK experts to participate actively in reviews of the assessment drafts. ILK holders from IPLCS and ILK experts who have provided *in-situ* knowledge to the assessment should use their own community-based validation and documentation processes during the first and second reviews and the finalization of the Summary for Policy Makers.

    - Review Editors:

    In order to ensure appropriate and high quality inclusion of ILK in assessment reports, governments and stakeholders should be encouraged to nominate Review Editors who are ILK holders from IPLCs and/or ILK experts, including individuals on the roster of ILK holders from IPLCs and ILK experts. The MEP should make every effort to include an appropriate number of Review Editors with ILK experience and expertise on each assessment team.

- Evaluation of gaps in ILK experience and expertise:

    The MEP, in collaboration with the assessment co-chairs, could consult the roster of ILK holders from IPLCs and ILK experts in order to identify additional individuals who can fill the gap in ILK on the team of Review Editors. The proposed procedure to fill gaps in experts for thematic or methodological assessments (IPBES/4/15) could be followed, if approved by the Plenary.

Stage 4 Preparation and approval of summaries for policy makers

Responsibility for preparing first drafts and revised drafts of summaries for policymakers lies with the report co-chairs and an appropriate representation of CLAs and LAs (Item 3.8 in IPBES-3/3). The MEP and Bureau should ensure that an appropriate number of individuals with ILK experience and expertise is included in the author team for the summary for policymakers.

Stage 5 Preparation, approval and adoption of synthesis reports by the Plenary

The writing team for the synthesis report could be composed of report co-chairs, CLAs, and Multidisciplinary Expert Panel and Bureau members (Item 3.9 in IBES-3/3). The MEP should ensure that the writing team includes an appropriate number of individuals with ILK experience and expertise.

Stage 6 Dissemination of outputs and monitoring and evaluation of the procedures

In keeping with the approaches for working with ILK holders from IPLCs and ILK experts, the assessment process should provide communities with the results of assessments that are packaged, ‘authored’, credited and shared using socio-culturally appropriate modalities including oral and/or visual forms, as well as relevant language. This includes the results of the assessments, authored with the names of contributing ILK holders from IPLCs and ILK experts.

7.3 Draft ILK specific mechanism for preparation of platform deliverables[14]

The ILK-specific mechanisms recognizes the benefits of collaborative assessment framework and design. Six steps are currently being piloted and recommended for future pilots (Table 2). Collaboration can facilitate respectful interactions between worldviews, knowledge systems and recognition of respective different agenda and goals of ILK knowledge holders and scientific communities. Tasks include establishment of mutual goals, benefit-sharing, capacity building, selection of knowledge co-production tools (e.g. participatory scenarios and modeling), domain assessment, context and other analysis, problem definition and activity selection. The processes currently recommended as practical steps will require further adjustments with the ILK-holders, at all levels, from local to global levels, to tailor the activities to the specific context.

Table 3

Practical steps in the ILK-specific mechanism for preparation of platform deliverables

Step 1	Identification and mobilisation of knowledge and knowledge-holders for an ILK resource workshop (call)
Step 2	Identify key ILK research and select pilot sites
Step 3	Support local preparatory meetings
Step 4	ILK resource workshops and collaboration at the First Author Meetings
Step 5	ILK work sessions and contributions to the First Order Draft (FOD)
Step 6	Collaboration at the Second Authors' Meeting
Step 7	ILK incorporation into the Second Order Draft (SOD) and Summary for Policy Makers SPM)
Step 8	Appropriate packaging, authorship and dissemination of results/outputs – under development

Step 1: Identification and mobilization of knowledge and knowledge-holders for an ILK resource workshop

Careful preparation is undertaken to initiate collaboration between ILK holders, practitioners and experts, particularly those from ILK communities, and the Lead Authors and Coordinating Lead Authors. The key task is to disseminate a global/regional/sub-regional call seeking contributions of ILK and identification of ILK-holders, and to prepare for an ILK resource workshop. The call needs to occur within a timeframe that facilitates participation by the ILK-holders, including time necessary for collective decision-making processes. Preliminary ILK stakeholder mapping is necessary to identify and mobilize relevant ILK and knowledge holders through the call. This requires networking with organizations, associations, nodes, and researchers involved in work with ILK-holders as well as making use of the Roster of ILK Experts. Assistance may be available from the ILK Taskforce. The following activities occur:

- Call at global/regional/sub-regional levels for interested participants and relevant ILK contributions from ILK holders and experts (e.g. key ILK holder and expert participants; significant sets of ILK-based scientific and grey literature; relevant ILK from holders and experts):
  - ensure call provides sufficient time for mobilization of ILK-holders and experts, and is at least 6 weeks before ILK resource workshop.

Step 2: Identify key ILK research and select pilot sites

This step involves selection of the knowledge sources and the ILK-holders that will underpin the contribution of ILK to the assessment. The following activities occur:

- analyze inputs received from the call

[14] The draft ILK-specific mechanism will further piloted and revised during 2016-2018.

- identify through transparent criteria-based process, assisted by relevant ILK expert group (ILK Taskforce, Interim ILK Reference Group or relevant ILK group within the Participatory Mechanism once established) appropriate ILK holders and experts for ILK resource workshop[15];
- place relevant ILK-holders and experts on the Roster of Experts with their agreement and consent[16];
- analyse for relevance and to identify key themes) the inputs from the call for ILK scientific and gray literature, and compile into a searchable data base for use by authorship team, including key terms from the thematic analysis and any notes about priority high-quality resources, and other relevant issues identified in the analysis.
- contact identified ILK holders and experts and relevant authors, agree on terms of engagement (including prior informed consent), and provide information to prepare participants for the ILK resource workshop;
- encourage authors to adopt a listening role, and utilize appropriate participatory workshop formats and tools, to ensure that ILK inputs reflect the context and are not inappropriately constrained by the format, content and organization of previous assessments.
- complete information and logistic preparations to allow ILK holders, experts and authors to attend the ILK resource workshop, including through preparatory meetings (see next step).

Step 3: Support local preparatory meetings

In this step, meetings help raise community awareness about IPBES and disseminate information about the scoping document and the stages and steps in an assessment. The following activities occur:

- Address mechanisms to ensure the principles are followed including for example:
    - arrangements for protection of intellectual and cultural rights and FPIC
    - approaches to knowledge co-production
    - tools that will be used in ILK resource workshops including maps, paintings etc; how information from the assessments will be provided back to communities and in what modes
    - arrangements for capacity-building and training
    - local work sessions to enable contributions of *in-situ* ILK to the First Order Draft, in appropriate forms that reflect the knowledge systems modes and contents, and co-production activities
    - provision of information and undertaking of co-production activities from ILK work sessions to the authors in time for the First Order Draft (FOD)
    - include consideration of levels of confidence in information provided for the FOD
    - awareness-raising and increased IPBES visibility at national and sub-national levels
    - feedback to communities: identified ILK holders and experts present the ILK (and scientific) information about the ILK resources workshop
- Consider the benefits of a local preparatory meeting information pack to enable self-organisation of local meetings by identified workshop attendees (which may be most suitable for those with previous involvement with IPBES), with or without assistance from IPBES secretariat staff.
- Ensure ILK holders or representatives invited to the local preparatory and ILK workshops receive timely information before all meetings. Language, academic standards and ways of communication should fit with the invited ILK holders in prior communication and workshop processes to ensure their effective participation in the assessment process. Support ILK Work Sessions organized by identified ILK holders and experts:

Step 4: ILK resource workshops and collaboration at the First Author Meetings

This step focuses on the development of relationships of mutual trust and respect across diverse groups of knowledge

[15] The pollination pilot utilised nine criteria classified according to two categories: knowledge contribution (relevance; experience; co-production; focused on assessment topic; publications); and ability to contribute (ability to write; community endorsement; regional balance; gender balance).

[16] In order for ILK holders and experts to assume roles as CLAs and LAs, they would need to be subject to the formal nomination process; additional Contributing Authors can be brought in without this formal nomination process.

holders through the conduct of an ILK resource workshop and collaboration at the First Authors Meeting. Following appropriate protocols and approaches for mutual exchange, documentation and analysis of information will ensure reciprocity, transparency, shared benefits, and foresee potential risks. Interactions with local communities (including some in their local contexts) at the ILK resource workshop will develop trust and ensure that individuals representing the communities, and different actors using different sets of knowledge, understand the process. The ILK resource workshop is thus key to building mutual understanding and trust between authors and ILK holders and scientists, and to align expectations.

- Conduct an ILK resource workshop with identified ILK holders, experts and assessment co-chairs, CLAs and LAs to:
    - create an environment, use appropriate participatory approaches and tools, which allow ILK-holders to contribute freely and in confidence. Core themes for discussion can be identified separately by ILK holders and assessment authors and then pooled to facilitate agenda
      co-design;
    - encourage, and facilitate with participatory methods, knowledge co-production, build dialogue and mutual understanding between assessment authors and ILK holders/experts, and align expectations;
    - hold in-depth discussions to reach mutual understanding of how to address FPIC, intellectual and cultural rights and jointly elaborate methodologies for working together;
    - reach agreement on how to implement the approaches through the ILK-specific procedure:
        - Mutual objectives that are meaningful and respectful for both ILK holders/experts and assessment authors
        - benefit sharing arrangements
        - arrangements for protection of intellectual and cultural rights and FPIC
        - approaches to knowledge co-production
        - tools that will be used including maps, paintings etc
        - how information will be provided back to communities and in what modes
        - arrangements for capacity-building and training
        - provisions for validating the inclusion of both *in-situ* and *ex-situ* ILK in the assessments
        - provisions for assigning confidence levels to statements about ILK in the assessments;
    - jointly agree on priority issues within chapters to be addressed through ILK:
        - Establish the role and contributions of *in-situ* work with ILK-holders to each chapter
        - Establish the role of and contributions of *ex-situ* ILK to each chapter;
    - co-design the ILK literature review for the assessment. Present findings from the thematic analysis of the ILK literature. Co-design should include:
        - delivery of the searchable data base and discussion with assessment authors
        - co-development of an analytical framework to structure the search terms
        - documentation of the best and richest sources of information available in other searchable data-bases and languages is necessary.
        - advice for assessment authors about how to treat literature that has been obtained without informed consent, or that includes particularly biased material
        - processes for validating the inclusion of *ex-situ* ILK into the assessments.
- MEP members (ILK co-chairs and MEP on the ILK task force) with selected members of the ILK task force, engage with Co-chairs, CLAs and LAs to invite ILK-holders and experts to contribute to the First Authors' Meeting (FAM) in order to:
    - provide for collaboration between Contributing Authors (CAs), Lead Authors (LAs), Coordinating Lead Authors (CLAs) and ILK holders and experts during the First Authors' Meeting (FAM)

  - support attendance for part of the FAM by representatives of the ILK holders who will contribute the *in-situ* ILK required for the assessments and members of the ILK Reference Group
  - fully inform CAs, LAs and CLAs during the FAM about the draft ILK strategy for the assessment, the specific procedures that will facilitate interactions with ILK holders during all the stages of the assessment process and the role and members of the ILK Reference Group.
  - provide capacity building Authors (LAs and CLAs) about
    - the characteristics of ILK as presented above (e.g. how it is framed and presented in formats that may not be a usual one for scientists)
    - the validity methods applied in ILK systems and other issues raised in the Approaches
    - how levels of confidence related to ILK knowledge will be assigned following a process involving ILK holders and experts.

Step 5: ILK work sessions and contributions to the First Order Draft (FOD)

This step focuses on mobilization and validation of in-situ knowledge through work sessions processes that are driven by ILK-holders to enable contributions to the First Order Draft. As detailed in the Approaches, ILK is developed and validated through its application as a living knowledge system, which translates into formats that are highly diverse including myths, songs, and knowing by practicing. Support and collaboration with ILK holders and practitioners will be necessary to enable ILK-driven processes that co-produce their knowledge into IPBES assessments, taking care of not distorting the above formats. Collaboration at the Second Author's Meeting provides an opportunity to ensure advice on responses to the reviews, and the assigning of confidence levels that are valid and robust in terms of the ILK systems.

- Co-produce knowledge within First Order Draft through sharing different sets of knowledge from the ILK work sessions and scientific information provided assessment authors.
- Prepare and publish the Proceedings from the ILK resource workshops on the occasion of the regional first author meetings in support of the eventual inclusion of relevant ILK in the FODs by the assessment co-chairs, CLAs and LAs.

Step 6: Collaboration at the Second Authors' Meeting

This step focuses on ensuring that appropriate and mutually agreed validation methods and approaches to assigning confidence are employed that recognize the distinctive features of different knowledge systems including diverse categorizations and classifications of BES using different knowledge systems; and that the methods correspond to different categories and epistemological models of thinking. Validation is undertaken by ILK holders, through the practice of their own knowledge systems, and within their own terms. The following activities occur:

- Support local work sessions by ILK-holders who are providing in-situ knowledge to conduct their own community-based validation of the First Order Draft, and approve the form of words in the draft assessments.
  - provide information about the FOM in format suitable to enable review of key issues and components during work sessions to the authors in time for the First Order Draft (FOD)
  - include discussion of appropriate levels of confidence for information included provided for the FOD
  - feedback to communities: identified ILK holders and experts present the ILK (and scientific) information about the ILK resources workshop
- MEP members (ILK co-chairs and MEP on the ILK task force) with selected members of the ILK task force, engage with Co-chairs, CLAs and LAs to invite ILK-holders and experts to contribute to the Second Authors' Meeting (SAM) in order to:
  - provide collaboration between Contributing Authors (CAs), Lead Authors (LAs), Coordinating Lead Authors (CLAs) and ILK-holders and experts during the Second Authors' Meeting (SAM)
  - Led by the CLAs and LAs, assign initial levels of confidence at the SAM in close coordination with the ILK-holders and ILK Reference Group:
    - Ensure ILK-holders validate the inclusion of their own *in-situ* knowledge contributions
    - Support contributions to validation of how ex-situ knowledge has been incorporated into the assessment by the ILK Reference Group for the assessment or other ILK expert group (e.g. ILK Taskforce or relevant group as part of the Participatory Mechanism, once established)
  - Apply the set of pre-defined criteria developed by the Knowledge and Data Task Force in collaboration with the ILK Task Force. This should include consideration by sufficient relevant ILK-holders experts to reasonably assign confidence
  - criteria to assign confidence level may be also further defined during assessments within local contexts through integrating a larger number of people than those who are present during the global dialogue and final assessment meetings. Level of confidence may be for example, the

extent to which a set of knowledge is shared collectively; timeframe and depth of uses of practices; means of transmission and sharing; and level of specialization.

Step 7: ILK incorporation into the Second Order Draft (SOD) and Summary for Policy Makers (SPM)

- Support local work sessions by ILK-holders who are providing in-situ knowledge to conduct their own community-based validation of the Second Order Draft (SOD) and Summary for Policy Makers (SPM), and approve the form of words in the draft assessments.
  - provide information about the SOD and SPM in format suitable to enable review of key issues and components during work sessions to the authors in time for the Third Author Meeting
  - include discussion of appropriate levels of confidence for information included provided for the SOD
  - feedback to communities: ongoing promotion of the work of IPBES;
- Provide for advice to be available from ILK-holders at the Plenary session where the SPM will be reviewed, revised and adopted
  - ensure ILK Reference Group members are available, and in touch with ILK-holders for discussion either as CLAs or in close contact with CLAs
  - ensure ILK stakeholders in attendance are briefed about the assessment and the ILK issues and priorities.

Step 8: Appropriate packaging, authorship and dissemination of results/outputs

This step focuses on, ensure that outputs are packaged, "authored", credited and shared with communities using socio-culturally appropriate ways including oral, language or art forms. The diversity of local and indigenous knowledge holders and ILK communities means that the material must be tailored to the context. In particular, it is a key issue that ILK holders and communities are cited in IPBES assessments whenever their knowledge has been used.

- Provide results of assessments to communities
  - appropriately packaged so that these may go back to local and indigenous communities, and transferred within and across generations.
  - include proceedings of ILK co-design scoping workshops and ILK resource workshops, local work sessions, authored with the names of contributing ILK authors as well as their communities.
  - provide diverse forms of packaging, such as videos, with translation into local languages.
  - make available results of scientific assessments in formats that can be transferred by ILK holders and experts to local and indigenous communities.

An iterative approach supported by IPBES in engaging ILK after the resource workshops and authors' meetings and beyond the assessment and interactions with authors needs to be put in place, to help ILK holders package the results into other formats and consolidate the results of their knowledge within the assessments.

AN ILLUSTRATION OF STEPS FROM THE FAST TRACK POLLINATION ASSESSMENT

Step1: **Identify relevant ILK holders, scientists, experiences and literature**

Global call for inputs to identify ILK and ILK-holders relevant to the pollination assessment (e.g. key bodies of scientific and gray literature, primary ILK holders and relevant research)

Contributions from ILK Task Force members and their networks of expertise

Initial compilation and analysis of relevant ILK in the scientific and grey literature

The Participatory Mechanism can inform different networks of the relevant aspects for the pollination assessment.

Step 2**: Identify key ILK research and select pilot sites**

Analyse inputs from the global call, and continue compilation and analysis of ILK literature

Identify ILK holders and ILK scientists with best-suited ILK expertise for this assessment

Relevant networks with the Participatory Mechanism interact to mobilize ILK

Select 3-4 sites to pilot procedures to bring ILK into the Pollination Assessment

Step3: **Prepare selected ILK holders for the Global Dialogue (inception) workshop**

Contact selected ILK holders and ILK scientists to brief them on IPBES, agree on terms of engagement, and prepare their participation in the assessment;

Virtual meetings to plan and prioritize with ILK experts (knowledge holders and scientists)

Logistical preparations for global dialogue workshop The Participatory Mechanism can improve the virtual dialogue about ILK networks in order to provide inputs to the Global dialogue Workshop in Paris Step 4: **Global Dialogue (Inception) Workshop in Paris** Conduct a global dialogue (inception) workshop with selected ILK holders, researchers and FTA authors to: Build dialogue and mutual understanding between authors and ILK holders/scientists, and align expectations; Jointly agree on priority issues within chapters to be addressed through ILK; Jointly elaborate objectives that are meaningful for both ILK holders and authors, and discuss methodologies for fast track work with ILK-holders and scientists. Review key findings from the ILK literature with authors and selected ILK holders and scientists and convey initial information from primary ILK holders, Deliver a first set of ILK information to CLAs and LAs during the review phase for the First-order draft. Step 5: **ILK Work Sessions in selected pilot sites** Work sessions at pilot sites with relevant ILK holders and scientists, focusing on the objectives identified at the Global Dialogue Workshop. This work will include compilation, recording and systematization of ILK. Participatory process at national and sub national levels including ILK workshops and pilot studies in order to record ILK knowledge and experiences related to the pollination assessment. The Participatory Mechanism can provide technical assistance in order to improve compilation and recording of ILK. The pilot sites are planned and learning shared through shared learning and dialogue (SLD) methods, Step 6: **Second Authors' Meeting for FTA Pollination** Present initial ILK findings and discuss, review and further advance the delivery of ILK at the second Authors' meeting for the pollination assessment; Step 7: **ILK incorporated into the drafting of the Second-order Draft** Final phase of work to finalise the compilation of ILK and outputs, and verify with ILK-holders its appropriate packaging, acknowledgement and dissemination The second-order draft is circulated among key actors in the Participatory Mechanism. Step 8: **Feedback to ILK holders and communities** ILK experts and scientists present the relevant ILK (and scientific) information contained within the second draft report and summary for policymakers to contributing ILK communities for verification and feedback; Analysis of lessons learned from the piloting of ILK procedures and approaches and participatory mechanism into decision document for Plenary-4

References

Agrawal A (2002) Indigenous knowledge and the politics of classification. Int. Soc. Sci. J. 54: 287-297.

Antons C (2013) Asian Borderlands and the Legal Protection of Traditional Knowledge and Traditional Cultural Expressions. Modern Asian Studies 47: 1403-1433.

Berkes F (2012) Sacred ecology, Third Edition. Routledge, New York, USA

Berkes F, Berkes MK, and Fast H (2007) Collaborative integrated management in Canada's north: The role of local and traditional knowledge and community-based monitoring. Coastal Management 35: 143-162.

Berkes F, Colding J, and Folke C (2000) Rediscovery of traditional ecological knowledge as adaptive management. Ecological Applications 10: 1251-1262.

Bolivia (2013) Living-well in balance and harmony with Mother Earth: A proposal for establishing a new global relationshipbetween human beings and nature. Bolivia: Ministry of Foreign Affairs, Plurinational State.

Carino J, and Colchester M (2010) From dams to development justice: progress with 'free, prior and informed consent' since the World Commission on Dams. Water Alternatives 3: 423-437.

Coombes B, Johnson JT, and Howitt R (2013) Indigenous geographies II: The aspirational spaces in postcolonial politics - reconciliation, belonging and social provision. Progress in Human Geography 37: 691-700.

Descola P (2014) Modes of being and forms of predication. Journal of Ethnographic Theory 4: 271-280.

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

Drahos P (2014) Intellectual Property, Indigenous People and their Knowledge. Cambridge University Press, Cambridge, UK

Duraiappah AK, Asah ST, Brondizio ES, Kosoy N, O'Farrell PJ, Prieur-Richard A-H, Subramanian SM, and 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.

Edwards R (2013) Power and trust: an academic researcher's perspective on working with interpreters as gatekeepers. International Journal of Social Research Methodology 16: 503-514.

Evans L, Scott H, Muir K, and Briscoe J (2009) Effective intellectual property protection of traditional knowledge of plants and their uses: an example from Australia. GeoJournal 74: 391-401.

Fenelon JV, and Hall TD (2008) Revitalization and indigenous resistance to globalization and neoliberalism. Am. Behav. Sci. 51: 1867-1901.

Gratani M, Butler JRA, Royee F, Valentine P, Burrows D, Canendo WI, and Anderson AS (2011) Is Validation of Indigenous Ecological Knowledge a Disrespectful Process? A Case Study of Traditional Fishing Poisons and Invasive Fish Management from the Wet Tropics, Australia. Ecology and Society 16: 25.

Hill R (2011) Towards equity in Indigenous co-management of protected areas: Cultural planning by Miriuwung-Gajerrong people in the Kimberley, Western Australia. Geographical Research 49: 72-85.

Hill R, Davies J, Bohnet IC, Robinson CJ, Maclean K, and Pert PL (2015) Collaboration mobilises institutions with scale-dependent comparative advantage in landscape-scale biodiversity conservation. Environmental Science & Policy 51: 267-277.

International Society of Ethnobiology (2006) ISE Code of Ethics (with 2008 additions). Online: http://ethnobiology.net/code-of-ethics/: International Society of Ethnobiology.

Johnson JT, Louis RP, and Kliskey A (2013) Weaving Indigenous and Sustainability Sciences: Diversifying our Methods (WIS^2DOM) Workshop. Arlington, USA: Arctic Social Sciences Program, Directorate for Geosciences, National Science Foundation.

Kamau EC, Feder B, and Winter G (2012) The Nagoya protocol on access to genetic resources and benefit sharing: what is new and what are the implications for provider and user countries and the scientific community? Law, Environment and Development Journal 6: 248-262.

Legrady G, Scott K, Duran RJ, and Ieee (2013) The James Bay Cree Visual Ethnographic Digital Online Cultural Atlas. 2013 International Conference on Culture and Computing (Culture and Computing 2013): 129-130.

Lyver PO, Moller H, and Thompson C (1999) Changes in sooty shearwater Puffinus griseus chick production and harvest precede ENSO events. Mar. Ecol.-Prog. Ser. 188: 237-248.

Maffi L, and Woodley E, (eds) (2010) Biocultural Diversity Conservation A Global Sourcebook. London, UK and Washington, USA, Earthscan.

Ostrom E (2012) Why do we need to protect institutional diversity? Eur. Polit. Sci. 11: 128-147.

Parlee BL, Goddard E, and Smith M (2014) Tracking change: traditional knowledge and monitoring of wildlife health in Northern Canada. Human Dimensions of Wildlife 19: 47-61.

Perez E, Esquit E, and Martinez A (2007) La tradición del chib'al: un encuentro entre el conocimiento tradicional y el fenómeno de la migración de aves e insectos. Proyecto FODECYT No 084.

Pfeiffer JM, and Butz RJ (2005) Assessing cultural and ecological variation in ethnobiological research: The importance of gender. J. Ethnobiol. 25: 240-278.

Robinson C, Maclean K, Hill R, Bock E, and Rist P (2015) Participatory mapping to negotiate indigenous knowledge used to assess environmental risk. Sustain Sci: 1-12. DOI 10.1007/s11625-11015-10292-x.

Sen A (2013) The Ends and Means of Sustainability. J. Hum. Dev. Capab. 14: 6-20.

Tengö M, Brondizio E, Elmqvist T, Malmer P, and Spierenburg M (2014) Connecting Diverse Knowledge Systems for Enhanced Ecosystem Governance: The Multiple Evidence Base Approach. AMBIO: 1-13.

Thaman R, Lyver POB, Mpande R, Perez E, Cariño J, and Takeuchi K, (eds) (2013) The Contribution of Indigenous and Local Knowledge Systems to IPBES: Building Synergies with Science. Paris, France, IPBES Expert Meeting Report, UNESCO/UNU.

Wilson S (2008) Research is Ceremony. Indigenous Research Methods. Fernwood Publishing, Black Point, Canada

Section IV: Identifying and Addressing Data, Information and Knowledge Resources and Gaps

Coordinating Authors: Walter Jetz, Belinda Reyers, Sheila Vergara, Eugenie Regan, Luthando Dziba

Authors: András Báldi, Patricia Balvanera, Eun-Shik Kim, Szabolcs Lengyel, Heather Tallis, James Watson, Catherine Laurent, Sandra Knapp, Mialy Andriamahefazafy, Eduardo Dalcin, Antonio Saraiva, Gregory Insarov, Jae Choe, Nidhi Nagabhatla, Jörg Freyhof, Tim Hirsch, Sheila Mbiru, Ferenc Horváth, Mark Lonsdale, Romain Julliard

Introduction

The following guidelines are intended to provide the framework by which to organize, implement, document and present results of assessments so they are comparable across regions, sectors and time relevant to policy, but not policy prescribed. They are based on contributions from experts and drawn from their collective experience and consultations among relevant stakeholders.

Principles

- Knowledge, information, and data (KID) used in IPBES assessments are those components that are willingly being shared in the elaboration of an assessment (Chapter 7 of the Assessment Guide)
- Excellence in gathering of KID coupled with transparency, consistency, comparability, replicability, potential to integrate, credibility, and preservation of resources will underpin IPBES assessments.

The IPBES assessment process aims to evaluate status and trends of biodiversity and ecosystem services (BES), their interlinkages, the impact of biodiversity and ecosystem services on human well-being and the effectiveness of responses (IPBES-2/5). Such assessments are critically dependent on a multitude of data types and sources from a variety of domains and scales. These support the development of information, including metrics and indicators, which in turn support knowledge generation, assessments and policy support tools, three of the four main IPBES functions (Chapter 1).

A major objective of the assessment process is that policy-makers have sufficient confidence in assessment conclusions to use them in support of policy and decisions. To achieve this, certain key principles and practices regarding the collection, processing and use of data, information and knowledge need to be respected and applied consistently:

- **Inclusion of all** relevant and available or readily mobilizable data, information and knowledge from different knowledge systems and sources;
- **Transparency** at all steps of collection, selection, analysis and archiving, in order to enable informed feedback on assessments and replicability of results, and to enable comparability across scales and time; and
- **Systematic and well-documented methodology** in all steps of the assessment process, including documentation of the representativeness of the available evidence and of the remaining gaps and uncertainty.

The guidance in this chapter aims to support the application of these principles in the implementation of all assessments carried out under the IPBES Work Programme. It provides definitions of knowledge, information and data respectively; outlines the available sources and types of KID relating to biodiversity and ecosystem services; emphasizes the importance of standards and metadata; addresses issues of quality and confidence; and offers advice regarding selection of fit-for-use resources and responsible archiving.

Use of KID in the IPBES assessment process

In order to attain the IPBES goal of “strengthen[ing] the science-policy interface for biodiversity and ecosystem services for the conservation and sustainable use of biodiversity, long term human well-being and sustainable development” assessment authors will need to include knowledge resources from a wide variety of sources and communities.

Successful IPBES assessments are expected to bring together and to create new knowledge about the state of Nature and Nature’s Benefits, the state of indirect and direct drivers impacting them, and the type and consequences of these impacts at global, regional, and sub-regional level. In the IPBES conceptual framework (Diaz et al. 2006), Nature is represented by the properties and processes of biodiversity and ecosystems and Nature’s Benefits are represented by the goods and services those properties and processes provide. Indirect drivers are socio-political, economic, technological or cultural conditions associated with human life. Direct drivers (pressures) include habitat conversion, exploitation, climate change, pollution, and species introductions.

In the IPBES process, parties will assess the KID available and accessible; they will also reveal gaps in KID and generate queries about biodiversity and ecosystem services that will guide the development of useful new knowledge by collecting, analysing and synthesising sets of knowledge resources (data, information and knowledge). A successful assessment depends on clearly crafted queries that bring together knowledge resources, thematically organized such that the necessary literature and other knowledge sources, data and data bases, indicators, indices and metrics are aligned to inform the discovery and synthesis of knowledge and support the assessment conclusions.

Assessments will aim to provide an understanding of the causal links between the effects of drivers or pressures and Nature or Nature's Benefits (Díaz et al. 2006, Dawson et al. 2011). Given the large scope of IPBES assessments, these links will often be based on observations rather than experiments and developed statistically in a model-based framework. Such models can make predictions about the state of biodiversity and ecosystems in particular places and support projection of future states for different scenarios and decision support (Pereira et al. 2010; also see Section 3).

Descriptive links will also be important for generating predictions and bring together quantitative or qualitative information about the variation in drivers, pressures, Nature, or Nature's Benefits in space and time. These will come from many sources and domains, and will be captured over different scales, at different resolutions and with different sampling methods. We expect an iterative process of identifying assessment knowledge, information, and data needs and gaps, which in turn will drive subsequent analysis and mobilization of additional knowledge resources.

Definitions

Data, information, and knowledge represent the key empirical underpinnings of IPBES functions. Our operational definitions of these and related terms are as follows (Figure 8.1):

- **Data** represent raw observations or measurements of states or drivers, which may be qualitative or quantitative. Data may be subdivided along a wide variety of themes, for example, thematic, geographical, or taxonomic lines, *inter alia*. The ways that data can be used and interpreted depends on their scale, resolution, quality and how representative they are.
- **Information** includes "processed data" and quantitatively "aggregated knowledge", which might be metrics, indicators, trends or model parameter estimates or other types of variables derived from aggregating, integrating and analysing other data or analysis results. Such information is usually directly derived from data, but may be the outcome of models or may include quantitatively aggregated results from published studies supporting meta-analyses.
- **Indicators** are derived information products that can be used to characterize biodiversity or ecosystem states or drivers, and design to help stakeholders to take decisions.
- **Knowledge** refers to understanding gained through analysis and interpretation, experience, reasoning, perception, intuition and learning, which is developed as result of using and processing data and information. It empowers people to take action and supports decision-making. There are many knowledge systems that will be useful in the IPBES assessment process. Some examples of common knowledge systems in the IPBES context are:
  - Scientific knowledge (Science) systems are characterized by use of data to construct theories and models that are testable. Sources of scientific knowledge include publication in the peer-reviewed scientific literature or scientific reports.
  - Indigenous and local knowledge (ILK) systems are characterized by being place- or practice-based integrations of environmental experience over varying periods of time that are often longer than those of scientific studies. Sources of ILK include an interview with village elders, a painting describing local management or a description of local farming technology.
  - Expert knowledge (Expert) systems are characterized by personal expertise of individuals based on their own experience. Sources of expert knowledge include land manager experiences or IUCN Red List assessments.
- **Knowledge resources** are any or all of data, information or knowledge derived from a wide variety of different sources.
- **Metadata** provide standardized descriptors that are required to characterise, manage and exchange any of these knowledge resources. Metadata, for example, can refer to the type of resource (e.g., film, scientific paper; the type of data set – observation, specimen-based) and are based on standards established by communities (e.g., DarwinCore, DublinCore).

Existing knowledge resources will be used for the assessments but assessments will themselves generate new knowledge resources.

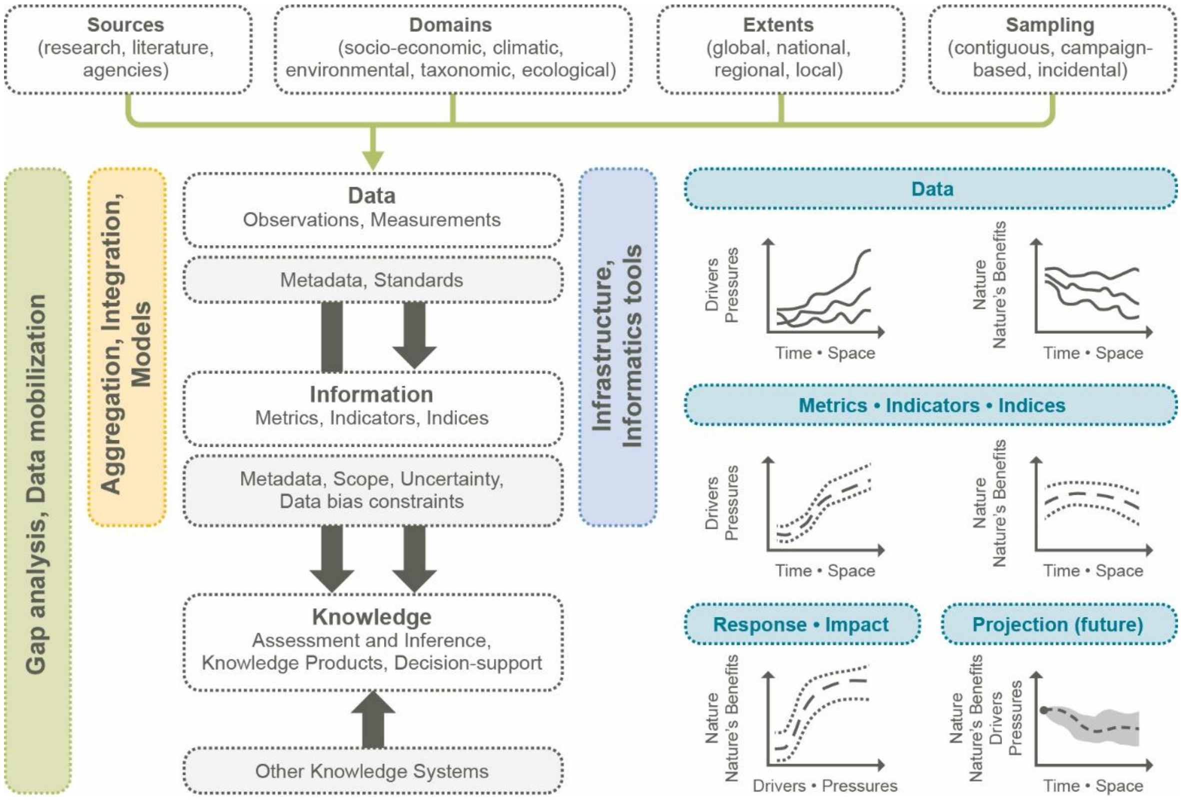


Figure 8.1: Conceptual connection among knowledge resources. The left side conveys the flow of data to information and knowledge relevant to IPBES, facilitated by a variety of approaches highlighted in colored boxes. Data may lead to Knowledge directly or, outside this hierarchy of scientific inference, come from other Knowledge Systems. The right portion illustrates how raw data on temporal or spatial variation in drivers, pressures, and Nature (biodiversity and ecosystem properties and processes) may be combined to establish information about them, such as in the form of metrics, indicators or indices. Other knowledge systems directly contribute to assessment and inference for future projection. Data or information from science contribute to knowledge about causal associations between drivers and response (or impact), which may then be used for projection.

Scientific approaches may rely on processes where data are turned into information and then into knowledge. This process can be thought of as sequential, with each step building on the last, with new knowledge derived by bringing together information from several data sources. New knowledge is also gained from analysis, re-structuring and re-interpretation of existing knowledge as is commonly done in literature reviews in the scientific domain. An incremental process for production of new knowledge based on existing knowledge transmitted by a variety of means (oral transmission, training, scientific papers) and up-dated through various procedures (such as experience or experiment) is important for valuing and including diverse knowledge systems in the assessment process.

Chapter 8: Data

8.1 Types and Sources

There has been a remarkable and continued growth in knowledge and data that are of an appropriate spatial resolution (local) and extent (global) (Figure 8.2) to inform needs relevant to IPBES. Vital spatiotemporal data for biodiversity and ecosystem properties and services, and their drivers include, but are not limited to:

- satellite and airborne remote sensing (Turner et al. 2003, Estes et al. 2010, Schimel et al. 2013, Andrew et al. 2014);
- in situ sensor-based data (Wikelski et al. 2007, O'Connell et al. 2010, Blumstein et al. 2011, Heidemann et al. 2012);
- attempts to quantify select ecosystem services (Boyd & Banzhaf 2007, Brauman et al. 2007);
- species interaction network data and ecological trait compilations (Brose et al. 2006, Kattge et al. 2011, Wilman et al. 2014);
- museum collections (Graham et al. 2004, Suarez & Tsutsui 2004);
- long-term monitoring ecological data at local, regional and global level (e.g. Hobbie et al., 2003, Haberl et al., 2006, Pauli et al., 2012)
- formal biodiversity survey efforts (Roemmich & McGowan 1995, Harrison et al. 1997, Settele et al. 2008) and project-driven data collection campaigns;
- citizen science contributions (Dickinson et al. 2010, Hochachka et al. 2012)
- raw and integrated species distribution sources (Jetz et al. 2012)

A variety of efforts have attempted to combine data into metrics or indicators that provide aggregate information about status and trends of biodiversity and ecosystems and of pressures. For more background on indicators see Chapter 10 of the Assessment Guide. Examples include:

- Indicators associated with the Convention of Biological Diversity 2020 targets (UNEP/CBD/COP/DEC/X/2, Leadley et al. 2014; http://www.bipindicators.net)
- Metrics and indicators provided by key data integrators and aggregators and ongoing research
- 'Essential' Climate or Biodiversity Variables (Pereira et al. 2013) – depending on level of integration these may represent data or information.

Further, a range of knowledge sources are available, including, but not limited to:

- practice-based expert knowledge from local and indigenous communities (see Chapter 7 of the Assessment Guide);
- literature search engines such as Web of science and Google Scholar;
- published journal articles and books, reports from the 'grey literature'; and
- literature resources from Biodiversity Heritage Library and many others to be added by experts.

The knowledge resources used in IPBES assessments and their appropriate level of aggregation are likely to vary depending on availability and purpose. Even for a single IPBES component and variable family (for example land cover), they may vary from raw data (e.g. non-ground checked satellite imagery) to highly derived and processed or modelled summary metrics (e.g. forest structure), and extend to indigenous and local knowledge. Knowledge resources may be geographically sporadic (e.g. widely spread plot measurements or species observations), only available from a very limited geographic area or fully continuous (e.g. remote sensing-based layers). While the spatial scope for many IPBES assessments would usually be regional or global, the temporal scope may be limited, and both spatial and temporal grain may vary from very fine (e.g. 30 m, daily in remotely sensed data) to coarse (hundreds of kilometers, decadal in many other data). Existing or future web-based infrastructure may facilitate access or provide easy to use compilations addressing multiple data types (O'Leary & Kaufman 2011, Jetz et al. 2012, Scholes et al. 2012). Existing indicator or other efforts may already have translated data into information suitable for assessments. While new informatics tools and infrastructure to analyze and synthesize will be helpful, what is vital is a standardized and systematic approach to make assessments readily comparable, replicable and updateable.

8.1.1 General guidance

Both raw data, information and, the knowledge gained from these need to be of a standard that will ensure that IPBES assessments are accepted by stakeholders, updated, and can be further synthesised. This has to be documented and tracked for all knowledge, information and data used for any given assessment. Hence, all assessments and associated products should be based on knowledge resources that are:

i. fully referenced and for which all contributions are appropriately attributed and recognized;

ii. comprehensively documented in underlying sources and methodologies and that adhere to domain-specific metadata standards; and

iii. archived and accessible to IPBES experts and, wherever possible, the public.

A useful function would be to be able to combine and disaggregate knowledge across scales, among regions and among the different IPBES domains. For this to be possible, it is vital that knowledge assessments follow clear standards that facilitate interoperability and are, if possible, readily electronically accessible. Knowledge products that follow the same procedures and approaches will most readily enable cross-regional comparisons and synthesis.

8.1.2 Global sources

A powerful way for IPBES regional and sub-regional assessments to efficiently enable aggregation and ensure comparability is to use the same core sources and knowledge products across multiple or all regions. Such key global sources and knowledge products serve a significant role for allowing (sub-) regional assessments to replicate and standardize efforts, simplify documentation requirements, and facilitate global synthesis. Providers and sources of near-global data and information (Figure 8.2) include:

- International organizations;
- National agencies with international scope;
- Internationally active non-governmental organizations;
- Globally active research institutes and initiatives; and
- Academic research groups and networks that work on global questions.

8.1.3 Regional and sub-regional sources

In certain cases, data, information and knowledge products of near-global scope that are used elsewhere may not be adequate for a given region, due to high uncertainties or limited representativeness. Regional and sub-regional assessments may be able to tap into geographically restricted knowledge resources of greater relevance, quality, spatial resolution, accessibility, taxonomic, thematic or temporal scope than are available globally. This may give rise to novel data of unique regional relevance, including expert-based quality-control of existing datasets, or additional data-points. These new or improved datasets may offer valuable information beyond the focal region and new opportunities for comparison and aggregation. They will need to fulfil minimum quality thresholds (e.g. being peer-reviewed, fully documented, accessible; see below) to ensure a comparable level of scientific rigor among assessments. Assessment groups should consult with the Task Force on Knowledge and Data and its Technical Support Unit on how best to include new regional data in the planned larger architecture so that the data are easy to find and access by everyone (Figure 8.1).

Providers and sources of regional to sub-regional data products include the following, all with national or regional remit:

- Governmental ministries and agencies;
- Regionally focused institutes;
- Active non-governmental organizations that have regional and landscape scale focus
- Regionally focused initiatives, projects and research groups.
- Local practice-based knowledge from communities
- Indigenous environmental knowledge willing to be shared in the assessment process

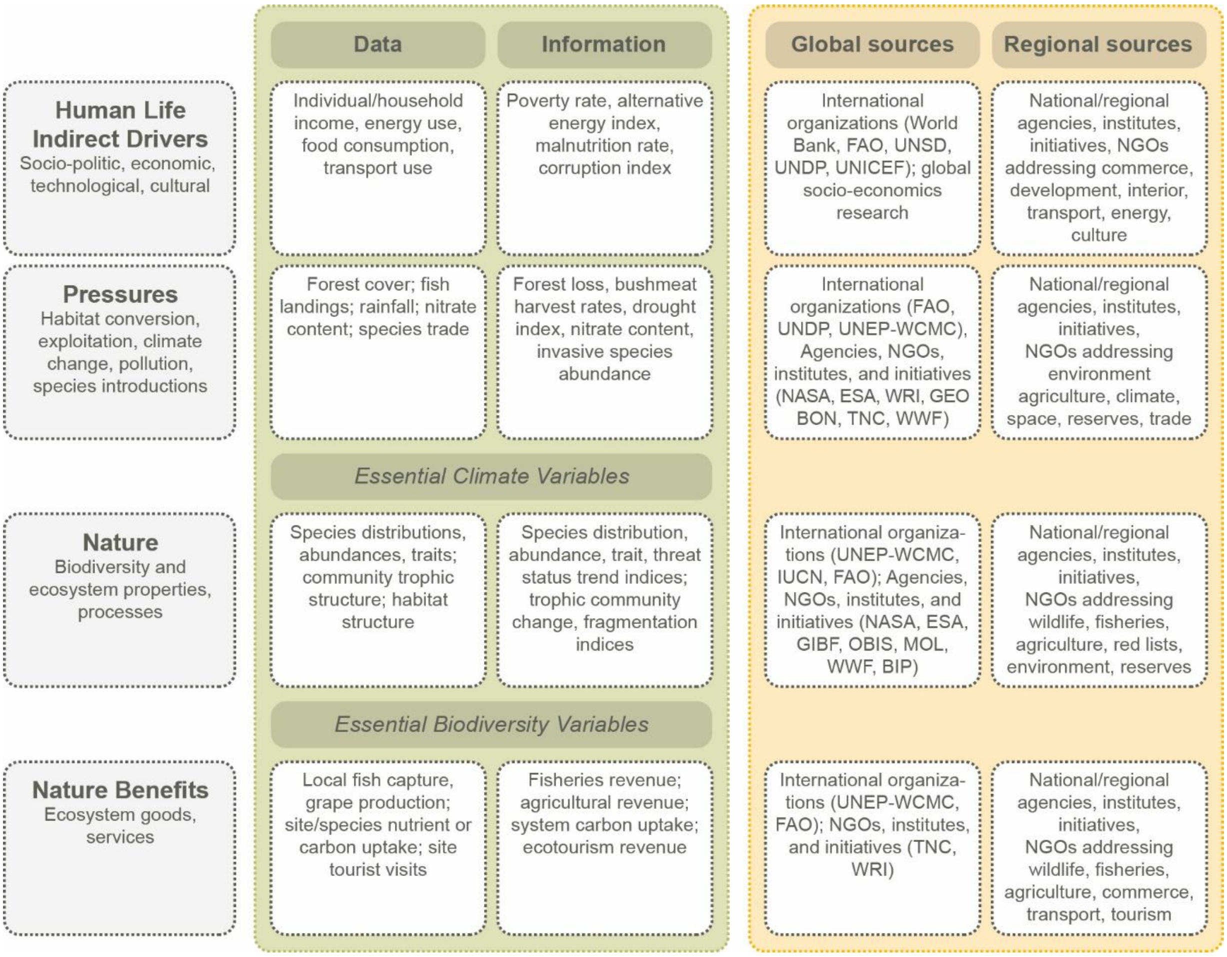


Figure 8.2. Examples of data and information and sources addressing the different IPBES foci and potential sources at global and regional level.

8.1.4 Source recommendations

In Table 8.1, the IPBES Task Force on Knowledge and Data provides has selected a list of specific global data resources well-suited for IPBES needs. The criteria for selection were: - substantial relevance to assessment chapters; - scientific and institutional credibility; - near global coverage; disaggregation by region; recently updated; - data transparency and availability; - within and among regional representativeness and comparability. This is not a closed list and of course multiple other global and regional sources are expected to inform regional assessments. For all datasets, the consideration and documentation of quality, uncertainty and representativeness is critical (see Section 5).

Table 8.1

Examples of key global information sources and layers for IPBES Regional Assessments

Name	Chapter*	Type	Source
Human population density	2, 4	Gridded human population density	http://www.un.org/en/development/desa/population/ http://www.fao.org/geonetwork/srv/en/metadata.show?id=14053
Ecoregions	2,3,4,6	Global regionalization based on dominant habitats	http://wwf.panda.org/about_our_earth/ecoregions/ecoregion_list/
Ecological Land Units	2,3,4,6	Global Ecological Land Units	https://catalog.data.gov/dataset/global-ecological-land-units-elus
Red List	2, 3	Conservation assessments	http://www.iucnredlist.org/
Map of Life	3, 6	Species distributions, trends	http://mol.org/
GBIF	3, 6	Species occurrence points	http://www.gbif.org/
OBIS	3, 6	Species occurrence points	http://www.iobis.org/
Global Invasive Species Database	3	Biodiversity	http://www.issg.org/database/welcome/
Protected Areas	4,6	Protected area network	http://www.protectedplanet.net/
Landsat Tree cover	4, 6	Remotely sensed tree cover	http://earthenginepartners.appspot.com/science-2013-global-forest
MODIS Land cover	4, 6	Remotely sensed land cover	http://modis.gsfc.nasa.gov/data/dataprod/dataproducts.php?MOD_NUMBER=12
GlobCover	4, 6	Remotely sensed land cover	http://due.esrin.esa.int/page_globcover.php
Remotely sensed habitat and climate	4, 6	Remote-sensed based layers for biodiversity and ecosystem modeling	http://www.earthenv.org
Terrestrial Human Footprint	3,4	Anthropogenic impacts on terrestrial environment	http://sedac.ciesin.columbia.edu/data/set/wildareas-v2-human-footprint-geographic ; 2015 update forthcoming
Past climate conditions	4	Climate Research Unit	http://www.cru.uea.ac.uk/cru/data/hrg/
Change in climatic conditions	4	IPCC	https://www.ipcc.ch/report/ar5/ ; http://www.ccafs-climate.org/data/ ; https://nex.nasa.gov/nex/projects/1356/
Global Observation Research Initiative in Alpine Environments	3, 4, 6	GLORIA	http://www.gloria.ac.at/
International Long-Term Ecological Research Network	3, 4, 6	ILTER	http://www.ilternet.edu/

Name	Chapter*	Type	Source
Various socioeconomic data sets	3, 4	World Bank data sets	http://data.worldbank.org/
Millennium Development Goal Indicator data sets	3, 4	UN Statistics Division data sets	http://mdgs.un.org/unsd/mdg/Default.aspx

8.2 Standards

Standards associated with the knowledge resources of IPBES (and associated metadata) generated by a diverse community of globally-distributed stakeholders are essential for facilitating their access, integration and (re-)use. Systematic and consistent adoption of existing standards where available and relevant is thus critical for IPBES assessments and important. A list of key, currently available standards relevant to IPBES assessments can be found in Appendix 1. The need for standardization extends to the vocabulary of terms (ontologies) used to ensure semantic interoperability of different data knowledge resources.

8.2.1 Knowledge resources

The IPBES Task Force on Knowledge and Data recommends adopting internationally accepted, open data standards regarding all appropriate types of data and information relating to biodiversity and ecosystem services.

However, in some domains such as species-related data, there is wide adoption of standards developed by the biodiversity informatics community through Biodiversity Information Standards (www.tdwg.org). In such cases use of these standards is highly recommended in IPBES assessments. This may include certain types of species occurrences, species abundances, species traits, species interactions, as well as various ecological, agricultural, socio-economic, and climatic data, among others.

For many types of biodiversity and ecosystem data, such as ecosystem services, standards are currently still lacking or are under development. In such cases, the use of structured metadata is especially important (see ‘Metadata’ section below). Use of standards will assist in the archiving, discovering and future accessibility of data and knowledge resources used in IPBES assessments, promoting interoperability.

While standards have mostly been applied to data and metadata, knowledge itself may be described using standard vocabularies and terms through semantic web tools and developing standards such as the Simple Knowledge Organization System (http://www.w3.org/2004/02/skos/).

8.2.2 Metadata

Metadata provide standardized descriptors to characterize, manage, and exchange knowledge resources (data, information and knowledge) in a common platform. In the case of datasets using common standards, structured metadata capture information describing the scope and context of the collected data that is vital for their discovery, re-use and integration with other datasets. A number of metadata standards relevant to particular data types are available (see Appendix 1) and the Task Force strongly encourages their use by IPBES assessments.

Knowledge can be represented in many different forms such as scientific papers, interviews, artworks, videos, among others. All these representations can be characterized using common metadata. Use of metadata requires a set of terms and vocabularies to characterize, classify, store and retrieve these representations.

The Dublin Core (http://wiki.dublincore.org/index.php/User_Guide) metadata standard should be used to describe these different forms of representation of knowledge in order to facilitate work of assessments. Dublin Core elements encompass a wide range of knowledge products held in a variety of media, from published works to artwork to interviews and group discussions. They provide descriptors that allow the aggregation of knowledge derived from different knowledge systems on a common platform. Dublin Core terms may not be sufficient to capture all aspects of ILK (e.g., gender) and a separate effort is required to ensure they are included.

Table 8.2

Hypothetical examples of metadata that may arise in the assessment process and associated Dublin Core Terms.

Dublin Core Term	Dublin Core definition	Example 1	Example 2
Contributor(s)	An entity responsible for making contributions to the resource.	Efraim Suclli, Josefina Cortes, Eduardo Dalcin…….	João Renato Stehmann, Leandro L. Giacomin
Creator	An entity primarily responsible for making the resource (person, institution etc.).	Communidad de Santa Elena, Puntarenas	Sandra Knapp
Audience (option)	A class of entity for whom the resource is intended or useful.	Ramsar Convention	World Flora Online; SolanaceaeSource
Coverage	The spatial or temporal topic of the resource, the spatial applicability of the resource, or the jurisdiction under which the resource is relevant.	Costa Rica	Southern Brazil
Spatial coverage	Spatial characteristics of the resource.	Puntarenas, Costa Rica	Bahia, Brazil
Temporal coverage	Temporal characteristics of the resource.	Yearly cycle of events	--
Created [date created/published]	Date of creation of the resource.	July-August 2014	12 January 2015
Title	A name given to the resource.	Nuestro Año	New species of Solanum from Bahia
Subject	The topic of the resource.	Wetlands; management	Taxonomy; Solanaceae
Description	An account of the resource (could be free text).	This is a painting depicting the community's vision of how wetlands are managed sustainably over the course of a year	This paper describes four new species of forest shrubs [could be the abstract for the paper]
Format	The file format, physical medium, or dimensions of the resource.	watercolor on paper	Scientific article
Medium	The material or physical carrier of the resource.	tiff	pdf
Identifier	An unambiguous reference to the resource within a given context.		doi: 10.3897/phytokeys.47.9076
Language	A language of the resource.	Spanish	English

8.3 Data and Information Quality, Uncertainty and Representativeness

Data, information and knowledge on biodiversity and ecosystem services and pressures are subject to observation and sampling errors affecting their quality, have limits to their certainty, and are often of limited scope. All of these issues affect the level of confidence and generality that can be attached to the conclusions they support. Failing to quantify and document them has the potential to result in false conclusions or unwarranted actions based on analysis of trends or on prioritization. Supporting effective decision-making and policy relies on careful and clear delineation and communication of these limitations

Addressing data quality. The quality and uncertainty of available raw data are key factors limiting the quality of scientific papers, reports and other knowledge products based on that as well as decisions derived using data as evidence source (e.g. Stirling, 2010). Data quality remains a long term concern for scientific assessments and knowledge production. As data needs and sampling strategies vary from region to region and from sector to sector, a need for explicit rules for quality assessment framework stands as an immediate priority. For improving information derived from data, this long standing issue needs to be addressed for both qualitative and quantitative data. For solving challenges linked to data quality, sole defendant on quality measure indicators is reported to have limitations, and stochastic models are filling those gaps only to an extent. Thematic domains such as the natural sciences, biotechnical sciences and social sciences differ in their consideration of quantitative approaches and associated uncertainty and quality assessments to derive knowledge, and may require specific, customized quality measures. The use of standard parameters to assess the data quality for quantitative data should not lead to the exclusion of knowledge derived from qualitative approaches. Here, explicit ways to assess the data quality of qualitative data should be considered (Tong et al. 2007), together with rules and concepts for assessing the quality of both qualitative and quantitative knowledge produced in different scientific areas. In addition to preventive or corrective actions, data quality should be assessed and evaluated before data are used as support tools to inform stakeholders and policymakers. We recommend development of methods, standards, tools and guidelines for data quality assessment that contributes to clear and harmonious practices of data quality estimates in advance of data usage. Quality assessment should assess the nature of the considered knowledge and how it aligns to the needs of policy makers. Guidelines on data quality should consider the new understanding of ‘fitness of use’, currently debated as an alternative approach to factor uncertainty in data quality (Chapman 2005).

Measuring and reporting uncertainty. The uncertainty around observations, derived metrics or indicators, and predictions can pose important limits on the inference about status and trends that is possible and constrain assessment knowledge. The results of the aggregation and analysis of data have inherent uncertainty determined by the nature of what is observed (social interactions, species occurrences, etc.), the goals of the studies (documentation, assessment of effectiveness of an intervention, study of a certain mechanism, etc.), sampling and measurement technique, sample size, model type, and other methodological aspects. IPBES relevant reporting of results include, where possible domain-typical metrics of statistical confidence in derived metrics, indicators, predictions, and projections. These need to carefully address all sources of potential uncertainty, e.g. in climate, biodiversity and socioeconomic variables. They are expected to reduce uncertainty through careful methodology, dealing with structural uncertainty and to characterize the degree of certainty/uncertainty in their findings. Wherever possible, IPBES reports should aim to include domain-typical metrics of uncertainty, such as statistical confidence, to support the inference gathered from all knowledge resources. See Chapter 4 of the Assessment Guide for additional, methodological considerations regarding uncertainty sources and assessment.

Measuring and reporting representativeness. The scope of biodiversity, ecosystem service, and pressures data and information available for inference often imperfectly represents the scope of assessment. Usually, data is systematically scarcer for certain regions, spatial resolutions, taxa, functions and services, etc. than others. Often such gaps in knowledge resources that cause a mismatch between the scope of available evidence and scope of assessment are also non-uniform and non-random resulting in potential biases in inference. These issues have the potential to distort IPBES relevant results, indicators and, by extension, knowledge in a way not captured by traditional statistical metrics. IPBES assessments thus require a careful, and where possible quantitative, evaluation of the congruence between the scope of available information and that of the reporting target. We recommend dedicated scientific and capacity building activities that help document and assess limits to the representativeness of available data for IBPES and the resulting constraints on relevant metrics and inference, and inform efforts for gap filling.

8.4 Data mobilization and archiving

The regional assessments represent an outstanding opportunity to not only identify data gaps, but also take steps toward addressing these gaps, e.g. through mobilization of data from institutions or individuals. Mobilized data resources may contribute to regional assessments or strengthen the foundation of later assessment efforts – an important aspiration. Participants of regional assessments are encouraged to contribute data to the recommended global data sources listed in Table 8.1. These may include GBIF or Map of Life for species distribution relevant information and other sources or partners for data on traits, ecosystem services, or information on pressures. The assessments groups are invited to consult with the Task Force on Data and Knowledge Technical Support Unit for advice and support for data mobilization, storage and archiving. This also concerns the archiving of assessment relevant data. Most digital storage media have short lifetimes of only a few years. An archive ensures that data is preserved and maintained in file formats that are most likely to be useable in the future. Most data archives serve the dual purpose of data preservation and dissemination and facilitate the discovery of data. See also Chapter 9 for additional guidance on Knowledge Gaps in general.

8.5 Practical considerations regarding KID in IPBES assessments

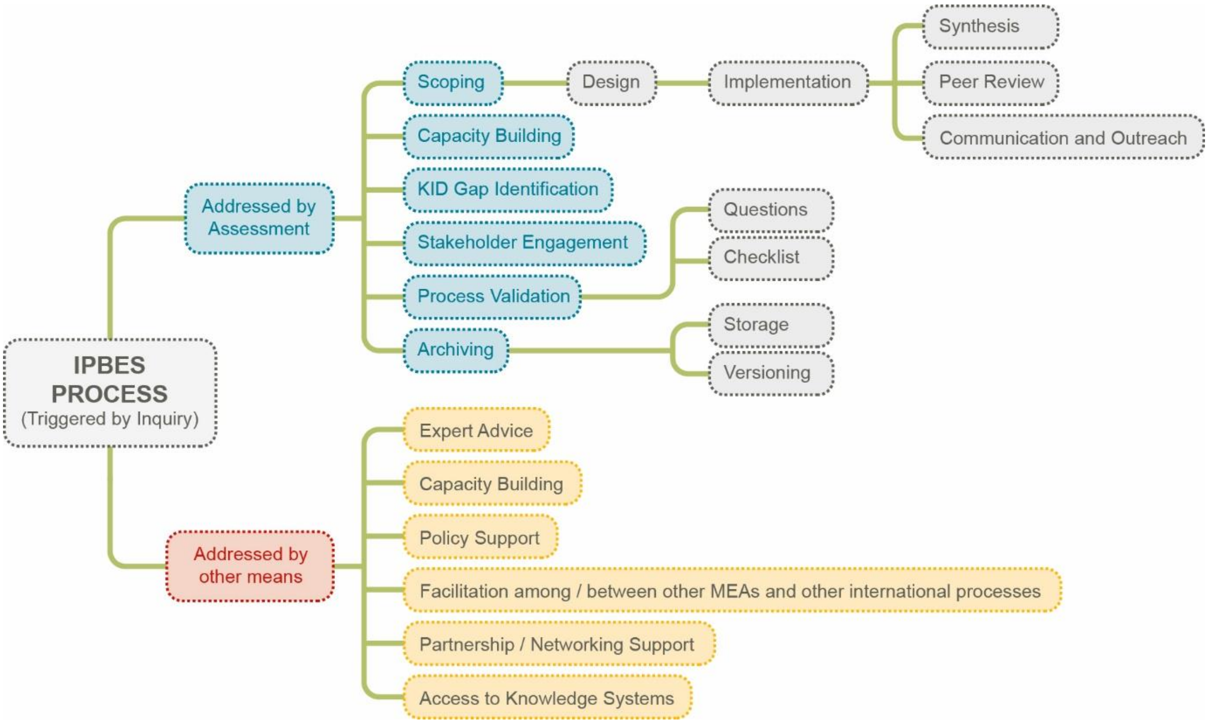


Figure 8.3: Steps in the IPBES process as triggered by an inquiry.

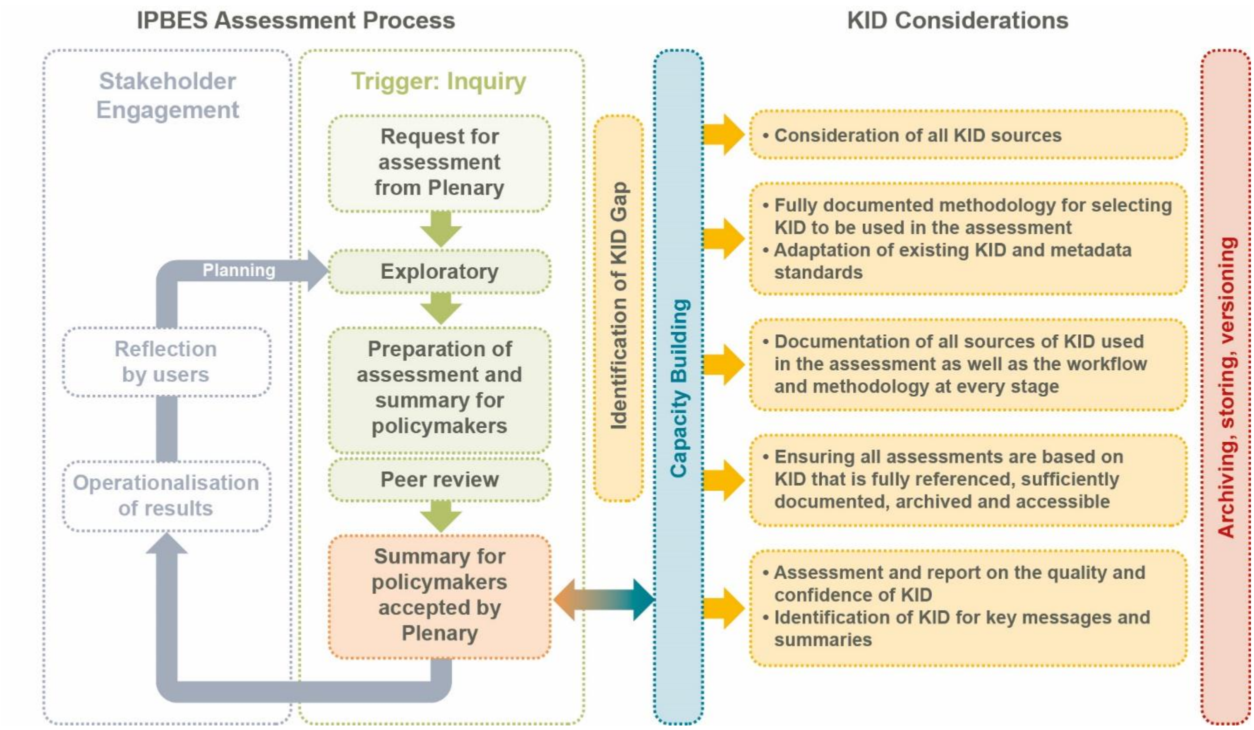


Figure 8.4: Knowledge, information, and data (KID) resource considerations at each stage in the IPBES assessment process.

KID checklist for IPBES assessments

1. Consider all sources of KID (global, regional, local) – noting that:

    a. key global datasets and knowledge products serve a significant role for allowing (sub-) regional assessments to replicate and standardize efforts, simplify documentation requirements, and facilitate global synthesis; and

b. regional and sub-regional assessments may be able to tap into geographically restricted data, information and knowledge products of greater relevance, quality, spatial resolution, accessibility, taxonomic or temporal scope than are available globally (see section 8.1).

2. Fully document methodology for selecting KID to be used in the assessment.
3. All assessments and associated products should be based on KID that is
   a. fully referenced;
   b. sufficiently documented and that adhere to domain-specific metadata standards; and
   c. archived and accessible (see section 8.1).
4. Adopt existing KID and metadata standards (see section 8.2).
5. KID quality and confidence should be assessed and reported (see section 8.3).
6. Ensure long term storage and archiving of KID versions used in the assessment to ensure transparency and replicability (see section 8.4).

Chapter 9: Knowledge, Information and Data (KID) Gaps

9.1 Background

One of the functions of IPBES is “to catalyse efforts to generate new knowledge by engaging in dialogue with key scientific organizations, policymakers and funding organizations, but not to directly undertake new research”. The IPBES function of catalysing knowledge generation relies on identification and prioritization of knowledge, information and data gaps. Objective 1d of the IPBES Work Programme is, therefore, to ensure that priority knowledge and data needs for policymaking are addressed.

IPBES assessments will involve a critical evaluation of the state of knowledge which will naturally lead to identification of knowledge, information and data gaps (Mace 2005; Carpenter et al 2009). Key objectives for this are to help influence research strategies of national and international research agencies and institutions and to support investments in data mobilization and knowledge generation activities. Through highlighting gaps IPBES assessments are expected to play a particular role in helping to catalyse knowledge generation. Once gaps have been identified, objective prioritisation of efforts how to close them are needed.

In order for IPBES to deliver on commitments related to the generation and management of knowledge and data and access thereto, the Plenary established a Task Force on Knowledge and Data[17]. In close interaction with the assessment processes, the task force is envisioned to contribute to a regularly updated list of priority knowledge needs and gaps for policymaking as well as to a regular dialogue on how such needs can be addressed.

9.2 Identifying Gaps

Data, information, and knowledge about pressures, ecosystem services and biodiversity remain inadequate. There are various reasons why these knowledge, information and data gaps exist (Geijzendorffer et al 2015; Meyer et al 2015) and it is important that IPBES assessment teams are aware of these gaps as they can result in biased assessments (Schimel et al. 2015; Pino-Del-Carpio et al. 2014) and will limit the inferences that can be drawn from the assessments. Assessments should clearly articulate any gaps, setting priorities for them so that the IPBES platform can make decisions about where to target efforts to generate new knowledge. We here outline mechanisms and tools for assessment teams, and IPBES more broadly, to identify and prioritize knowledge gaps.

In the case of biodiversity, key shortcomings are that many living species have not been formally described (the “Linnean shortfall”; Brito 2010) and there is limited information about the geographical distributions of most species (the Wallacean shortfall) (Beck et al. 2013).and the virtual absence of ecological background data (needed for modeling) especially in areas which high biodiversity richness and high dependence of humans to ecosystem services. Similarly, data, information and knowledge about ecosystems and ecosystem services remain inadequate (*inter alia* Pagella and Sinclair, 2014; Egoh et al. 2012; Eigenbrod et al., 2010).Nor, crucially, is it clear how much information we need to make sound management decisions about biodiversity and ecosystem services.

Knowledge, data and information gaps can also originate when the indicators used are not comparable across regions or sites or due to the lack of reliable or comparable data (Geijzendorffer et al 2015; Meyer et al 2015). Some of the challenges that limit access to robust and reliable data include data confidentiality, usage restrictions, limited accessibility of data sets, remoteness of ecosystems or data integration and quality issues (Henry et al. 2008; Geijzendorffer et al 2015; Meyer et al 2015; Pauly and Froese 2012).The review of the Millennium Assessment noted the scarcity of long term data and the challenges this presents for evaluation of long term trends (Carpenter et al 2009). Recent efforts in data mobilization (e.g. fisheries’ catch reconstruction), contributions from new sources (e.g. citizen science data), and statistical integration of different data types are gradually changing this state of affairs (Anticamara et al. 2012; Jetz et al 2012). However, critical gaps in data and information still exist in areas that were identified in the MA review such as: a) information on changes in land cover and land use; b) data and information on the ecology and use of the oceans; c) spatial patterns and changes in freshwater quantity and quality; d) stocks, flows, and economic values of ecosystem services; e) use of ecosystem services; f) institutions and governance arrangements; and d) human well-being (Carpenter et al 2009; Cressey 2015; Meyer et al 2015).

IPBES Assessments are expected to carefully identify, document, and where possible address knowledge gaps, and to carefully describe the limitations they impose on assessment conclusions. Assessments authors should invoke a variety of sources to estimate how and where lack of representative data or information may impose limits on inference. For biodiversity this may include the consultation of spatial inventory, completeness metrics and maps (e.g. provided in Map of Life), or an evaluation of the taxonomic coverage, and representativeness, of data on species traits and function. Assessors should generally consider how well available empirical evidence on biodiversity attributes, ecosystem services, and pressures represents their thematic or regional focus. For biodiversity data, a number of

[17] IPBES-2/5 Deliverable 1(c).

factors have been identified that may provide proxy indication about the completeness of datasets (Table 9.1; after Meyer et al 2015).

Table 9.1

Determinants of Completeness of Biodiversity Data (after Meyer et al 2015)

Determinants of Completeness	Factors	Impact of factors affecting completeness on KID gaps
Appeal	Endemism richness, existence and state of protected areas	Locations with high endemism and/or where protected areas exist are preferred and tend to be well covered. Low data gaps
Accessibility	Proximity to travel infrastructure like airports, proximity to research institutions	Accessible areas and those close to well established research institutions
Security	Political instability, armed conflict and public unrest	Areas with continued armed conflict and violent public unrest are likely to be poorly represented in datasets
International Scientific integration	Participation in global data sharing efforts such as GBIF	There is a growing role played by GBIF nodes in contributing to data
Financial and institutional resources	National and international research funding and size of publishing institutions	Institutional resources are critical to collection, storing and processing of data. Areas with strong R&D institutions tend have areas in close proximity well covered

A more comprehensive approach to identifying data and information gaps in biodiversity conservation is needed. IPBES can support the mobilization of data and information needed to support ecosystem service assessments by ensuring completeness of records of existing databases, particularly focusing efforts in data poor environments as identified by various reviews and platforms such as GBIF and Map of Life.

Considering that IPBES assessments will rely on diverse knowledge systems, including Indigenous and Local Knowledge, it is envisaged that there will be challenges in synthesizing the state of knowledge, information and data without the utmost collaboration of citizen scientists, relevant knowledge holders, policy makers and experts. A systematic way of identifying and classifying gaps in knowledge, information and data is needed, a process to which individual assessments are expect to contribute. Investments and incentives to foster multi institutional and global level collaboration to identify knowledge, information and data gaps is critical to decision support, conservation and to ongoing and future assessment processes.

9.3 Prioritizing and Addressing Gaps

9.3.1 Prioritization

Once data, information and knowledge gaps have been identified, IPBES will facilitate a process to address them by catalysing new knowledge generation. The gaps in our knowledge are significant and geographically and thematically highly uneven and limited resources and time will not allow addressing them all. Instead, IPBES will aim to systematically prioritise gaps. Prioritization of gaps will then depend on a variety of aspects, including questions of scale (gaps at global or regional may be more critical than those at sub-regional, national or local scale) as well as the level of rarity and risk of biodiversity and ecosystem services under consideration. Various groups might express needs for various knowledge, information and data gaps to be filled (Table 9.2).

Table 9.2

Various sources of requests for new knowledge generation by approximate order of priority

Source Group	Description of the Source Group	Nature of request and other potential source groups
Requests from assessment groups	Identified gaps emanating from assessment reports Requests from expert involved in IPBES assessments	Room for requests coming from the scientific community in general and requests from other knowledge holders
Requests from regions	Requests by policy makers and other users at a regional level	This will be a by-product of the regional assessment process and may be informed by requests arising from implementation of IPBES assessment
Requests from subregions	Similar to regions	This will be a by-product of the regional assessment process and may be informed by requests arising from implementation of IPBES assessment
Requests from global institutions	Institutions or IPBES Observers	This will be a by-product of the global and regional assessment process and may be informed by requests arising from implementation of IPBES assessment
Requests from IPBES and CBD member states	Countries who are members of IPBES may make requests as needed	This will be a by-product of the regional assessment process and may be informed by requests arising from implementation of IPBES assessment

9.3.2 Determination of actions

The preferred activity following the identification of knowledge gaps will depend on their nature. Table 9.3 provides a simple process to classify and act on knowledge, information and data gaps and access barriers.

Table 9.3

Example Data and Information Gaps and Access Barriers and potential actions.

Potential gaps and access barriers	Actions
Data and Information not collected or discovered	Convene a knowledge dialogue (with international institutions, major funding organisations) to catalyse new research or collection techniques
Data and Information not mobilised or digitised	Work with partners (NGOs, country institutions, national focal points, networks, etc.) and raise large scale funds for data mobilisation and digitisation.
Data and Information not accessible	Work with partners to discover data and raise funds to encourage data and information holders to improve accessibility
Indigenous and Local Knowledge	Work with partners and raise funds to find ways to get diverse knowledge systems involved in the process
Language barrier and/or differences in knowledge systems	Liaise with TSU, the ILK task force and KID task force to generate advice on how to include it in the knowledge database. Engage native speaking experts.

9.3.3 Engagement of strategic research partners and funding bodies

First, IPBES will publish gaps identified in the assessments reports in platforms that are accessible to a wider range of stakeholders and the general public. Making these reports accessible will enable research foundations, regional economic partners, national governments, institutions and individual scientists as well as knowledge producers other from other knowledge systems to support their efforts to address the identified priorities. Guidance on priorities enables research partners to focus and align their efforts to address both their knowledge generation needs as well as those of IPBES.

Second, IPBES will also engage global, multilateral, regional and national funding agencies to influence their funding calls so that they may include some of the relevant priorities identified in the IPBES priority knowledge, information and data gaps. This engagement should also include international research organizations, for example Future Earth, and funding bodies such as the Belmont Forum and include partnerships between developed countries, developing countries and countries with *economies*.

9.3.4 Knowledge dialogues

IPBES will engage in knowledge dialogues with stakeholders including multilateral environmental agreements, United Nations bodies and networks of scientists and knowledge holders, to fill the identified gaps through collaboration. IPBES will also engage key global, regional and national scientific organizations as well as policymakers in interchanges aimed at mobilizing the relevant knowledge, information and data needed to address the requests for knowledge generation received by the Platform. Expected outcomes of such *knowledge dialogues* are to:

- generate advice on strategic partnerships for improved access to knowledge, information and data, and to facilitate other activities that have the same effect
- collaborate with existing initiatives, to fill gaps while avoiding duplication, including with networks of scientists and knowledge holders
- recognise, respect and implement the contribution of indigenous and local knowledge to the conservation and sustainable use of biodiversity and ecosystems
- contribute directly and substantially to deliverable 1d of the IPBES Work Programme 2014 – 2018, which is to catalyze efforts to generate new knowledge and data in order to address priority knowledge and data needs for policymakers.

9.4 Acknowledging the Variability of Knowledge Systems

- There are various knowledge systems that support biodiversity conservation, ecosystem services and sustainable use. The concept of Traditional Knowledge systems for biodiversity conservation “recognizes that the well-being of human society is closely related to the well-being of natural ecosystems”. The intellectual resources on which sustainability science is building on needs to take into account the knowledge of local people as well. We need, therefore, to foster a sustainability science that draws on the collective intellectual resources of both formal sciences, and local systems of knowledge (often referred as ethnoscience) (Pandey, 2001[18]).”
- Societies have survived the pre-scientific era with traditional systems of management, the success of which are demonstrated in the biodiversity that we have today. These traditional systems have been motivated by self-interest to sustain access to such resources. The persistence of traditional knowledge embodies the adaptation of humans to the changes to their environments and is valuable input to effective biodiversity conservation (Berkes, Folke & Gadgil, 1995).
- Dynamic sets of conservation knowledge and practices reside in indigenous and local communities who are aware of local plant and animal varieties as well as the character of their landscapes: knowledge that they use to conserve and manage biodiversity. One interdisciplinary initiative, developed by UNESCO, is the Local and Indigenous Knowledge Systems (LINKS) programme, which works to secure an active and equitable role for local communities in resource management, strengthens knowledge transmission across and within generations, and explores pathways to balance community-based knowledge with global knowledge in formal and non-formal education. All of these activities contribute to the equitable and sustainable use and management of biodiversity (UNESCO, 2014). Another example is the Satoyama initiative, a movement developed to evaluate degraded ecosystems and promote their revival through “multi-functional land use systems in which agricultural practices and natural resource management techniques are used to optimize the benefits derived from local ecosystems” (UNU, 2009).

[18] http://www.infinityfoundation.com/mandala/t_es/t_es_pande_conserve.htm.

Chapter 10: Biodiversity and Ecosystem Service Indicators

10.1 Introducing indicators of biodiversity and ecosystem services

Indicators are defined as values or signs that unambiguously reflect the status, cause or outcome of an object or process and are an important tool in the assessment of biodiversity and ecosystem services (Ash et al. 2010). Biodiversity and ecosystem service indicators serve multiple purposes which can broadly be categorized into three key functions: (1) tracking performance; (2) monitoring the consequences of alternative policies; and (3) scientific exploration (Failing & Gregory 2003). Assessments mostly use them for the first two purposes, which are the focus of this section.

Data such as observations and measurements (Figure 8.1) are used as the basis for deriving indicators. Sometimes several measurements can be combined in a particular way to derive an index. . It is important that background data of indices are openly accessible to allow independent recalculation and that indices can be disaggregated and traced back to their component measures (see Ash et al. 2010).

The domain of biodiversity and ecosystem service assessment is very large, encompassing many attributes and measurements related to a wide variety of policies. This breadth could result in the use of long lists of measures and indicators. However, using a clear process from data collection through to communication can identify a few carefully designed datasets that populate a large and consistently evolving set of metrics, and indicators for use across many aspects of science and policy. Recently, Essential Biodiversity Variables have been proposed, adding an important additional element connecting data more directly to metrics of indicator value (Pereira et al 2013). This large set of metrics, and indicators can in turn be refined into a smaller set of composite indices which can be used to inform high level policy and decisions. We emphasize the importance of effective and efficient data collection, variables and index design, while allowing for innovation and exploration in the analysis and development of metrics and indicators (Tallis et al. 2012).

Indicators can vary substantially in terms of their data requirements, calculation, typology and eventual outputs. However, they all have one thing in common: they are focused on answering specific questions. These questions can be scientific, policy-driven or arising from civil society and decision-maker interest. Focusing on the question being asked of the assessment and its indicators, can help simplify the enormous complexity of datasets, variables, indicators, frameworks and approaches available (Box 10.1).

Box 10.1: Questions used to direct the Millennium Ecosystem Assessment and the development of indicators and metrics used in the global and sub-global assessments.

1. How have ecosystems changed?
2. How have ecosystem services and their uses changed?
3. How have ecosystem changes affected human well-being and poverty alleviation?
4. What are the critical factors causing ecosystem change?
5. How might ecosystems and their services change in the future under various plausible scenarios?
6. What can be learned about the consequences of ecosystem change?
7. What is known about time scales, inertia, and the risk of nonlinear changes in ecosystems?
8. What options exist to manage ecosystem sustainably?

9.What are the most important uncertainties hindering decision-making concerning ecosystems?

10.2. The role of indicators in assessments

Across sectors and disciplines, indicators inform data collection and collation of variables (see Chapter 8); they are useful tools for communicating the results of assessments (see Chapter 12) and are a popular policy support tool (see Chapter 11) used at multiple scales in tracking performance, exploring progress to policy targets, and understanding the consequences of particular decisions, interventions or even future scenarios (see Chapter 6). Indicators are able to present information so that it can be easily communicated and intuitively understood, allowing policy- and decision-makers to base their decisions on evidence (Layke et al. 2012).

One of the major roles played by indicators is in monitoring and communicating progress to policy targets, for example, the CBD Biodiversity 2010 Target and Aichi Targets. Butchart et al. (2010) reviewed the global progress towards the CBD 2010 target and, using 31 indicators, highlighted that in general targets were not being met, although large challenges were identified in the development of appropriate indicators (see Mace & Baillie 2007; Mace et al. 2010). More recently, discussions around post-2015 Millennium Development Goals have also begun to focus on the topic of biodiversity and ecosystem service indicators for measuring progress to development goals (Griggs et al. 2013; Sachs et al. 2009).

More generally, biodiversity and ecosystem service indicators are frequently used to answer questions that society, researchers or policy makers ask about biodiversity and ecosystem service on topics such as ecosystem change and its consequences, the costs and benefits of a particular intervention, the value of biodiversity to a community, or the status of a particular ecosystem or species etc. This is likely the role that indicators will play in most assessments (e.g. Box 10.1) – where the questions asked of the assessment will inform the design and development of the necessary indicators to be used.

10.3. What makes a good indicator?

As no single indicator can provide information on all of an assessment's policy relevant aspects, assessments rely on sets of indicators. The chosen set ideally includes only a relatively small number of individual indicators representative of the relevant issue. The size of the set needs to balance out the costs and complexity of communicating a large number of indicators, with the potential of a small and simple set to ignore important aspects of the issue being assessed. Beyond making sure the indicators are appropriate for answering the questions posed of the assessment, there are several publications that list multiple criteria to consider when selecting and developing indicators (e.g. Ash et al. 2010; Layke et al. 2012; Mace & Baillie 2007). In summary, individual indicators should be policy relevant, scientifically sound, simple and easy to understand, practical and affordable, sensitive to relevant changes, suitable for aggregation and disaggregation, and useable for projections of future scenarios (Box 10.2, Ash et al. 2010). Of these criteria, perhaps the most pertinent to this guideline is the need to make the indicators relevant to the purpose. This not only requires setting clear goals and targets in the indicator development process, but also a thorough understanding of the target audience and their needs (Mace & Baillie 2007).

Box 10.2: Principles for choosing indicators

1. Policy relevant

Indicators should provide policy-relevant information at a level appropriate for decision-making.

Where possible, indicators should allow for assessment of changes in ecosystem status related to baselines and agreed policy targets.

2. Scientifically sound

Indicators should be based on clearly defined, verifiable, and scientifically acceptable data, collected using standard methods with known accuracy and precision or based on traditional knowledge that has been validated in an appropriate way.

3. Simple and easy to understand

Indicators should provide clear, unambiguous information that is easily understood. It is important to jointly involve policymakers, major stakeholders, and experts in selecting or developing indicators to ensure that the indicators are appropriate and widely accepted.

4. Practical and affordable

Obtaining or using data on the indicator should be practical and affordable.

5. Sensitive to relevant changes

Indicators should be sensitive and able to detect changes at time frames and spatial scales that are relevant to the decision making. At the same time, they should be robust to measurement errors or random environmental variability in order to prevent "false alarms". The most useful indicators are those that can detect change before it is too late to correct the problems.

6. Suitable for aggregation and disaggregation

Indicators should be designed in a manner that facilitates aggregation or disaggregation at a range of spatial and temporal scales for different purposes. Indicators that can be aggregated for ecosystem as well as political boundaries are very useful.

In addition to these general characteristics, indicators and background Essential Variables need to have an appropriate temporal and geographical coverage (see Chapter 2), and ideally be spatially explicit. Making indicators spatially explicit not only allows people to examine the spatial and temporal dynamics of biodiversity and ecosystem services, but also helps make assumptions explicit, and identifies important gaps and needs for further information. The benefits of ecosystems and biodiversity are often used away from where they are produced, so a spatially explicit approach is essential to capture effects across scales and to fully evaluate the importance of ecosystem services and the impacts of related policy actions.

10.4. Indicator frameworks and approaches

There are several frameworks which can help guide the design and development of indicators for assessments. The Drivers-Pressures-State-Impact-Response (DPSIR) framework is a popular indicator framework often used in State of Environment reporting. This framework distinguishes between driving forces of environmental change, pressures on the environment, state of the environment, impacts on population, economy, ecosystems and response of society. Several authors have evolved this framework to more specifically link with conceptual frameworks of biodiversity and ecosystem services (e.g. Reyers et al. 2013; Rounsevell, Dawson & Harrison 2010) which may help assessments in using the IPBES Conceptual Framework to direct indicator development.

In addition to these frameworks to guide indicator selection, it is important to explore which attributes, features or components of biodiversity and ecosystem services need to be measured to develop indicators that are fit for purpose. This is preferable to relying on existing data and indicators which has resulted in our current inability to develop indicators relevant to policy targets (Mace & Baillie 2007). Below we introduce some of the major components of biodiversity and ecosystem services and provide some examples of indicators within each.

10.4.1 Developing indicators of biodiversity

Biodiversity is a multi-faceted, multi-attribute concept of a hierarchy of genes, species and ecosystems, with structural, functional and compositional aspects within each hierarchical level.

Change in biodiversity is also multi-faceted and can include loss of quantity (abundance, distribution), quality (ecosystem degradation) or variability (diversity of species or genes) within all levels and aspects (see also Pereira et al. 2013 for dimensions of biodiversity change). As Mace, Norris, & Fitter (2012) highlight, different facets of change will have different implications for different ecosystem services, for example changes in functional and structural variability in species will have broad-ranging impacts on most services, while changes in the quantity and distribution of populations and ecosystems will be important for many provisioning and regulating services. In developing indicators of biodiversity it is important to explore the appropriate attributes of biodiversity requiring measurement, namely diversity, quantity and condition, rather than just using the more common indicators like species richness or ecosystem extent. A fourth category useful in developing indicators, drawn from the DPSIR framework, is one that measures pressures exerted on the biodiversity. Table 10.1 illustrates how these attributes can be useful in identifying different indicators for development.

Table 10.1

Categories of biodiversity indicators and some examples of indicators from each category for use in assessments (TEEB, 2010)

Category of indicator	Examples
Measures of diversity	Species diversity, richness and endemism Beta-diversity (turnover of species) Phylogenetic diversity Genetic diversity Functional diversity
Measures of quantity	Extent and geographic distribution of species and ecosystems Abundance/population size Biomass/Net Primary Production (NPP)
Measures of condition	Threatened species/ecosystems Ecosystem connectivity/fragmentation (Fractal dimension, Core Area Index, Connectivity, Patch Cohesion) Ecosystem degradation Trophic integrity Changes in disturbance regimes (human induced ecosystem failure, changes in fire frequency and intensity) Population integrity/abundance measures
Measures of pressures	Land cover change Climate change Pollution and eutrophication (Nutrient level assessment) Human footprint indicators Levels of use (harvesting, abstraction) Alien invasive species

10.4.2 Developing indicators of ecosystem services.

The chain linking biodiversity to its final impacts on society has recently been divided into separate components or steps to structure its assessment (Tallis et al., 2012; Chapter 1). Table 10.2 outlines these components of ecosystem services and provides some examples of possible indicators useful for each stage. Nature´s benefits to society are produced by species within ecosystems, ecological processes and their interactions with social systems and human management of ecosystems. These factors determine the *supply* (arrow 4 in the CF), that is, the potential flow of benefits from nature to people. The next step is the contact between this flow of benefits and the final beneficiaries of the ecosystem service, determined by the location of beneficiaries, their needs and perceptions, and how regulations or governance determine access to services. These factors determine the *delivery* (arrow 8 in the CF) of nature's benefits to society. The next step captures the consequences these benefits have for the wellbeing of individual stakeholders and society at large. Factors such as the other anthropogenic assets (from the CF) determine nature's *contribution to well-being* through ecosystem services. The final step captures the way in which such benefits are accounted for or valued by different stakeholders, including individuals, social groups or societies at large, when taking into account different perspectives, preferences, and social values or norms. These factors determine the *value* of ecosystem services. Value is commonly captured by monetary indicators, but reflects a much wider field of exploration in economics and human welfare and includes a varied set of possible indicators in development (see Chapter 5).

This step-wise approach is helpful in making clear which components of ecosystems and social systems require monitoring and assessment in order to understand the impacts that ecosystems have on people. The application of this approach need not be done in the order as outlined in Table 10.2, nor do all steps or components need assessment in all contexts. The appropriate approach will depend on the context, questions being asked of the assessment and data available (see Chapter 3). In addition the approach, while linear in application, is part of a larger complex system of interactions and feedbacks between social systems, ecosystems and social-ecological systems (see Chapter 1).

Table 10.2

Examples of ecosystem service indicators capturing the series of ecosystem and social system components necessary to reflect the links between ecosystems and society. Source: GEO BON Ecosystem Services Working group.

Type of services	Ecosystem Service Component			
			Good quality of life	
	Nature	Benefits	Contributions to well- being	Value
Provisioning	Amount of biomass available for fodder (pasture or forage, Tons). Biomass or abundance of important species.	Total production of all commercial crops (Tons). Caloric or micronutrient content of fish landings (grams). Volume of harvested wood (m^3).	% caloric or micronutrient intake contributed by crops, % income or number of jobs contributed by aquaculture. Basic needs satisfied via ecosystem good or service.	Market value of all livestock products ($). Marginal contribution of irrigation to crop market value. Change in malnutrition rate due to wild harvest food.
Regulating	Amount of carbon absorbed by vegetation from the atmosphere (Tons) Mass of nutrients, organic matter, sediments, or toxic organisms or compounds removed (Kg), changes in temperature, pH Pollinator abundances and pollination rates	Water conditions (e.g. nutrient content, presence of harmful bacteria) in relation to standards for different water users at or above withdrawal point Marginal contribution of soils to agricultural, forestry and biofuel production Area of avoided flood damaged due to regulation by vegetation and soils (ha)	% of population with reduced negative impacts (e.g. from floods, wind, drought) Number of people protected from infrastructure loss, flooding and erosion from coastal protection Marginal contribution of pest control to food or biofuel production	Market value of carbon uptake (US$) Avoided water treatment costs (US$) Avoided economic loss by flood regulation from vegetation and soils (US$)
Cultural	Area that provides aesthetic views Area that is suitable for nature-based tourism Abundance of plants	Ecotourism visitation rates, collection rates of plants used for ritual practices	Marginal contributions to income or well-being of visitors and to local inhabitants derived from aesthetic views, attendance at ritual events, frequency of cultural activities	Economic revenues derived from visits to aesthetic areas, marginal contribution to real estate prices by nature-based tourism ($), strength of cultural identity

10.4.3 Indicators of trade-offs and synergies of biodiversity and ecosystem services

Resource management has often focused on increasing the delivery of a single service (very often food or energy production) at the expense of the decline (e.g. impacts on water quality or biodiversity) of other services. While indicators of these trade-offs have not been systematically developed, some common approaches have been used and can serve as indicators. Examples of these approaches include indicators of pair-wise relationships, bundles of services and evenness of services. Indicators of pair-wise relationships often use correlation analysis or similar statistics to indicate positive (synergistic) or negative (trade-off) between pairs of services (Raudsepp-Hearne, Peterson & Bennett 2010). Indicators that reflect the bundles of services provided by an area can be used to reflect groups of services that appear together repeatedly through space and time. These groups can be identified using multivariate techniques (e.g. through schematic representations including flower or radar diagrams (e.g. Foley et al., 2005), or with matrices reflecting the state and magnitude of each service across a variety of systems or areas (e.g. MA, 2005). Furthermore, evenness in service delivery using measures such as Simpson’s diversity index can be used to assess the relative magnitudes of a set of services in an area useful for depicting dominant services or even magnitudes across services. For several of these indicators, services can be measured in different metrics and differences across a particular study region can be calculated relative to maximum possible magnitude (e.g. Reyers et al., 2009). However, it is important that the same component (e.g. quantity or diversity, supply or value) is measured across all biodiversity and ecosystem services to allow bundles or trade-offs to be comparable. New methods are constantly evolving and should be explored for use by IPBES.

10.4.4 Ecosystem Service models

Models are increasingly being used to generate maps, Essential Variables (Pereira et al 2013) and indicators of supply, delivery, contributions to well-being and value of ecosystem services across space and time. Such models can be built from a variety of data sources, including remote sensing data, geographic information, field- based estimations, expert assessments and participatory mapping (Tallis et al. 2012). They can be useful in data-poor areas or in exploring impacts of future scenarios around specific decisions (see Chapter 6). There are an ever-increasing number of these models available for use in assessments. Below we introduce some of the more widely available and widely used modelling platforms, but note the constant growth of new models and approaches which should be included for use in IPBES (see review in Matrinez-Harms & Balvanera 2012).

The Integrated Valuation of Ecosystem Services and Tradeoffs (InVEST) platform is a free and open- source software tool aimed at informing and improving natural resource management and investment decisions (Tallis et al. 2013). It focuses on modeling how different social and ecological conditions modify the supply, delivery and value of individual ecosystem services. It also allows for the exploration of the relationships among multiple services. The Multiscale Integrated Models of Ecosystem Services (MIMES) platform focuses on spatial and temporal changes in ecosystem service values (Altman et al. In press). The models are developed in collaboration with stakeholders and emphasise the interactions among services and emerging trade-offs. The Lund-Potsdam-Jena managed Land Dynamic Global Vegetation and Water Balance Model (*LPJmL*) was developed to assess vegetation dynamics under climate change (Bondeau et al. 2007). The supply of services tightly linked to climate variation and vegetation dynamics (water, carbon, wood, woodfuel, agriculture) can be modelled with this platform globally or regionally, though with low resolution (50 km X 50 km grid cell size). The Artificial Intelligence for Ecosystem Services (ARIES) models track components of services (supply, demand-delivery, flow-link between areas of supply and those of delivery, depletion-balance between supply and demand, and value) of ecosystem services (Bagstad et al. 2013). Generic models built via Bayesian belief networks are adapted to specific applications at different spatial scales and for particular social-ecological contexts, and becomes increasingly easy to apply in data poor regions the more it is used.

10.5 Summary of current indicators

Indicators and metrics of biodiversity, ecosystem services and human wellbeing have proliferated over the past several years, largely in response to the setting of the CBD Targets, the Millennium Ecosystem Assessment and its sub-global activities, as well as recent work on post 2015 Millennium Development Goals agenda. An exhaustive review of all these indicators and measures is not intended here (see Butchart et al., 2010; TEEB, 2010; Layke et al., 2012 for in depth reviews); rather this section highlights what types of indicators and measures are available and reviews their relative strengths and weaknesses in an effort to guide the selection and development of appropriate indicators and measures. In general, existing reviews have found that complexities in current targets, the diversity of target audiences and their needs, the resources required to turn measures into effective indicators, and the reliance of most current measures and indicators on very limited available data have posed substantial obstacles in the development of relevant and useful indicators.

10.5.1 Indicators of biodiversity and ecosystem functioning

An assessment by TEEB (2010) showed that there are a large number of measures and indicators available across geographic scales and regions for assessing biodiversity and ecosystem services. Much of the existing data and indicators were collected and developed for multiple purposes other than biodiversity and ecosystem service assessment, and are therefore not necessarily fit for assessing biodiversity and ecosystem change. In reviewing the list of indicators presented in Table 8.2, indicators of diversity were found to be well developed at a global level for some taxa e.g. mammals and amphibians, while at sub-global scales these are supplemented by measures and indicators of genetic and ecosystem diversity. However, measures of functional diversity, relevant to many ecosystem services, remain under-developed.

Indicators of quantity e.g. changes in ecosystem extent (e.g. forest area), in species abundances (e.g. number of waterbirds) or in biomass and productivity are relatively well developed at global and sub-global levels for ecosystems and species, as well as often easily associated with indicators of provisioning service levels (e.g. marine fish stocks). However, these indicators often focus only on a narrow range of species and ecosystems, and often do not include useful non-food plant and animal species.

Indicators of condition or quality e.g. habitat fragmentation, population integrity and extinction risk indicators (e.g. Biodiversity Intactness Index (BII), Red List Index (RLI)) are quite common and widely used in science and policy reporting. They have been applied at global and sub-global levels and are useful communication tools, but require careful disaggregation and interpretation. They are data and knowledge intensive in development.

Indicators of anthropogenic drivers are very common, often reflecting changes in the main drivers of biodiversity loss e.g. habitat loss and fragmentation, alien invasive species or pollution levels.

They are also often used to construct aggregated indices including the Living Planet Index (LPI) and the Ecological Footprint. These indicators are very useful communication tools, but require careful thought in linking them to the relevant aspects of biodiversity change.

10.5.2 Indicators of benefits

Across ecosystem service categories, several reviews have found current indicators inadequate for characterizing the diversity and complexity of the benefits provided by ecosystem services (Table 2). Most current indicators focus on provisioning services, although emphasis is on delivery and market value, often ignoring wild food, capture fisheries, small scale aquaculture and genetic resources. Indicators for regulating services are under development and include supply, delivery and often value measures. Spatially explicit models, remote sensing, national statistics and field estimations are available for some regulating services, but lack of data is a key constraint in their development. Cultural services are difficult to elicit, except for the case of ecotourism, as they are highly context dependent and depend on world visions and deep values. Measures of spiritual or religious values are absent and even for measures of tourism, recreation and aesthetic value, data availability is limited and the indicators often fare poorly in ability to convey information. Recent work by (Daniel et al. 2012) may provide some future options for the development of cultural service measures and indicators.

10.5.3 Indicators of Nature’s Contribution to Human Wellbeing

Indicators of nature’s contribution to human wellbeing translate the amount of good or service delivered to people into the significance for a person’s welfare. Many indicators of human wellbeing exist, and have been the focus of decades of development and discussion. While many now reflect the diverse components of human wellbeing (MA, 2003) and provide information relevant to numerous decision contexts, few capture the specific role of nature (Daw et al. 2011).

For example, consider several of the indicators used by national governments to report on the Millennium Development Goals. This set of indicators will likely be a strong starting point for those used in developing indicators for the post-2015 Development Goals. These indicators are also used broadly by national governments to report on other international agreements and for internal decision making. One leading indicator is child malnutrition rate, used to track nutritional health. Nature may contribute to nutritional health through agricultural supporting services and wild-harvest provisioning services (e.g. fish, bushmeat). While child malnutrition rates may change in response to a changing natural resource base, they may also change as a result of diseases that affect nutritional health or in response to other drivers of food availability (policies, food aid programs, etc.). As such, child malnutrition is not a useful indicator of nature’s contribution to nutritional health as it might depend on many other drivers. Similarly, poverty is often indicated as the number of people living on less than $1 per day. It has been shown that the poor are often disproportionately reliant on nature, and so nature may contribute significantly to increases in their income. A more direct indicator of this benefit from nature would be the proportion of people advanced over the poverty line by nature-based income. The employment to population ratio is a popular indicator of jobs, but captures all kinds of jobs, not just those supported by nature. To capture this ecosystem service, an indicator such as the nature-based employment to population ratio would be needed. In many development contexts, the proportion of the population with access to medical services is used as an indicator of overall health care provision. To isolate the provisioning ecosystem service provided by medicinal plants, we would need a different indicator such as the proportion of the population reliant on traditional medicine.

Few of the human wellbeing metrics and indicators regularly reported address the role of nature in achieving the captured human condition. Examples do exist, including the proportion of total water resources used, an indicator used in reporting on the Millennium Development Goals. Assessments can create indicators by creatively combining some existing data sets and doing targeted additional data collection to focus on the specific links between ecosystem services and human wellbeing.

Household surveys and national census information offer an avenue worth exploring for assessments (see Tallis et al. 2012).

10.5.4 Value Indicators (also see Chapter 5 of Assessment Guide)

Indicators of nature's contribution to human wellbeing tell us how much better off people are because of benefits from the environment. They do not, however, tell us how much people value being better off in each case. Someone may receive more nutrition from wild-harvested food, but not find much value in that change if they were not hungry before, or see no difference in their health because of that change in food. Similarly, a farmer may enjoy higher crop yields because of native pollination, but not highly value that service because of other more dominant issues with wellbeing, such as a debilitating medical condition. A few farms down, a coffee farmer may not highly value increased yields from native pollination because of a saturated coffee market with low prices. We need a separate set of value indicators to reflect people's preferences for receiving different benefits in different contexts.

In a perfectly functioning market economy, people reveal this value by choosing how much to consume of each good or service on the basis of how much it contributes to their wellbeing relative to its price. In such a system, we could use observed market prices and quantities purchased to measure the value people hold for receiving ecosystem services. In our examples above, the first farmer would not spend money on fertilizer to increase yields because all income may be needed to pay for medical expenses. The second farmer would not pay for pollination (by renting domestic bee hives, etc.) because they would not have a viable market for improved yields. Most provisioning services are captured in markets and we can use market values as value indicators.

However, in the current global economic system, many ecosystem service values are not captured in existing markets. In the absence of market-derived values, other methods can be used to derive monetary indicators, such as people's willingness to pay for a given amount of an ecosystem good or service, or willingness to accept to give up an amount of good or service. Such indicators should be sure to reflect nature's contribution to the benefit people receive. For example, an indicator of people's willingness to pay to visit a tourism destination does not isolate the value that nature adds. Instead, it reflects the value of the whole tourism experience, from aesthetics to activities offered, to the quality of the food or accommodation, to the ease of access. In addition, value indicators should be related to a certain amount of service in a certain context. People seldom hold a constant value for a good or service. A familiar case is water scarcity, where people are willing to pay more for a given amount of water, (e.g. 1 litre) when water is scarce than when water is abundant. Similarly, people may express a higher willingness to pay for access to an important cultural site if it is the last of their social group's cultural sites than if it is one of hundreds already easily accessible.

Indicators of monetary value, regardless of method of determination (e.g. market, willingness to pay) are still insufficient to capture all values provided by ecosystem services. Many cultural values, spiritual values and existence values provide intangible experiences that are not captured well in any current valuation approaches. In these cases, stepping back the 'supply chain' of ecosystem services to human wellbeing indicators is a good interim alternative. While these indicators clearly lack important preference information, they at least place the importance of an ecosystem service in the context of a person's wellbeing.

10.6 A Shortlist of Indicators for Regional IPBES Assessments

To ensure a degree of comparability among regional assessments, the IPBES Task Force for Data and Knowledge is providing a shortlist of recommended indicators to consider. The criteria for selection were as follows:

- substantial relevance to assessment chapters;
- scientific and institutional credibility;
- near global coverage; disaggregation by region;
- continuously and recently updated;
- data transparency and availability;
- within and among regional representativeness and comparability.

Individual assessments will of course use global indicators not in this list and as well as regional indicators that do not fulfil the above criteria.

Table 10.3

A Shortlist of Indicators for Regional IPBES Assessments

Name	Regional Chapter*	Aichi Target	Provider	Note
Ratification status of the Nagoya protocol	2	AT 16	CBD	The objective of the Nagoya Protocol is the fair and equitable sharing of benefits arising from the utilization of genetic resources, thereby contributing to the conservation and sustainable use of biodiversity.
Ocean Health Index	2	AT 14	UCSB	Combines key ecological, economic, and social elements of the ocean's health. Not all aspects are equally usable.
Red List Index	2, 3	AT 12, 14	IUCN	Regional RLIs can be calculated either by disaggregating the global indices, or by repeatedly assessing extinction risk at the regional scale. In addition, they can be disaggregated by functional groups such as pollinating species.
Wetland Extent Trends Index	3	AT5	UNEP-WCMC/Ramsar	The Index enables the rate of loss of wetlands to be estimated, providing an indication of the status of wetlands globally and regionally
Protected area management effectiveness	3	AT 11	UNEP-WCMC	This global database can be used to report at national, regional and global levels and consists of individual assessments of management effectiveness.
Coverage of protected areas	3	AT 11	UNEP-WCMC	Quantifies reserve coverage by ecoregion
Species Habitat Index	3, 4	AT 5, 12	GEO BON / MOL	Captures availability and trends in suitable habitats for species using remote sensing, occurrence data and habitat need information.
Species Protection Index	3, 6	AT 11	GEO BON / MOL	Captures status and trends in species protected area coverage based on suitable habitat.
Trends in numbers of invasive alien species Introduction events	4	AT 9	IUCN ISSG	In current form addresses only islands, but all regions have islands and an indicator addressing mainland may become available soon.
Marine Trophic Index	4	AT 6	UBC, Sea Around Us	The index is available for the EEZs of every coastal country in the world and for all currently defined LMEs.
Nitrogen Surplus	4	AT8	PBL Netherlands	The annual soil nutrient budget includes the N and P inputs and outputs for 0.5 by 0.5 degree grid cells. It expresses the pressure of N on the environment, mainly by agricultural production.

Name	Regional Chapter*	Aichi Target	Provider	Note
Water Footprint	4	AT4	JRC	A multidimensional indicator, showing water consumption volumes by source and polluted volumes by type of pollution; all components are specified geographically and temporally, as a volumetric measure of water consumption and pollution.
Index of Linguistic Diversity	6	AT 18	Terralingua	A measure of status and trends in the world's linguistic diversity
Species Distribution Information Index	6	AT 19	GEO BON / MOL/GBIF	Captures status and trends in coverage of mobilized species occurrence information for variety of taxa
Marine stewardship council certified fishery tonnage and improvements	6	AT 6	MSC	An indicator produced using green weight catch data collected by MSC-accredited third party certification companies. Some catch data is available from individual fishery reports hosted on the MSC website.
Area of forest under sustainable management certification	6	AT 7	FSC, PEFC	The data for this indicator originate from the global FSC Certificate Database which can also be filtered by country or region as well as the PEFC database.

*** Chapter 2: Nature's benefits to people and quality of life; Chapter 3: Status, trends and future dynamics of biodiversity and ecosystems underpinning nature's benefits to people; Chapter 4: Direct and indirect drivers of change in the context of different perspectives of quality of life; Chapter 6: Options for governance, institutional arrangements and private and public decision-making across scales and sectors**

References

Altman, I., R. Boumans, J. Roman, S. Gopal, & L. Kaufman. An Ecosystem Accounting Framework for Marine Ecosystem-Based Management. *The Sea*. **In press.**

Andrew, M. E., Wulder, M. A. & Nelson, T. A. (2014). Potential contributions of remote sensing to ecosystem service assessments. *Progress in Physical Geography:* 0309133314528942.

Anticamara, J.A., R. Watson, A. Gelchu and D. Pauly. 2011. Global fishing effort (1950-2010): Trends, gaps, and implications. Fisheries Research 107: 131-136. doi:10.1016/j.fishres.2010.10.016

Ash, N., Blanco, H., Brown, C., Garcia, K., Henrichs, T., Lucas, N., Raudsepp-Hearne, C., Simpson, R.D., Scholes, R., Tomich, T.P., Vira, B., and Zurek, M. (Eds). (2010). *Ecosystems and Human Well-being: A Manual for Assessment Practitioners*. Washington DC: Island Press.

Bagstad, K. J., G. W. Johnson, B. Voigt, & F. Villa. (2013). Spatial dynamics of ecosystem service flows: A comprehensive approach to quantifying actual services. *Ecosystem Services 4*:117- 125.

Beck, J., Ballesteros-Mejia, L., Nagel, P., Kitching, I. J. (2013), Online solutions and the 'Wallacean shortfall': what does GBIF contribute to our knowledge of species' ranges?. Diversity and Distributions, 19: 1043–1050. doi: 10.1111/ddi.12083

Berkes, F., Folke, C. & Gadgil, M. (1995). Traditional ecological knowledge, biodiversity, resilience and sustainability. *Biodiversity Conservation, 4*, 281-299.

Blumstein, D. T., Mennill, D. J., Clemins, P., Girod, L., Yao, K., Patricelli, G., Deppe, J. L., Krakauer, A. H., Clark, C., Cortopassi, K. A., Hanser, S. F., McCowan, B., Ali, A. M., & Kirschel, A. N. G. (2011). Acoustic monitoring in terrestrial environments using microphone arrays: applications, technological considerations and prospectus. *Journal of Applied Ecology*, 48:758-767.

Bondeau, A., Smith, P. C., Zaehle, S., Schaphoff, S., Lucht, W., Cramer, W., Gerten, D., Lotze-Campen, H., Muller, C., Reichstein, M. & Smith, B. (2007). Modelling the role of agriculture for the 20th century global terrestrial carbon balance. *Global Change Biology*, 13, 679–706.

Boyd, J. & Banzhaf, S. (2007). What are ecosystem services? The need for standardized environmental accounting units. *Ecological Economics* 63:616-626.

Brauman, K. A., Daily, G. C., Duarte, T. K. e. & Mooney, H. A. (2007). The nature and value of ecosystem services: an overview highlighting hydrologic services. *Annu. Rev. Environ. Resour,* 32:67-98.

Brito D. 2010. Overcoming the Linnean shortfall: Data deficiency and biological survey priorities. Basic and Applied Ecology, 11, 709-713.

Brose, U., Jonsson, T., Berlow, E. L., Warren, P., Banasek-Richter, C., Bersier, L.-F., Blanchard, J. L., Brey, T., Carpenter, S. R. & Blandenier, M.-F. C. (2006). Consumer-resource body-size relationships in natural food webs. *Ecology 87*:2411-2417.

Butchart, S. H. M., Walpole, M., Collen, B., van Strien, A., Scharlemann, J. P. W., Almond, R. E. A., Baillie, J. E. M., Bomhard, B., Brown, C., Bruno, J., Carpenter K., Carr, G., Chanson, J., Chenery, A.M., Csirke, J., Davidson, N., Dentener, F., Foster, M., Galli, A., Galloway, J., Genovesi, P., Gregory, R., Hockings, M., Kapos, V., Lamarque, J., Leverington, F., Loh, J., McGeoch, M., McRae, L., Minasyan, A., Hernández, M., Thomasina, M., Oldfield, E., Pauly, P., Quader, S., Revenga, C., Sauer, J., Skolnik, B., Spear, D., Stanwell-Smith, D., Stuart, S., Symes, A., Tierney, M., Tyrrell, T., Vié, J. & Watson, R. (2010). Global biodiversity: indicators of recent declines. *Science, 328,* 1164–1168.

Carpenter et al 2009. Science for managing ecosystem services: Beyond the Millennium Ecosystem Assessment. PNAS 106: 1305–1312.

Carpenter et al. 2012. Program on ecosystem change and society: an international research strategy for integrated social–ecological systems. Current Opinion in Environmental Sustainability 4:1–5.

Chapman, A. D. (2005). Principles of Data Quality, version 1.0. Report for the Global Biodiversity Information Facility, Copenhagen. ISBN 87-92020-03-8. Available online at http://www.gbif.org/orc/?doc_id=1229.

Chavan, V. & Penev, L. (2011). The data paper: a mechanism to incentivize data publishing in biodiversity science. *BMC Bioinformatics 12* (Suppl15)52.

Cressey, D. 2015. Eyes on the ocean. Nature 519(280): 280-282. doi:10.1038/519280a

Daniel, T. C. Muhar, A., Arnberger, A., Aznar, O., Boyd, J. W., Chan, K. M. A., Costanza, R., Elmqvist, T., Flint, C. G., Gobster, P. H., Gret-Regamy, A., Lave, R., Muhar, S., Panker, M., Ribe, R. G., Schauppenlehner, T., Sikor, T., Soloviy, I., Spierenburg, M., Taczanowska, K., Tam, J. & von der Dunk, A. (2012). Contributions of Cultural

Services to the Ecosystem Services Agenda. *Proceedings of the National Academy of Sciences of the United States of America, 109* (23), 8812-8819

Daw, T.I., Brown, K., Rosendo, S. & Pomeroy, R. (2011). Applying the Ecosystem Services Concept to Poverty Alleviation: The Need to Disaggregate Human Well- Being. *Environmental Conservation 38*: 370–79.

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 332:*53-58.

Díaz, S., Fargione, J., Chapin, F. S., & Tilman, D. (2006). Biodiversity Loss Threatens Human Well-Being. *PLoS Biol 4*:e277.

Dickinson, J., Zuckerberg, B. & Bonter, D. N. (2010). Citizen science as an ecological research tool: challenges and benefits. *Annual Review of Ecology, Evolution, and Systematics* 41.

Egoh, B., Drakou, E.G. Dunbar, M.B., Maes, J., Willemen 2012. Indicators for mapping ecosystem services: a review. Joint Research Centre/Publications Office of the European Union, Luxembourg.

Eigenbrod, F., Armsworth, P.R., Anderson, B.J., Heinemeyer, A., Gillings, S., Roy, D.B., Thomas, C.D., Gaston, K.J. 2010. The impact of proxy-based methods on mapping the distribution of ecosystem services. Journal of Applied Ecology 47, 377-385.

Environmental Protection Agency. (2012). *Indicators and Methods for Constructing a U.S. Human Well-being Index (HWBI) for Ecosystem Services*. Research Report # EPA/600/R-12/023

Estes, L., Reillo, P., Mwangi, A., Okin, G. & Shugart, H. (2010). Remote sensing of structural complexity indices for habitat and species distribution modeling. *Remote Sensing of Environment 114*:792-804.

Failing, L., & Gregory, R. (2003). Ten Common mistakes in designing biodiversity indicators for forest policy. *Journal of Environmental Management 68*: 121–32.

Foley, J. A., DeFries, R., Asner, G. P., Barford, C., Bonan, G., Carpenter, S. R., Chapin, F. S., Coe, M. T., Daily, G. C., Gibbs, H. K., Helkowski, J. H., Holloway, T., Howard, E. A., Kucharik, C. J., Monfreda, C., Patz, J. A., Prentice, I. C., Ramankutty, N. & Snyder, P. K. (2005). Global Consequences of Land Use. *Science, 309*(5734): 570–74.

Geijzendorffer et al 2015. Bridging the gap between biodiversity data and policy reporting needs: An Essential Biodiversity Variables perspective. Journal of Applied Ecology 2015 doi: 10.1111/1365-2664.12417.

Graham, C. H., Ferrier, S., Huettman, F., Moritz, C., & Peterson, A. T. (2004). New developments in museum-based informatics and applications in biodiversity analysis. *Trends in Ecology & Evolution 19*:497-503.

Griggs, D., Stafford Smith, M., Gaffney, O., Rockstrom, J., Ohman, M. C., Shyamsundar, P., Steffen, W., Glaser, G., Kanie, N. & Noble, I. (2013). Policy: Sustainable development goals for people and planet. *Nature 495*: 305–7.

Haberl, H., Winiwarter, V., Andersson, K., Ayres, R.U., Boone, C., Castillo, A., et al.(2006). From LTER to LTSER: Conceptualizing the socioeconomic dimensionof long-term socioecological research. *Ecology and Society 11*(2) p.13.

Harrison, J. A., Allan, D. G., Underhill, L. G., Herremans, M., Tree, A. J., Parker, V., & Brown C. J. (1997). *The Atlas of Southern African Birds.* Birdlife South Africa: Johannesburg.

Heidemann, J., Stojanovic, M. & Zorzi, M. (2012). Underwater sensor networks: applications, advances and challenges. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences 370*:158-175.

Henry, P.Y., Lengyel, S., Nowicki, P., Julliard, R., Clobert, J., Celik, T. et al. 2008.Integrating ongoing biodiversity monitoring: potential benefits and methods. Biodiversity and Conservation, 17, 3357–3382.

Hobbie, J.E., Carpenter, S.R., Grimm, N.B., Gosz, J.R., & Seastedt, T.R. (2003). TheUS long term ecological research program. *BioScience 53*(1) pp. 21–32.

Hobern, D., Apostolico, A., Arnaud E., Bello, J.C., Canhos, D., Dubois, G., et al. 2013. Global Biodiverity Informatics Outlook: Delivering Biodiversity Knowledge in the Information Age. Global Biodiversity Information Facility, Copenhagen.

Hochachka, W. M., Fink, D., Hutchinson, R. A., Sheldon, D., Wong, W.-K. & Kelling, S. (2012). Data-intensive science applied to broad-scale citizen science. *Trends in Ecology & Evolution 27*:130-137.

Inthasone, S., Pasquier,N., Tettamanzi, A.G.B., Da Costa Pereira, C. 2015. Biodiversity and Environment Data Mining. Scientific Journal of National University of Laos, 9,116-128.

Jetz, W., McPherson J. M., & Guralnick, R. P. (2012). Integrating biodiversity distribution knowledge: toward a global map of life. *Trends in Ecology and Evolution 27:*151-159.

Kattge, J., Diaz, S., Lavorel, S., Prentice, I. C., Leadley, P., BÖNisch, G., Garnier, E., Westoby, M., Reich, P. B., Wright, I. J., Cornelissen, J. H. C., Violle, C., Harrison, S. P., Van Bodegom, P. M., Reichstein, M., Enquist, B. J., Soudzilovskaia, N. A., Ackerly, D. D., Anand, M., Atkin, O., Bahn, M., Baker, T. R., Baldocchi, D., Bekker, R., Blanco, C. C., Blonder, B., Bond, W. J., Bradstock, R., Bunker, D. E., Casanoves, F., Cavender-Bares, J., Chambers, J. Q., Chapin III, F. S., Chave, J., Coomes, D., Cornwell, W. K., Craine, J. M., Dobrin, B. H., Duarte, L., Durka, W., Elser, J., Esser, G., Estiarte, M., Fagan, W. F., Fang, J., Fernandez-Mendez, F., Fidelis, A., Finegan, B., Flores, O., Ford, H., Frank, D., Freschet, G. T., Fyllas, N., MGallagher, R. V., Green, W. A., Gutierrez, A. G., Hickler, T., Higgins, S. I., Hodgson, J. G., Jalili, A., Jansen, S., Joly, C. A., Kerkhoff, A. J., Kirkup, D., Kitajima, K., Kleyer, M., Klotz, S., Knops, J. M. H., Kramer, K., Kuhn, I., Kurokawa, H., Laughlin, D,. Lee, T. D., Leishman, M., Lens, F., Lenz, T., Lewis, S. L., Lloyd, J., Llusia, J., Louault, F., Ma, S., Mahecha, M. D., Manning, P., Massad, T., Medlyn, B. E., Messier, J., Moles, A. T., Muller, S. C., Nadrowski, K., Naeem, S., Niinemets, Ü., Nollert, S., Nuske, A., Ogaya, R., Oleksyn, J., Onipchenko, V. G., Onoda, Y., Ordonez, J., Overbeck, G., Ozinga, W., Apatino, S., Paula, S., Pausas, J. G., Penuelas, J., Phillips, O. L., Pillar, V., Poorter, H., Poorter, L., Poschlod, P., Prinzing, A., Proulx, R., Rammig, A., Reinsch, S., Reu, B., Sack, L., Salgado-Negret, B., Sardans, J., Shiodera, S., Shipley, B., Siefert, A., Sosinski, E,. Soussana, J. F., Swaine, E., Swenson, N., Thompson, K., Thornton, P., Waldram, M., Weiher, E., White, M., White, S., Wright, S. J., Yguel, B., Zaehle, S., Zanne, A. E. & Wirth C. (2011). TRY – a global database of plant traits. *Global Change Biology 17:*2905-2935.

Knight, S., Danks, F.S. and Burgess, N.D. 2015 Mapping Ecosystem Services. UNEP-WCMC.

Layke, C., Mapendembe, A., Brown, C., Walpole, M. & Winn, J. (2012). Indicators from the global and sub-global Millennium Ecosystem Assessments: An Analysis and next Steps. *Ecological Indicators 17*: 77–87.

Leadley, Paul W., Krug, Cornelia B., Alkemade, Rob, Pereira, Henrique M., Sumaila, U. Rashid, Walpole, Matt, Marques, Alexandra, Newbold, Tim, Teh, Louise S. L., van Kolck, Jennifer, Bellard, Céline, Januchowski-Hartley, Stephanie R. and Mumby, Peter J. (2014). Progress towards the Aichi Biodiversity Targets: an assessment of biodiversity trends, policy scenarios and key actions. Montreal, QC, Canada: Secretariat of the Convention on Biological Diversity.

Mace et al 2005. Chapter 4: Biodiversity. Millennium Ecosystem Assessment Report.

Mace, G., Norris, K. & Fitter, A. (2012). Biodiversity and Ecosystem Services: A multilayered Relationship. *Trends in Ecology & Evolution, 27*(1): 19–26.

Mace, G., Cramer, W., Diaz, S., Faith, D. P., Larigauderie, A., Le Preste, P., Palmer, M., Perrings, C., Scholes, R. J., Walpole, M., Walther, B. A., Watson J. E. M. & Mooney, H. A. (2010). Biodiversity Targets after 2010. *Current Opinion in Environmental Sustainability 2*: 3–8.

Mace, G. & Baillie, E. (2007). The 2010 Biodiversity Indicators: Challenges for Science and Policy. *Conservation Biology*, 1406–13.

Martinez-Harms, M. & Balvanera, P. (2012). Methods for mapping Ecosystem Service supply: a review. *International Journal of Biodiversity Science, Ecosystem Services & Management 8* (1-2): 17-25.

Meyer C, Kreft C, Guralnick R, Jetz W. 2015. Global priorities for an effective information basis of biodiversity distributions. PeerJ PrePrints: http://dx.doi.org/10.7287/peerj.preprints.856v1

Millennium Ecosystem Assessment. (2003). *Millennium Ecosystem Assessment: Ecosystems and Human Well-Being - A Framework for Assessment*. Washington, DC: World Resources Institute.

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

O'Connell, A. F., J. D. Nichols, and K. U. Karanth. 2010. Camera traps in animal ecology: methods and analyses. Springer.

O'Leary, M. A. & Kaufman, S. (2011). MorphoBank: phylophenomics in the "cloud". Cladistics 27:529-537.

Pagella, T.F. and Sinclair, F.L. 2014. Development and use of a typology of mapping tools to assess their fitness for supporting management of ecosystem service provision. Landscape Ecology, 29, 383-399.

Pandey, D.N. (2001). A bountiful harvest of rainwater. Science 293: 1763-1763.

Pauli, Harald, Michael Gottfried, Stefan Dullinger, Otari Abdaladze, Maia Akhalkatsi, José Luis Benito Alonso, Gheorghe Coldea, Jan Dick, Brigitta Erschbamer, Rosa Fernández Calzado, Dany Ghosn, Jarle I. Holten, Robert Kanka, George Kazakis, Jozef Kollár, Per Larsson, Pavel Moiseev, Dmitry Moiseev, Ulf Molau, Joaquín Molero Mesa, Laszlo Nagy, Giovanni Pelino, Mihai Puscas, Graziano Rossi, Angela Stanisci, Anne O. Syverhuset, Jean-Paul Theurillat, Marcello Tomaselli, Peter Unterluggauer, Luis Villar, Pascal Vittoz, Georg Grabherr (2012). Recent Plant Diversity Changes on Europe's Mountain Summits
Science 20 April 2012: Vol. 336 no. 6079 pp. 353-355 DOI: 10.1126/science.1219033

Pauly, D. and R. Froese 2012. Comments on FAO's State of Fisheries and Aquaculture, or 'SOFIA 2010'. Marine Policy 36(3): 746-752. doi:10.1016/j.marpol.2011.10.021

Pereira, H.M., Leadley, P., Proença, V., Alkemade, R., Scharlemann, J., Fernandez-Manjarrés, J., Araújo, M., Balvanera, P., Biggs, R., Cheung, W. Chini, L., Cooper, H. D., Gilman, E. L., Guenette, S., Hurtt, G. C., Huntington, H. P., Mace, G. M., Oberhdorff, T., Revenga, C., Rodrigues, P., Scholes, R. J., Sumaila, U. R. & Walpole, M. (2010). Scenarios for global biodiversity in the 21st century. Science, 330 (6010), pp. 1496-1501.

Pereira H.M., Ferrier S., Walters M., Geller G.N., Jongman R.H.G., Scholes R.J., Bruford M.W., Brummitt N., Butchart S.H.M., Cardoso A.C., Coops N.C., Dulloo E., Faith D.P., Freyhof J., Gregory R.D., Heip C., Höft R., Hurtt G., Jetz W., Karp D.S., McGeoch M.A., Obura D., Onoda Y. , Pettorelli N., Reyers B., Sayre R., Scharlemann J.P.W., Stuart S.N., Turak E., Walpole M. & Wegmann M. (2013). Essential Biodiversity Variables. *Science 339*:277-278

Pino-Del-Carpio, A., Arino, A.H., Villarroya, A., Puig, J. and Miranda, R. 2014. The biodiversity data knowledge gap: Assessing information loss in the management of Biosphere Reserves. Biological Conservation 173, 74-79.

Raudsepp-hearne, C., Peterson, D. & Bennett, E. (2010). Ecosystem Service Bundles for Analyzing Tradeoffs in Diverse Landscapes. *Proceedings of the National Academy of Sciences:* 1–6.

Reyers, B., O'Farrell, P. J., Cowling, R. M., Egoh, B. N., Le Maitre, D. C. & Vlok, J. H. J. (2009). Ecosystem services, land-cover change, and stakeholders: finding a sustainable foothold for a semiarid biodiversity hotspot. *Ecology and Society 14*(1): 38.

Reyers, B., Biggs, R., Cumming, G. S., Elmqvist, T., Hejnowicz, A. P. & Polasky, S. (2013). Getting the measure of ecosystem services: A social–ecological approach. *Frontiers in Ecology and the Environment 11*: 268–73.

Roemmich, D. and J. McGowan. (1995). Climatic warming and the decline of zooplankton in the California Current. *Science 267:*1324-1326.

Rounsevell, M., Dawson, T. P. & Harrison, P. A. (2010). A conceptual framework to assess the effects of environmental change on ecosystem services. *Biodiversity and Conservation 19*: 2823–42.

Sachs, J. D., Baillie, J. E., Sutherland, W. J., Armsworth, P. R., Ash, N., Beddington, J., Blackburn, T. M., Collen, B., Gardiner, B., Gaston, K. J., Godfray, H. C. J., Green, R. E., Harvey, P. H., House, B., Knapp, S., Kumpel, N. F., Macdonald, D. W., Mace, G. M., Mallet, J., Matthews, A., May, R. M., Petchey, O., Purvis, A., Roe, D., Safi, K., Turner, K., Walpole, M., Watson, R. & Jones, K. E. (2009). Biodiversity conservation and the millennium development goals. *Science*, *325*(5947), 1502-1503.

Schimel, D., Pavlick, R., Fisher, J.B., Asner, G.P., Saatchi, S., Townsend, P., Miller, C., Frankenberg, C., Hibbard, K., Cox, P. 2015. Observing terrestrial ecosystems and the carbon cycle from space. Global Change Biology, 21, 1762-1776.

Schimel, D. S., Asner, G. P. & Moorcroft, P. (2013). Observing changing ecological diversity in the Anthropocene. *Frontiers in Ecology and the Environment*, 11:129-137.

Scholes, R. J., Walters, M., Turak, E., Saarenmaa, H., Heip, C. H. R., Tuama, É. Ó., Faith, D. P., Mooney, H. A., Ferrier, S., Jongman, R. H. G., Harrison, I. J., Yahara, T., Pereira, H. M., Larigauderie, A. & Geller G. (2012). Building a global observing system for biodiversity. *Current Opinion in Environmental Sustainability*, 4:139-146.

Settele, J., Kudrna, O., Harpke, A., Kühn, I., Van Swaay, C., Verovnik, R., Warren, M., Wiemers, M., Hanspach, J. & Hickler, T. (2008). Climatic risk atlas of European butterflies. *BioRisk 1*:1-712.

Stirling, A. (2010). Keep it complex. *Nature* 468: 1029-31. doi: 10.1038/4681029a.

Suarez, A. V. & Tsutsui, N. D. (2004). The value of museum collections for research and society. *Bioscience 54:*66-74.

Tong, A., Sainsbury, P. & Craig, J. (2007). Consolidated criteria for reporting qualitative research (COREQ): a 32-item checklist for interviews and focus groups. International Journal for Quality in Health Care 19: 6, 349–357.

Tallis, H., Mooney, H., Andelman, S., Balvanera, P., Cramer, W., Karp, D., Polasky, S., Reyers, B., Ricketts, T., Running, S., Thonicke, K., Tietjen, B & Walz, A. (2012). A global system for monitoring ecosystem service change. *BioScience, 62*(11), 977-986.

Tallis, H. T., T. Ricketts, A. D. Guerry, S. A. Wood, R. Sharp, E. Nelson, D. Ennaanay, S. Wolny, N. Olwero, K. Vigerstol, D. Pennington, G. Mendoza, J. Aukema, J. Foster, J. Forrest, D. Cameron, K. Arkema, E. Lonsdorf, C. Kennedy, G. Verutes, C. K. Kim, G. Guannel, M. Papenfus, . Toft, J. Marsik, M., Bernhardt, J & Griffin, R. (2013). *InVEST 2.5.3 User's Guide*. The Natural Capital Project: Stanford, USA.

TEEB. (2010). The Economics of Ecosystems and Biodiversity Ecological and Economic Foundations. Edited by Pushpam Kumar. Earthscan: London and Washington.

Turner, W., Spector, S., Gardiner, N., Fladeland, M., Sterling, E. & Steininger, M. (2003). Remote sensing for biodiversity science and conservation. *Trends in Ecology & Evolution 18*:306-314.

UNEP/CBD/COP/DEC/X/2. (2010). The Strategic Plan for Biodiversity 2011-2020 and the Aichi Biodiversity Targets. Decision adopted by the conference of the parties to the convention on biological diversity at its tenth meeting.

UNESCO. (2014). *Local and indigenous knowledge*. Retrieved September 2014 from http://www.unesco.org/new/en/natural-sciences/priority-areas/links/

United Nations University. (2009). *The Satoyama Initiative*. Retrieved September 2014 from http://onlinelearning.unu.edu/en/the-satoyama-initiative/

Wikelski, M., Kays, R. W., Kasdin, N. J., Thorup, K., Smith, J. A., & Swenson, G. W. (2007). Going wild: what a global small-animal tracking system could do for experimental biologists. *Journal of Experimental Biology 210:1*81-186.

Wilman, H., Belmaker, J., Simpson, J., Rosa, C. d. l., Rivadeneira, M. and Jetz. W. (2014). EltonTraits 1.0: Species-level foraging attributes of the world's birds and mammals. *Ecology 95:*202

Appendix 1. Biodiversity Data and Metadata Standards, Terms and

Biodiversity Data and Metadata Standards

Name	Description	Maintained / Proposed by	Link
General Metadata & Web-based Data Interchange Guideline			
ISO			http://www.iso.org/iso/home/standards.htm
Dublin Core	Web resources (video, images, web pages, etc.), as well as physical resources such as books or CDs, and objects like artworks.	Dublin Core® Metadata Initiative (DCMI)	http://dublincore.org/
OAI-PMH - Open Archives Initiative Protocol for Metadata Harvesting	Metadata harvesting on web domains via HTTP	Open Archives Initiative	http://www.openarchives.org/pmh/
SKOS - Simple Knowledge Organization System	SKOS is an area of work developing specifications and standards to support the use of knowledge organization systems (KOS) such as thesauri, classification schemes, subject heading systems and taxonomies within the framework of the Semantic Web.	W3C	http://www.w3.org/2004/02/skos/
Darwin Core Archive (DwC-A)	A data exchange format that makes use of Darwin Core (see below) to produce a single, self-contained dataset for species occurrence or checklist data. Consists of set of text (CSV) files with a simple metadata descriptor, zipped into a compressed archive file. Preferred format for publishing data to the GBIF network (www.gbif.org)	Biodiversity Information Standards (TDWG)	http://www.gbif.org/resource/80636
Globally Unique Identifiers (GUID)			
DOI - Digital Object Identifier	Character string of electronic documents	International DOI Foundation (IDF)	http://www.doi.org/
GUID -Globally Unique Identifiers- and LSID -Life Sciences Identifiers- Applicability Statements	Identification of Life Science data objects	TDWG work group	http://www.tdwg.org/standards/150/
RDF - Resource Description Framework	Standard model for data interchange on the Web	RDF - working group	http://www.w3.org/RDF/
Biodiversity Metadata Standards			
EML - Ecological Metadata Language	Metadata specification for ecology discipline	Ecological Society of America and associated efforts	https://knb.ecoinformatics.org/#tools/eml

DIF - Directory Interchange Format	Catalog Interoperability (CI) to find scientific data in another sites	NASA's Master Directory (NMD)	http://gcmd.gsfc.nasa.gov/add/difguide/index.html
NBN metadata standard	Geo-spatially referenced datasets	National Biodiversity Network - UK	http://www.nbn.org.uk/Share-Data/Providing-Data/NBN-Metadata-Standard.aspx
Biodiversity Information Standards - TDWG (Taxonomic Databases Working Group)			
Darwin Core	Darwin Core (often abbreviated to DwC) is an extension of Dublin Core for biodiversity informatics. It is meant to provide a stable standard reference for sharing information on biological diversity. The terms described in this standard are a part of a larger set of vocabularies and technical specifications under development and maintained by Biodiversity Information Standards (TDWG) (formerly known as the Taxonomic Databases Working Group (TDWG)).	TDWG - Biodiversity Information Standards	http://rs.tdwg.org/dwc/ https://github.com/tdwg/dwc
Audubon Core	Vocabularies to metadata for biodiversity multimedia resources and collections	Joint GBIF-TDWG Multimedia Resources Task Group (MRTG)	https://github.com/tdwg/dwc
SDD - Structured Descriptive Data	Descriptive data about a taxon or species	TDWG - Biological Descriptions Interest Group	http://www.tdwg.org/standards/116/
ABCD - Access to Biological Collection Data	Access to and exchange of data about specimens and observations	TDWG - Biodiversity Information Standards	http://www.tdwg.org/standards/115/
TAPIR - TDWG Access Protocol for Information Retrieval	XML-based request for accessing online databases	TAPIR Task Group	http://www.tdwg.org/standards/449/
Additional biodiversity data standards (pending ratification)			
Plinian Core	Standard to share species level information	Maintained by open source community / Proposed on TDWG 2013 (INBio, Costa Rica / GBIF, Spain / UG, Spain / IAvH , Colombia / Conabio, Mexico / USP, Brazil)	https://code.google.com/p/pliniancore/
Genomic Contextual Data Markup Language (GCDML)	Descriptors for describing the exact origin and processing of a sequenced biological sample, from sampling to sequencing, and subsequent analysis	Core project of the Genomic Standards Consortium (GSC)	http://gensc.org/projects/gcdml/

Terms and Vocabularies

http://vocabularies.gbif.org/

http://www.iucnredlist.org/technical-documents/data-organization

http://standard.biodinfo.org/bsbc/

http://dev.e-taxonomy.eu/trac/wiki/CommonDataModel

http://www.openarchives.org/

http://www.biodiversitya-z.org

http://bioscience.oxfordjournals.org/content/64/4/311

http://gensc.org/

http://www.gbif.org/resources/2647

http://www.bionomenclature.net/

http://terms.tdwg.org/wiki/Darwin_Core

Section V: Enhancing the Utility of Assessments for Decision Makers and Practitioners

IPBES aims to encourage decision makers and other practitioners to use its assessment findings, as set out in its third function: "Promote the development and use of policy support tools and methodologies so that the results of assessments can be more effectively applied with a particular focus on policy support tools".

This section describes ways of making assessment findings useful for decision-makers and practitioners. The first chapter focuses on policy support tools and methodologies. It draws on the work of the expert group for Deliverable 4c, including the guide and in particular the Catalogue of Policy Support Tools. The second chapter focuses on communication and stakeholder engagement. While there is a communication and stakeholder engagement plan for IPBES, it is recommended that assessments (particularly regional, national and local assessments), have their own plan to ensure that the assessment process is relevant, credible and legitimate to end users. This is a short chapter outlining key principles, and issues around communication and stakeholder engagement with reference to other key resources.

Chapter 11: Policy support tools and methodologies [GUIDANCE TO UPDATED FOLLOWING BUDAPEST MEETING]

Coordinating Authors: Sebsebe Demissew, Julia Carabias, Thomas Koetz, Lucy Wilson

Authors: Jay Ram Adhikari, Mialy Andriamahefazafy, Sujata Arora, Ivar Andreas Baste, Gunay Erpul, Ersin S. Esen, Moustafa Mokhtar Ali Fouda, Mary George, Steve Hatfield-Dodds, Howard Hendriks, Claudia Ituarte Lima, Tatiana Kluvankova, Ryo Kohsaka, Claudio C Maretti, Juana L. Marino, Rodger Lewis Mpande, Emmanuel Munyeneh, Roberto Oliva, Paul Ongugo, Unai Pascual, György Pataki, Tamar Pataridze, László Podmaniczky, Irene Ring, Leonel Sierralta, Azime Tezer, Juliette Young, Carlos Ivan Zambrana-Flores.

11.1 IPBES and policy support tools and methodologies

There is a wide range of policy support tools and methodologies available for different purposes, at various stages of the policy cycle. Despite the abundance of ecosystem service-related tools, there have been few systematic reviews or evaluations of ecosystem services tools that have determined their strengths, weaknesses, and applicability to various settings or that have simultaneously applied several tools to a common study area (Bagstad et al. 2013). Consequently, it is often difficult for decision-makers, at different scales, to access information on policy support tools and methodologies, or to identify how relevant these tools and methodologies might be for their specific context.

To address this challenge, IPBES will support decision-makers forming and implementing policy by identifying policy-relevant tools and methodologies (including those arising from assessments) and making them easier for decision-makers to access. Where necessary, the Platform will also catalyse the further development of policy support tools and methodologies[19]. An expert group has been established to support the MEP and Bureau in developing a 'Catalogue of Policy Support Tools and Methodologies' in order to provide guidance on how the further development of such tools and methodologies could be promoted and catalysed in the context of the Platform. This catalogue and guidance will be reviewed at the 3rd Plenary session in January 2015 (IPBES 3/3/5; IPBES 3/INF/8).

This chapter is based on draft guidance developed by the expert group, which provides a clear definition and explanation of what 'policy support tools and methodologies' are and conceptualizes these in the context of IPBES objectives, functions and its conceptual framework (IPBES 3/3/5; IPBES 3/INF/8). The draft guidance also suggests how the further development of the policy tools and methodologies could be promoted and catalysed and recommends how policy tools and methodologies could be more systematically identified, made accessible and disseminated by the Platform. Collectively, the catalogue and guidance seek to serve the needs of a range of social actors, focusing primarily, but not exclusively, on diverse decision-makers and implementing bodies and information providers and brokers. They also provide a channel for IPBES to engage in dialogues with other conventions and initiatives with similar visions and complementary mandates to explore possible synergies on the use and further development of relevant tools and methodologies.

11.1.1 What are policy support tools and methodologies?

The draft guidance (IPBES 3/3/5; IPBES 3/INF/8) defines policy support tools and methodologies as:

"Policy support tools and methodologies are approaches and techniques based on science and other knowledge systems that can inform and assist policy-making and implementation at local, national, regional and international levels to protect and promote nature, nature's benefits to people, and a good quality of life."

This definition seeks to include all tools and methodologies that can contribute to desired outcomes for people and nature in relation to biodiversity and ecosystem services. Such a broad definition is needed to support the

[19] UNEP/IPBES.MI/2/9, 19 Appendix1, paragraph 1(d)

development of a comprehensive catalogue and guidance that is useful for policy makers, member states, allied organisations, and other stakeholders.

The context of policy support tools and methodologies is important. Specifically, they need to be understood in the context of socio-ecological challenges and what can be done to tackle them. Figure 11.1 provides a simple illustration of the interrelation of policy formulation, policy instrument design and implementation, and policy support tools and methodologies for biodiversity loss and degradation of ecosystem services.

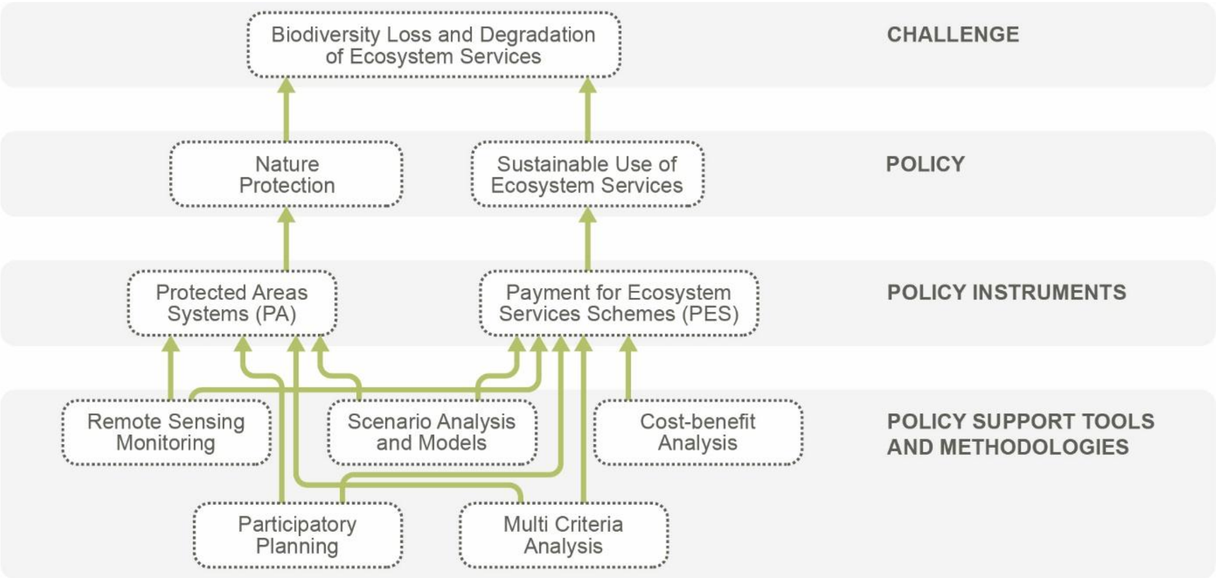


Figure 11.1: Schematic representation of the context of policy support tools and methodologies. Source: IPBES 3/3/5 and IPBES/3/INF/8

In accordance with the IPBES mandate, it is suggested the policy support function of IPBES should focus on:

1. enabling decision makers across scales to gain easy access to identified policy support tools and methodologies to better inform and assist the different phases of policy making and implementation.
2. allowing more tailored information on policy tools to be easily accessible to users of the catalogue.
3. identifying gaps in tools and methodologies and propose the need to develop new ones.

These goals will be achieved through the development of an online, user-focused platform. In addition to being a repository of high quality information on available policy support tools and methodologies, the catalogue will enable decision-makers, practitioners and other social groups to adopt a step-wise approach to identify the most relevant tools and methodologies for their individual needs.

A seven family typology of approaches and techniques has been proposed by the expert group based on the broad challenges that may arise in the development and implementation of sound policy for the benefit of people and nature. Box 11.1 provides a list of these families and gives examples of tools and methodologies for each one.

The catalogue of policy support tools and methodologies will eventually be able to provide further guidance on how to use the tools and methodologies it contains.

Box 11.1: Proposed families of policy support tools and methodologies with examples

1. **Assembling data and knowledge (including monitoring)** – indicators, oral history, mapping of ecosystem services, census data, population dynamics.
2. **Assessment and evaluation** – trade-off analysis, management effectiveness, trend analysis, indigenous and community conserved areas (ICCAs) identification and assessment, quantitative modelling, cost-benefit analysis / non-monetary valuation, scenarios.
3. **Public discussion, involvement and participatory process** – expert interviews, stakeholder consultation, cultural mapping and implications for policy goals and criteria, social media tools.
4. **Selection and design of policy instruments** – instrument impact evaluation, ex-ante evaluation of options and scenarios, designing of individual territory sets or systems of protected areas.
5. **Implementation, outreach and enforcement** – audits, risk-based enforcement effort, process standards (e.g. ISO) , MRV (monitoring reporting and verification)
6. **Capacity building** – handbooks, manuals, guides, e-learning resources, training, education, knowledge sharing.
7. **Social learning, innovation and adaptive governance** – strategic adaptive management, social learning theory.

Source: IPBES 3/3/5 and IPBES/3/INF/8

11.1.2 What role do assessments play in relation to policy support tools and methodologies?

In the context of IPBES, assessments relate to policy support tools and methodologies in three distinct dimensions. Firstly, assessments are an important policy support tool in their own right. Assessment reports and the assessment process itself have become powerful tools in environmental governance. Whether regulated in the context of e.g. Environmental Impact Assessments or as a result of a larger international initiative, such as the Millennium Ecosystem Assessment, assessment reports and processes have become critical tools within policy making, in particular for the agenda setting and review phase of the policy-cycle.

Secondly, as part of their process, assessments also incorporate and utilize other policy support tools and methodologies. For example, they use scenarios (see Chapter 6 on Scenarios; Henrichs et al. 2010) to explore future changes to ecosystems and services they deliver, and valuation methodologies to better understand the trade-offs in the different kinds of values within and among stakeholders (see Chapter 5 on Values). Policy support tools can also help to visualise and communicate the findings of an assessment to different audiences. For instance, maps can be effective tools for displaying spatial variation in the delivery of ecosystem services at numerous scales. Further examples of tools and methodologies can be found in Box 11.1.

Thirdly, assessments are key mechanisms for identifying effective policy responses or policy instruments, as well as the policy support tools and methodologies needed to implement these policy instruments in the most rigorous and effective way. An assessment can evaluate the effectiveness of a range of policy instruments with different contexts, sectors and scales (such as Protected Areas Schemes or Payments for Ecosystem Services Schemes). They can also identify which policy support tools and methodologies have been used in implementing these policy instruments and their strengths and weaknesses (e.g. availability of the tool and/or data needed to feed it, effectiveness, practicability and replicability of current and emerging policy support tools and methodologies). They can identify gaps and what is needed to further strengthen the policy support tools and methodologies.

In ensuring that all IPBES assessments identify and assess the availability, effectiveness, practicability and replicability of current and emerging policy support tools and methodologies, as well as their gaps and needs, IPBES assessments will also provide a key mechanism to provide substance to the catalogue of policy support tools and methodologies and keep it up-to-date as new tools and methodologies are made available.

11.2 Guidance on identifying and assessing policy support tools and methodologies

IPBES assessments play a key role in identifying and assessing current and emerging policy support tools and methodologies. In particular, when assessing the effectiveness of policy responses or policy instruments, assessments should systematically identify and assess policy support tools and methodologies as defined by the expert group on deliverable 4c. In doing so, the assessments should address aspects such as the availability, effectiveness, practicability and reliability of policy support tools and methodologies, as well as their requirements, needs and gaps.

Key resources

- Ash, N., Blanco, H., Brown, C., Garcia, K., Henrichs, T., Lucas, N., Raudsepp-Hearne, C., Simpson, R.D., Scholes, R., Tomich, T.P., Vira, B., and Zurek, M. (Eds). (2010) Ecosystems and Human Well-being: A Manual for Assessment Practitioners. Island Press, Washington D.C. Available at: http://www.unep-wcmc.org/resources-and-data/ecosystems-and-human-wellbeing--a-manual-for-assessment- practitioners
- Bagstad, K.J., Semmens D.J., Waage, S., Winthrop, R. (2013) A comparative assessment of decision-support tools for ecosystem services quantification and valuation. Ecosystem Services 5: 27–39. http://www.sciencedirect.com/science/article/pii/S221204161300051X
- Henrichs, T., Zurek, M., Eichhout, B., Kok, Kasper, Raudsepp-Hearne, C., Ribeiro, T., Vuuren, D. van & Volkery, A. (2010) Scenario development and analysis for forward-looking ecosystem assessment. (2010) In: Ecosystems and Human Well-being: A Manual for Assessment Practitioners. Ash, N., Blanco, H., Brown, C., Garcia, K., Henrichs, T., Lucas, N., Raudsepp-Hearne, C., Simpson, R.D., Scholes, R., Tomich, T.P., Vira, B., and Zurek, M. (Eds). Island Press, Washington D.C. Available at: http://www.unep-wcmc.org/resources-and-data/ecosystems-and-human-wellbeing--a-manual-for-assessment-practitioners
- IPBES 3/3/5. Deliverable 4(c) guide on policy support tools and methodologies. Available at: http://www.ipbes.net/plenary/ipbes-3.html
- IPBES 3/INF/8. Update on deliverable 4(c) policy support tools and methodologies. Available at: http://www.ipbes.net/plenary/ipbes-3.html

- The Catalogue of Policy Support Tools and Methodologies will be a key resource once it has been developed.

Chapter 12: Communication and stakeholder engagement

12.1 Communication

Communication and outreach are necessary to ensure that assessment results are put into use and have an impact. An assessment itself can be thought of as a communication tool between researchers and decision-makers, as it translates scientific information into policy-relevant information. If an assessment is technically proficient but fails to communicate, it tends to fail overall. Therefore, choosing the best ways to present the information from the assessment to the intended audiences deserves great care (Box 12.1). The overall products should be readable, understandable, and unambiguous.

Box 12.1: Target groups and report style

Decision-makers

Content should be short, specific, fact-based and consist of the latest information.

Media

Content should be short and consist of findings relevant for broad audiences, with messages that can easily be linked to other issues in the news.

Students

Content should be well explained, and the language should be simple.

Scientists

Content should be fact based and rely on the latest data. The language can be scientific and include technical terms.

Indigenous and Local Knowledge (ILK) Holders

Content should be simple, straightforward, problem-oriented in terms of addressing local concerns and disseminated via the most suitable, possibly non-published, media

Source: UNEP, 2007

A communication strategy should be developed at the outset and followed carefully, with continuous communication and capacity building throughout the assessment process. The main purpose of developing a communication strategy at the start of the assessment is to ensure the right people are communicated with at the right time via the right media, with salient and useful information (Box 12.2). It helps to focus resources on the specific communication ideas that are most beneficial to achieving the overall assessment goal. Once the data analysis has reached a conclusion, communication of the key findings and messages is very important.

Box 12.2: Developing a comprehensive communications plan ensures effective outreach

The Millennium Ecosystem Assessment in Biscay (EEMBizkaia) is a local scale assessment which has achieved success due to a clear outreach and coordination strategy. An extensive communication plan was carried out in coordination with researchers, local authorities and NGOs, ensuring stakeholder participation from the outset and the subsequent socialisation of results. Key aspects of this communication plan included:

- Involving stakeholders at multiple stages of the assessment; either in educational workshops, research surveys and interviews, or sharing results via conferences or modern media channels.
- Encouraging direct contact and continuous communication between all stakeholders and the technical assessment team to voice problems and concerns and guide outputs.
- Specifically, local, national and international conferences and workshops were conducted to articulate the assessment benefits to key audiences. This was alongside continuous development of outreach materials and publications in both specialised journals and the general public media, including short, simple audio-visual media to convey key messages in a friendly manner and engage diverse interest groups. Further, continuous communication with international partners and other multidisciplinary teams, particularly the Millennium Ecosystem Assessment of Spain, ensured coordinated efforts, engagement with the wider community and scaling of results.
- With widespread buy-in from a range of key stakeholders, results of the assessment are being integrated into policy and implemented by local technical authorities.

Source: Booth et al. (2012)

When developing a comprehensive communications strategy, consider who to engage and how best to engage them and build this in to the overall assessment timeline. Using different languages and communication tools for different audiences, can help focus on their specific priorities. Tips on how to present assessment findings in a variety of ways from the Guidance Manual for TEEB Country Studies (2013) include:

- Producing a synthesis report (see Chapter 3) and accompanying presentations for use by stakeholders
- Focusing the assessment key findings to show the relevance and benefits for each stakeholder (see Box 12.3)
- Using different avenues for dissemination of results e.g.
  - Briefings for government
  - Press coverage (articles and interviews)
  - Launch events and/or workshops
  - Publication of studies in academic journals
  - Electronic communications such as websites, e-newsletters and social media (see Box 12.4)
- Using specialist writers to help convey complicated or technical messages to non-technical audiences
- Producing visual aids such as charts, graphs and pictures to easily communicate messages within the text. Use of these supporting visuals may also increase the chance of greater media coverage (UNEP, 2007)
- Encouraging eminent members of the assessment to act as 'champions', opening channels within their sectors and to higher levels of authority.

Box 12.3: UK National Ecosystem Assessment Follow-on Phase Knowledge Exchange Strategy

In 2011 the UK National Ecosystem Assessment (UK NEA) delivered a wealth of information on the state, value (economic and social) and possible future of terrestrial, freshwater and marine ecosystems across the UK, but also identified a number of key uncertainties. A two-year 'follow-on phase' (UK NEAFO) was initiated in 2012 in order to further develop and promote the arguments that the UK NEA put forward and make them applicable to decision and policy making at a range of spatial scales across the UK to a wide range of stakeholders.

Following extensive stakeholder engagement, it was decided that the synthesis report of the UK NEAFO would include a series of stand-alone reports that summarize the key findings from the UK NEA and UK NEAFO that are most relevant for specific audiences and end users. These audiences were:

- national government departments;
- government agencies;
- local authorities;
- general public;
- businesses;
- environmental nongovernmental organizations; and
- the research community.

The reports were written by or with individuals from each of the target audience groups in a collaborative process with the report lead authors. The targeted reports demonstrate the usefulness of the assessment outputs across a range of user groups and help these groups to acquire a greater understanding of the assessment key messages. They also serve to create a sense of ownership of the central assessment output by further engaging stakeholders in the assessment process.

Source: UK NEA (2014)

Box 12.4: The Spanish National Ecosystem Assessment's (EME) Communication Strategy.

The general aim of the communication strategy of the EME is to build a social network around the vision of nature conservation as a necessary action for human wellbeing. To achieve this general aim, the following objectives were set:

- To coordinate internal communication elements that allow proper scientific exchange between the research teams involved in the project under the integrated and inclusive framework of the Millennium Ecosystem Assessment.
- To bring the development of the EME to the attention of stakeholders and listen to their needs and contributions regarding ecosystem services to ensure that the results will be useful to them as well as taking into account the different actors involved in or dependent on ecosystem services.
- Develop external communication tools tailored to the needs of different target audiences or stakeholders as well as innovative formats and channels for the dissemination of the results of EME in different social spheres, such as the media, school communities, NGOs and social movements.
- Characterize the messages that define the approach of the project regarding the human-nature relationship as well as building a graphic identity for the project and amplifying its messages through existing channels and networks.
- Contribute to the international dissemination and projection of the Millennium Assessment (included the participants in the Sub-global Assessment Network) and other national and international collaboration channels associated with the project.
- Increase the interaction and information flow between the scientific community, policy-makers, businesses and society in general to improve decision making in the management of ecosystems according to the project's objectives.

Source: Evaluación de los Ecosistemas del Milenio de España (2014)

12.2 Stakeholder engagement

Stakeholder involvement is often central to creating the appropriate enabling environment to undertake an assessment. The core principles of successful assessments (relevance, credibility and legitimacy) are best achieved through strategic and effective participation of all relevant stakeholders in the assessment process. Having a diverse range of stakeholders involved in an interactive process can promote knowledge and information exchange and allows different groups to express their positions and interests on issues. Furthermore the involvement of multiple stakeholders can enrich the process, with individuals and organisations working to a common goal, and ownership of the assessment contributing to the authorisation environment. Stakeholder involvement in the assessment can take the following forms[20]:

- Being consulted on the needs for an assessment;
- Being consulted on key questions framing the assessment;
- Receiving information about assessment progress, findings, and opportunities to participate;
- Contributing knowledge to the assessment report;
- Contributing contextual information about an ecological or social system;
- Being consulted on the condition and trends of ecosystem services and human well-being in a region (practitioners and holders if local knowledge);
- Attending a public hearing about assessment processes and findings;
- Attending education or capacity building workshops on assessment processes and findings;
- Participating in the assessment process as student interns or fellows of the assessment;
- Participating in the assessment governance;
- Being a formal end user of the assessment products;

[20] MA Methods Manual.

- Participating in the peer review of the assessment; and
- Acting as a partner for the dissemination of assessment findings.

Stakeholder engagement may involve some or all of the options outlined above. The scale at which the assessment is taking place may influence the most appropriate involvement of stakeholders. However, there are risks involved with including a wide-range of stakeholders, which may include lobby groups, therefore stakeholder involvement should be clearly planned in order not to jeopardise the independence of the assessment. A conflict of interest policy is likely to be an important within your stakeholder plan.

References

Booth, H., Simpson, L., Ling, M., Mohammed, O., Brown, C., Garcia, K. & Walpole, M. (2012). *Lessons learned from carrying out ecosystem assessments: Experiences from members of the Sub-Global Assessment Network.* UNEP-WCMC, Cambridge

Evaluación de los Ecosistemas del Milenio de España. (2014). *Comunicación y Educación.* Retrieved September 2014 from http://www.ecomilenio.es/comunicacion

Hesselink, F.J. (2007), Communication, Education and Public Awareness, a toolkit for the Convention on Biological Convention, Montreal www.cepatoolkit.org

TEEB. (2013). *Guidance Manual for TEEB Country Studies*. Version 1.0.

UK National Ecosystem Assessment. (2014). *The UK National Ecosystem Assessment Follow-on: Synthesis of the Key Findings*. UNEP-WCMC, LWEC, UK.

UNEP (2007) *Global Environment Outlook 4*. London: Earthscan Publications.

UNEP (2008) *IEA Training Manual: A training manual integrated environmental assessment and reporting*, UNEP and IISD www.unep.org/ieacp/iea/training/manual/

Section VI Strengthening Capacities in the Science - Policy interface

This section deals with capacity-building under the fourth function of IPBES, *Identify and prioritize capacity building needs for improving the science-policy interface at appropriate levels, and provide, call for and facilitate access to the necessary resources for addressing the highest priority needs directly relating to its activities.* Assessments are often viewed as vehicles for developing capacity at different scales (e.g. learning through doing).

This section draws upon the work of the Task Force for Capacity Building and sets out the opportunities available to build capacity through IPBES and elements which assessment practitioners working at national and local scales might like to consider when planning an assessment.

Chapter 13 Identifying and addressing Capacity-building Needs through Assessments

Coordinating Author: Ivar Baste

Authors: Jerry Harrison, Sebsebe Demissew, Floyd Homer, Prudence Galega, Rob Hendriks, Nina Vik

13.1 The capacity-building function of IPBES

Capacity-building is a fundamental element of IPBES' work. IPBES is committed to improving human, institutional and technical capacities for the informed and effective implementation and use of assessments, for the development and use of policy support tools and methodologies, and for improving access to necessary data, information and knowledge. It aims not only to enable experts and institutions to contribute to and benefit from IPBES' own deliverables, but also to more generally improve the science-policy interface. Its efforts are geared towards fully integrating capacity-building into the implementation of the work programme, as well as to enhancing the enabling environment for its implementation. Capacity-building is supported and facilitated through the IPBES Trust Fund, and in addition IPBES will catalyse support for capacity-building through its own 'matchmaking' efforts and through an IPBES Capacity-building Forum. The proposed IPBES matchmaking facility aims at matching priority capacity-building needs related to its activities with financial and technical resources, and the capacity-building forum will increase access to potential technical and financial support through building partnerships and increasing alignment of capacity-building activities. This is addressed in more detail below.

13.2 Issues, concepts and definitions of key terms

13.2.1 Capacity-building in IPBES

The focus of capacity-building in IPBES is set out in the resolution establishing IPBES[21] (UNEP 2012). The IPBES programme of work 2014-2018 identifies two capacity-building deliverables, which address the following issues:

- ***Priority capacity-building needs to implement the Platform's work programme are matched with resources through catalyzing financial and other in kind support***. Priority capacity-building needs will be identified based on submissions from member states and observers, and through the scoping of Platform deliverables (including the various assessments). The Platform is also mandated to provide a "forum" with conventional and potential sources of funding which amongst other things would advise the Plenary on the identification of priority capacity-building needs and the acceptance of financial and in- kind support. The forum would also oversee a web-based "matchmaking facility" set up to help to match available technical and financial resources with priority capacity-building needs.

- ***Ensure that capacities needed to implement the Platform's work programme are developed***. Capacity-building activities will address the priority needs identified under the previous deliverable. Activities would include technical assistance, training workshops, fellowship and exchange programmes and support for the evolution of national, subregional and regional science-policy networks, platforms and centers of excellence, including consideration of indigenous knowledge systems where appropriate. These activities would constitute an integrated part of the processes for delivering the assessment, data management and policy support tools set out in other deliverables of the work programme. Capacity-building would be supported through, and build on, a geographically widespread network of institutions and initiatives.

Terms of reference for an IPBES Task Force on Capacity-building were agreed by the second IPBES Plenary. Following a nomination process, a task force of 20 members has been selected and appointed, serving together with two members of the IPBES Bureau, and three members of the IPBES Multidisciplinary Expert Panel. Additional resource persons can be invited at the discretion of the co-chairs of the task force to support specific activities, and

[21] Adopted on 21 April 2012 by the second session of the Plenary meeting to determine modalities and institutional arrangements for an intergovernmental science-policy platform on biodiversity and ecosystem services in Panama City, 16-21 April 2012.

these typically come from organizations actively working on supporting relevant capacity-building activities. The Technical Support Unit for the task force is provided as an in-kind contribution by the Norwegian Environment Agency for the life of the current IPBES work programme.

The task force and its technical support unit will help to identify and address the prioritized capacity-building needs agreed by the Plenary, drawing on resources made available through the Platform's trust fund or provided through additional in-kind financial and technical resources. Periodically, the task force will analyze the extent to which priority capacity-building needs identified by the Platform have been addressed.

13.2.2 Priority capacity-building needs

Priority capacity-building needs are those that have been approved by the IPBES Plenary. The Task Force on capacity-building recommended that the highest priority capacity-building needs are those that fulfil the following criteria:

a) They can be addressed through activities that are integrated into deliverables of the Platform's work programme (resourced through the Platform trust fund, in-kind contributions, the capacity-building forum and the matchmaking facility);

or:

b) They can be addressed through activities which enable the implementation of the Platform's work programme (resourced through the capacity-building forum and the matchmaking facility);

and in both cases:

c) They are driven by demands expressed and promote the sustainability of capacity-building over time, including by building on existing initiatives and institutions;

d) They stimulate awareness of and engagement with the Platform and support the implementation of and interlinkages among multilateral environmental agreements.

The Platform compiled and synthesised expressions of capacity-building needs received through submissions and consultations, and these are summarized and categorized in the table below. The table also suggests how such needs can be matched with resources.

Drawing on the expressions of capacity-building needs identified in the table below, the following priority capacity-building needs and means for addressing them were approved by the IPBES Plenary[22] based on the advice of the task force on capacity-building:

a) Focus on the ability to participate in the Platforms deliverables; primarily addressed through the proposed fellowship, exchange and training programme, with the priority placed on the Platform's regional assessments. This would be resourced through the Platform trust fund and in-kind contributions. The extent and reach of this programme will be increased over time by facilitating the mobilization of resources through the capacity-building forum and the piloting of a prototype matchmaking facility;

b) Focus on enhancing the capacity to undertake, use and improve national assessments of biodiversity and ecosystem services, by facilitating the development and implementation of proposals based on expressions of interest, and develop the capacity for the use of assessment findings in policy development and decision-making. Facilitation will be resourced through the Platform trust fund and in-kind contributions, while support for the development and implementation of national project proposals will be sought through the capacity-building forum and the piloting of a prototype matchmaking facility;

c) Focus on the development and implementation of pilot or demonstration projects addressing other categories of needs, by facilitating the development and implementation of proposals based on expressions of interest. Facilitation will be resourced through the Platform trust fund and in-kind contributions, while support for the development and the implementation of national project proposals will be sought through the capacity-building forum and piloting of the matchmaking facility;

d) Also, the Platform acknowledges the specific capacity-building needs related to the development and strengthening of the participatory mechanism and indigenous and local knowledge approaches and procedures through the Platform trust fund and in-kind contributions.

[22] Approved in January 2015 as part of decision IPBES-3/1, and included in Annex 1 to that decision. Table 13.1 also comes from the same annex.

Table 13.1

Capacity-building needs identified by members and other stakeholders, and potential sources of support for addressing their needs

<table>
<tr><th rowspan="2">Capacity need categories</th><th rowspan="2">Needs identified by governments and other stakeholders</th><th colspan="3">Potential source of support</th></tr>
<tr><th>Trust Fund</th><th>Matchmaking facility</th><th>Notes</th></tr>
<tr><td rowspan="4">1. Enhance the capacity to participate effectively in implementing the Platform work programme</td><td>1.1 Develop the capacity for effective participation in the Platform regional and global assessments</td><td>✓</td><td>✓</td><td rowspan="4">Priority for the Platform trust fund, largely delivered through the fellowship, exchange and training programme
Supplemented through the Platform's matchmaking facility</td></tr>
<tr><td>1.2 Develop the capacity for effective participation in the Platform thematic assessments</td><td>✓</td><td>✓</td></tr>
<tr><td>1.3 Develop the capacity for effective participation in the Platform methodological assessments and for the development of policy support tools and methodologies</td><td>✓</td><td>✓</td></tr>
<tr><td>1.4 Develop the capacity for monitoring national and regional participation in the implementation of the Platform work programme, and responding to deficiencies identified</td><td>✓</td><td></td></tr>
<tr><td rowspan="8">2. Develop the capacity to carry out and use national and regional assessments</td><td>2.1 Develop the capacity to carry out assessments, including on different initiatives, methodologies and approaches</td><td>✓</td><td>✓</td><td rowspan="8">Priority for the Platform's matchmaking facility</td></tr>
<tr><td>2.2 Develop the capacity among policymakers and practitioners for the use of assessment findings in policy development and decision-making</td><td>✓</td><td>✓</td></tr>
<tr><td>2.3 Develop the capacity to develop and use non-market-based methods of valuing biodiversity and ecosystem services</td><td>✓</td><td>✓</td></tr>
<tr><td>2.4 Develop the capacity to assess specific priority habitats and ecosystems, including ecosystems that cross ecological and political boundaries</td><td>✓</td><td>✓</td></tr>
<tr><td>2.5 Develop the capacity to develop and effectively use indicators in assessments</td><td>✓</td><td>✓</td></tr>
<tr><td>2.6 Develop the capacity to value and assess management options and effectiveness</td><td>✓</td><td>✓</td></tr>
<tr><td>2.7 Develop the capacity to retrieve and use all relevant data, information and knowledge</td><td>✓</td><td>✓</td></tr>
<tr><td>2.8 Develop the capacity to introduce different worldviews and indigenous and local knowledge systems into the different assessments</td><td></td><td>✓</td></tr>
<tr><td rowspan="4">3. Develop the capacity to locate and mobilize financial and technical resources</td><td>3.1 Develop the institutional capacity to locate and mobilize financial and technical resources</td><td>✓</td><td>✓</td><td rowspan="4">Pilot project(s) through the Platform matchmaking facility</td></tr>
<tr><td>3.2 Develop the capacity for clearly communicating capacity-building needs to potential providers of financial and technical support</td><td></td><td>✓</td></tr>
<tr><td>3.3 Develop the capacity to identify current investments as well as the gap between identified needs and available resources for the effective strengthening of the science-policy interface on biodiversity and ecosystem services</td><td></td><td>✓</td></tr>
<tr><td>3.4 Develop the capacity to mobilise the institutional and technical resources to manage data and knowledge for the effective monitoring of biodiversity and ecosystem services</td><td>(✓)</td><td></td></tr>
</table>

Capacity need categories	Needs identified by governments and other stakeholders	Potential source of support		
		Trust Fund	Matchmaking facility	Notes
4. Improve the capacity for access to data, information and knowledge (including the experience of others)	4,1 Develop the capacity for improved access to data, information and knowledge including its capture, generation, management and use (including indigenous and local knowledge and knowledge from participatory science solial networks and large volumes of data)	(✓)	✓	Pilot project(s) through the Platform matchmaking facility
	4.2 Develop the capacity to gain access to data, information and knowledge managed by internationally active organizations and publishers		✓	
	4,3 Develop the capacity for enhancing collaboration among research institutions and policymakers at the national and regional levels, in particular for encouraging multidisciplinary and cross-sectoral approaches	✓	✓	
	4.4 Develop the capacity for the conversion of scientific and social assessments of biodiversity and ecosystem services into a format easily understood by policymakers	✓	✓	
	4.5 Develop the effective capacity to promote an interscience dialogue between different world views, modern science and indigenous and local knowledge systems, including by facilitating the effective engagement of indigenous and local communities, scientists and policymakers	✓	✓	
	4.6 Develop the capacity to gain access to and use technologies and networks that support biodiversity taxonomy, monitoring and research		✓	
5. Develop the capacity for enhanced and meaningful multi-stakeholder engagement	5.1 Develop the capacity for effective engagement of stakeholders in assessment and other related activities at the national level, including for understanding who the stakeholders are and how they should be engaged		✓	Pilot project(s) through the Platform's matchmaking facility
	5.2 Develop the capacity for effective communication of why biodiversity and ecosystem services are important, and why their many values should be used in decision-making	✓	✓	
	5.3 Develop the capacity to effectively use the Platform's deliverables in implementing national obligations under biodiversity-related multilateral environmental agreements	✓	✓	
	5.4 Develop the capacity to strengthen different networks of actors, including those of indigenous and local peoples, for strengthening the sharing of information among different knowledge systems		✓	

13.2.3 Access to technical and financial resources

IPBES is mandated to provide a means for catalyzing further funding for capacity-building. However this is only part of the story: technical resources are as necessary as financial resources to address priority capacity needs. As a result, IPBES has decided to establish a "matchmaking facility".

The **IPBES Matchmaking Facility** is being developed to provide a "bridge" between those who have technical and/or financial capacity-building needs, and those able to help meet those needs. It will comprise two components:

- a web-based tool bringing together those looking for support and those seeking to offer support for development and implementation of capacity-building activities in a common, searchable interface; and
- a set of enabling activities including regional dialogues, a Capacity-building Forum, and other face-to-face networking and support activities.

Together, the two components of the prototype Matchmaking Facility will provide a significant opportunity for institutions, organisations and individuals that are either searching for technical or financial support for capacity-building projects, or are seeking to participate in such projects through contribution of technical or financial resources.

The prototype will be developed prudently and incrementally, creating a solid foundation for successful matchmaking that builds on experience. The first steps in the IPBES matchmaking process will entail consideration of the types of projects and activities that might be supported, the potential donors and partners that might be involved, and the trialling of face-to-face contacts and networking activities, supported by processes management and an online tool. The intention is to learn from the operation of the prototype and then systematically and over time build up a matchmaking facility in a modular fashion.

IPBES is also mandated to help catalyze financing for capacity-building activities by providing a forum with conventional and potential sources of funding. In order to build engagement and promote partnerships amongst those in a position to support capacity development and those requiring it, the **IPBES Capacity-building Forum** is being convened to facilitate:

- identified support for specific priority capacity-building activities
- increased alignment of relevant capacity-building activities
- strengthened relationships among relevant organizations, further building cooperation

The Capacity-building Forum is a potentially important venue for a global dialogue between IPBES and relevant public and private institutions on how their missions in capacity-building could be aligned. The aim is for IPBES to be a catalyst in creating opportunities for capacity-building in the science-policy interface for biodiversity and ecosystem service. The first meeting of the Forum took place in 2015, and discussed a range of options for addressing both matchmaking and alignment of capacity-building interests and activities.

13.2.4 Integrating capacity-building into assessments

Assessments provide opportunities to build capacities as part of the assessment process through participation in the process itself, and through the sharing and gaining of experience. This involves the authors themselves learning by doing, as well as involving fellows learning from working alongside more experienced authors. Additionally there is potential for both Technical Support Unit for the assessment and the Secretariat both to help build capacity, and to learn from supporting the process.

In order to enhance the ability of individuals and institutions to participate in delivering the agreed work programme, IPBES has established a programme with the following components, and such approaches could also be included in national assessments:

- fellowships to promote engagement of young professionals in the assessments
- secondments and exchanges to build the experience of those involved
- mentoring schemes to support the development of individual capacity
- training, including on processes and methodologies

Within IPBES, this programme will receive support from the IPBES Trust Fund, but further investment of funds will be sought so that the programme can grow over time. Additional funding and technical support for specific activities will also be sought through the Matchmaking Facility. It will aim to:

- build and strengthen individual and institutional capacities in support of the work programme deliverables and the overall functions of IPBES.

- contribute to enhanced science-policy dialogue and knowledge of assessment processes, and the more effective use of knowledge in decision making
- increased cooperation between centres of expertise/institutions

Particular focus during 2014-2018 would be on regional assessments and on all thematic and methodological deliverables of IPBES, included on the data management and policy support tools.

It is well understood that there are many institutions and networks that could play very valuable roles in supporting the scoping and implementation of assessments, and in facilitating and promoting the use of assessment outcomes. These range from universities to "boundary" organizations already working at the science-policy interface, and from observation and data management programmes to private sector associations. Facilitating the engagement of relevant institutions and networks, building capacity, where necessary and promoting collaboration and sharing of experience will be very important.

13.3 Roadmap with recommended practical steps to be followed for different IPBES related assessments

Step 1. Integrate capacity-building into the pre-scoping phase

a) Identify the focus of the assessment in question through a pre-scoping process which may include a dialogue among stakeholders (scientists, government officials, policymakers and other stakeholders).

i) For assessments within the IPBES work programme, the pre-scoping will be taken under the auspices of the MEP and Bureau in line with the process set out in Section 2, Chapter 3.

ii) For assessments outside the IPBES work programme (such as assessments at national and subregional levels), practitioners are encouraged to consider the need for support for the pre-scoping process. An expression of interest for the need of such support could be submitted to the IPBES Matchmaking Facility in accordance with its procedures set out above. Support could entail financial and/or technical resources needed for the preparation, facilitation and undertaking dialogues within the pre-scoping process.

b) Identify the expertise and functions needed for scoping the assessment and institutions for managing the scoping process.

c) Assess the availability of expertise and institutions and the need for capacity to fill any gaps identified.

i) For assessments within the IPBES work programme, the MEP and Bureau will identify the needs and request the Task Force on Capacity-building through the IPBES technical support unit for capacity-building to address those needs.

ii) For assessments outside the IPBES work programme (such as assessments at national and subregional level), practitioners are encouraged to consider the need for support to building capacities for the scoping process. An expression of interest for the need of such support could be submitted to the IPBES Matchmaking Facility in accordance with its procedures set out above. Support could entail financial and/or technical resources.

Step 2. Integrate capacity-building into the scoping phase

a) Scope the assessment through a scoping process which includes a dialogue among stakeholders (scientists, government officials, policymakers and other stakeholders).

i) For assessments within the IPBES work programme, the scoping will be taken under the auspices of the MEP and Bureau in line with the process set out in Section 2, Chapter 3.

ii) For assessments outside the IPBES work programme (such as assessments at national and subregional level), practitioners may want to consider the need for support to the scoping process. An expression of interest for the need of such support could be submitted to the IPBES Matchmaking Facility in accordance with its procedures set out above. Support could entail financial and/or technical support for the preparation, facilitation and undertaking dialogues within the scoping process.

b) Identify the expertise and functions needed for undertaking the assessment and institutions for managing the assessment process.

c) Assess the availability of expertise and institutions and the need for capacity to fill any gaps identified.

Step 3. Solicit support for capacity-building needs in assessment

a) Solicit support for addressing capacity-building in order to fill gaps identified in the scoping process.

i) For assessments within the IPBES work programme, the MEP and Bureau will identify the needs and request the Task Force on Capacity-building through the IPBES technical support unit for capacity-building to address those needs.

ii) For assessments outside the IPBES work programme (such as assessments at national and subregional level), scientists, government officials, policymakers and other stakeholders initiating the assessment are encouraged to consider the need for support to building capacities for the assessment process. An expression of interest for the need of such support could be submitted to the IPBES Matchmaking Facility in accordance with its procedures set out above. Support could entail developing a proposal for financial and/or technical support to undertaking the assessment in accordance with the scope of the assessment.

Step 4. Integrate capacity-building into the assessment process

a) Identify **opportunities** for integrating capacity-building into the assessment process by promoting learning by doing, the sharing of experience amongst those involved, developing mentoring opportunities and the involvement of early career scientists, knowledge holders and policymakers through fellowships. This would apply to both assessments within and outside the IPBES work programme.

b) Identify **needs** for capacity-building in support of the undertaking of the assessment by Co-chairs, Coordinating Lead Authors, Authors, Reviewers and Peer Review Editors as supported by technical support units through technical assistance and the IPBES Fellowship, exchange and training programme.

i) For assessments within the IPBES work programme, the assessment Co-chairs and the assessment TSU will in consultation with experts and stakeholders involved in the assessment identify the needs and submit them to the Task Force on Capacity-building through the IPBES technical support unit for capacity-building in order to seek help in addressing those needs.

ii) For assessments outside the IPBES work programme (such as assessments at national and subregional level), the assessment Co-chairs and the assessment TSU are encouraged to identify the need for support to building capacities for the assessment process in consultation with experts and stakeholders involved in the assessment. An expression of interest for the need of such support could be submitted to the IPBES Matchmaking Facility in accordance with its procedures set out above. Support could entail financial and/or technical resources.

Step 5. Identify capacity-building needs through the assessment process

a) Use the assessment to identify capacity-building needs in the science policy interface relevant to IPBES at all levels. This would apply to both assessments within and outside the IPBES work programme. In assessing capacity-building needs authors may want to identify the urgency, importance and quantity of capacity-building needs related to aspects of the assessment process, and any geographical imbalances.

b) Use the assessment to identify and assess options for how such needs best could be addressed.

Step 6. Use the assessment findings to sustain capacity in the science policy interface

a) Explore ways of capitalising on the capacities built throughout the assessment in processes such as research, monitoring, and the development of policies and policy support tools. This would apply to both assessments within and outside the IPBES work programme, and would include activities such as identifying how to share experience gained and lessons learnt in further building individual and institutional capacities.

b) Enter into a dialogue with scientists, government officials, policymakers and other stakeholders involved in capacity development in order to communicate the assessment findings on capacity-building needs and the identified options for addressing those needs.

i) For assessments within the IPBES work programme, the Bureau, MEP and Task Force on Capacity-building as supported by the TSU will use the findings as relevant in implementing the capacity-building aspects of the IPBES work programme.

ii) For assessments outside the IPBES work programme (such as assessments at national and subregional level), the assessment Co-chairs and the assessment TSU are encouraged to convey their findings to the IPBES secretariat.

13.4 References

UNEP. (2012). Report of the second session of the plenary meeting to determine the modalities and institutional arrangements for IPBES, UNEP/IPBES.MI/2/9, http://ipbes.net/images/Functions operating principles and institutional arrangements of IPBES_2012.pdf

UNEP. (2013). Report of the second session of the Plenary of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, UNEP/IPBES/2/17, decision IPBES-2/5 Annex 1, http://ipbes.net/images/decisions/Decision%20IPBES_2_5.pdf

Glossary

Acceptance of the Platform's global, regional, subregional, eco-regional, thematic and methodological reports 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.

Adoption of the Platform's reports 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.

Approval of the Platform's summaries for policymakers signifies that the material has been subject to detailed, line-by-line discussion and agreement by consensus at a session of the Plenary.

Acceptance, adoption and preliminary approval of regional reports will be undertaken by the regional representatives at a session of the Plenary, and such reports will be "further reviewed and agreed" by the Plenary as a whole

Anthropogenic assets: Built-up infrastructure, health facilities, 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 among others.

Assessment reports are published assessments of scientific, technical and socio-economic issues that take into account different approaches, visions and knowledge systems, including global assessments of biodiversity and ecosystem services, regional, subregional and eco-regional 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 may be composed of two or more sections including: (a) summary for policymakers; (b) optional technical summary; (c) individual chapters and their executive summaries.

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).

Biocultural diversity: The total sum of the world's differences, irrespective of their origin. The concept encompasses biological diversity at all its levels and cultural diversity in all its manifestations. It is derived from the myriad ways in which humans have interacted with their natural surroundings. [UNESCO 2010]

Biodiversity: The variability among living organisms from all sources including terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part; this includes diversity within species, between species and of ecosystems. [UNESCO 2010]

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.

Bureau: means a subsidiary body established by the Plenary which carries out the administrative functions agreed upon by the Plenary, as articulated in the document on functions, operating principles and institutional arrangements of the Platform.

Cosmocentric: a vision of reality that places the highest importance or emphasis in the universe or nature, as opposite to and anthropocentric vision, which strongly focuses on humankind as the most important element of existence.

Drivers (of change): All the external factors that cause change in nature, anthropogenic assets, nature's benefits to people and a good quality of life. They include institutions and governance systems and other indirect drivers and direct drivers (both natural and anthropogenic).

Drivers, anthropogenic direct: Elements of direct drivers that are the result of human decisions, namely, of institutions and governance systems and other indirect drivers.

Drivers, direct: Drivers (both natural and anthropogenic) that operate directly on nature (sometimes also called pressures).

Drivers, indirect: Drivers that operate by altering the level or rate of change of one or more direct drivers. [Millennium Ecosystem Assessment 2005]

Drivers, institutions and governance and other indirect: The ways in which societies organize themselves. They are the underlying causes of environmental change that are external (exogenous) o the ecosystem in question [Millennium Ecosystem Assessment 2005].

Drivers, natural direct: Direct drivers that are not the result of human activities and are beyond human control.

Ecosystem functioning: The flow of energy and materials through the arrangement of 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. The concept is used here in the broad sense and it can thus be taken as being synonymous with ecosystem properties or ecosystem structure and function.

Ecosystem services: The benefits (and occasionally disbenefits or losses) that people obtain from ecosystems. These include provisioning services such as food and water; regulating services such as flood and disease control; and cultural services such as recreation, ethical and spiritual, educational and sense of place. In the original definition of the Millennium Ecosystem Assessment the concept of "ecosystem goods and services" is synonymous with ecosystem services. Other approaches distinguish "final ecosystem services" that directly deliver welfare gains and/or losses to people through goods from this general term that includes the whole pathway from ecological processes through to final ecosystem services, goods and anthropocentric values to people.

Ecosystems goods: According to the Millennium Ecosystem Assessment, they are included in the general definition of ecosystem services. According to other approaches, they are objects from ecosystems that people value through experience, use or consumption. The use of this term in the context of this document goes well beyond a narrow definition of goods simply as physical items that are bought and sold in markets, and includes objects that have no market price.

Good quality of life: The achievement of a fulfilled human life, the criteria for which may vary greatly across different societies and groups within societies. It is a context-dependent state of individuals and human groups, comprising aspects such 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 other Earth" and "human well-being" are examples of different perspectives on good quality of life

Human well-being: See well-being.

Indigenous and local knowledge system (ILK): A cumulative body of knowledge, practice and belief, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment. It is also referred to by other terms such as e.g. Indigenous, local or traditional knowledge, traditional ecological/environmental knowledge (TEK), farmers' or fishers' knowledge, ethnoscience, indigenous science, folk science.

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.

Knowledge system: A body of propositions that are adhered to, whether formally or informally, and are routinely used to claim truth.

Level of resolution: Degree of detail or contemplated 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.

Living in harmony with nature: 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.

Living-well in balance and harmony with Mother Earth: A concept originating in the visions of indigenous peoples worldwide which refers to the broad understanding of the relationships among people and between people and Mother Earth. The concept of living-well refers to: (a) balance and harmony of individuals considering both the material and spiritual dimensions; (b) balance and harmony among individuals taking into account the relationship of individuals with a community; and (c) balance and harmony between human beings and Mother Earth. Living-well means living in balance and harmony with everybody and everything, with the most important aspect being life itself rather than the individual human being. Living-well refers to living in community, in brotherhood, in complementarity; it means a self-sustaining, communitarian and harmonic life.

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.

Multidisciplinary Expert Panel: means a subsidiary body established by the Plenary which carries out the scientific and technical functions agreed upon by the Plenary, as articulated in the document on functions, operating principles and institutional arrangements of the Platform.

Nature: The natural world, with particular emphasis on biodiversity.

Nature's benefits to people: All the benefits (and occasionally disbenefits or losses) that humanity obtains from Nature.

Plenary: means the Platform's decision-making body comprising all the members of the Platform.

Policy tools: Instruments used by governance bodies at all scales to implement their policies. Environmental policies, for example, could be implemented through tools such as legislation, economic incentives or dis-incentives, including taxes and tax exemptions, or tradeable permits and fees.

Policy support tools and methodologies: approaches and techniques based on science and other knowledge systems that can inform and assist policy making and implementation at local, national, regional and international levels to protect and promote nature, nature's benefits to people, and a good quality of life.

Policy instruments: structured activities by means of which decision-making authorities attempt to realize or achieve a decision to ensure support and effect or prevent social change in order to address an identified challenge. (Vedung, 2011).

Reports means the main deliverables of the Platform, including assessment reports, synthesis reports and their summaries for policymakers and technical summaries, technical papers and technical guidelines.

Scenarios: Plausible alternative future situations based on a particular set of assumptions. Scenarios are associated with lower certainty than projections, forecasts or predictions. For example, socio-economic scenarios are frequently based on storylines describing several alternative, plausible trajectories of population growth, economic growth and per capita consumption, among other things. These are commonly coupled with projections of impacts on biodiversity and ecosystem services based on more quantitative models. The term "scenarios" is sometimes used to describe the outcomes of socio-economic scenarios coupled with models of impacts, owing to the high uncertainty associated with the socio-economic trajectories.

Scoping is the process by which the Platform will define the scope and objective of a deliverable and the information, human and financial requirements to achieve that objective.

Session of the Plenary means any ordinary or extraordinary session of the Platform's Plenary.

Session of the Bureau means a series of meetings of the elected members of the Bureau of the Plenary and the Multidisciplinary Expert Panel co-chair(s).

Session of the Panel means a series of meetings of the elected members of the Platform's Multidisciplinary Expert Panel and agreed observers (the Bureau of the Plenary and chairs of the subsidiary scientific bodies of multilateral environmental agreements, and the Chair of the Intergovernmental Panel on Climate Change).

Social-ecological system: A bio-geo-physical unit and its associated social actors and institutions. Social-ecological systems are complex and adaptive and are delimited by spatial or functional boundaries surrounding particular ecosystems and their specific context.

Synthesis reports synthesize and integrate materials contained within the assessment reports, are written in a non-technical style suitable for policymakers and address a broad range of policy-relevant questions. They are composed of two sections: (a) summary for policymakers; (b) full report.

Summary for policymakers is a component of any report, providing a policy-relevant but not policy prescriptive summary of that report.

Supporting material consists of four categories:

(a) Intercultural and interscientific dialogue reports that are based on the material generated at the eco-regional level by discussions between members of academic, indigenous and social organizations and that take into account the different approaches, visions and knowledge systems that exist as well as the various views and approaches to sustainable development;

(b) Workshop proceedings and materials that are either commissioned or supported by the Platform;

(c) Software or databases that facilitate the use of the Platform's reports;

(d) Guidance materials (guidance notes and guidance documents) that assist in the preparation of comprehensive and scientifically sound Platform reports and technical papers.

Systems of life: The complex, integrated interactions of living beings (including humans), such as the cultural attributes of communities, socio-economic conditions and biophysical variables.

Technical papers are based on the material contained in the assessment reports and are prepared on topics deemed important by the Plenary.

Technical summary is a longer and more technical summary of the material contained in the summary for policymakers.

Trend: The general direction in which the structure or dynamics of a system tends to change, even if individual observations vary.

Validation of the Platform's reports is a process by which the Multidisciplinary Expert Panel and the Bureau provide their endorsement that the processes for the preparation of Platform reports have been duly followed.

Values: Those actions, processes, entities or objects that are worthy or important (sometimes values may also refer to moral principles).

Values, bequest: The satisfaction of preserving the option of future generations to enjoy nature's benefits.

Values, existence: The satisfaction obtained from knowing that nature endures.

Values, instrumental: The direct and indirect contributions of nature's benefits to the achievement of a good quality of life. These values are conceived in terms of preference satisfaction.

Values, intrinsic: The values inherent to nature, independent of human experience and evaluation, and therefore beyond the scope of anthropocentric valuation approaches.

Values, option: The potential ability to use some nature's benefits in the future, although they are not currently used or the likelihood for their future use is low. It represents the willingness to preserve an option for the future enjoyment of nature's benefits.

Values, relational: The values that contribute to desirable relationships, such as those among people and between people and nature, as in "Living in harmony with nature".

Value 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 and thus families, stakeholder groups and ethnic groups may be characterized by specific value systems.

Well-being: A perspective on a good life that comprises access to basic materials for a good life, freedom and choice, health and physical well-being, good social relations, security, peace of mind and spiritual experience.