IPBES-4/1: Work programme of the Platform

The Plenary,

Welcoming the report of the Executive Secretary on the implementation of the work programme for 2014–2018,[1] which includes lessons and challenges during the second year of implementation,

Acknowledging the outstanding contributions made by all experts to date in the implementation of the work programme and thanking them for their unwavering commitment,

Decides to proceed with the implementation of the work programme in accordance with the decisions set out below and the approved budget set out in decision IPBES-4/2;

I

Capacity-building

1. *Requests* the task force on capacity-building to continue the piloting of the draft programme on fellowship, exchange and training,[2] to report on its progress and to make recommendations for its further development to the Plenary at its fifth session;

2. *Also requests* the task force on capacity-building to continue the piloting of the prototype matchmaking facility,[3] including the online elements hosted by the web-portal Biodiversity and Ecosystem Services Network, in collaboration with strategic partners representing both implementers and conventional and potential sources of funding, and to report on its progress and make recommendations for the further development and implementation of the facility to the Plenary at its fifth session;

3. *Further requests* the task force to further prioritize the list of capacity-building needs[4] with regard to those needs most important and pressing, with a view to the implementation of the first work programme of the Platform;

4. *Takes note* of the lessons learned from the first capacity-building forum of the Platform and requests the Bureau, with the support of the secretariat and the task force on capacity-building and its technical support unit, to convene a second forum during the second half of 2016 with representatives of the implementers and conventional and potential sources of funding, and requests that a report on the outcome of the forum be presented to the Plenary at its fifth session;

II

Knowledge foundations

1. *Takes note* of the progress made in piloting indigenous and local knowledge dialogue workshops and requests the continued piloting of such workshops in the preparation of assessments, with a view to considering the methodology that has been employed thus far in the organization of the workshops for submission to the Plenary at its fifth session;

2. *Takes note* of the progress to date on the development of a roster of indigenous and local knowledge holders and indigenous and local knowledge experts[5] and urges the Multidisciplinary Expert Panel, in conjunction with the indigenous and local knowledge task force, to further develop that roster*;*

3. *Takes note* of the approach to the participatory mechanism for working with indigenous, local and various knowledge systems[6] and requests the Multidisciplinary Expert Panel, with the support of the task force on indigenous and local knowledge systems, to pilot the mechanism, report on progress made in pilot activities and make recommendations for the further development and implementation of the mechanism to the Plenary at its fifth session;

[1] IPBES/4/2.

[2] Decision IPBES-3/4, annex II.

[3] IPBES/4/6, section IV B.

[4] Decision IPBES-3/1, annex I.

[5] IPBES/4/7, section III.

[6] IPBES/4/7, section IV.

4. *Requests* the Multidisciplinary Expert Panel to report to the Plenary at its fifth session on progress made and options for bringing indigenous and local knowledge into Platform products, including, inter alia, processes for addressing prior informed consent, taking into account existing international, regional and national legal and non-legal frameworks, as appropriate;

5. *Requests* the task force and the Multidisciplinary Expert Panel to continue, through an iterative process, to further develop, for consideration by the Plenary at its fifth session, the approaches to incorporating indigenous and local knowledge into the Platform[7];

III

Global, regional and subregional assessments

1. *Welcomes* the review and updating of the guide on the production and integration of assessments from and across all scales[8] and the plan to make the guide available as an e-book on the Platform's website and update it on a regular basis;

2. *Also welcomes* the progress made in the implementation of the regional and subregional assessments on biodiversity and ecosystem services;[9]

3. *Approves* the undertaking of a global assessment of biodiversity and ecosystem services in accordance with the procedures for the preparation of the Platform's deliverables[10] and as outlined in the scoping report for a global assessment of biodiversity and ecosystem services set out in annex I to the present decision, for consideration by the Plenary at its seventh session;

IV

Thematic assessments

1. *Approves* the summary for policymakers of the report of the assessment of pollinators, pollination and food production set out in annex II to the present decision and accepts the individual chapters of the assessment report and their executive summaries;[11]

2. *Welcomes* the progress made in the assessment of land degradation and restoration;[12]

3. *Approves* the scoping report for a thematic assessment of invasive alien species and their control set out in annex III to the present decision and decides to consider at its fifth session the undertaking of the assessment;

4. *Welcomes* the progress made in the scoping of the assessment of sustainable use of biodiversity;

5. *Requests* the Multidisciplinary Expert Panel in consultation with the Bureau to undertake a further scoping of the thematic assessment of the sustainable use of biodiversity initiated pursuant to decision IPBES-3/1, in accordance with the procedures for the preparation of the platform's deliverables,[13] including by:

(a) Organizing a face-to-face scoping workshop of experts, involving relevant stakeholders, to produce a revised draft scoping report for the assessment that gives consideration to the revision of the title of the assessment;

(b) Organizing an open review of the revised draft scoping report by Governments and stakeholders, taking into account section 3.1, paragraph (g), of the procedures for the preparation of the platform's deliverables;

[7] IPBES/4/7, annex, sect. A.

[8] IPBES/4/INF/9.

[9] IPBES/4/INF/10.

[10] Decision IPBES-2/3, annex.

[11] IPBES/4/INF/1/Rev.1, which includes the individual chapters and their executive summaries, reflecting the summary for policymakers as approved.

[12] IPBES/4/INF/11.

[13] Decision IPBES-2/3, annex.

(c) Preparing a revised scoping report for the assessment for consideration by the Plenary at its fifth session;

V

Methodological assessments

1. *Approves* the summary for policymakers of the report of the methodological assessment of scenarios and models of biodiversity and ecosystem services set out in annex IV to the present decision and accepts the individual chapters of the report and their executive summaries;[14]

2. *Requests* the Multidisciplinary Expert Panel to oversee further work related to scenarios and models according to the terms of reference set out in annex V to the present decision and to appoint an expert group to perform that work in accordance with the approved rules of procedure and the terms of reference, and requests the Executive Secretary to make the necessary institutional arrangements as outlined in the terms of reference;

3. *Welcomes* the preliminary guide on the conceptualization of values of biodiversity and nature's benefits to people;[15]

4. *Approves* the scoping report on the methodological assessment regarding diverse conceptualization of multiple values of nature and its benefits, including biodiversity and ecosystem functions and services, set out in annex VI to the present decision and decides to consider at its fifth session the undertaking of the assessment;

5. *Requests* the Multidisciplinary Expert Panel to nominate two experts per Platform assessment to ensure, in collaboration with the Multidisciplinary Expert Panel, that values and valuation are incorporated appropriately into all Platform assessments;

VI

Catalogue of policy tools and methodologies

1. *Takes note* of the guidance for further work on policy support tools and methodologies,[16] encourages stronger integration of work regarding policy support tools and methodologies across all relevant deliverables of the work programme and invites the submission of relevant policy support tools and methodologies by experts, Governments and stakeholders for inclusion in the catalogue of policy support tools and methodologies;

2. *Requests* the Multidisciplinary Expert Panel, supported by the expert group on policy support tools and methodologies:

(a) To continue the development of the online catalogue of policy support tools and methodologies[17] and to make available to Governments and stakeholders a prototype of the online catalogue for testing and review prior to the fifth session of the Plenary;

(b) To identify the various needs of users for, and facilitate the development of, policy support tools for all relevant deliverables of the work programme, as appropriate;

(c) To undertake an evaluation of the use and effectiveness of the online catalogue;

3. *Also requests* the Multidisciplinary Expert Panel to oversee the content of the online catalogue and, in consultation with the Bureau, to further develop the governance of the catalogue, including by developing criteria and an open and transparent process for the inclusion of policy support tools and methodologies provided by experts, Governments and stakeholders;

4. *Further requests* the Multidisciplinary Expert Panel to provide a report on progress made in the development of the online catalogue to the Plenary at its fifth session for further guidance;

[14] IPBES/4/INF/3/Rev.1, which includes the individual chapters of the assessment report and their executive summaries, reflecting the summary for policymakers as approved.

[15] IPBES/4/INF/13.

[16] IPBES/4/12, section II.

[17] IPBES/4/INF/14.

5. *Approves*, until further consideration by the Plenary at its fifth session, the extension of the mandate of the expert group on policy support tools and methodologies to continue its work in developing the online catalogue of policy support tools and methodologies, which, at the discretion of the Chairs, following consultations with the Bureau, could be further supported by a limited number of resource persons and representatives of strategic partners as resources permit;

6. *Notes* that the activities herein with resource implications are to be undertaken subject to the availability of resources;

VII

Independent review

Recalling decision IPBES-2/5, in which the Plenary requested the Multidisciplinary Expert Panel in consultation with the Bureau to develop a procedure for the review of the effectiveness of the administrative and scientific functions of the Platform,

1. *Welcomes* the proposal for the procedure of the review of the effectiveness of the administrative and scientific functions of the Platform[18];

2. *Invites* Governments and stakeholders to provide further views on the draft terms of reference for the end-of-work-programme review set out in annex VII to the present decision, taking into account the need to integrate the internal and external elements of the review;

3. *Requests* the Multidisciplinary Expert Panel, in consultation with the Bureau, to further refine the scope and terms of reference of the end-of-work-programme review, in the light of the aforementioned inputs, for consideration by the Plenary at its fifth session;

VIII

Technical support for the work programme

1. *Welcomes* the offers of in-kind contributions to support the implementation of the work programme that have been received as at 27 February 2016, as listed in table 2 of the annex to decision IPBES-4/2, and invites the submission by 31 March 2016 of additional offers of in-kind contributions to support the implementation of the work programme;

2. *Requests* the secretariat, in consultation with the Bureau and in accordance with the approved budget set out in the annex to decision IPBES-4/2, to establish the institutional arrangements necessary to operationalize the technical support required for the work programme.

Annex I to decision IPBES-4/1

Scoping report for a global assessment on biodiversity and ecosystem services

I. Scope, geographic coverage, rationale, utility and methodological approach

A. Scope

1. The global assessment will critically assess the state of knowledge on past, present and possible future trends in multi-scale interactions between people and nature, taking into consideration different world views and knowledge systems. The assessment will examine status, trends (past and future), direct and indirect drivers of change, values[19] and response options regarding nature (including

[18] IPBES/4/16.

[19] Values will be assessed following guidance laid out in the preliminary guide regarding diverse conceptualization of multiple values of nature and its benefits, including biodiversity and ecosystem services (deliverable 3 (d)) (IPBES/4/INF/13).

biodiversity and the structure and functioning of ecosystems on land and in inland waters, coastal zones and global oceans), nature's benefits to people (including ecosystem goods and services) and the interlinkages between the elements in the conceptual framework.[20] The assessment will also highlight thresholds, feedbacks and resilience in such linkages, as well as opportunities, synergies and trade-offs between different response options. The assessment will furthermore analyse the contributions of biodiversity, ecosystems and their benefits to a long-term good quality of life in the context of sustainable development as expressed in the Sustainable Development Goals. The assessment will consider the synergies and trade-offs associated with meeting multiple goals and the interactions among the social (including cultural), economic and environmental dimensions of sustainable development. This analysis will be undertaken in the context of the Strategic Plan for Biodiversity 2011–2020 and its 2050 Vision and Aichi Biodiversity Targets, as well as national biodiversity strategies and action plans.[21] The assessment is intended to strengthen the science-policy interface on biodiversity, ecosystem functioning and ecosystem goods and services at a range of spatial scales from local to global by providing the knowledge and policy support tools needed for informed decision-making by Governments, the private sector and civil society**.**

2. The time frame of analyses will cover the current status, trends up to 2020 (going back as far as 50 years)[22] and plausible future projections,[23] with a focus on various periods between 2020 and 2050[24] that cover key target dates related to the Strategic Plan for Biodiversity 2011–2020 and the Sustainable Development Goals. The conceptual framework of the Platform will guide these analyses of the social and ecological systems that operate at various time and space scales. The assessment will draw on and synthesize information from the four regional/subregional assessments of the Platform, as well as other previous and ongoing relevant assessments, and address issues of a global nature not covered in the regional and cross-regional assessments and global indirect drivers, such as economic, demographic, governance, technological and cultural ones, among others. Special attention will be given, among indirect drivers, to the role of institutions (both formal and informal) and impacts of the patterns of production, supply and consumption on nature, nature's benefits to people and good quality of life. The assessment will also cover direct drivers such as climate change, pollution, land use change, invasive alien species and zoonoses, including their effects across regions. The assessment will also examine other relevant issues such as biological and cultural diversity and the links between them, globally important biodiversity hotspots and migratory species. The assessment will demonstrate how the integration of nature and ecosystems into development can advance human quality of life.

3. The global assessment will address the following questions:

(a) What is the status of and trends in nature, nature's benefits to people and indirect and direct drivers of change?

(b) How do nature and its benefits to people contribute to the implementation of the Sustainable Development Goals? What is the evidence base that can be used for assessing progress towards the achievement of the Aichi Biodiversity Targets?

(c) What are the plausible futures for nature, nature's benefits to people and their contribution to a good quality of life between now and 2050?

(d) What pathways and policy intervention scenarios relating to nature, nature's benefit to people and their contributions to good quality of life can lead to sustainable futures?

(e) What are the opportunities and challenges, as well as options available to decision makers, at all levels relating to nature, nature's benefit to people and their contributions to good quality of life?

[20] The terms "nature", "nature's benefits to people" and "good quality of life" correspond to the inclusive categories defined in the conceptual framework of the Platform (decision IPBES-2/4) and its glossary (see Diaz et al. (2015), The Platform's conceptual framework – connecting nature with people, Current Opinion in Environmental Sustainability, 14:1–16).

[21] As expressed in deliverable 2 (b) of the work programme of the Platform (decision IPBES-2/5, annex I).

[22] Long-term historical data as well as the longer-term paleoecological record will be used to estimate species extinction rates.

[23] A range of techniques will be used as discussed in the methodological assessment of scenarios and models of biodiversity and ecosystem services (see Annex IV to decision IPBES-4/1 and document IPBES/4/INF/3/Rev.1).

[24] Some projections may go to 2100 to assess the implications of projected changes in climate.

B. Geographic coverage of the assessment

4. For the purposes of the global assessment, the geographic area includes land, inland waters, coastal zones and oceans.

C. Rationale

5. The rationale for this assessment is to undertake for the first time a comprehensive global intergovernmental assessment of nature, nature's benefits to people, their contribution to a good quality of life and the way in which they are affected by indirect and direct drivers, incorporating multiple world views, different knowledge systems and diverse values.

6. Nature and its benefits to people provide the basis for economies, livelihoods, spirituality and a good quality of life, including by contributing to security of people around the world. The assessment will address issues across regions and of a global nature, such as global drivers and processes and consequences for people that cannot be addressed in the regional assessments.

7. The assessment will contribute to the development of a strengthened knowledge base and interplay between policymakers,[25] scientists and holders of different knowledge (such as indigenous and local knowledge) [26] from different knowledge and value systems.

8. The assessment will contribute to the implementation of the Platform's functions as they relate to capacity-building (the assessment is an important vehicle for capacity-building and will identify future capacity-building needs), identification of knowledge gaps, knowledge generation and enhanced use of policy support tools. Furthermore, the assessment is critical to furthering the Platform's operational principle of ensuring the full use of national, subregional and regional knowledge and tools, as appropriate, including a bottom-up approach, in providing knowledge for informed decision-making.

D. Utility

9. The global assessment will provide users (e.g., Governments, multilateral organizations, the private sector and civil society, including indigenous peoples and local communities and non-governmental organizations) with a relevant, credible, legitimate, authoritative, evidence-based, holistic and comprehensive analysis based on the current state of scientific and other knowledge systems (including indigenous and local knowledge). For example, the assessment will analyse, model and synthesize the potential effectiveness of response options as they relate to the Sustainable Development Goals and the sustainable management of nature and nature's benefits to people under plausible global scenarios and present best practices and lessons learned. It will also catalyse critical knowledge generation and identify current gaps in capacity, knowledge and policy and options for addressing them at the relevant levels.

10. The assessment will provide information relevant to a range of stakeholders in the public and private sectors and civil society. The findings and key messages will be presented to a broad audience as outlined in the Platform's communications strategy. The outputs will also include a summary for policymakers, highlighting key policy-relevant, but not policy-prescriptive, findings. The information will be widely disseminated, including (but not exclusively) by making use of new information and communications technologies. The findings and key messages of the assessment will provide Governments and intergovernmental fora, e.g., the Convention on Biological Diversity and United Nations General Assembly oceans-related processes, with a knowledge base (highlighting key policies) to inform national, regional and global policies on the conservation and sustainable use of biodiversity and ecosystems and their benefits to people. The assessment will also provide knowledge for a wide range of other decision makers as set out in the description of chapter 6 in the chapter outline below.

11. The assessment will be well placed in time to contribute to the fifth edition of the Global Biodiversity Outlook of the Convention on Biological Diversity to be undertaken by the Convention on Biological Diversity. The fifth edition will report in 2020 on the implementation of the Strategic Plan for Biodiversity 2011–2020 and assess the achievement of the Aichi Biodiversity Targets. It will be based on the sixth national reports of parties to the Convention on Biological Diversity, on the one hand, and on the outcome of the assessment and other relevant work of the Platform (UNEP/CBD/SBSTTA/19/9), on the other. It is expected that the Subsidiary Body on Scientific,

[25] Governments will be involved in the peer review process in accordance with the rules for the preparation of assessments.

[26] Procedures have been developed to ensure that indigenous and local knowledge will be incorporated into all the Platform's assessments. See annex II to decision IPBES-4/3.

Technical and Technological Advice at a meeting in the fourth quarter of 2019 will consider this assessment and its implications for the future work of the Convention on Biological Diversity and that the fifth edition of the Global Biodiversity Outlook will be launched at a meeting in the second quarter of 2020.

12. The completion of the assessment will be timed to provide information relevant to the assessment of progress towards the achievement of the Aichi Biodiversity Targets and the review of implementation of the Strategic Plan for Biodiversity 2011–2020 foreseen at the fifteenth meeting of the Conference of the Parties to the Convention on Biological Diversity in 2020 (recommendation XIX/5 of the Subsidiary Body on Scientific, Technical and Technological Advice). The scope of the assessment is designed to be complementary to and provide an input for the fifth edition of the Global Biodiversity Outlook. In this regard the assessment will be additional and complementary to the sixth national reports of parties to the Convention (UNEP/CBD/SBSTTA/19/9).

13. The assessment, including in particular its scenarios and consideration of response options, is also well placed in time to contribute to the update/follow-up of the Strategic Plan for Biodiversity beyond 2020, which will be considered by the Conference of the Parties to the Convention on Biological Diversity at its fifteenth meeting (decision XII/31 of the Conference of the Parties to the Convention on Biological Diversity), and to other fora.

14. The assessment is particularly well placed in time to contribute to the assessment of the achievement of several biodiversity-related targets of the Sustainable Development Goals and other relevant conventions and agreements, as appropriate and in accordance with the respective mandates of those conventions and agreements.

E. Methodological approach

15. The global assessment will be based on existing data (including, as appropriate, national data), published scientific and grey literature and other information, including indigenous and local knowledge, according to the guidelines of the Platform. The expression "analysis and synthesis" is used frequently in the assessment. In the context of the assessment and in accordance with the principles of the Platform, analysis refers to a critical evaluation of the evidence base; it does not refer to new research. Synthesis refers to the combining of evidence from multiple sources, and is a key step in carrying out analyses in the context of assessments.

16. The assessment will draw on the Platform's regional/subregional, thematic and methodological assessments and guidelines, as well as other relevant global assessments such as the Global Biodiversity Outlook series, assessments by the Food and Agriculture Organization of the United Nations, the Global Environmental Outlook series, the reports of the Intergovernmental Panel on Climate Change, the Millennium Ecosystem Assessment, the first World Ocean Assessment (WOA I) and other assessments prepared under the Regular Process for Global Reporting and Assessment of the State of the Marine Environment, including Socio-economic Aspects. The assessment will also use existing data and information held by global, regional, subregional and national institutions such as relevant multilateral environmental agreements. The assessment will rely on existing scenarios and models and will also make use of scenarios and models that may be catalysed as part of the follow-up to the methodological assessment, among others. In this context, the Platform will work closely with the research communities, including those working on the shared socio-economic pathways (SSP) to be used by the Intergovernmental Panel on Climate Change.

17. The Platform's global assessment will build on WOA I, which was completed in 2015. The component of the assessment focused on the oceans will include elements such as values, indirect drivers, scenarios associated with marine biodiversity and its benefits to people and management of marine resources. The assessment will also directly address how changes in human quality of life are linked to the trends in ocean uses and ocean biodiversity documented in WOA I.

18. Experts involved in the assessment will work closely with the task force on indigenous and local knowledge systems to ensure that the multiple sources of knowledge are drawn upon using indigenous and local knowledge procedures.[27] The group of experts for the assessment will, in accordance with the procedures for the preparation of Platform deliverables, reflect the appropriate geographic, disciplinary, gender and expertise balance (policy, terrestrial and marine natural sciences, social and economic sciences and arts and humanities). The authors will work with expert groups undertaking regional, thematic and methodological assessments in order to ensure conceptual and methodological coherence. The authors will work closely with the task forces on knowledge and data, indigenous and local knowledge systems and capacity-building, taking into account the rights of

[27] Annex II to decision IPBES-4/3.

knowledge holders. The group of experts will be supported by the guide to the production and integration of assessments (see IPBES/4/INF/9) and the preliminary guide regarding the diverse conceptualization of multiple values of nature and its benefits, including ecosystem functions and services (IPBES/4/INF/13).

19. The Multidisciplinary Expert Panel, in overseeing the group of experts, will facilitate liaison with the scientific advisory bodies and secretariats of the relevant global processes at all stages of the preparation of the assessment to ensure that the needs of the end users are effectively addressed.

20. Stakeholders will be engaged throughout the assessment process through a number of mechanisms such as the participation of stakeholders, where appropriate, in the development of new scenarios and models developed in response to the needs of the Platform for the assessment, as well as through consultations between experts and stakeholders at meetings held with the support of the capacity-building deliverable of the Platform or with in-kind support.

II. Chapter outline

21. The assessment report will be a policy-relevant, six-chapter report, as set out below. The overall chapter structure outlined here does not preclude dividing the chapters into smaller components (as long as the high-level titles are maintained in the overall structure) in order to ensure clarity and manageable tasks for authors. Each chapter will include an executive summary. A summary for policymakers will outline the key findings and messages most relevant to policymakers in a non-prescriptive manner.

22. Chapter 1 will set the stage for the assessment by outlining the elements in the relationship between people, nature, nature's benefits to people, a good quality of life and indirect and direct drivers of change and anthropogenic assets and their major interactions, as defined in the Platform's conceptual framework. The assessment will incorporate multiple world views, multiple knowledge systems and diverse values. Chapter 1 will provide a road map and overarching rationale for the sequence of chapters in the assessment. In assessing the contributions of nature and nature's benefits to people to achieving a good quality of life, the chapter will recognize synergies and trade-offs associated with meeting multiple goals and the need for balanced integration between the social (including cultural), economic and environmental dimensions of sustainable development.

23. Chapter 2 will address question (a) in paragraph 3 above. The chapter will assess the global and cross-regional status of, and trends in, nature, nature's benefits to people, their contribution to a good quality of life, indirect and direct drivers of change and the major interactions among these elements as set out in figure I of the conceptual framework. The analysis and synthesis will cover ecosystems on land and in inland waters, coastal zones and global oceans and will include analyses of the roles of formal institutions as well as informal institutions (i.e., socially shared rules and cultural practices). The chapter will draw on multiple evidence bases, including natural and social sciences and indigenous and local knowledge, and will cover:

(a) Analysis and synthesis of the Platform's regional/subregional assessments and other regional scale assessments, focusing on status and trends. Emerging issues and lessons from case studies from the regions will be identified and commonalities and divergences across regional and subregional scales highlighted. Syntheses across regions regarding some key biomes or ecosystem types covered in the regional assessment could also be considered;

(b) Synthesis of prior global assessments, including the Platform's thematic assessments and those mentioned in paragraph 16, as well as new global-scale evidence, focusing on status and trends with an explicit consideration of linkages across regions;

(c) Evaluation highlighting the status and trends of institutional drivers at the global level and across regions such as investment initiatives and multilateral environmental, trade and health agreements, as well as their effects on other components of the conceptual framework;

(d) Identification of information and knowledge gaps, as well as needs for capacity-building.

24. Chapter 3 will address question (b) in paragraph 3 above. The chapter will focus on the evidence available for assessing progress towards meeting major international objectives related to biodiversity and ecosystem functions and services, with special attention given to the Aichi Biodiversity Targets and relevant Sustainable Development Goals, as well as the objectives of other biodiversity-related agreements. The analyses in this chapter will build on those in the previous chapter but will explicitly focus on internationally agreed targets and goals in consultation with relevant institutions (e.g., the Convention on Biological Diversity and the United Nations Statistics

Division). These analyses will use multiple evidence bases, including natural and social sciences and indigenous and local knowledge. This chapter will cover:

(a) Analysis and synthesis of the evidence base that can be used to determine progress towards the achievement of the Aichi Biodiversity Targets and relevant Sustainable Development Goals, recognizing that the final assessment of achievement of the Aichi Targets will be carried out for the fifth edition of the Global Biodiversity Outlook using this evidence base and additional information, including national reports under the Convention on Biological Diversity;

(b) Analysis and synthesis of the underlying reasons why progress has or has not been made towards achieving the Aichi Biodiversity Targets, relevant Sustainable Development Goals and other major international goals related to biodiversity and ecosystem functions and services. It will include consideration of the contributions of past and ongoing policy and management actions and resource mobilization to achieving these goals;

(c) Analysis and synthesis of the evidence base that can inform the development of new targets for the follow-up to the Strategic Plan for Biodiversity 2011–2020, including analysis of the interactions between trends towards the achievement of the Aichi Biodiversity Targets with the aim of understanding how they contribute to reaching the 2050 Vision. The chapter will also include consideration of the availability of existing and emerging indicators, including indicators that are being developed in the context of the reporting obligations of the Parties to relevant biodiversity-related agreements;

(d) Identification of information and knowledge gaps, as well as needs for research and capacity-building, that would need to be addressed in order to enhance understanding of progress towards the achievement of these international goals.

25. Chapter 4 will address question (c) in paragraph 3 above. The chapter will focus on plausible futures of nature, nature's benefits to people and their contributions to a good quality of life, by considering a wide range of scenarios of direct and indirect drivers, focusing on the 2030 and 2050 time frames. The assessment in this chapter will evaluate how these scenarios of direct and indirect drivers impact nature, nature's benefits to people and good quality of life using quantitative and qualitative models that mobilize a full range of world views and knowledge systems. Outcomes of the scenarios will be assessed in relation to internationally agreed goals related to biodiversity and ecosystem functions and services such as the relevant Sustainable Development Goals, the 2050 Vision and other relevant conventions and agreements, as appropriate and in accordance with their respective mandates, in order to facilitate better understanding of which types of socio-economic development pathways lead to outcomes that are closest to or furthest from these goals. This chapter will include:

(a) Assessment of positive and negative feedback loops in social and ecological systems and their contributions to potential future shifts;

(b) Attribution of changes in nature, nature’s benefits to people and good quality of life resulting from direct and indirect drivers;

(c) Evaluation following consideration of a diverse set of values, following the preliminary guide regarding diverse conceptualization of multiple values of nature and its benefits, including biodiversity and ecosystem functions and services (IPBES/4/INF/13) of policy actions or inaction;

(d) Evaluation of uncertainty, and methods for dealing with uncertainty in decision-making;

(e) Reflections on how the evidence from the scenarios may contribute to the elaboration of the follow-up to the Strategic Plan for Biodiversity 2011–2020.

26. Plausible future scenarios will be analysed based on three broad classes of methods: statistical extrapolations (like those carried out for the fourth edition of the Global Biodiversity Outlook); exploratory scenarios of direct and indirect drivers coupled with quantitative or qualitative models (like the scenarios and models used in the Millennium Ecosystem Assessment); and inferences from patterns in case studies that focus on general lessons that can be learned from such studies on a global scale (see also annex IV to decision IPBES-4/1).

27. Chapter 5 will address question (d) in paragraph 3 above. The chapter focuses on scenarios and pathways towards a sustainable future, in particular on the means of achieving internationally agreed upon goals and targets related to biodiversity and ecosystem functions and services. The chapter will focus on the components of sustainable development related to biodiversity and ecosystem functions and services and, therefore, cover only a subset of sustainability issues. It will take into account trade-offs, synergies, feedbacks and opportunities; make extensive use of work based on participatory

scenarios; take into consideration a nested range of decision-making processes in Government, the private sector and civil society; and recognize power and policy asymmetries. This chapter will:

(a) Describe the roles in, and contexts of, decision-making in identifying opportunities for future development, building on analyses from the Platform's regional, subregional and thematic assessments, and explore:

(i) How drivers are relative to decision makers and can be seen as being within their control (endogenous) or beyond their control (exogenous);

(ii) The role of timescales and time lags (inertia) in social, cultural, economic and natural systems, including in human responses to endogenous and exogenous drivers of change;

(iii) Analyses of relevant policies and legislative tools at the local to regional scales and how they are congruent with or in conflict with global goals;

(b) Review the outcomes of the following types of scenarios by building on existing work and available new scenarios developed in response to, or of relevance to, the needs of the Platform: target-seeking scenarios that examine broad suites of actions needed to improve sustainable development; policy and management screening scenarios that explore the contributions and effects of specific interventions, including trade-offs and opportunity costs; and inferences from patterns in case studies and analyses across scales and regions (see also document IPBES/4/4);

(c) Analyse paths of dependency and adaptive (versus locked-in) institutional and governance structures as indirect drivers (in the context of the conceptual framework) that will determine dominant values and potential future impacts on nature and nature's benefits to people. This will take into account information from chapters 1–4 to identify the state of knowledge of relevant processes in support of the Sustainable Development Goals and the 2050 Vision, thus contributing to the follow-up to the Strategic Plan for Biodiversity 2011–2020.

28. Chapter 6 will address question (e) in paragraph 3 above. The chapter will focus on opportunities and challenges for decision makers at all levels and will build on the analysis of the roles of decision-making as well as the decision-making contexts of earlier chapters. The chapter will analyse specific issues and opportunities for action for a range of policymakers and decision makers at all levels, including relevant United Nations agencies, biodiversity-related agreements and other relevant conventions and agreements, as appropriate and in accordance with their respective mandates.

29. In identifying opportunities and challenges, efforts will be made to recognize the variety of decision-making processes, the role of timescales and time lags (inertia) in social, cultural, economic and natural systems and that for all decision makers some drivers will be seen as within their control and others as beyond their control.

30. The chapter will identify the target audiences and their needs that are to be addressed within a range of stakeholders such as policymakers, legislators, financial planners at overarching levels and decision makers, as well as all other relevant stakeholders, including civil society and indigenous peoples and local communities, who are directly or indirectly related to biodiversity, ecosystem functioning and ecosystem services.

III. Data and information

31. The global assessment will draw on data and information from diverse knowledge systems, addressing all the components of the conceptual framework in order to explore the interrelationships between nature, nature's benefits, drivers and human well-being. The assessment process will interact with the Platform's regional/subregional assessments and other global assessments to explore, integrate and interpret emerging transregional issues of global importance.

32. Attention will be given, in accordance with the Platform's data and information management plan, to ensuring access to metadata and, whenever possible, the corresponding underlying data, through an interoperable process to ensure comparability between assessments. Furthermore, the task force on data and knowledge will develop recommendations and procedures to assure that data and information used in the global assessment will be widely available for future Platform assessments and other uses.

33. The assessment will also identify and seek access to any other globally relevant data and information sources that may exist or emerge. These sources include global, regional and national institutions and organizations, scientific literature, and indigenous and local knowledge. The

requirements of the assessment process will be communicated widely in order to identify and encourage the sharing of relevant data and information.

34. The task force on data and knowledge will provide active guidance on data and information quality, confidence, indicators, baselines and representativeness. A core set of indicators with appropriate baselines will be used consistently across the global and regional/subregional assessments and will be closely aligned with existing international frameworks such as the indicators for the Strategic Plan for Biodiversity 2011–2020 and the Sustainable Development Goals, building on and supporting existing international processes on indicators to share the same data and methods and to avoid additional reporting burdens.

35. Similarly, the task force on indigenous and local knowledge systems will guide the procedures for the analysis and use of indigenous and local knowledge. The collective ability to perform these tasks will be strengthened through capacity-building, knowledge-sharing and international collaboration.

IV. Strategic partnership and initiatives

36. Under the operating principles of the Platform, partnerships are important in order to avoid duplication and promote synergies with ongoing activities. Strategic partnerships are a critical subset of the many possible forms of partnership with the Platform. In the context of the global assessment, strategic partnerships are those that promote, for example, opportunities to increase alignment and reciprocity, and reduce duplication, between global assessments, or to build and maintain relationships with multiple relevant bodies under one global umbrella. Strategic partners should be identified for the assessment process in accordance with the guidance on the development of strategic partnerships and other collaborative arrangements (decision IPBES-3/4). Among key strategic partners currently identified are Future Earth, the Group on Earth Observations Biodiversity Observation Network and the Biodiversity Indicators Partnership. Other interested organizations are invited to engage with the assessment process.

V. Technical support

37. Technical support for the assessment will be provided by a technical support unit, located within the Platform secretariat, in order to promote synergies with the rest of the work programme and with the regional and thematic assessments in particular. The unit will be composed of one full-time staff member, supported by one or more full-time staff members seconded to the secretariat. The technical support unit will liaise with other technical support units, including those for the regional assessments.

VI. Capacity-building

38. A key objective of the global assessment is to build capacity to undertake assessments at the global level and to encourage the creation of an independent capacity-building network that will continue after the assessment is complete. Capacity-building will also include the strengthening of effective contributions of indigenous and local knowledge systems to assessments. Furthermore, capacity-building interventions will be designed to enable the effective participation of experts from developing countries in the assessment. The assessment will be supported by the task force on capacity-building and its technical support unit, in particular through the implementation of the proposed programme on fellowships, temporary secondment of staff and exchange of individuals, mentoring and training presented in document IPBES/4/6. The assessment will identify a pool of experts that can be used to provide support for capacity-building activities related to the Platform.

VII. Communication and outreach

39. The global assessment report and its summary for policymakers will be published in electronic format and will be made available on the Platform website. The summary for policymakers will be available in all official languages of the United Nations and will be printed on demand. Outreach to a broad set of stakeholders, including the general public, will be based on the Platform's communications and outreach strategy and budget. Dissemination will target all Platform stakeholders and will be adapted to the specific interests of different users. Metadata used in the assessment will be made publicly available in accordance with relevant guidance developed by the Platform.

40. Communication and outreach will be undertaken from the outset of the assessment in order to build engagement with the wider scientific community and the end users of the assessment.

Engagement with users will help to define the type and range of communication products and policy support tools that will be developed as part of the assessment.

VIII. Process and timetable

41. The proposed process and timetable for preparing the assessment report, including actions, milestones and institutional arrangements, is set out below.

Time frame		*Actions and institutional arrangements*
2016	First quarter	The Plenary, at its fourth session, approves the undertaking of the global assessment of biodiversity and ecosystem services and asks for offers of in-kind support for staff secondments for the technical support unit for the global assessment
		The Chair, through the secretariat, requests nominations from Governments and other stakeholders of experts to prepare the global assessment report
	Second quarter	Secretariat compiles lists of nominations
		*June: the Panel and the Bureau select the assessment co-chairs, coordinating lead authors, lead authors and review editors, using the approved selection criteria set out in decision IPBES-3/3, annex I)
		*June: meeting of the Management Committee (co-chairs, the technical support unit and Panel/Bureau members) to select the remaining members of the expert team and assign roles (i.e., coordinating lead authors, lead authors and review editors) and prepare for the first author meeting
		Selected nominees contacted, gaps filled and the list of co-chairs, authors and review editors finalized
	Early third quarter	*15–19 August: first author meeting with approximately 150 participants: co-chairs, coordinating lead authors and lead authors, Panel/Bureau members and technical support unit
	Third quarter	*22–26 August: co-chairs (and two or three relevant coordinating lead authors) of the global assessment participate in joint second author meeting of the regional assessments and the land degradation and restoration assessment
	Fourth quarter	Zero order drafts of chapters prepared and sent to secretariat through the technical support unit
2017	First quarter	Preparation of first order drafts of chapters and submission to secretariat
	Second quarter	May–June: first order draft of global assessment sent for expert review (6 weeks)
		Collation of review comments by secretariat for revision (1 week)
	Early third quarter	Second author meeting, including: 3 co-chairs, 20 coordinating lead authors and 14 review editors, Panel/Bureau members and technical support unit
	Third quarter	Preparation of second order drafts of chapters, including graphics and first order draft of summary for policymakers prepared (5–6 months)
2018	First quarter	Second order draft of the assessment and first order draft of the summary for policymakers sent for Government and expert review (8 weeks)
	First quarter	Collation of review comments for second order draft of the assessment and first order draft of the summary for policymakers sent to authors (2 weeks)
	End of first quarter	Co-chairs to attend the sixth session of the Plenary to observe consideration by the Plenary of the regional and land degradation assessments
	Second/early third quarter	Third author meeting (participants: co-chairs, coordinating lead authors, lead authors, review editors, Panel/Bureau members and technical support unit)
	Third and fourth quarters	Preparation of final text changes to the assessment and the summary for policymakers (6 months)
2019	First quarter	Translation of the summary for policymakers into the six official languages of the United Nations (6 weeks)
	First quarter	Submission of the assessment report, including the translated summary for policymakers, to Governments for final review prior to the Plenary session (8 weeks)
	First quarter	Final Government comments on the summary for policymakers for consideration by authors prior to the Plenary session (2 weeks)
	Second quarter	May (to be confirmed): Plenary to consider and possibly approve and accept the summary for policymakers and the technical global assessment report, respectively

*These dates are tentative and may vary by a few weeks.

IX. Cost estimate

42. The table below shows the estimated cost of conducting and preparing the assessment report.

Year	*Cost item*	*Assumptions*	*Estimated cost (United States dollars)*
2016	Meeting of co-chairs, secretariat/technical support and Multidisciplinary Expert Panel/Bureau members	Venue costs (0.5 week, 10 participants, in Bonn)	0
		Travel and DSA (5 x $3,750)	18 750
	First author meeting (participants: co-chairs, coordinating lead authors, lead authors and Panel/Bureau members)	Venue costs (1 week, 115 participants) (25 per cent in kind)	37 500
		Travel and DSA (86 x $3,750)	322 500
	Co-chairs participation in joint regional land degradation and restoration assessment meeting	Travel and DSA (2 x $3,750)	7 500
	Technical support	1 full-time equivalent Professional position; to be assisted by one or more people (in-kind contribution)	150 000
2017	Second author meeting (participants: co-chairs, coordinating lead authors, review editors and Panel/Bureau members)	Venue costs (1 week, 40 participants) (25 per cent in kind)	11 250
		Travel and DSA (30 x $3,750)	112 500
	Technical support	1 full-time equivalent Professional position; to be assisted by one or more people (in-kind contribution)	150 000
	Co-chairs to attend the sixth session of the Plenary of the Platform	Observe negotiations on regional assessments	22 500
2018	Third author meeting (participants: co-chairs, coordinating lead authors, lead authors, review editors and Panel/Bureau members)	Venue costs (1 week, 130 participants)	37 500
		Travel and DSA (100 x $3,750)	375 000
	Communications	Graphic design, data visualization, dissemination and outreach (public relations and media, etc.)	500 000
	Technical support	1 full-time equivalent Professional position; to be assisted by one or more people (in-kind contribution)	150 000
2019	Participation by the 12 co-chairs and coordinating lead authors in the sixth session of the Plenary	Travel and DSA (9 x $3,750)	33 750
	Technical support	1 full-time equivalent Professional position; to be assisted by one or more people (in-kind contribution)	93 750
Total			**2 022 500**

Annex II to decision IPBES-4/1

Summary for policymakers of the assessment report of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services on pollinators, pollination and food production

Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services

(deliverable 3 (a)) of the 2014–2018 work programme

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The thematic assessment of pollinators, pollination and food production carried out under the auspices of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services aims to assess animal pollination as a regulating ecosystem service underpinning food production in the context of its contribution to nature's gifts to people and supporting a good quality of life. To achieve this, it focuses on the role of native and managed pollinators, the status and trends of pollinators and pollinator-plant networks and pollination, drivers of change, impacts on human well-being, food production in response to pollination declines and deficits and the effectiveness of responses.

The report on the outcome of the assessment is available as document IPBES/4/INF/1/Rev.1. The present document is a summary for policymakers of the information presented in the full assessment report.

Key messages

Values of pollinators and pollination

1. **Animal pollination plays a vital role as a regulating ecosystem service in nature.** Globally, nearly 90 per cent of wild flowering plant species depend, at least in part, on the transfer of pollen by animals. These plants are critical for the continued functioning of ecosystems as they provide food, form habitats and provide other resources for a wide range of other species.

2. **More than three quarters of the leading types of global food crops rely to some extent on animal pollination for yield and/or quality.** Pollinator-dependent crops contribute to 35 per cent of global crop production volume.

3. **Given that pollinator-dependent crops rely on animal pollination to varying degrees, it is estimated that 5–8 per cent of current global crop production, with an annual market value of $235 billion–$577 billion (in 2015, United States dollars[28]) worldwide, is directly attributable to animal pollination**.

4. **The importance of animal pollination varies substantially among crops, and therefore among regional crop economies.** Many of the world's most important cash crops benefit from animal pollination in terms of yield and/or quality and are leading export products in developing countries (e.g., coffee and cocoa) and developed countries (e.g., almonds), providing employment and income for millions of people.

5. **Pollinator-dependent food products are important contributors to healthy human diets and nutrition.** Pollinator-dependent species encompass many fruit, vegetable, seed, nut and oil crops, which supply major proportions of micronutrients, vitamins and minerals in the human diet.

6. **The vast majority of pollinator species are wild, including more than 20,000 species of bees, some species of flies, butterflies, moths, wasps, beetles, thrips, birds, bats and other vertebrates. A few species of bees are widely managed, including the western honey bee (*Apis mellifera*),[29] the eastern honey bee (*Apis cerana*), some bumble bees, some stingless bees and a few solitary bees.** Beekeeping provides an important source of income for many rural livelihoods. The western honey bee is the most widespread managed pollinator in the world, and globally there are about 81 million hives producing an estimated 1.6 million tonnes of honey annually.

7. **Both wild and managed pollinators have globally significant roles in crop pollination, although their relative contributions differ according to crop and location. Crop yield and/or quality depend on both the abundance and diversity of pollinators.** A diverse community of pollinators generally provides more effective and stable crop pollination than any single species. Pollinator diversity contributes to crop pollination even when managed species (e.g., honey bees) are present in high abundance. The contribution of wild pollinators to crop production is undervalued.

8. **Pollinators are a source of multiple benefits to people, beyond food provisioning, contributing directly to medicines, biofuels (e.g. canola[30] and palm oil), fibres (e.g., cotton and linen) construction materials (timbers), musical instruments, arts and crafts, recreational activities and as sources of inspiration for art, music, literature, religion, traditions, technology and education.** Pollinators serve as important spiritual symbols in many cultures. Sacred passages

[28] Value adjusted to 2015 United States dollars taking into account inflation only.

[29] Also called the European honey bee, native to Africa, Europe and Western Asia, but spread around the globe by beekeepers and queen breeders.

[30] Also called oilseed rape.

about bees in all the worlds' major religions highlight their significance to human societies over millennia.

9. **A good quality of life for many people relies on ongoing roles of pollinators in globally significant heritage, as symbols of identity, as aesthetically significant landscapes and animals, in social relations, for education and recreation and in governance interactions.** Pollinators and pollination are critical to the implementation of the Convention for the Safeguarding of the Intangible Cultural Heritage; the Convention Concerning the Protection of the World Cultural and Natural Heritage; and the Globally Important Agricultural Heritage Systems Initiative.

Status and trends in pollinators and pollination

10. **Wild pollinators have declined in occurrence and diversity (and abundance for certain species) at local and regional scales in North West Europe and North America.** Although a lack of wild pollinator data (species identity, distribution and abundance) for Latin America, Africa, Asia and Oceania preclude any general statement on their regional status, local declines have been recorded. Long-term international or national monitoring of both pollinators and pollination is urgently required to provide information on status and trends for most species and most parts of the world.

11. **The number of managed western honey bee hives has increased globally over the last five decades, even though declines have been recorded in some European countries and North America over the same period.** Seasonal colony loss of western honey bees has in recent years been high at least in some parts of the temperate Northern Hemisphere and in South Africa. Beekeepers can under some conditions, with associated economic costs, make up such losses through the splitting of managed colonies.

12. **The International Union for Conservation of Nature (IUCN) Red List assessments indicate that 16.5 per cent of vertebrate pollinators are threatened with global extinction (increasing to 30 per cent for island species). There are no global Red List assessments specifically for insect pollinators. However, regional and national assessments indicate high levels of threat for some bees and butterflies.** In Europe, 9 per cent of bee and butterfly species are threatened and populations are declining for 37 per cent of bees and 31 per cent of butterflies (excluding data deficient species, which includes 57 per cent of bees). Where national Red List assessments are available, they show that often more than 40 per cent of bee species may be threatened.

13. **The volume of production of pollinator-dependent crops has increased by 300 per cent over the last five decades, making livelihoods increasingly dependent on the provision of pollination. However, overall these crops have experienced lower growth and lower stability of yield than pollinator-independent crops**. Yield per hectare of pollinator-dependent crops has increased less, and varies more year to year, than yield per hectare of pollinator-independent crops. While the drivers of this trend are not clear, studies of several crops at local scales show that production declines when pollinators decline.

Drivers of change, risks and opportunities, and policy and management options

14. **The abundance, diversity and health of pollinators and the provision of pollination are threatened by direct drivers that generate risks to societies and ecosystems.** Threats include land-use change, intensive agricultural management and pesticide use, environmental pollution, invasive alien species, pathogens and climate change. Explicitly linking pollinator declines to individual or combinations of direct drivers is limited by data availability or complexity, yet a wealth of individual case studies worldwide suggests that these direct drivers often affect pollinators negatively.

15. **Strategic responses to the risks and opportunities associated with pollinators and pollination range in ambition and timescale from immediate, relatively straightforward, responses that reduce or avoid risks to relatively large-scale and long-term responses that aim to transform agriculture or society's relationship with nature.** There are seven broad strategies, linked to actions, for responding to risks and opportunities (**table SPM.1**), including a range of solutions that draw on indigenous and local knowledge. These strategies can be adopted in parallel and would be expected to reduce risks associated with pollinator decline in any region of the world, regardless of the extent of available knowledge about the status of pollinators or the effectiveness of interventions.

16. **A number of features of current intensive agricultural practices threaten pollinators and pollination. Moving towards more sustainable agriculture and reversing the simplification of agricultural landscapes offer key strategic responses to risks associated with pollinator decline.** Three complementary approaches to maintaining healthy pollinator communities and productive agriculture are: (a) ecological intensification (i.e., managing nature's ecological functions to improve agricultural production and livelihoods while minimizing environmental damage); (b) strengthening existing diversified farming systems (including forest gardens, home gardens, agroforestry and mixed cropping and livestock systems) to foster pollinators and pollination through practices validated by science or indigenous and local knowledge (e.g., crop rotation); and (c) investing in ecological infrastructure by protecting, restoring and connecting patches of natural and semi-natural habitats throughout productive agricultural landscapes. These strategies can concurrently mitigate the impacts of land-use change, land management intensity, pesticide use and climate change on pollinators.

17. **Practices based on indigenous and local knowledge can be a source of solutions to current challenges, in co-production with science, by supporting an abundance and diversity of pollinators.** Practices include diverse farming systems; favouring heterogeneity in landscapes and gardens; kinship relationships that protect many specific pollinators; using seasonal indicators (e.g., flowering) to trigger actions (e.g., planting); distinguishing a wide range of pollinators; and tending to nest trees and floral and other pollinator resources. Knowledge co-production has led to improvements in hive design, new understanding of parasite impacts and the identification of stingless bees new to science.

18. **The risk to pollinators from pesticides arises through a combination of toxicity and the level of exposure, which varies geographically with the compounds used and the scale of land management and habitat in the landscape. Pesticides, particularly insecticides, have been demonstrated to have a broad range of lethal and sublethal effects on pollinators under controlled experimental conditions.** The few available field studies assessing effects of field-realistic exposure provide conflicting evidence of effects based on species studied and pesticide usage. It is currently unresolved how sublethal effects of pesticide exposure recorded for individual insects affect colonies and populations of managed bees and wild pollinators, especially over the longer term. Recent research focusing on neonicotinoid insecticides shows evidence of lethal and sublethal effects on bees and some evidence of impacts on the pollination they provide. There is evidence from a recent study that shows impacts of neonicotinoids on wild pollinator survival and reproduction at actual field exposure.[31] Evidence, from this and other studies, of effects on managed honey bee colonies is conflicting.

19. **Exposure of pollinators to pesticides can be decreased by reducing the use of pesticides, seeking alternative forms of pest control and adopting a range of specific application practices, including technologies to reduce pesticide drift. Actions to reduce pesticide use include promoting Integrated Pest Management, supported by educating farmers, organic farming and policies to reduce overall use.** Risk assessment can be an effective tool for defining pollinator-safe uses of pesticides, which should consider different levels of risk among wild and managed pollinator species according to their biology. Subsequent use regulations (including labelling) are important steps towards avoiding the misuse of specific pesticides. The FAO International Code of Conduct on the Distribution and Use of Pesticides provides a set of voluntary actions for Government and industry to reduce risks for human health and environment, although only 15 per cent of countries are using it.[32]

20. **Most agricultural genetically modified organisms (GMOs) carry traits for herbicide tolerance (HT) or insect resistance (IR).** Reduced weed populations are likely to accompany most herbicide-tolerant (HT) crops, diminishing food resources for pollinators. The actual consequences for the abundance and diversity of pollinators foraging in herbicide-tolerant (HT)-crop fields is unknown. Insect-resistant (IR) crops can result in the reduction of insecticide use, which varies regionally according to the prevalence of pests, the emergence of secondary outbreaks of non-target pests or primary pest resistance. If sustained, the reduction in insecticide use could reduce pressure on non-target insects. How insect-resistant (IR) crop use and reduced pesticide use affect pollinator abundance and diversity is unknown. Risk assessments required for the approval of genetically-modified organism (GMO) crops in most countries do not adequately address the direct sublethal effects of insect-resistant (IR) crops or the indirect effects of herbicide-tolerant (HT) and insect-resistant (IR) crops, partly because of a lack of data.

[31] Rundlöf et al. (2015). Seed coating with a neonicotinoid insecticide negatively affects wild bees. Nature 521: 77-80 doi:10. 1038/nature14420.

[32] Based on a survey from 2004–2005; Ekström, G., and Ekbom, B. (2010). Can the IOMC Revive the 'FAO Code' and take stakeholder initiatives to the developing world? Outlooks on Pest Management 21:125-131.

21. **Bees suffer from a broad range of parasites, including *Varroa* mites in western and eastern honey bees. Emerging and re-emerging diseases are a significant threat to the health of honey bees, bumble bees and solitary bees, especially when they are managed commercially.** Greater emphasis on hygiene and the control of pathogens would help reduce the spread of disease across the entire community of pollinators, managed and wild. Mass breeding and large-scale transport of managed pollinators can pose risks for the transmission of pathogens and parasites and increase the likelihood of selection for more virulent pathogens, alien species invasions and regional extinctions of native pollinator species. The risk of unintended harm to wild and managed pollinators could be decreased by better regulation of their trade and use.

22. **The ranges, abundances and seasonal activities of some wild pollinator species (e.g., bumble bees and butterflies) have changed in response to observed climate change over recent decades.** Generally, the impacts of ongoing climate change on pollinators and pollination services to agriculture may not be fully apparent for several decades, owing to a delayed response in ecological systems. Adaptive responses to climate change include increasing crop diversity and regional farm diversity and targeted habitat conservation, management or restoration. The effectiveness of adaptation efforts at securing pollination under climate change is untested.

23. **Many actions to support wild and managed pollinators and pollination (described above and in table SPM.1) could be implemented more effectively with improved governance.** For example, broad-scale government policy may be too homogenous and not allow for local variation in practices; administration can be fragmented into different levels; and goals can be contradictory between sectors. Coordinated, collaborative action and knowledge sharing that builds links across sectors (e.g., agriculture and nature conservation), across jurisdictions (e.g., private, Government, not-for-profit), and among levels (e.g., local, national, global) can overcome these challenges and lead to long-term changes that benefit pollinators. Establishing effective governance requires habits, motivations and social norms to change over the long term. However, the possibility that contradictions between policy sectors may remain even after coordination efforts have been undertaken should be acknowledged and should be a point of attention in future studies.

Background to pollinators, pollination and food production

Pollination is the transfer of pollen between the male and female parts of flowers to enable fertilization and reproduction. The majority of cultivated and wild plants depend, at least in part, on animal vectors, known as pollinators, to transfer pollen, but other means of pollen transfer such as self-pollination or wind-pollination are also important {1.2}.

Pollinators comprise a diverse group of animals dominated by insects, especially bees, but also include some species of flies, wasps, butterflies, moths, beetles, weevils, thrips, ants, midges, bats, birds, primates, marsupials, rodents and reptiles (figure SPM.1). While nearly all bee species are pollinators, a smaller (and variable) proportion of species within the other taxa are pollinators. More than 90 per cent of the leading global crop types are visited by bees and around 30 per cent by flies, while each of the other taxa visits less than 6 per cent of the crop types. A few species of bees are managed, such as the western honey bee (*Apis mellifera*) and eastern honey bee (*Apis cerana*), some bumble bees, some stingless bees and a few solitary bees; however, the vast majority of the world's 20,077 known bee species are wild (i.e., free living and unmanaged) {1.3}.

Pollinators visit flowers primarily to collect or feed on nectar and/or pollen, although a few specialist pollinators may also collect other rewards such as oils, fragrances and resins offered by some flowers. Some species of pollinators are specialists (i.e., visiting a small variety of flowering species), while others are generalists (i.e., visiting a wide range of species). Similarly, specialist plants are pollinated by a small number of species while generalist plants are pollinated by a broad range of species {1.6}. **Section A** of this summary examines the diversity of values[33] associated with pollinators and pollination, covering economic, environmental, socio-cultural, indigenous and local perspectives. **Section B** characterizes the status and trends of wild and managed pollinators and pollinator-dependent crops and wild plants. **Section C** considers the direct and indirect drivers of plant-pollinator systems and management and policy options for adaptation and mitigation when impacts are negative.

The assessment report evaluates a large knowledge base of scientific, technical, socio-economic and indigenous and local knowledge sources. **Appendix 1** defines the central concepts used in the report

[33] Values: those actions, processes, entities or objects that are worthy or important (sometimes values may also refer to moral principles). Díaz et al. (2015) "The IPBES Conceptual Framework - connecting nature and people." *Current Opinion in Environmental Sustainability* 14: 1–16.

and in the present summary for policymakers, and **appendix 2** explains the terms used to assign and communicate the degree of confidence in the key findings. Chapter references enclosed in curly brackets in the present summary for policymakers, e.g., {2.3.1, box 2.3.4}, indicate where support for the findings, figures, boxes and tables may be found in the assessment report.

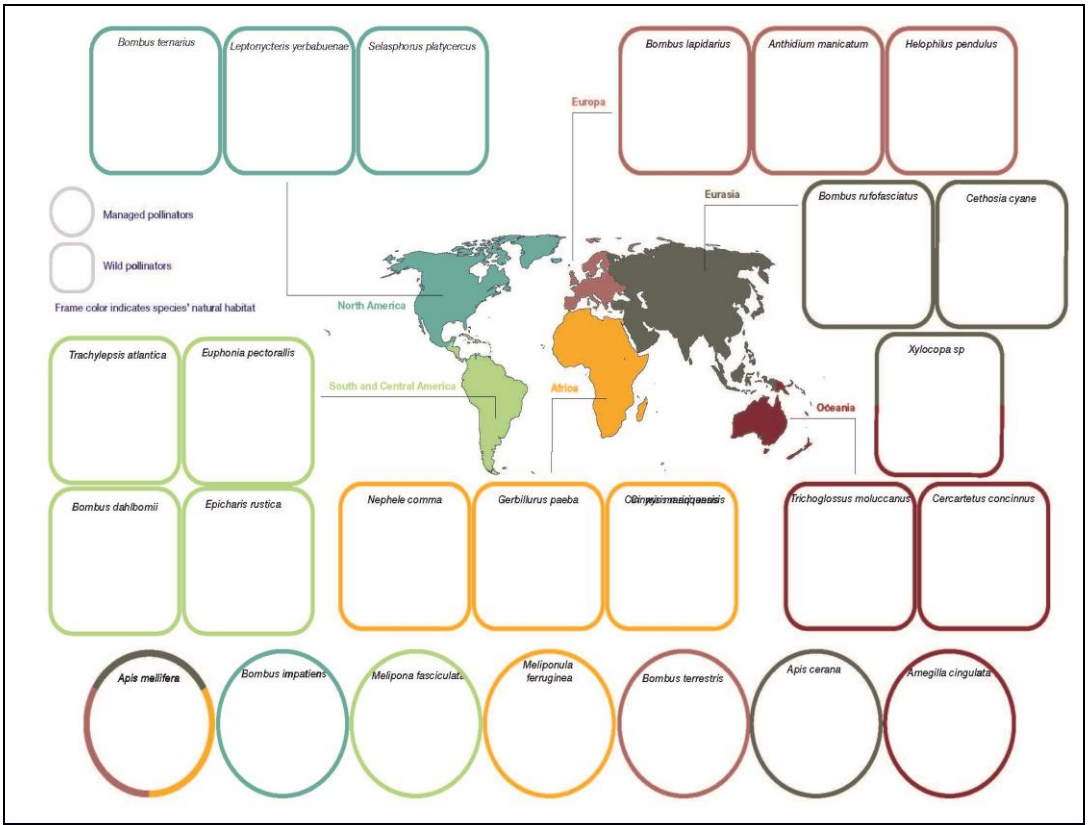

Figure SPM.1: Global diversity of wild and managed pollinators. Examples provided here are purely illustrative and have been chosen to reflect the wide variety of animal pollinators found regionally. *Photos will be shown upon confirmation of copyright/photo credits.

A. Values of pollinators and pollination

Diverse knowledge systems, including science and indigenous and local knowledge, contribute to understanding pollinators and pollination, their economic, environmental and socio-cultural values and their management globally (*well established*). Scientific knowledge provides extensive and multi-dimensional understanding of pollinators and pollination, resulting in detailed information on their diversity, functions and steps needed to protect pollinators and the values they produce. In indigenous and local knowledge systems, pollination processes are often understood, celebrated and managed holistically in terms of maintaining values through fostering fertility, fecundity, spirituality and a diversity of farms, gardens and other habitats. The combined use of economic, socio-cultural and holistic valuation of pollinator gains and losses, using multiple knowledge systems, brings different perspectives from different stakeholder groups, providing more information for the management of and decision-making about pollinators and pollination, although key knowledge gaps remain {4.2, 4.6, 5.1.1, 5.1.2, 5.1.3, 5.1.4, 5.1.5, 5.2.1, 5.2.5, 5.3.1, 5.5, figure 5-5 and boxes 5-1, 5-2}.

Animal pollination plays a vital role as a regulating ecosystem service in nature. An estimated 87.5 per cent (approximately 308,000 species) of the world's flowering wild plants depend, at least in part, on animal pollination for sexual reproduction, and this ranges from 94 per cent in tropical communities to 78 per cent in temperate zone communities (*established but incomplete)*. Pollinators play central roles in the stability and functioning of many terrestrial food webs, as wild plants provide a wide range of resources such as food and shelter for many other invertebrates, mammals, birds and other taxa {1.2.1, 1.6, 4.0, 4.4}.

Production, yield and quality of more than three quarters of the leading global food crop types, occupying 33-35 per cent of all agricultural land, benefit[34] from animal pollination *(well established)*. Of the 107 leading global crop types,[35] production from 91 (fruit, seed and nut) crops rely to varying degrees upon animal pollination. Total pollinator loss would decrease crop production by more than 90 per cent in 12 per cent of the leading global crops, would have no effects in 7 per cent of the crops and would have unknown effects in 8 per cent of the crops. In addition, 28 per cent of the crops would lose between 40 and 90 per cent of production, whereas the remaining crops would lose between 1 and 40 per cent (**figure SPM.2**). In terms of global production volumes, 60 per cent of production comes from crops that do not depend on animal pollination (e.g., cereals and root crops), 35 per cent of production comes from crops that depend at least in part on animal pollination and 5 per cent have not been evaluated (*established but incomplete*). In addition, many crops, such as potatoes, carrots, parsnips, alliums and other vegetables, do not depend directly on pollinators for the production of the parts we consume (e.g., roots, tubers, stems, leaves or flowers), but pollinators are still important for their propagation via seeds or in breeding programmes. Furthermore, many forage species (e.g., legumes) also benefit from animal pollination {1.1, 1.2.1, 3.7.2}.

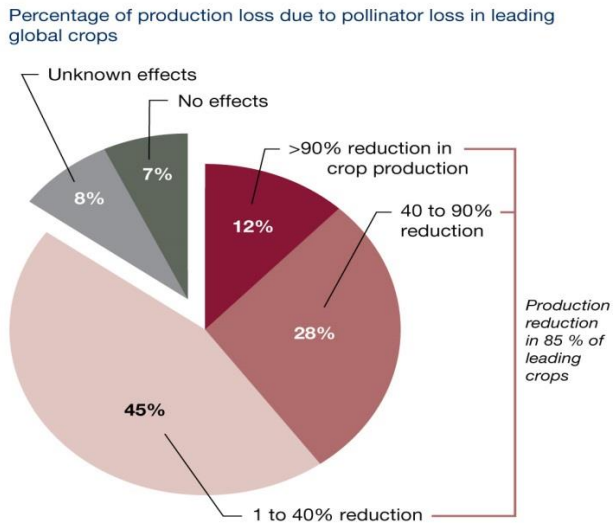

Figure SPM.2: Percentage dependence on animal-mediated pollination of leading global crops that are directly consumed by humans and traded on the global market.[36]

Animal pollination is directly responsible for between 5 and 8 per cent of current global agricultural production by volume (i.e., this amount of production would be lost if there were no pollinators), and includes foods that supply major proportions of micronutrients, such as vitamin A, iron and folate, in global human diets (**figure SPM.3A**) **(*established but incomplete*)** {3.7.2, 5.2.2}. Loss of pollinators could lead to lower availability of crops and wild plants that provide essential micronutrients for human diets, impacting health and nutritional security and risking increased numbers of people suffering from vitamin A, iron and folate deficiency. It is now well recognized that hunger and malnutrition are best addressed by paying attention to diverse nutritional requirements and not to calories alone, but also to the dietary nutritional value from non-staple crop products, many of which are dependent on pollinators {1.1, 2.6.4, 3.7, 3.8. 5.4.1.2}. This includes some animal pollinators that are themselves consumed for food and are high in protein, vitamins and minerals.

[34] When other factors are not limiting, e.g., crop nutrition.

[35] Klein et al. (2007) "Importance of pollinators in changing landscapes for world crops" Proc. R. Soc. B 274: 303-313. Note that this graph and figures are taken from fig. 3 in Klein et al., 2007, and only include crops that produce fruits or seeds for direct human use as food (107 crops), but exclude crops for which seeds are only used for breeding or to grow vegetable parts for direct human use or for forage and crops known to be only wind-pollinated, passively self-pollinated or reproduced vegetatively.

[36] Klein et al. (2007) "Importance of pollinators in changing landscapes for world crops" Proc. R. Soc. B 274: 303-313. Note that this graph and figures are taken from fig. 3 in Klein et al., 2007, and only includes crops that produce fruits or seeds for direct human use as food (107 crops), but excludes crops for which seeds are only used for breeding or to grow vegetable parts for direct human use or for forage, and crops known to be only wind-pollinated, passively self-pollinated or reproduced vegetatively.

The annual market value of the 5–8 per cent of production that is directly linked with pollination services is estimated at $235 billion–$577 billion (in 2015 US$) worldwide (*established but incomplete*) (figure SPM.3B) {3.7.2, 4.7.3}. On average, pollinator-dependent crops have higher prices than non-pollinator dependent crops. The distribution of these monetary benefits is not uniform, with the greatest additional production occurring in parts of Eastern Asia, the Middle East, Mediterranean Europe and North America. The additional monetary output linked to pollination services accounts for 5–15 per cent of total crop output in different United Nations regions, with the greatest contributions in the Middle East, South Asia and East Asia. In the absence of animal pollination, changes in global crop supplies could increase prices to consumers and reduce profits to producers, resulting in a potential annual net loss of economic welfare of $160 billion–$191 billion globally to crop consumers and producers and a further $207 billion–$497 billion to producers and consumers in other, non-crop markets (e.g., non-crop agriculture, forestry and food processing) {4.7}. The accuracy of the economic methods used to estimate these values is limited by numerous data gaps, and most studies focus on developed nations {4.2, 4.3, 4.5, 4.7}. Explicit estimation and consideration of economic benefits through tools such as cost-benefit analyses and multi-criteria analyses provide information to stakeholders and can help inform land-use choices with greater recognition of pollinator biodiversity and sustainability {4.1, 4.6}.

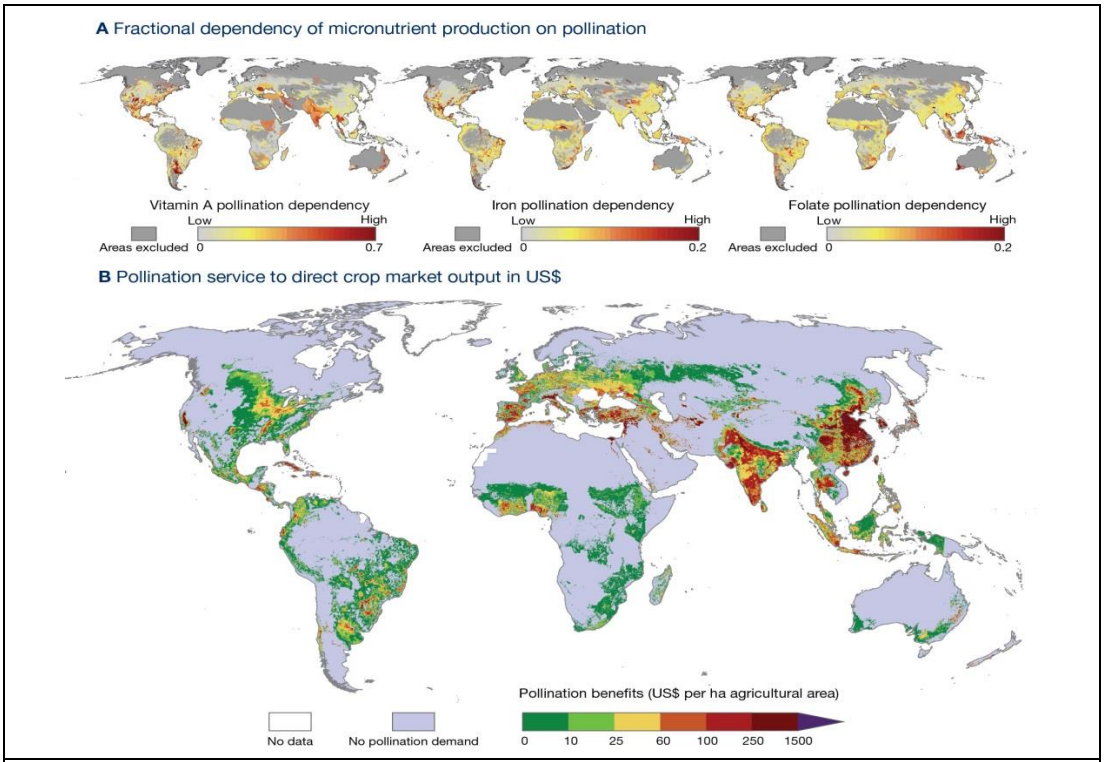

Figure SPM.3: (A) **Fractional dependency of micronutrient production on pollination.** This represents the proportion of production that is dependent on pollination for (a) vitamin A, (b) iron, and (c) folate. Based on Chaplin-Kramer et al. (2014).[37].(B) **Global map of pollination service to direct crop market output in terms of US$ per hectare of added production on a 5' by 5' latitude longitude grid.** Benefits are given as US$ for the year 2000 and have been corrected for inflation (to the year 2009) and for purchasing power parities. Analyses used country-specific FAO-data on production prices and production quantities and on the pollination dependency ratio of the crops. Based on Lautenbach et al. (2012).[38]

Many livelihoods depend on pollinators, their products and their multiple benefits *(established but incomplete)*. Many of the world's most important cash crops are pollinator-dependent. These constitute leading export products in developing countries (e.g., coffee and cocoa) and developed countries (e.g., almonds) providing employment and income for millions of people. Impacts of pollinator loss will therefore be different among regional economies, being higher for economies with a stronger reliance on pollinator-dependent crops (whether grown nationally or imported). Existing studies of the economic value of pollination have not accounted for non-monetary aspects of

[37] Chaplin-Kramer et al. (2014) "Global malnutrition overlaps with pollinator-dependent micronutrient production." Proc. R. Soc. B 281: 2014.1799.

[38] Lautenbach et al. (2012) "Spatial and temporal trends of global pollination benefit." PLoS ONE 7: e35954.

economies, particularly the assets that form the basis of rural economies, for example human (e.g., employment of beekeepers), social (e.g., beekeepers associations), physical (e.g., honey bee colonies), financial (e.g., honey sales) and natural assets (e.g., wider biodiversity resulting from pollinator-friendly practices). The sum and balance of these assets are the foundation for future development and sustainable rural livelihoods {3.7, 4.2, 4.4, 4.7}.

Livelihoods based on beekeeping and honey hunting are an anchor for many rural economies and are the source of multiple educational and recreational benefits in both rural and urban contexts (*well established*). Globally, available data show that 81 million hives annually produce 65,000 tonnes of beeswax and 1.6 million tonnes of honey, of which an estimated 518,000 tonnes are traded. Many rural economies favour beekeeping and honey hunting, as minimal investment is required; diverse products can be sold; diverse forms of ownership support access; family nutrition and medicinal benefits can be derived from it; the timing and location of activities are flexible; and numerous links exist with cultural and social institutions. Beekeeping is also of growing importance as an ecologically-inspired lifestyle choice in many urban contexts. Significant unrealized potential exists for beekeeping as a sustainable livelihood activity in developing world contexts {4.3.2, 4.7.1, 5.2.8.4, 5.3.5, 5.4.6.1, case examples 5-10, 5-11, 5-12, 5-13, 5-14, 5-21, 5-24, 5-25, and figures 5-12, 5-13, 5-14, 5-15, 5-22}.

Pollinators are a source of multiple benefits to people well beyond food-provisioning alone, contributing directly to medicines, biofuels, fibres, construction materials, musical instruments, arts and crafts and as sources of inspiration for art, music, literature, religion and technology (*well established*). For example, some anti-bacterial, anti-fungal and anti-diabetic agents are derived from honey; Jatropha oil, cotton and eucalyptus trees are examples of pollinator-dependent biofuel, fibre and timber sources respectively; beeswax can be used to protect and maintain fine musical instruments. Artistic, literary and religious inspiration from pollinators includes popular and classical music (e.g., I'm a King Bee by Slim Harpo, the Flight of the Bumblebee by Rimsky-Korsakov); sacred passages about bees in the Mayan codices (e.g., stingless bees), the *Surat An-Naĥl* in the Qur'an, the three-bee motif of Pope Urban VIII in the Vatican and sacred passages of Hinduism, Buddhism and Chinese traditions such as the Chuang Tzu. Pollinator-inspired technical design is reflected in the visually guided flight of robots and the 10 metre telescopic nets used by some amateur entomologists today {5.2.1, 5.2.2., 5.2.3, 5.2.4, case examples 5-2, 5-16, and figures 5-7, 5-8, 5-9, 5-10, 5-24}.

A good quality of life for many people relies on the ongoing roles of pollinators in globally significant heritage as symbols of identity, as aesthetically significant landscapes, flowers, birds, bats and butterflies and in the social relations and governance interactions of indigenous peoples and local communities (*well established*). As examples, the World Heritage site the Agave Landscape and Ancient Industrial Facilities of Tequila depends on bat pollination to maintain agave genetic diversity and health; people show marked aesthetic preferences for the flowering season in diverse European cultural landscapes; a hummingbird is the national symbol of Jamaica, a sunbird of Singapore, and an endemic birdwing the national butterfly of Sri Lanka; seven-foot wide butterfly masks symbolize fertility in festivals of the Bwa people of Burkina Faso; and the Tagbanua people of the Philippines, according to their tradition, interact with two bee deities living in the forest and karst as the ultimate authority for their shifting agriculture {5.3.1, 5.3.2, 5.3.3, 5.3.4, 5.3.6, case examples 5-16, 5-17, 5-18, 5-19, 5-20, and figures 5-16, 5-17, 5-18, 5-19, 5-20, 5-21}.

Diversified farming systems, some linked to indigenous and local knowledge, represent an important pollinator-friendly addition to industrial agriculture and include swidden, home garden, commodity agroforestry and bee farming systems (*established but incomplete*). While small holdings (less than 2 hectares) constitute about 8–16 per cent of global farm land, large gaps exist in our knowledge on the area of diversified farming systems linked to indigenous and local knowledge. Diversified farming systems foster agro-biodiversity and pollination through crop rotation, the promotion of habitat at diverse stages of succession, diversity and abundance of floral resources; ongoing incorporation of wild resources and inclusion of tree canopy species; innovations, for example in apiaries, swarm capture and pest control; and adaptation to social-environmental change, for example through the incorporation of new invasive bee species and pollination resources into farming practices {5.2.8, case examples 5-7, 5-8. 5-9, 5-10, 5-11, 5-12, 5-13, and figures 5-14, 5-15, 5-22}.

A number of cultural practices based on indigenous and local knowledge contribute to supporting an abundance and diversity of pollinators and maintaining valued "biocultural diversity" (for the purposes of this assessment, biological and cultural diversity and the links between them are referred to as "biocultural diversity") (*established but incomplete*). This includes practices of diverse farming systems; of favouring heterogeneity in landscapes and gardens; of kinship relationships that protect many specific pollinators; of using biotemporal indicators that rely

on distinguishing a great range of pollinators; and of tending to the conservation of nesting trees and floral and other pollinator resources. The ongoing linkages among these cultural practices, the underpinning indigenous and local knowledge (including multiple local language names for diverse pollinators) and pollinators constitute elements of "biocultural diversity". Areas where "biocultural diversity" is maintained are valued globally for their roles in protecting both threatened species and endangered languages. While the extent of these areas is clearly considerable, for example extending over 30 per cent of forests in developing countries, key gaps remain in the understanding of their location, status and trends {5.1.3, 5.2.5, 5.2.6, 5.2.7, 5.4.7.2, case example 5-1, 5-3, 5-5, 5-6, and figures 5-4, 5-11}.

B. Status and trends in pollinators, pollination and pollinator-dependent crops and wild plants

More food is produced every year and global agriculture's reliance on pollinator-dependent crops has increased in volume by more than 300 per cent over the last five decades (*well established*). The extent to which agriculture depends on pollinators varies greatly among crops, varieties and countries (figure SPM.4). Animal pollination benefits have increased most in the Americas, the Mediterranean, the Middle East and East Asia, mainly due to their cultivation of a variety of fruit and seed crops {3.7.2, 3.7.3, 3.7.4, 3.8.3}.

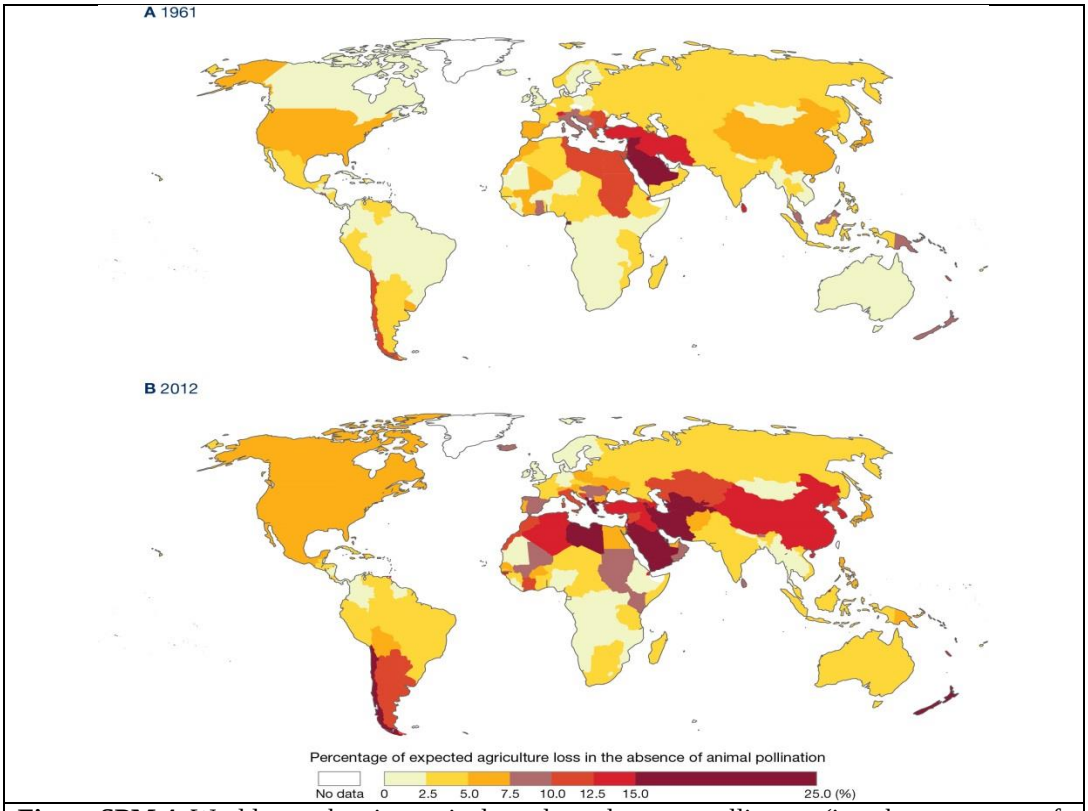

Figure SPM.4: World map showing agriculture dependence on pollinators (i.e., the percentage of expected agriculture production volume loss in the absence of animal pollination (categories depicted in the coloured bar) in 1961 and 2012, based on FAO dataset (FAOSTAT 2013) and following the methodology of Aizen et al. (2009).[39]

While global agriculture is becoming increasingly pollinator-dependent, yield growth and stability of pollinator-dependent crops are lower than those of pollinator-independent crops (*well established*). Yield per hectare of pollinator-dependent crops has increased less, and varies more year to year, than yield per hectare of pollinator-independent crops. While the drivers of this trend are not clear, studies of several crops at local scales show that production declines when pollinators decline. Furthermore, yields of many crops show local declines and lower stability when pollinator communities lack a variety of species (*well established*). A diverse pollinator community is more likely to provide stable, sufficient pollination than a less diverse community, as a result of pollinator species having different food preferences, foraging behaviour and activity patterns. Furthermore, studies at local scales show that crop production is higher in fields with diverse and abundant

[39] Aizen et al. (2009) "How much does agriculture depend on pollinators? Lessons from long-term trends in crop production" *Annals of Botany* 103: 15791–588.

pollinator communities than in fields with less diverse pollinator communities. Wild pollinators, for some crops, contribute more to global crop production than do honey bees. Managed honey bees often cannot compensate fully for the loss of wild pollinators, can be less effective pollinators of many crops and cannot always be supplied in sufficient numbers to meet pollination demand in many countries (*established but incomplete*). However, certain wild pollinator species are dominant. It is estimated that 80 per cent of the pollination of global crops can be attributed to the activities of just 2 per cent of wild bee species. A diversity of pollination options, including both wild and managed species, is needed in most open field systems, where weather and environment can be unpredictable (*established but incomplete*) {3.7.2, 3.8.2, 3.8.3}.

The number of managed western honey bee hives is increasing at the global scale, although seasonal colony loss is high in some European countries and in North America (*well established*) (figure SPM.5). Colony losses may not always result in irreversible declines, as losses can be mitigated by beekeepers splitting colonies[40] to recover or even exceed seasonal losses. The seasonal loss of western honey bees in Europe and North America varies strongly by country, state and province and by year, but in recent decades (at least since the widespread introduction of *Varroa*) has often been higher than the 10–15 per cent that was previously regarded as normal (*established but incomplete*). Data for other regions of the world is largely lacking {2.4.2.3, 2.4.2.4, 3.3.2, 3.3.3, 3.3.4, 3.3.5}.

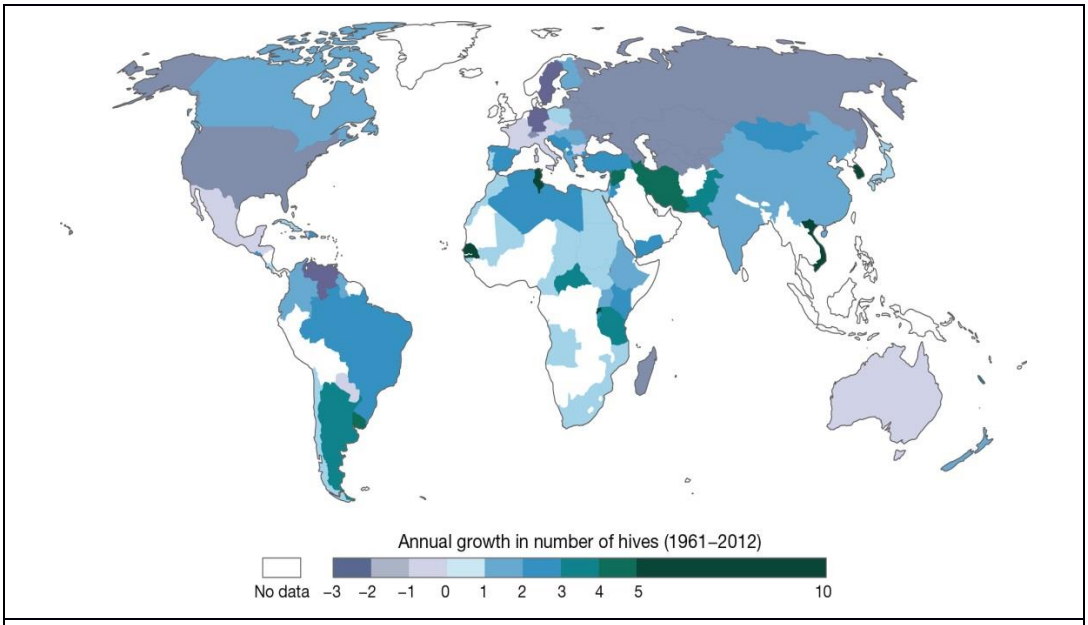

Figure SPM.5: World map showing the annual growth rate (per cent per year) in the number of honey bee hives for countries reporting those data to FAO between 1961 and 2012 (FAOSTAT 2013).[41]

[40] Bee colonies are split by taking a portion of the workers from a strong colony and a new queen reared elsewhere to form a new colony; this activity has an associated economic cost.

[41] Data from the countries that were part of the former Soviet Union, the former Yugoslavia or the former Czechoslovakia were combined.

Many wild bees and butterflies have been declining in abundance, occurrence and diversity at local and regional scales in North-West Europe and North America (*established but incomplete*); data for other regions and pollinator groups are currently insufficient to draw general conclusions, although local declines have been reported. At a regional level, declines in the diversity of bees and pollinator-dependent wild plants have been recorded in highly industrialized regions of the world, particularly Western Europe and Eastern North America, over the last century (*well established*). Some species have declined severely, such as Franklin's bumble bee (*Bombus franklini*) in the western United States of America and the great yellow bumble bee (*Bombus distinguendus*) in Europe (*well established*). Trends for other species are unknown or are only known for a small part of the species' distribution. Declines have also been recorded in other insect and vertebrate pollinator groups such as moths, hummingbirds and bats (*established but incomplete*). In some European countries, declining trends in insect pollinator diversity have slowed down or even stopped (*established but incomplete*). However, the reason(s) for this remain(s) unclear. In agricultural systems, the local abundance and diversity of wild bees have been found to decline strongly with distance from field margins and remnants of natural and semi-natural habitat at scales of a few hundred metres (*well established*) {3.2.2, 3.2.3}.

While global agriculture is becoming increasingly pollinator-dependent, yield growth and stability of pollinator-dependent crops are lower than those of pollinator-independent crops (*well established*). Yield per hectare of pollinator-dependent crops has increased less, and varies more year to year, than yield per hectare of pollinator-independent crops. While the drivers of this trend are not clear, studies of several crops at local scales show that production declines when pollinators decline. Furthermore, yields of many crops show local declines and lower stability when pollinator communities lack a variety of species (*well established*). A diverse pollinator community is more likely to provide stable, sufficient pollination than a less diverse community as a result of pollinator species having different food preferences, foraging behaviour and activity patterns. Furthermore, studies at local scales show that crop production is higher in fields with diverse and abundant pollinator communities than in fields with less diverse pollinator communities. Managed honey bees often cannot compensate fully for the loss of wild pollinators, can be less effective pollinators of many crops and cannot always be supplied in sufficient numbers to meet pollination demand in many countries (*established but incomplete*). However, certain wild pollinator species are dominant. It is estimated that 80 per cent of the pollination of global crops can be attributed to the activities of just 2 per cent of wild bee species. A diversity of pollination options, including both wild and managed species, is needed in most open field systems, where weather and environment can be unpredictable (*established but incomplete*) {3.7.2, 3.8.2, 3.8.3}.

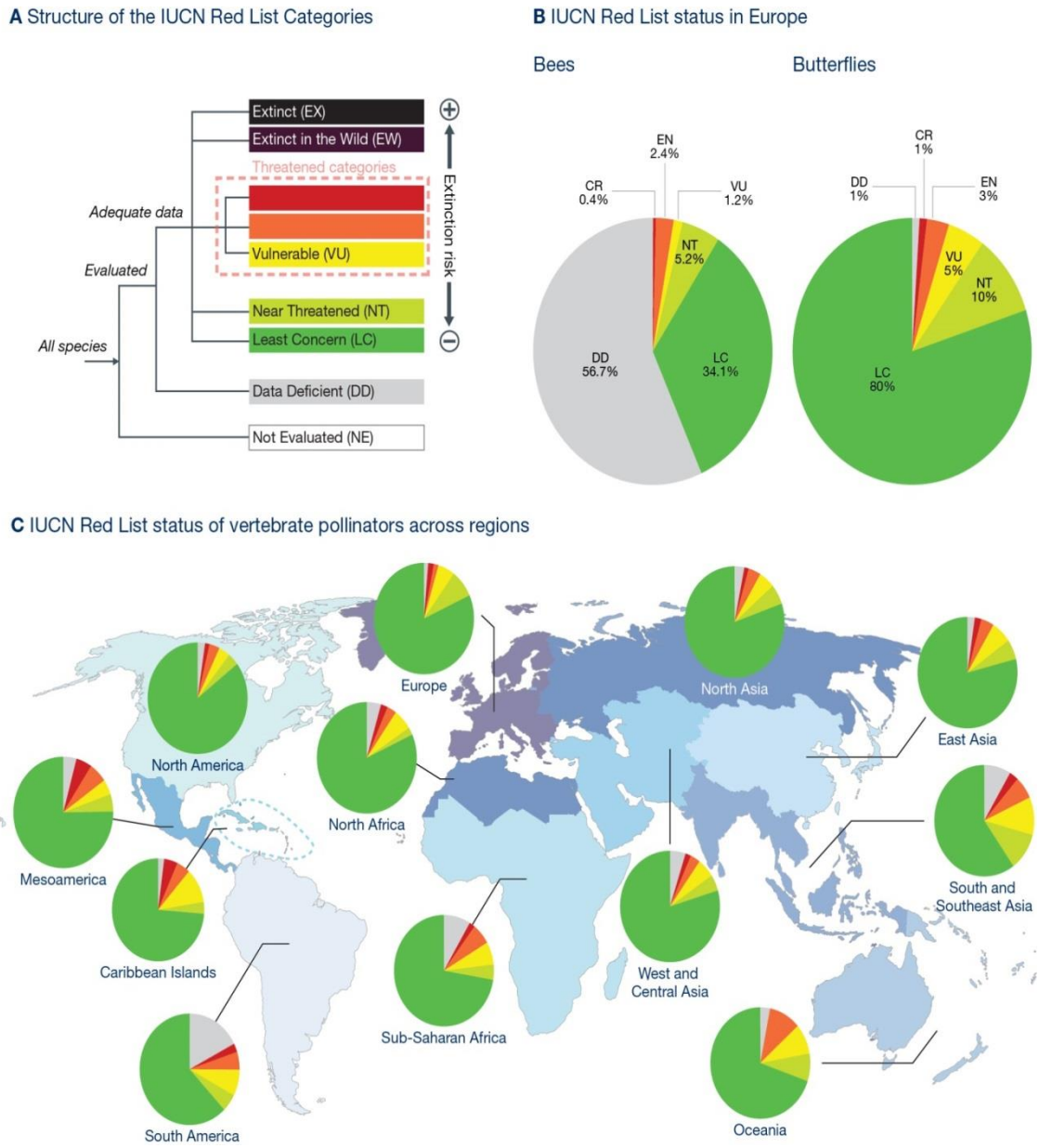

Figure SPM.6: The International Union for Conservation of Nature (IUCN) Red List status of wild pollinator taxa. (**A**) IUCN relative risk categories: EW = Extinct in the wild; CR = Critically Endangered; EN = Endangered; VU = Vulnerable; NT = Near Threatened; LC = Least Concern; DD = Data Deficient; NE = Not Evaluated. (**B**) European bees and butterflies. (**C**) Vertebrate pollinators (including mammals and birds) across IUCN regions.

An objective evaluation of the status of a species is The International Union for Conservation of Nature (IUCN) Red List assessment. Global assessments are available for many vertebrate pollinators, e.g., birds and bats (figure SPM.6A). An estimated 16.5 per cent of vertebrate pollinators are threatened with global extinction (increasing to 30 per cent for island species) ***(established but incomplete)*****, with a trend towards more extinctions** ***(well established)*****. Most insect pollinators have not been assessed at the global level** ***(well established)*****. Regional and national assessments of insect pollinators indicate high levels of threat, particularly for bees and butterflies (often more than 40 per cent of species threatened) (*****established but incomplete*****).** Recent European scale assessments indicate that 9 per cent of bees and 9 per cent of butterflies are threatened (**figure SPM.6B**) and that populations are declining for 37 per cent of bees and 31 per cent of butterflies (excluding data deficient species). For the majority of European bees, data are insufficient to make IUCN assessments. At the national level, where Red Lists are available they show that the numbers of threatened species tend to be much higher than at the regional level. In contrast, crop pollinating bees are generally common species and rarely threatened species. Of 130 common crop pollinating bees, only 58 species have been assessed either in Europe or North America, of which

only two species are threatened, two are near threatened, and 42 are not threatened (i.e., Least Concern IUCN risk category), and for 12 species data are insufficient for assessment. Of 57 species considered in a 2007 assessment of global crop pollination,[42] only 10 species have been formally assessed, of which one bumble bee species is critically endangered. However, at least 10 other species, including three honey bee species, are known to be very common, although the health of honey bee colonies should also be considered {3.2.2, 3.2.3}.

C. Drivers of change, risks and opportunities and policy and management options

A wealth of observational, empirical and modelling studies worldwide point to a high likelihood that many drivers have affected, and are affecting, wild and managed pollinators negatively (*established but incomplete*). However, a lack of data, particularly outside Western Europe and North America, and correlations between drivers make it very difficult to link long-term pollinator declines with specific direct drivers. Changes in pollinator health, diversity and abundance have generally led to locally reduced pollination of pollinator-dependent crops (lowering the quantity, quality or stability of yield) and have contributed to altered wild plant diversity at the local and regional scales, and resulted in the loss of distinctive ways of life, cultural practices and traditions as a result of pollinator loss (*established but incomplete*). Other risks, including the loss of aesthetic value or well-being associated with pollinators and the loss of long-term resilience in food production systems, could develop in the longer-term. The relative importance of each driver varies between pollinator species according to their biology and geographic location. Drivers can also combine or interact in their effects, complicating any ranking of drivers by risk[43] of harm (*unresolved*) {2.7, 4.5, 6.2.1}.

Habitat destruction, fragmentation and degradation, along with conventional intensive land management practices, often reduce or alter pollinators' food (*well established*) and nesting resources (*established but incomplete*). These practices include high use of agrochemicals and intensively performed tillage, grazing or mowing. Such changes in pollinator resources are known to lower densities and diversity of foraging insects and alter the composition and structure of pollinator communities from local to regional scales (*well established*) {2.2.1.1, 2.2.1.2, 2.2.2, 2.3.1.2, 2.3.1.3, 3.2}.

Three complementary strategies are envisaged for producing more sustainable agriculture that address several important drivers of pollinator decline: ecological intensification, strengthening existing diverse farming systems and investing in ecological infrastructure (table SPM.1). (i) Ecological intensification involves managing nature's ecological functions to improve agricultural production and livelihoods while minimizing environmental damage. (ii) Strengthening existing diverse farming systems involves managing systems such as forest gardens, home gardens and agroforestry to foster pollinators and pollination through practices validated by science or indigenous and local knowledge (e.g., crop rotation). (iii) Ecological infrastructure needed to improve pollination includes patches of semi-natural habitats distributed throughout productive agricultural landscapes, providing nesting and floral resources. These three strategies concurrently address several important drivers of pollinator decline by mitigating the impacts of land-use change, pesticide use and climate change (*established but incomplete*). The policies and practices that form them have direct economic benefits to people and livelihoods in many cases (*established but incomplete*). Responses identified for managing immediate risks in agriculture (table SPM.1) tend to mitigate only one or none of the drivers of pollinator decline. Some of these responses (marked with an asterisk in table SPM.1) have potential adverse effects, both on pollinators and for wider agricultural sustainability, that need to be quantified and better understood {2.2.1, 2.2.2, 2.3.1, 2.3.2.3, 3.2.3, 3.6.3, 5.2.8, 6.9}.

Responses known to reduce or mitigate negative agricultural impacts on pollinators include organic farming and planting flower strips, both of which increase local numbers of foraging pollinating insects (*well established*) and pollination (*established but incomplete*). Long-term abundance data (which are not yet available) would be required to establish whether these responses have population-level benefits. Evidence for the effects of organic farming comes largely from Europe and North America. Actions to enhance pollination on intensive farmland also enhance other ecosystem services, including natural pest regulation (*established but incomplete*). There are, however, potential trade-offs between enhancing yield and enhancing pollination. For example, in many, but not all, farming systems current organic practices usually produce lower yields (*well established*). Better

[42] Klein et al. (2007). "Importance of pollinators in changing landscapes for world crops." *Proceedings of the Royal Society B* 274:303-313.

[43] This assessment uses a scientific-technical approach to risk, in which a risk is understood as the probability of a specific, quantified hazard or impact taking place.

understanding the role of ecological intensification could address this issue of trade-off by increasing organic farm yields while boosting pollination benefits. The effects of this response, including its utility in reducing the tradeoff, represent a knowledge gap {6.4.1.1.1, 6.4.1.1.4, 6.7.1, 6.7.2}.

Greater landscape-scale habitat diversity often results in more diverse pollinator communities *(well established)* and more effective crop and wild plant pollination (*established but incomplete*). Depending on land use (e.g., agriculture, forestry, grazing, etc.,), landscape habitat diversity can be enhanced to support pollinators through intercropping; crop rotation including flowering crops; agroforestry; and creating, restoring or maintaining wildflower habitat or native vegetation (*well established*). The efficacy of such measures can be enhanced if implemented from field to landscape scales that correspond with pollinator mobility, hence assuring connectivity among these landscape features (*established but incomplete*) {2.2.2, 2.2.3, 3.2.3}. Such actions can be achieved by rewarding farmers or land managers for good practices (*well established*), by demonstrating the economic value of pollination services in agriculture, forestry or livestock production and by using (agricultural) extension services to convey knowledge and demonstrate practical application to farmers or land managers (*established but incomplete*). The protection of large areas of semi-natural or natural habitat (tens of hectares or more) helps to maintain pollinator habitats at regional or national scales (*established but incomplete*), but will not directly support agricultural pollination in areas that are more than a few kilometres away from large reserves because of the limited flight ranges of crop pollinators (*established but incomplete*). Enhancing connectivity at the landscape scale, for example by linking habitat patches (including with road verges), may enhance pollination of wild plants by enabling the movement of pollinators (*established but incomplete*), but its role in maintaining pollinator populations remains unclear {2.2.1.2, 6.4.1.1.10, 6.4.1.5, 6.4.1.3, 6.4.3.1.1, 6.4.3.1.2, 6.4.3.2.2, 6.4.5.1.6}.

Managing and mitigating the impacts of pollinator decline on people's good quality of life could benefit from responses that address loss of access to traditional territories, loss of traditional knowledge, tenure and governance, and the interacting, cumulative effects of direct drivers (*established but incomplete*). A number of integrated responses that address these drivers of pollinator decline have been identified: 1) food security, including the ability to determine one's own agricultural and food policies, resilience and ecological intensification; 2) conservation of biological and cultural diversity and the links between them; 3) strengthening traditional governance that supports pollinators; 4) prior and informed consent for conservation, development and knowledge-sharing; 5) recognizing tenure; 6) recognizing significant agricultural, biological and cultural heritage and 7) framing conservation to link with peoples' values {5.4, case examples 5-18, 5-19, 5-20, 5-21, 5-22, 5-23, 5-24, 5-25, 5-26, figures 5-26, 5-27, and box 5-3}.

Managing urban and recreational green spaces to increase the local abundance of nectar-providing and pollen-providing flowering plants increases pollinator diversity and abundance (*established but incomplete*), although it is unknown whether this has long-term benefits at the population level. Road verges, power lines, railway banks (*established but incomplete*) in cities also have a large potential for supporting pollinators if managed appropriately to provide flowering and nesting resources {6.4.5.1, 6.4.5.1.6}.

The risk to pollinators from pesticides arises through a combination of toxicity (compounds vary in toxicity to different pollinator species) and the level of exposure (*well established*). The risk also varies geographically, with the compounds used, with the type and scale of land management (*well established*) and potentially with the refuges provided by un-treated semi-natural or natural habitats in the landscape (*established but incomplete*). Insecticides are toxic to insect pollinators and the direct lethal risk is increased, for example, if label information is insufficient or not respected, where application equipment is faulty or not fit-for-purpose, or the regulatory policy and risk assessment are deficient (*well established*). A reduction of pesticide use or use within an established Integrated Pest Management approach would lower the risk of not sustaining populations of pollinators, many of which deliver pollination to crops and wild plants, but needs to be considered while balancing the need to ensure agricultural yields {2.3.1, 2.3.1.2, 2.3.1.3, and box 2.3.5}.

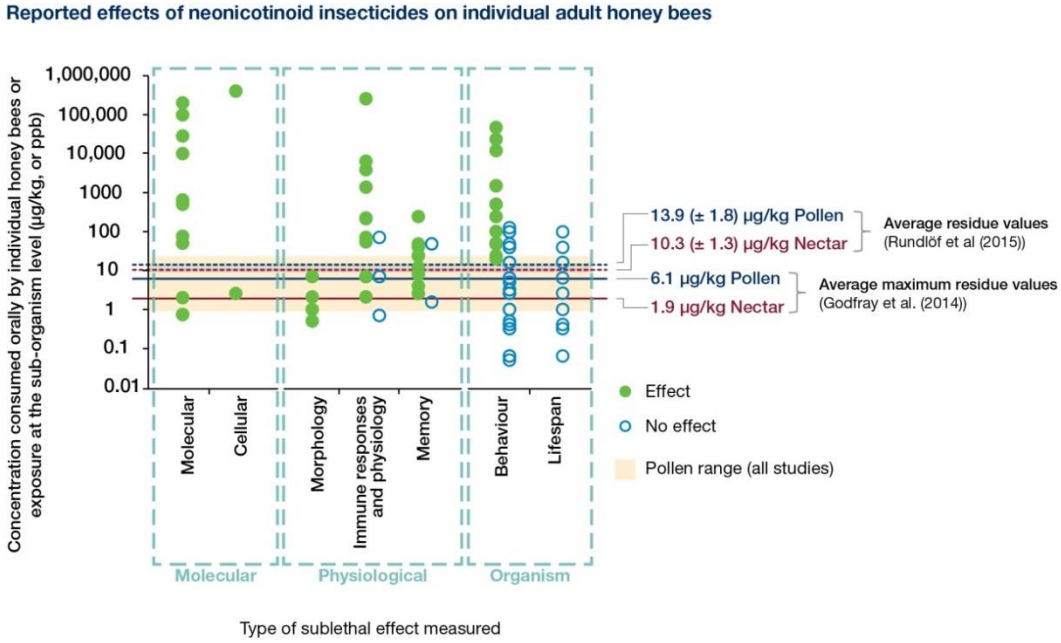

Figure SPM.7. This graph shows whether different concentrations of neonicotinoid insecticides have been reported to have sublethal (adverse, but not fatal) effects on individual adult honey bees (green closed circles) or not (blue open circles). Studies included used any one of three neonicotinoid insecticides: imidacloprid, clothianidin and thiamethoxam. Exposure was either by oral consumption or directly on internal organs and tissues. Different types of sublethal effect that have been tested from molecular to whole-organism (bee) scales are shown on the horizontal axis. Colony-level effects, such as growth or success of whole honey bee colonies, are not included. The shaded area shows the full range of concentrations (0.9-23 µg/Kg) that honey bees could be exposed to observed in pollen following seed treatment in all known field studies.
Levels of clothianidin in oilseed rape pollen (blue; 13.9 ± 1.8 µg/Kg, range 6.6–23 µg/Kg) and nectar (red; 10.3 ± 1.3 µg/Kg, range 6.7–16 µg/Kg) measured in a recent field study in Sweden (Rundlöf et al, 2015) are shown by dashed lines.
Maximum residues measured following seed treatment of crops reported by all the studies reviewed by Godfray et al. (2014) are shown by solid lines for pollen (blue, 6.1 µg/Kg) and nectar (red, 1.9 µg/Kg); lines show an average of the maximum values across studies. Honey bees feeding in fields consume only nectar. Honey bees staying in the hive also consume pollen (16 per cent of their diet; European Food Safety Authority (EFSA) 2013, United States Environmental Protection Agency (USEPA, 2014).[44]

Pesticides, particularly insecticides, have been demonstrated to have a broad range of lethal and sublethal effects on pollinators under controlled experimental conditions *(well established)*. The few available field studies assessing effects of field-realistic exposure (figure SPM.7) provide conflicting evidence of effects based on the species studied and pesticide usage (*established but incomplete*). It is currently unresolved how sublethal effects of pesticide exposure recorded for individual insects affect colonies and populations of managed bees and wild pollinators, especially over the longer term. Most studies of sublethal impacts of insecticides on pollinators have tested a limited range of pesticides, recently focusing on neonicotinoids, and have been carried out using honey bees and bumble bees, with fewer studies on other insect pollinator taxa. Thus, significant gaps in our knowledge remain (*well established*) with potential implications for comprehensive risk assessment. Recent research focusing on neonicotinoid insecticides shows evidence of lethal and sublethal effects on bees under controlled conditions (*well established*) and some evidence of impacts on the pollination they provide (*established but incomplete*). There is evidence from a recent study that shows impacts of neonicotinoids on wild pollinator survival and reproduction at actual field exposure

[44] EFSA (2013) "Guidance on the risk assessment of plant protection products on bees (*Apis mellifera*, *Bombus* spp. and solitary bees)". *EFSA Journal* 11: 3295; USEPA (2014) "Guidance for Assessing Pesticide Risks to Bees." *United States Environmental Protection Agency.*

(*established but incomplete*).[45] Evidence, from this and other studies, of effects on managed honey bee colonies is conflicting (*unresolved*). What constitutes a field realistic exposure, as well as the potential synergistic and long-term effects of pesticides (and their mixtures), remain unresolved. (2.3.1.4)

Risk assessment of specific pesticide ingredients and regulation based on identified risks are important responses that can decrease the environmental hazard from pesticides used in agriculture at the national level (*established but incomplete*) {2.3.1.1, 2.3.1.3, 6.4.2.4.1}. Pesticide exposure can be reduced by decreasing the usage of pesticides, for example by adopting Integrated Pest Management practices, and where they are used, the impacts of pesticides can be lessened through application practices and technologies to reduce pesticide drift (*well established*) {2.3.1.3, 6.4.2.1.2, 6.4.2.1.3, 6.4.2.1.4}. Education and training are necessary to ensure that farmers, farm advisers, pesticide appliers and the public use pesticides safely (*established but incomplete*). Policy strategies that can help to reduce pesticide use, or avoid misuse, include supporting farmer field schools, which are known to increase the adoption of Integrated Pest Management practices as well as agricultural production and farmer incomes (*well established*). The FAO International Code of Conduct on the Distribution and Use of Pesticides sets out voluntary actions for Government and industry, although, a survey from 2004 and 2005 suggests that only 15 per cent of countries are using it {6.4.2.1, 6.4.2.2.5, 6.4.2.2.6, 6.4.2.4.2}. Research aimed at improving the effectiveness of pest management in pesticide-free and pesticide minimized (e.g., Integrated Pest Management) farming systems would help provide viable alternatives to conventional high chemical input systems that are productive while at the same time reducing the risks to pollinators.

Use of herbicides to control weeds indirectly affects pollinators by reducing the abundance and diversity of flowering plants providing pollen and nectar (*well established*). Agricultural and urban land management systems that allow a variety of weedy species to flower support more diverse communities of pollinators, which can enhance pollination (*established but incomplete*) {2.2.2.1.4, 2.2.2.1.8, 2.2.2.1.9, 2.2.2.3, 2.3.1.2, 2.3.1.4.2}. This can be achieved by reducing herbicide use or taking less stringent approaches to weed control, paying careful attention to the potential trade-off with crop yield and control of invasive alien species {2.3, 6.4.2.1.4, 6.4.5.1.3.}. One possible approach is demonstrated by traditional diversified farming systems, in which weeds themselves are valued as supplementary food products {5.3.3, 5.3.4, 5.4.2, 6.4.1.1.8}. The potential direct sublethal effects of herbicides on pollinators are largely unknown and seldom studied {2.3.1.4.2}.

Most agricultural genetically modified organisms (GMOs) carry traits for herbicide tolerance (HT) or insect resistance (IR). Reduced weed populations are likely to accompany most herbicide-tolerant (HT) crops, diminishing food resources for pollinators (*established but incomplete*). The actual consequences for the abundance and diversity of pollinators foraging in herbicide-tolerant (HT)-crop fields is unknown {2.3.2.3.1}. Insect-resistant (IR) crops result in the reduction of insecticide use, which varies regionally according to the prevalence of pests, and the emergence of secondary outbreaks of non-target pests or primary pest resistance (*well established*). If sustained, this reduction in insecticide use could reduce pressure on non-target insects (*established but incomplete*). How insect-resistant-(IR) crop use and reduced pesticide use affect pollinator abundance and diversity is unknown {2.3.2.3.1}. No direct lethal effects of insect-resistant (IR) crops (e.g., producing *Bacillus thuringiensis* (Bt) toxins) on honey bees or other Hymenoptera have been reported. Lethal effects have been identified in some butterflies (*established but incomplete*), while data on other pollinator groups (e.g., hoverflies) are scarce {2.3.2.2}. The ecological and evolutionary effects of potential transgene flow and introgression in wild relatives and non-genetically modified crops on non-target organisms, such as pollinators, need study {2.3.2.3.2}. The risk assessment required for the approval of genetically-modified-organism (GMO) crops in most countries does not adequately address the direct sublethal effects of insect-resistant (IR) crops or the indirect effects of herbicide-tolerant (HT) and insect-resistant (IR) crops, partly because of a lack of data {6.4.2.6.1}. Quantifying the direct and indirect impacts of genetically-modified organisms (GMOs) on pollinators would help to inform whether, and to what extent, response options are required.

Declines in the number of managed western honey bee colonies are due in part to socio-economic changes affecting beekeeping and/or poor management practices (*unresolved*) {3.3.2}. While pollinator management has developed over thousands of years, there are opportunities for further substantial innovation and improvement of management practices, including better management of parasites and pathogens (*well established*) {3.3.3, 3.4.3, 6.4.4.1.1.2}, improving selection for desired traits in bees (*well established*) and breeding for genetic diversity (*well established*) {6.4.4.1.1.3}.

[45] Rundlöf et al. (2015). Seed coating with a neonicotinoid insecticide negatively affects wild bees. Nature 521: 77-80 doi:10. 1038/nature14420.

Successful management of bees, including honey bees and stingless bees, often depends on local and traditional knowledge systems. The erosion of those knowledge systems, particularly in tropical countries, may contribute to local declines (*established but incomplete*) {3.3.2, 6.4.4.5}.

Insect pollinators suffer from a broad range of parasites, with *Varroa* mites attacking and transmitting viruses among honey bees being a notable example (*well established*). Emerging and re-emerging diseases (e.g., due to host shifts of both pathogens and parasites) are a significant threat to the health of honey bees (*well established*), bumble bees and solitary bees (*established but incomplete* for both groups) during the trade and management of commercial bees for pollination {2.4, 3.3.3, 3.4.3}. The western honey bee, *Apis mellifera*, has been moved around the world, and this has resulted in a spill over of pathogens both to this species, in the case of the *Varroa* mite, and from this species to wild pollinators, such as deformed wing virus (*established but incomplete*). Greater emphasis on hygiene and the control of pests (*Varroa* and other pests) and pathogens in managed insect pollinators would have health benefits for the entire community of pollinators, managed and wild, by limiting pathogen spread. There are no proven options for treating viruses in any managed pollinator species, but ribonucleic acid interference (RNAi) technology could provide one pathway toward such treatment (*established but incomplete*) {6.4.4.1.1.2.3.1}. *Varroa* mites, a key parasite of honey bees, have developed resistance to some chemical treatments (*well established*) so new treatment options are required {2.4, 3.2.3, 3.3.3, 3.4.3, 6.4.4.1.1.2.3.5}. Other stressors, such as exposure to chemicals or insufficient nutrition, may sometimes worsen the impacts of disease (*unresolved*) {2.7}. In comparison, there is very little research on diseases of other pollinators (e.g., other insects, birds, bats) {2.4}.

Commercial management, mass breeding, transport and trade in pollinators outside their original ranges have resulted in new invasions, transmission of pathogens and parasites and regional extinctions of native pollinator species (*well established*). Recently developed commercial rearing of bumble bee species for greenhouse and field crop pollination, and their introduction to continents outside of their original ranges, have resulted in biological invasions, pathogen transmission to native species and the decline of congeneric (sub-)species (*established but incomplete*). A well-documented case is the severe decline in and extirpation from many areas of its original range of the giant bumble bee, *Bombus dahlbomii*, since the introduction and spread of the European *B. terrestris* in southern South America (*well established*) {3.2.3, 3.3.3, 3.4.32, 3.4.3}. The presence of managed honey bees and their escaped descendants (for example African honey bees in the Americas) have changed visitation patterns to the native plants in those regions (*unresolved*) {3.2.3, 3.3.2, 3.4.2, 3.4.3}. Better regulation of the movement of all species of managed pollinators around the world, and within countries, can limit the spread of parasites and pathogens to managed and wild pollinators alike and reduce the likelihood that pollinators will be introduced outside their native ranges and cause negative impacts (*established but incomplete*) {6.4.4.2}.

The impact of invasive alien species on pollinators and pollination is highly contingent on the identity of the invader and the ecological and evolutionary context (*well established*) {2.5, 3.5.3}. Alien plants or alien pollinators change native pollinator networks, but the effects on native species or networks can be positive, negative or neutral depending on the species involved {2.5.1, 2.5.2, 2.5.5, 3.5.3}. Introduced invasive pollinators when reaching high abundances can damage flowers, thereby reducing wild plant reproduction and crop yield (*established but incomplete*) {6.4.3.1.4}. Invasive alien predators can affect pollination by consuming pollinators (*established but incomplete*) {2.5.4}. The impacts of invasive aliens are exacerbated or altered when they exist in combination with other threats such as disease, climate change and land-use change (*established but incomplete*) {2.5.6, 3.5.4}. Eradicating invasive species that negatively impact pollinators is rarely successful, and so policies that focus on mitigating their impact and preventing new invasions are important (*established but incomplete*) {6.4.3.1.4}.

Some pollinator species (e.g., butterflies) have moved their ranges, altered their abundance and shifted their seasonal activities in response to observed climate change over recent decades, while for many other pollinators climate change-induced shifts within habitats have had severe impacts on their populations and overall distribution (*well established*) {2.6.2.2, 3.2.2}. Generally, the impacts of ongoing climate change on pollinators and pollination services and agriculture may not be fully apparent for several decades owing to delayed response times in ecological systems (*well established*). Beyond 2050, all climate change scenarios reported by the Intergovernmental Panel on Climate Change suggest that (i) community composition is expected to change as certain species decrease in abundance while others increase (*well established*) {2.6.2.3, 3.2.2}; and (ii) the seasonal activity of many species is projected to change differentially, disrupting life cycles and interactions between species (*established but incomplete*) {2.6.2.1}. The rate of change of the climate across the

landscape, especially under mid-end and high-end IPCC greenhouse gas emissions scenarios[46] is predicted to exceed the maximum speed at which many pollinator groups (e.g., many bumble bee and butterfly species), can disperse or migrate, in many situations despite their mobility (*established but incomplete*) {2.6.2.2}. For some crops, such as apple and passion fruit, model projections at national scales have shown that climate change may disrupt crop pollination because the areas with the best climatic conditions for crops and their pollinators may no longer overlap in future (*established but incomplete*) {2.6.2.3}. Adaptive responses to climate change include increasing crop diversity and regional farm diversity and targeted habitat conservation, management and restoration. The effectiveness of adaptation efforts at securing pollination under climate change is untested. There are prominent research gaps in understanding climate change impacts on pollinators and efficient adaptation options {6.4.1.1.12, 6.4.4.1.5, 6.5.10.2, 6.8.1}.

The many drivers that directly impact the health, diversity and abundance of pollinators, from the gene to the biome scales, can combine in their effects and thereby increase the overall pressure on pollinators (*established but incomplete*) {2.7}. Indirect drivers (demographic, socio-economic, institutional and technological) are producing environmental pressures (direct drivers) that alter pollinator diversity and pollination (*well established*). The growth in global human population, economic wealth, globalized trade and commerce and technological developments (e.g. increased transport efficacy) has transformed the climate, land cover and management intensity, ecosystem-nutrient balance and biogeographical distribution of species (*well established*). This has had, and continues to have, consequences for pollinators and pollination worldwide (*well established*)**.** In addition, the area of land devoted to growing pollinator-dependent crops has increased globally in response to market demands from a growing and increasingly wealthy population, albeit with regional variations (*well established*) {2.8, 3.7.2, 3.7.3, 3.8}.

The variety and multiplicity of threats to pollinators and pollination generate risks to people and livelihoods (*well established*). In some parts of the world, there is evidence of impacts on peoples' livelihoods from crop pollination deficits (leading to lower yield and quality of food production, and human diet quality) and loss of distinctive ways of life, cultural practices and traditions. These risks are largely driven by changes in land cover and agricultural management systems, including pesticide use (*established but incomplete*) {2.2.1, 2.2.2, 2.3.1, 2.3.2.3, 3.2.2, 3.3.3, 3.6, 3.8.2, 3.8.3, 5.4.1, 5.4.2, 6.2.1}.

The strategic responses to the risks and opportunities associated with pollinators and pollination range in ambition and timescale from immediate, relatively straightforward, responses that reduce or avoid risks to relatively large-scale and long-term transformative responses. Table SPM.1 summarizes various strategies linked to specific responses based on the experiences and evidence described in this assessment.

Table SPM.1: Overview of strategic responses to risks and opportunities associated with pollinators and pollination. Examples of specific responses are provided, selected from chapters 5 and 6 of the assessment report to illustrate the scope of each proposed strategy. This is not a comprehensive list of available responses and represents around half of the available options covered in the assessment report. Not all the responses shown for "improving current conditions" will benefit pollinators in the long term, and those with potential adverse, as well as positive, effects are marked with an asterisk. All the responses from chapter 6 that are already being implemented somewhere in the world and have well established evidence of direct (rather than assumed or indirect) benefits to pollinators are included in the table and are highlighted in bold.

[46] As presented in the scenario process for the fifth assessment report of the Intergovernmental Panel on Climate Change (http://sedac.ipcc-data.org/ddc/ar5_scenario_process/RCPs.html).

Ambition	Strategy	Examples of responses	Chapter references
Improving current conditions for pollinators and/or maintaining pollination	**Manage immediate risks**	• **Create uncultivated patches of vegetation such as field margins with extended flowering periods**	2.2.1.1, 2.2.1.2, 2.2.2.1.1, 2.2.2.1.4, 6.4.1.1.1, 5.2.7.5, 5.2.7.7, 5.3.4
		• Manage blooming of mass-flowering crops*	2.2.2.1.8, 2.2.3, 6.4.1.1.3,
		• Change management of grasslands	2.2.2.2, 2.2.3, 6.4.1.1.7
		• **Reward farmers for pollinator-friendly practices**	6.4.1.3, 5.3.4
		• Inform farmers about pollination requirements	5.4.2.7, 2.3.1.1, 6.4.1.5
		• Raise standards of pesticide and genetically-modified organism (GMO) risk assessment	2.3.1.2, 2.3.1.3, 6.4.2.1.1, 6.4.2.2.5
		• Develop and promote the use of technologies that reduce pesticide drift and agricultural practices that reduce exposure to pesticides	2.3.1.2, 2.3.1.3, 6.4.2.1.3, 6.4.2.1.2
		• Prevent infections and treat diseases of managed pollinators; regulate trade in managed pollinators	2.4, 6.4.4.1.1.2.2, 6.4.4.1.1.2.3, 6.4.4.2
		• Reduce pesticide use (includes Integrated Pest Management, IPM)	6.4.2.1.4
	Utilize immediate opportunities	• Support product certification and livelihood approaches	5.4.6.1, 6.4.1.3
		• **Improve managed bee husbandry**	2.4.2, 4.4.1.1, 5.3.5, 6.4.4.1.3
		• Develop alternative managed pollinators*	2.4.2
		• Quantify the benefits of managed pollinators	6.4.1.3, 6.4.4.3
		• Manage road verges*	2.2.2.2.1, 6.4.5.1.4, 6.4.5.1.6
		• Manage rights of way and vacant land in cities to support pollinators	2.2.2.3, 6.4.5.1.4, 6.4.5.1.6, 6.4.5.4
Transforming agricultural landscapes	**Ecologically intensify agriculture through active management of ecosystem services**	• **Support diversified farming systems**	2.2.1.1, 2.2.1.2, 2.2.2.1.1, 2.2.2.1.6, 5.2.8, 5.4.4.1, 6.4.1.1.8
		• Promote no-till agriculture	2.2.2.1.3, 6.4.1.1.5
		• Adapt farming to climate change	2.7.1, 6.4.1.1.12
		• Encourage farmers to work together to plan landscapes; engage communities (participatory management)	5.2.7, 5.4.5.2, 6.4.1.4
		• Promote Integrated Pest Management (IPM)	2.2.2.1.1, 2.3.1.1, 6.4.2.1.4, 6.4.2.2.8, 6.4.2.4.2
		• Monitor and evaluate pollination on farms	5.2.7, 6.4.1.1.10
		• Establish payment for pollination services schemes	6.4.3.3
		• Develop and build markets for alternative managed pollinators	6.4.4.1.3, 6.4.4.3
		• Support traditional practices for managing habitat patchiness, crop rotation and co-production of knowledge between indigenous and local knowledge holders, scientists and stakeholders	2.2.2.1.1, 2.2.3, 5.2.7, 5.4.7.3, 6.4.6.3.3

Ambition	Strategy	Examples of responses	Chapter references
	Strengthen existing diversified farming systems	• **Support organic farming systems; diversified farming systems; and food security**, including the ability to determine one's own agricultural and food policies, resilience and ecological intensification	2.2.2.1.1, 2.2.2.1.6, 5.2.8, 5.4.4.1, 6.4.1.1.4, 6.4.1.1.8
		• Support "biocultural diversity" conservation approaches through recognition of rights, tenure and strengthening of indigenous and local knowledge and traditional governance that supports pollinators	5.4.5.3, 5.4.5.4, 5.4.7.2, 5.4.7.3
	Invest in ecological infrastructure	• **Restore natural habitats** (also in urban areas)	6.4.3.1.1, 6.4.5.1.1, 6.4.5.1.2
		• Protect heritage sites and practices	5.2.6, 5.2.7, 5.3.2, 5.4.5.1, 5.4.5.3
		• Increase connectivity between habitat patches	2.2.1.2, 6.4.3.1.2
		• Support large-scale land-use planning and traditional practices that manage habitat patchiness and "biocultural diversity"	5.1.3, 5.2.6, 5.2.7, 5.2.9, 6.4.6.2.1
Transforming society's relationship with nature	**Integrate peoples' diverse knowledge and values into management**	• Translate pollinator research into agricultural practices	2.2.1, 2.2.2, 2.2.3, 2.2.1.2, 6.4.1.5, 6.4.4.5
		• Support knowledge co-production and exchange among indigenous and local knowledge holders, scientists and stakeholders	5.4.7.3, 6.4.1.5, 6.4.6.3.3
		• Strengthen indigenous and local knowledge that fosters pollinators and pollination, and knowledge exchange among researchers and stakeholders	5.2.7, 5.4.7.1, 5.4.7.3, 6.4.4.5, 6.4.6.3.3
		• Support innovative pollinator activities that engage stakeholders with attachments to the multiple socio-cultural values of pollinators	5.2.3, 5.3.2, 5.3.3, 5.3.4, 5.4.7.1, 6.4.4.5
	Link people and pollinators through collaborative, cross sectoral approaches	• Monitor pollinators (collaboration between farmers, the broader community and pollinator experts)	5.2.4, 5.4.7.3, 6.4.1.1.10, 6.4.4.5, 6.4.6.3.4
		• Increase taxonomic expertise through education, training and technology	6.4.3.5
		• Education and outreach programmes	5.2.4, 6.4.6.3.1
		• Manage urban spaces for pollinators and collaborative pathways	6.4.5.1.3
		• Support high-level pollination initiatives and strategies	5.4.7.4, 6.4.1.1.10, 6.4.6.2.2

Indigenous and local knowledge systems, in co-production with science, can be a source of solutions for the present challenges confronting pollinators and pollination (*established but incomplete*). Knowledge co-production activities between farmers, indigenous peoples, local communities and scientists have led to numerous relevant insights including: improvements in hive design for bee health; understanding pesticide uptake into medicinal plants and the impacts of the mistletoe parasite on pollinator resources; identification of species of stingless bees new to science; establishing baselines to understand trends in pollinators; improvements in economic returns from forest honey; identification of change from traditional shade-grown to sun-grown coffee as the cause of declines in migratory bird populations; and a policy response to risk of harm to pollinators leading to a restriction on the use of neonicotinoids in the European Union (5.4.1, 5.4.2.2, 5.4.7.3, tables 5-4 and 5-5).

Long-term monitoring of wild and managed pollinators and pollination can provide crucial data for responding rapidly to threats such as pesticide poisonings and disease outbreaks, as well as long-term information about trends, chronic issues and the effectiveness of interventions (*well established*). Such monitoring would address major knowledge gaps on the status and trends of pollinators and pollination, particularly outside Western Europe. Wild pollinators can be monitored to some extent through citizen science projects focused on bees, birds or pollinators generally {6.4.1.1.10, 6.4.6.3.4}.

Many actions to support pollinators are hampered in their implementation through governance deficits, including fragmented multi-level administrative units, mismatches between fine-scale variation in practices that protect pollinators and homogenizing broad-scale government policy, contradictory policy goals across sectors and contests over land use (*established but incomplete*). Coordinated, collaborative action and knowledge sharing that strengthens linkages across sectors (e.g., agriculture and nature conservation), across jurisdictions (e.g., private, Government, not-for-profit), and among levels (e.g., local, national, global) can overcome many of these governance deficits. The establishment of social norms, habits and motivation that are the key to effective governance outcomes involves long time frames {5.4.2.8, 5.4.7.4}. However, the possibility that contradictions between policy sectors may remain even after coordination efforts have been undertaken should be acknowledged and should be a point of attention in future studies.

Appendix 1

Terms that are central to understanding the summary for policymakers

The conceptual framework of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services is a highly simplified model of the complex interactions within and between the natural world and human societies. The framework includes six interlinked elements constituting a system that operates at various scales in time and space (**figure SPM.A1**): 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. This figure (adapted from Díaz et al. 2015[47]) is a simplified version of that adopted by the Plenary of the Platform in its decision IPBES-2/4. It retains all its essential elements, with additional text used to demonstrate its application to the pollinators, pollination and food production thematic assessment.

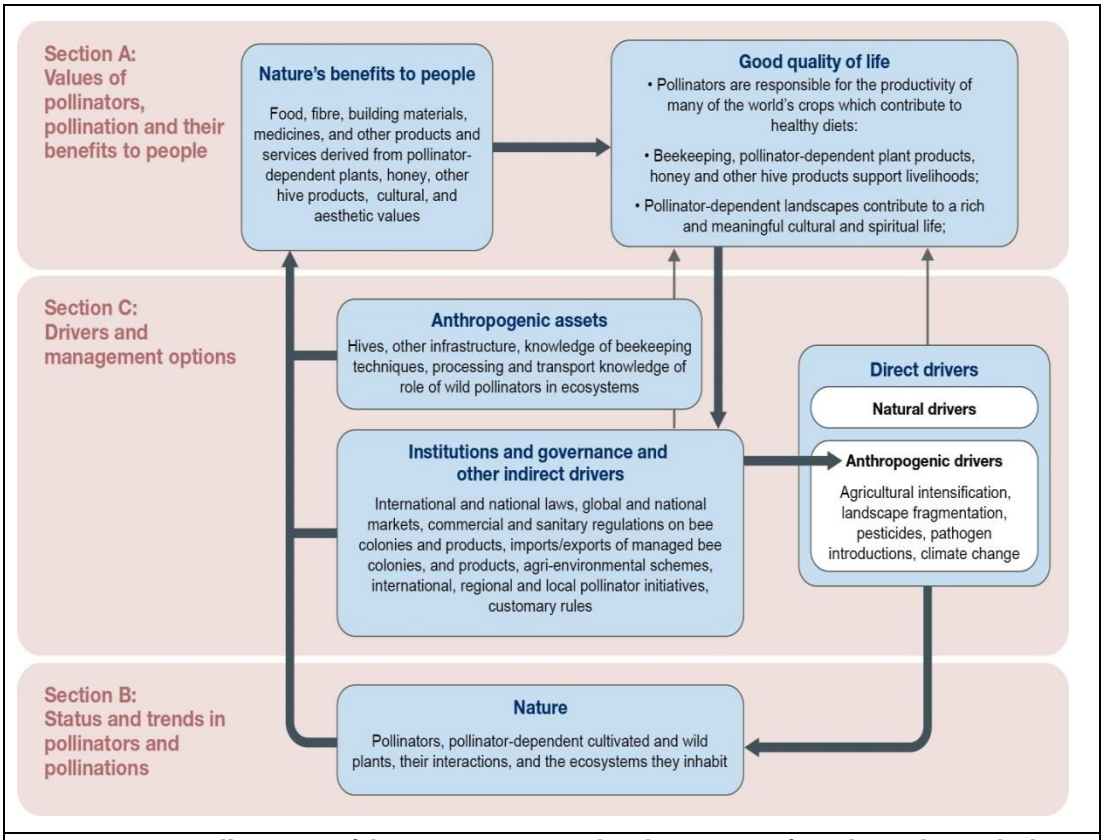

Figure SPM.A1: Illustration of the core concepts used in the summary for policymakers, which are based on the Platform's conceptual framework. Boxes represent main elements of nature and society and their relationships; headings in boxes are inclusive categories embracing both western science and other knowledge systems; thick arrows denote influence between elements (thin arrows denote links that are acknowledged as important, but are not the main focus of the Platform). Examples below bolded headings are purely illustrative and not intended to be exhaustive.

Key elements of the Platform's conceptual framework

"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.

"Anthropogenic assets" refers to 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. Anthropogenic assets have been highlighted to emphasize that a good quality of life is achieved by a co-production of benefits between nature and societies.

"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 the detrimental as well as the 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.

"Drivers of change" refers to all those external factors (i.e., generated outside the conceptual framework element in question) that affect nature, anthropogenic assets, nature's benefits to people and 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 make 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.

"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 that varies strongly across different societies and groups within societies. It is a state of individuals and human groups that is dependent on context, including access to food, water, energy and livelihood security, 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.

[47] Díaz et al. (2015) "The IPBES Conceptual Framework - connecting nature and people" *Current Opinion in Environmental Sustainability* 14: 1–16.

Appendix 2

Communication of the degree of confidence

In this assessment, the degree of confidence in each main finding is based on the quantity and quality of evidence and the level of agreement regarding that evidence (**figure SPM.A2**). The evidence includes data, theory, models and expert judgement. Further details of the approach are documented in the note by the secretariat on the guide to the production and integration of assessments of the Platform (IPBES/4/INF/9).

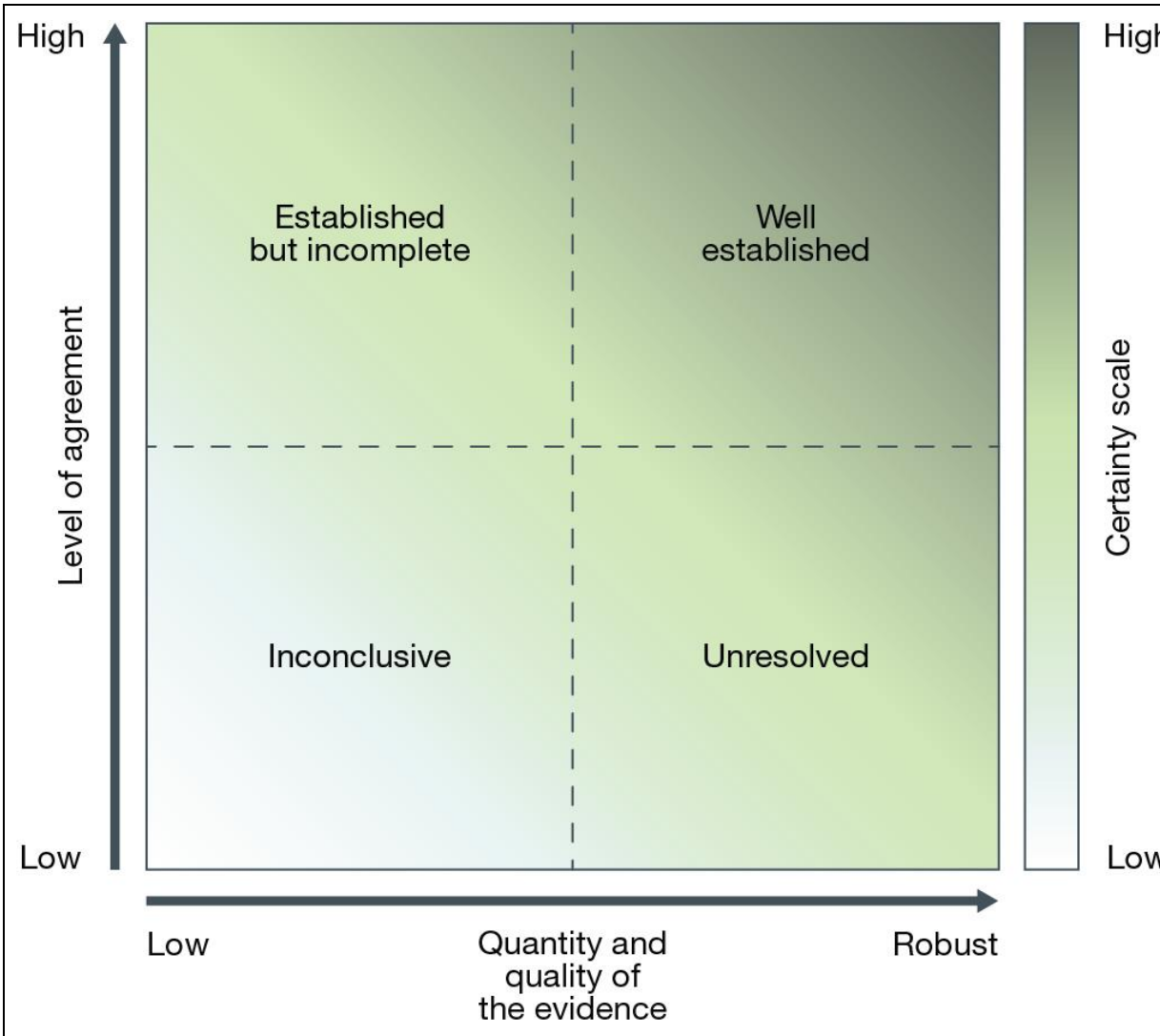

Figure SPM.A2: The four-box model for the qualitative communication of confidence. Confidence increases towards the top-right corner as suggested by the increasing strength of shading. Source: modified from Moss and Schneider (2000).[48]

[48] Moss R.H. and Schneider S.H. (2000) "Uncertainties in the IPCC TAR: Recommendations to lead authors for more consistent assessment and reporting", *Guidance Papers on the Cross Cutting Issues of the Third Assessment Report of the IPCC* [eds. R. Pachauri, T. Taniguchi and K. Tanaka], World Meteorological Organization, Geneva, pp. 33–51.

The summary terms to describe the evidence are:

- **Well established**: comprehensive meta-analysis[49] or other synthesis or multiple independent studies that agree.
- **Established but incomplete**: general agreement although only a limited number of studies exist; no comprehensive synthesis and/or the studies that exist address the question imprecisely.
- **Unresolved**: multiple independent studies exist but conclusions do not agree.

Inconclusive: limited evidence, recognizing major knowledge gaps.

[49] A statistical method for combining results from different studies that aims to identify patterns among study results, sources of disagreement among those results or other relationships that may come to light in the context of multiple studies.

Annex III to decision IPBES-4/1

Scoping for a thematic assessment of invasive alien species and their control (deliverable 3 (b) (ii))

I. Scope, rationale, utility and assumptions

A. Scope

1. The objective of the proposed thematic assessment of invasive alien species and their control is to assess the array of such species that affect biodiversity and ecosystem services; the extent of the threat posed by such species to various categories of biodiversity and ecosystem services, including impacts on agrobiodiversity and food, human health and livelihood security; the major pathways for and drivers of the introduction and spread of such species between and within countries; the global status of and trends in the impacts of such species and associated management interventions by region and subregion, taking into account various knowledge and value systems; the level of awareness of the extent of invasive alien species and their impacts; and the effectiveness of current international, national and subnational control measures and associated policy options that could be employed to prevent, eradicate and control invasive alien species. Emphasis should be placed on response options.

2. For purposes of the assessment, invasive alien species are defined as animals, plants or other organisms introduced directly or indirectly by people into places out of their natural range of distribution, where they have become established and dispersed, generating an impact on local ecosystems and species.

3. The assessment will focus on species fitting this definition, especially those with a demonstrable impact on or risk for biodiversity and, through their effects on ecosystem services, human well-being. In addition, however, for the assessment to be most useful for policy formulation it should assess not only the current impacts of invasive alien species, but also sources of emerging risk. The assessment should also recognize that invasive alien species do not constitute a purely passive phenomenon. Most of the movement of species is human mediated or human driven, e.g., through trade. Lastly, the assessment could suggest prevention and management strategies that are sensitive to the fact that many alien species may be both problematic and useful. Furthermore, some species will be manageable, but others will be intractable and need to be recognized as such. Responses, including strategies for prevention and adaptive management, will therefore need to be flexible and pragmatic.

B. Geographic coverage of the assessment

4. The assessment will be global, encompassing invasive alien species in terrestrial, freshwater and marine ecosystems.

C. Rationale

5. The proposed assessment responds directly to Aichi Biodiversity Target 9: “By 2020, invasive alien species and pathways are identified and prioritized, priority species are controlled or eradicated, and measures are in place to manage pathways to prevent their introduction and establishment”, as contained in the Strategic Plan for Biodiversity 2011–2020.[50] It also contributes directly to Sustainable Development Goal 15, target 15.8, of the 2030 Agenda for Sustainable Development: “By 2020, introduce measures to prevent the introduction and significantly reduce the impact of invasive alien species on land and water ecosystems and control or eradicate the priority species” (https://sustainabledevelopment.un.org/post2015/transformingourworld). Lastly, it will also contribute to the achievement of Aichi Biodiversity Targets 5, 11, 12 and 17 and help to determine priorities for prevention and management under these targets. Invasive alien species are acknowledged as major drivers of species extinctions globally; they degrade habitats and have serious impacts on protected areas around the world.

6. Invasive alien species constitute one of the most serious and rapidly growing threats to biodiversity, ecosystem services and food, health and livelihood security. Invasive alien species often show newly evolved traits, such as increased competitive and dispersal abilities in new habitats. For many countries, invasive alien species are seen as a more serious threat than climate change. Such species have been responsible for the extinction of native plants and animals, degradation of rare and

[50] Decision X/2 of the Conference of the Parties to the Convention on Biological Diversity, annex. Available at www.cbd.int/sp/targets.

threatened ecosystems and ecological communities, crop failure and declining agricultural productivity, loss of cultivar and animal breed diversity and damage to property, infrastructure, native fisheries, tourism and outdoor recreation. The threats to native biodiversity from marine invasive alien species, either from deliberate or accidental introductions (e.g., in contaminated ballast water or as encrusting organisms on ships), are increasingly serious and very poorly understood.

7. A large proportion of globally and locally threatened species and ecosystems are at risk from invasive alien species. Habitat loss remains the primary threat to most species, but the impact of invasive alien species is an additional significant threat. The impacts on oceanic islands are serious, with a majority of all extinctions of mammals, birds, amphibians, reptiles, land crabs, land snails and insects being directly or indirectly the result of invasive alien species. They also have a significant impact on economies: worldwide, for example, it has been estimated that the cost of damage from such species in 2001 exceeded $1.4 trillion, amounting to 5 per cent of the global economy.[51] The use of pesticides to control invasive alien species is also a major cause of the loss of biodiversity and represents a threat to human health. Similarly, invasive alien species may introduce pathogens leading to signficant public and agricultural health burden and associated disease treatment and control cost.

D. Utility

8. The rapidly growing threat that invasive alien species pose to biodiversity, ecosystem services, sustainable development and human well-being is generally poorly quantified and understood by decision makers. The proposed assessment would raise awareness of the nature and seriousness of the threat posed by such species and identify policies that could be used at the international level and by Governments, the private sector and civil society to prevent the spread of, eradicate or control the impact of invasive alien species. This assessment would highlight how the Platform can add value to policy formulation to address the biodiversity crisis.

9. The assessment will aim to address, inter alia, questions of relevance to decision makers dealing with invasive alien species, such as:

(a) What progress has been made in tackling the Aichi Biodiversity Targets of relevance to invasive alien species globally?

(b) What global-level policy initiatives would assist in invasive alien species prevention and management?

(c) What are the obstacles to the uptake of invasive alien species prevention and management measures?

(d) What methods are available for prioritizing invasive alien species threats?

(e) How can networks assist in the prevention and management of invasive alien species? What role can regional partnerships play?

(f) Are there perverse policy drivers that unintentionally create risks in relation to invasive alien species?

(g) How can decision makers decide which issues to tackle first given limited resources?

(h) Would there be value in developing a database of effective legislation, monitoring and response systems for invasive alien species, and of those countries and other stakeholders in need of capacity-building?

(i) What are the impacts, risks and benefits of invasive alien species for biodiversity and ecosystem services, sustainable development and human well-being?

(j) How might policy sectors, businesses, non-governmental organizations and other stakeholders benefit from better prevention and management of invasive alien species?

(k) How does one prevent and manage invasive alien species that cause harm to biodiversity but contribute to economic activities?

E. Assumptions

10. The proposed assessment will be based on existing assessments, scientific literature, grey literature and indigenous and local knowledge and will draw on the work of existing institutions and networks (see section IV on relevant stakeholders). The assessment team will be able to draw upon a

[51] Pimentel, D., et al., 2001. "Economic and environmental threats of alien plant, animal, and microbe invasions". *Agriculture, Ecosystems and Environment* 84: 1–20.

list of references of published and grey literature, along with comments assembled during the e-conference scoping process. Levels of confidence, as outlined in the Platform's guide for assessments, will be assigned to all findings. The assessment expert group will be diverse in terms of skills, gender and global coverage.

11. The assessment expert group will consist of 2 co-chairs, 52 authors and 12 review editors, who will be selected in accordance with the procedures for the preparation of the Platform's deliverables following a call for nominations after approval of the scoping report by the Plenary. The assessment expert group will be supported by a technical support unit (comprising one full-time equivalent Professional staff member).

12. As requested by the Plenary at its third session, the Multidisciplinary Expert Panel, in consultation with the Bureau, has developed a coordinated approach for regional and subregional assessments and thematic assessments. In accordance with this approach, ten authors with expertise in invasive alien species have been embedded in each of the expert groups for the four regional assessments approved by the Plenary at its third session.[52] These 40 experts are to contribute both to the regional assessments and, by virtual means, to the thematic assessment of invasive alien species. In addition, two of these ten experts from each of the regional assessments will be fully integrated, as lead authors, in the expert group for the invasive alien species assessment in order to ensure full coherence among all the assessments with regard to work on such species.

II. Chapter outline

13. The thematic assessment report will be a policy-relevant six-chapter report, as set out below.

14. Chapter 1 will be an introduction to the assessment. It will introduce the concept of invasive alien species. It will include terminology and definitions; the risks posed by such species to marine, freshwater and terrestrial ecosystems; information on invasive alien species in the context of the Platform's conceptual framework; and a brief overview of the importance of understanding perceptions of invasive alien species in the context of different value systems. The chapter provides a roadmap to the assessment.

15. Chapter 2 will provide an analysis and synthesis of previously completed invasive alien species assessments, the Platform's regional assessments, the scientific and grey literature and information from indigenous and local knowledge systems. The chapter should provide a synthesis of past and future trends in the spread, pathways, evolutionary change and distribution of invasive alien species and identify gaps in existing knowledge.

16. Chapter 3 will provide an analysis and synthesis of direct and indirect drivers responsible for, inter alia, the introduction, spread, abundance and dynamics of invasive alien species from previous assessments, Platofrm regional assessments, the scientific and grey literature and information from indigenous and local knowledge systems.

17. Chapter 4 will provide a global and overall analysis and synthesis of the environmental, economic and social impact of invasive alien species from previous assessments, including the Platform's regional and subregional assessments, the scientific and grey literature and information from indigenous and local knowledge systems. The chapter will focus on the impact of invasive alien species on nature and nature's benefits to people and a good quality of life, as defined in the conceptual framework, including non-economic values, e.g., cultural, social and shared, recreational, scientific, spiritual and aesthetic values.

18. Chapter 5 will review the effectiveness of past and current programmes and tools for the global, national and local prevention and management of invasive alien species and their impacts. In particular, the chapter will consider and assess past experience with:

(a) Preventing the international and intranational spread of invasive alien species, including the role of trade and economic development;

(b) The precautionary approach in preventing and managing invasive alien species and the efficacy of risk assessment as a tool for managing such species;

(c) National quarantine measures and the adoption of biosecurity approaches;

[52] The undertaking of four regional assessments was approved by the Plenary in decision IPBES-3/1, section III, paragraph 1.

(d) Managing complexity and intersectoral conflict, e.g., introduced species that are useful or harmful, depending on context and values;

(e) Uses of social media and citizen science for the detection, prevention and management of invasive alien species outbreaks;

(f) Eradicating or managing invasive alien species once they are present, including control options such as precision application of pesticides, baits and biological control, depleting populations of such species through use and exploitation and other practices such as "gene drive" technology. Methods for the ethical control of invasive animals will be documented;

(g) Capacities of different countries to manage invasive alien species, and barriers to the uptake of tools; and

(h) Managing invasive alien species in protected areas, including wetlands designated as significant under the Convention on Wetlands of International Importance, especially as Waterforwl Habitat, and biosphere reserves;

(i) Managing biological communities in which invasive alien species are present, considering co-existence, including direct and indirect interspecific interactions.

19. Chapter 6 will explore future options for the prevention and management of invasive alien species and provide an analysis of possible support tools for decision makers, such as the categorization and classification of invasive alien species according to the type and magnitude of their impact, as well as an analysis of their costs and benefits, in order to support decision-making about prevention and management and control options regarding invasive alien species. The chapter will present options for global awareness-raising, for creating early warning systems, for capacity-building and for sharing knowledge internationally and regionally in respect of prevention and management. The assessment will also suggest policy options for handling complex intersectoral trade-offs. Options such as strengthening international networks and customs controls, developing strategies and procedures for forecasting the spread of invasive alien species and preventing and controlling such spread will be assessed. The chapter will explore, where possible, information using scenarios and models for future invasive alien species trends, including their spread.

III. Indicators, metrics and data sets

20. Biodiversity and ecosystem service indicators serve multiple purposes that can broadly be categorized into three key functions: (a) tracking performance; (b) monitoring the consequences of alternative policies; and (c) scientific exploration. Assessments use these indicators mainly for the first two purposes.

21. The assessment will review the use and effectiveness of existing indicators, such as those developed by the Biodiversity Indicators Partnership, and will explore other possible indicators that could be used.

22. The assessment will survey the availability of data, recognizing that the scoping process indicated that such data are likely to be very patchy globally. Where possible, the assessment will be carried out at the country scale, or at a more detailed "actionable" scale when appropriate. Data collection and structuring should allow disaggregation based on relevant variables such as environment or system and taxa.

23. The assessment will use existing knowledge products and tools.

IV. Relevant stakeholders

24. Important stakeholders for this assessment will include decision makers who deal with biodiversity and borders and health. For such stakeholders, there needs to be a strong focus in the assessment on the benefits for countries and their people, including human well-being, of managing the risks of invasive alien species. However, because these species are often the result of intentional movement of species, or of human-driven processes such as trade, important stakeholders will also include international trade organizations, border officials and agencies involved in the intentional movement of species such as those in the forestry and agriculture sectors. Much invasive alien species prevention and management must be conducted at the local level. The assessment findings will therefore need to be communicated through context-sensitive material to a broad range of audiences at various scales, including indigenous and local knowledge holders. In addition, public demand for novel pets and ornamentals is a rich source of invasive alien species and many Governments will probably need support in communicating with this important risk-creating sector. Useful

communication materials stemming from the assessment could also include training material for natural resource managers and case studies of successful invasive alien species prevention and management plans. The assessment will consider the benefits of building an invasive alien species global support network to facilitate the sharing of expertise and experience. Maintaining capability and continuity in the long term has been a significant issue for many countries in the past; the assessment will need to explore mechanisms to address that.

V. Capacity-building

25. The list of priority capacity-building needs approved by the Plenary at its third session will be used in the invasive alien species assessment.

26. Capacity-building with regard to invasive alien species will aim to improve human, institutional and technical capacities in the long term 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 will draw upon the findings of the assessment, aiming to improve the science-policy interface. An important capability may well be the expertise to carry out assessments of existing and potential invasive alien species threats for any development or project and, based on these assessments, develop biosecurity plans and species management plans.

27. The assessment will identify gaps in scientific and other skills that are hindering the prevention and sound management of invasive alien species, including in relation to taxonomy, expertise in biotic impact assessment, active adaptive management, structured decision-making, systematic conservation planning and known response and management approaches (eradication, integrated pest management and biological control) and associated infrastructure.

VI. Process and timetable

28. The proposed process and timetable for preparing the assessment report, including actions, milestones and institutional arrangements, are set out below.

Date		*Actions and institutional arrangements*
Year 1	First quarter	The Plenary approves the conduct of the thematic assessment of invasive alien species and their control coupled with the regional assessments of biodiversity and ecosystem services, asks for offers of in-kind technical support for the assessment and requests the Bureau and the secretariat to establish the necessary institutional arrangements to put in place technical support
		The Chair, through the secretariat, requests from Governments and other stakeholders nominations of experts to prepare the assessment report
	Second quarter	The secretariat compiles the list of nominations
		The Panel selects the assessment co-chairs, coordinating lead authors, lead authors and review editors, using the approved selection criteria set out in decision IPBES-2/3 (IPBES/2/17, annex)
		Meeting of the management committee (co-chairs, head of the technical support unit, and Multidisciplinary Expert Panel/Bureau members) to select remaining expert team and respective roles (i.e., coordinating lead authors, lead authors and review editors) and prepare for the first author meeting
		Selected nominees contacted, gaps filled and list of co-chairs, authors and review editors finalized
	Second/early third quarter	First author meeting with co-chairs, coordinating lead authors and lead authors, 8 liaison experts involved in regional assessments (two experts for each of the four regional assessments), Panel/ Bureau members.
	Fourth quarter	Zero order drafts of chapters prepared and sent to secretariat (technical support unit)

Date		*Actions and institutional arrangements*
Year 2	First quarter	First order drafts of chapters prepared and sent to secretariat (technical support unit)
		Compilation of chapters into a first order draft (6 weeks)
	Second quarter	First order draft of collated regional and subregional invasive alien species assessments sent for expert review (6 weeks, June/July)
		Collation of review comments by secretariat (technical support unit) for first draft sent to authors (2 weeks)
	Early third quarter	Second author meeting including: 8 liaison experts involved in the regional assessments, Panel/ Bureau members, co-chairs, coordinating lead authors and review editors
	Third quarter	Second order drafts of chapters and first order draft of summary for policymakers prepared (5–6 months)
Year 3	First quarter	Second order draft of the assessment and first order draft of the summary for policymakers sent for Government and expert review (2 months)
	First quarter	Collation of review comments for second order draft of the assessment and first order draft of the summary for policymakers sent to authors (2 weeks)
	Second/early third quarter	Third author meeting (co-chairs, coordinating lead authors, lead authors, review editors and Panel/Bureau members)
	Third quarter	Final text changes to the assessment and the summary for policymakers (6 months)
	Fourth quarter	Translation of the summary for policymakers into the six official languages of the United Nations (12 weeks before the Plenary session)
	Fourth quarter	Submission of the assessment, including the translated summary for policymakers, to Governments for final review prior to next Plenary session (6 weeks)
	Fourth quarter	Final Government comments on the summary for policymakers for consideration by authors prior to next Plenary session
	Fourth quarter	Plenary to approve or accept the thematic assessment of invasive alien species, including the summary for policymakers

VII. Cost estimate

29. Discussions regarding the Platform's work programme budget at the fourth session of the Plenary indicated that the indicative cost of this assessment should not exceed $800,000. A revised cost estimate for this assessment will be presented at the fifth session of the Plenary, when the launch of the assessment will be reconsidered.

Annex IV to decision IPBES-4/1

Summary for policymakers of the assessment report of the methodological assessment of scenarios and models of biodiversity and ecosystem services

Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, IPBES Secretariat, Bonn, Germany, 2016

Deliverable 3 (c)

This summary for policymakers should be cited as:
IPBES (2016): Summary for policymakers of the assessment report of the methodological assessment of scenarios and models of biodiversity and ecosystem services by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. S. Ferrier, K. N. Ninan, P. Leadley, R. Alkemade, L. Acosta-Michlik, H. R. Akçakaya, L. Brotons, W. Cheung, V. Christensen, K. H. Harhash, J. Kabubo-Mariara, C. Lundquist, M. Obersteiner, H. Pereira, G. Peterson, R. Pichs-Madruga, N. H. Ravindranath, C. Rondinini, B. Wintle (eds.). Publishing Company (to be inserted), City [to be inserted], Country [to be inserted], pp. 1– .

Summary for policymakers of the assessment report on the methodological assessment of scenarios and models of biodiversity and ecosystem services (deliverable 3 (c))

High-level messages

High-level message 1: Scenarios and models can contribute significantly to policy support, even though several barriers have impeded their widespread use to date.

High-level message 2: Many relevant methods and tools are available, but they should be matched carefully with the needs of any given assessment or decision-support activity, and applied with care, taking into account uncertainties and unpredictability associated with model-based projections.

High-level message 3: Appropriate planning, investment and capacity-building, among other efforts, could overcome significant remaining challenges in developing and applying scenarios and models.

Introduction

The methodological assessment of scenarios and models of biodiversity and ecosystem services was initiated in order to provide expert advice on the use of such methodologies in all work under the Platform to ensure the policy relevance of its deliverables, as stated in the scoping report approved by the Plenary of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services at its second session (IPBES/2/17, annex VI). It is one of the first assessment activities of the Platform because it provides guidance for the use of scenarios and models in regional, global and thematic assessments, as well as by the other task forces and expert groups of the Platform.

The report on the outcome of the assessment is available as document IPBES/4/INF/3/Rev.1. The present document is a summary for policymakers of the information presented in the full assessment report.

"Models" are qualitative or quantitative descriptions of key components of a system and of relationships between those components. This assessment focuses mainly on models describing relationships between: (i) indirect and direct drivers; (ii) direct drivers and nature; and (iii) nature and nature's benefits to people.

"Scenarios" are representations of possible futures for one or more components of a system, particularly, in this assessment, for drivers of change in nature and nature's benefits, including alternative policy or management options.

Because the assessment focuses on methods, the summary for policymakers and the full assessment report are more technical in nature than are those of other thematic, regional and global assessments of the Platform. In particular, the assessment focuses on:

- Critical analyses of the state-of-the-art and best practices for using scenarios and models in assessments and policy design and implementation relevant to biodiversity and ecosystem services;
- Proposed means for addressing gaps in data, knowledge, methods and tools relating to scenarios and models;
- Recommendations for action by Platform member States, stakeholders and the scientific community to implement and encourage those best practices in regard to the use of scenarios and models, engage in capacity-building and mobilize indigenous and local knowledge.

Unlike the thematic, regional or global assessments of the Platform, the methodological assessment does not analyse the status of, trends in or future projections of biodiversity and ecosystem services.

There are several audiences for the methodological assessment. The summary for policymakers and chapter 1 have been written to be accessible to a broad audience, including audiences within the Platform community, as well as stakeholders and policymakers not directly involved with the Platform. The critical analyses and perspectives in chapters 2–8 are more technical in nature and address the broader scientific community in addition to the expert groups and task forces of the Platform.

Target audiences outside of the Platform include:

- Policy support practitioners and policymakers wishing to make use of scenarios and models to inform decision-making on the local to global scales: the assessment provides guidance on appropriate and effective use of scenarios and models across a broad range of decision contexts and scales;
- Scientific community and funding agencies: the assessment provides analyses of key knowledge gaps and suggests ways of filling those gaps that would increase the utility of scenarios and models for the Platform and for their use in policymaking and decision-making more broadly.

The intended target audiences within the Platform include:

- The Plenary, the Bureau and the Multidisciplinary Expert Panel: the summary for policymakers and chapter 1 provide a broad overview of the benefits of and limits to using scenarios and models, of their applications to Platform deliverables and of priorities for future development that could be facilitated by the Platform;
- Task forces and expert groups: the full assessment report provides guidance for catalysing, facilitating and supporting the use of scenarios and models within the Platform and beyond;
- Regional, global and thematic assessments: the summary for policymakers and chapter 1 give all experts an overview of the benefits of, and caveats regarding, the use of scenarios and models, and chapters 2–8 provide experts who are working specifically on scenarios and models with guidance on more technical issues related to the application of scenarios and models in assessments of biodiversity and ecosystem services.

The messages in the present summary for policymakers are divided into "key findings", "guidance for science and policy" and "guidance for the Platform and its task forces and expert groups".

Key findings are messages that arise from the critical analyses in the assessment and are aimed at a broad audience, both within and beyond the Platform. They are grouped under the three "high-level messages" emerging from the assessment.

Guidance for science and policy is based on the key findings and broadly addresses target audiences outside of the Platform, as called for in the scoping report approved by the Plenary at its second session.

Guidance for the Platform and its task forces and expert groups is based on the key findings and specifically addresses the Platform's Plenary, Multidisciplinary Expert Panel and Bureau, and experts involved in Platform deliverables, as called for in the scoping report approved by the Plenary at its second session. The guidance proposes actions that could be undertaken or stimulated by the Platform.

References enclosed in curly brackets at the end of each key finding and each guidance point in the present summary for policymakers, e.g., {2.3.1}, indicate where support for the findings and guidance point may be found in the chapters of the assessment report.

Key findings

High-level message 1: Scenarios and models can contribute significantly to policy support, even though several barriers have impeded their widespread use to date.

Key finding 1.1: Scenarios and models can provide an effective means of addressing relationships between nature, nature's benefits to people and good quality of life and can thereby add considerable value to the use of best available scientific, indigenous and local knowledge in assessments and decision support (figure SPM.1). Scenarios and models play complementary roles, with scenarios describing possible futures for drivers of change or policy interventions and models translating those scenarios into projected consequences for nature and nature's benefits to people. The contributions of scenarios and models to policymaking and decision-making are usually mediated by some form of assessment or decision-support process and are typically used in conjunction with knowledge from a broader, and often highly complex, social, economic and institutional context {1.2, 1.3, 1.4, 2.1, 2.5}.

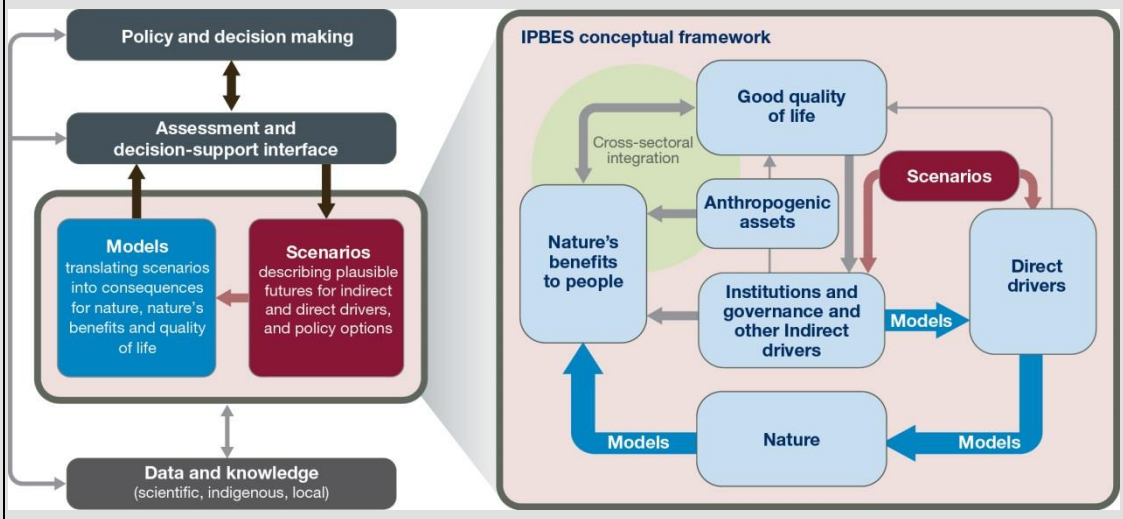

Figure SPM.1 – An overview of the roles that scenarios and models play in informing policy and decision-making. The left-hand panel illustrates how scenarios and models contribute to policy and decision-making through assessments, formal decision-support tools and informal processes (boxes and black arrows at top, chapters 1 and 2). Scenarios capture different policy options being considered by decision makers, which are then translated by models into consequences for nature, nature's benefits to people and quality of life. The left-hand panel also emphasizes that scenarios and models are directly dependent on data and knowledge for their construction and testing and provide added value by synthesizing and organizing knowledge (box and arrow on bottom). The right-hand panel provides a detailed view of the relationships between scenarios (burgundy arrows), models (blue arrows) and the key elements of the Platform's conceptual framework (light blue boxes, chapter 1; Diaz et al. 2015[53]). Grey arrows indicate relationships that are not the main focus of the assessment. The "cross-sectoral integration" element signifies that a comprehensive assessment of human well-being and good quality of life will often involve the integration of modelling from multiple sectors (e.g., health, education and energy) addressing a broader range of values and objectives than those associated directly with nature and nature's benefits.

Key finding 1.2: Different types of scenarios can play important roles in relation to the major phases of the policy cycle, which are (i) agenda setting, (ii) policy design, (iii) policy implementation and (iv) policy review (figures SPM.2, 3 and 4; table SPM.1). "Exploratory scenarios" that examine a range of plausible futures, based on potential trajectories of drivers – either indirect (e.g., socio-political, economic and technological factors) or direct (e.g., habitat conversion and climate change) – can contribute significantly to high-level problem identification and agenda setting. Exploratory scenarios provide an important means of dealing with high levels of unpredictability, and therefore uncertainty, inherently associated with the future trajectory of many drivers. "Intervention scenarios" that evaluate alternative policy or management options – through either "target-seeking" or "policy-screening" analysis – can contribute significantly to policy design and implementation. To date, exploratory scenarios have been used most widely in assessments on the global, regional and national scales (figure SPM.3, table SPM.1), while intervention scenarios have been applied to decision-making mostly on the national and local scales (figure SPM.4, table SPM.1) {1.3.2, 2.1.1, 3.2.2}.

[53] Díaz, S., Demissew, S., Joly, C., Lonsdale, W.M. and Larigauderie, A., 2015: A Rosetta Stone for nature's benefits to people. *PLoS Biology* **13**(1): e1002040.

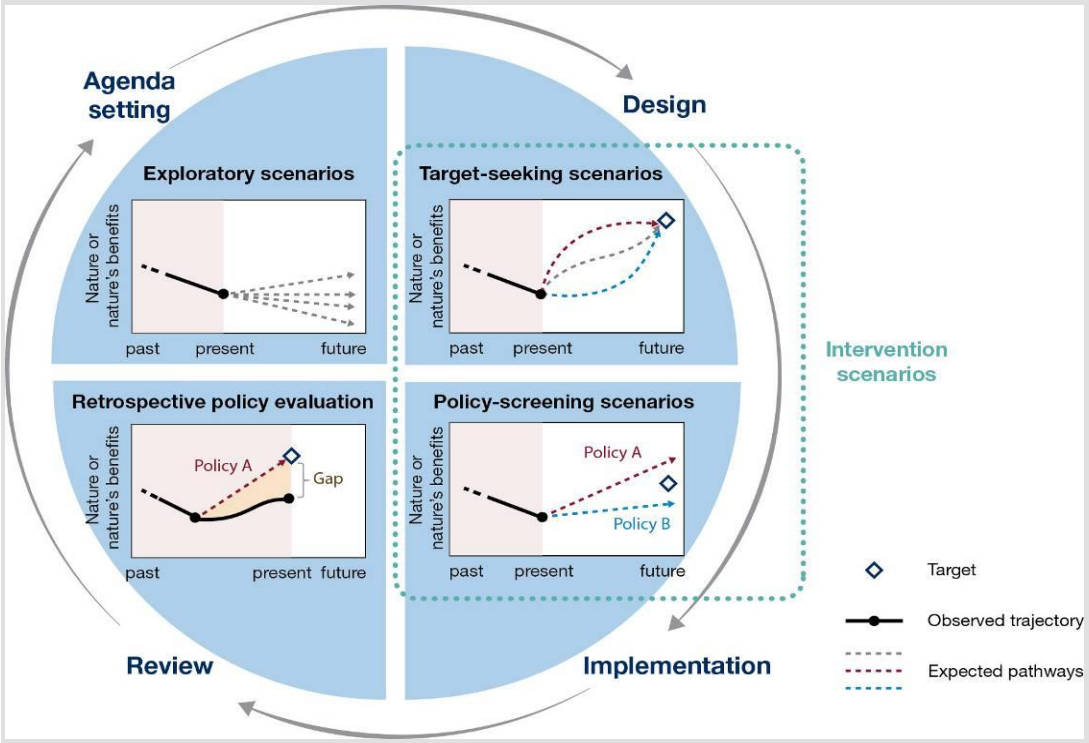

Figure SPM.2 – This figure shows the roles played by different types of scenarios corresponding to the major phases of the policy cycle. Types of scenarios are illustrated by graphs of changes in nature and nature's benefits over time. The four major phases of the policy cycle are indicated by the labels and grey arrows outside the blue-coloured quarters of the circle. In "exploratory scenarios", the dashed lines represent different plausible futures, often based on storylines. In "target-seeking scenarios" (also known as "normative scenarios"), the diamond represents an agreed-upon future target and the coloured dashed lines indicate scenarios that provide alternative pathways for reaching this target. In "policy-screening scenarios" (also known as "ex-ante scenarios"), the dashed lines represent various policy options under consideration. In "retrospective policy evaluation" (also known as "ex-post evaluation"), the observed trajectory of a policy implemented in the past (solid black line) is compared to scenarios that would have achieved the intended target (dashed line).

Key finding 1.3: Models can provide a useful means of translating alternative scenarios of drivers or policy interventions into projected consequences for nature and nature's benefits to people (figures SPM.1, 3 and 4; table SPM.1). The assessment focuses on models addressing three main relationships: (i) models projecting effects of changes in indirect drivers, including policy interventions, on direct drivers; (ii) models projecting impacts of changes in direct drivers on nature (biodiversity and ecosystems); and (iii) models projecting consequences of changes in biodiversity and ecosystems for the benefits that people derive from nature (including ecosystem services). The contributions of these models will often be most effective if they are applied in combination. The above relationships can be modelled using three broad approaches: (a) correlative models, in which available empirical data are used to estimate values for parameters that do not necessarily have predefined ecological meaning and for which processes are implicit rather than explicit; (b) process-based models, in which relationships are described in terms of explicitly stated processes or mechanisms based on established scientific understanding and whose model parameters therefore have clear ecological interpretation defined beforehand; (c) expert-based models, in which the experience of experts and stakeholders, including local and indigenous knowledge holders, is used to describe relationships {1.2.2, 1.3.1, 3.2.3, 4, 5.4}.

Key finding 1.4: Several barriers have impeded widespread and productive use of scenarios and models of biodiversity and ecosystem services in policymaking and decision-making. Those barriers include (i) a general lack of understanding among policymaking and decision-making practitioners about the benefits of and limits to the use of scenarios and models for assessment and decision support; (ii) a shortage of human and technical resources, as well as data, for developing and using scenarios and models in some regions; (iii) insufficient involvement of, and interactions between, scientists, stakeholders and policymakers in developing scenarios and models to assist policy design and implementation; (iv) lack of guidance in model choice and deficiencies in the transparency of development and documentation of scenarios and models; and (v) inadequate characterization of

uncertainties derived from data constraints, problems in system understanding and representation or low system predictability {1.6, 2.6, 4.3.2, 4.6, 7.1.2, 8.2}. All of these barriers, and approaches to addressing them, are discussed in detail in subsequent key findings and guidance points.

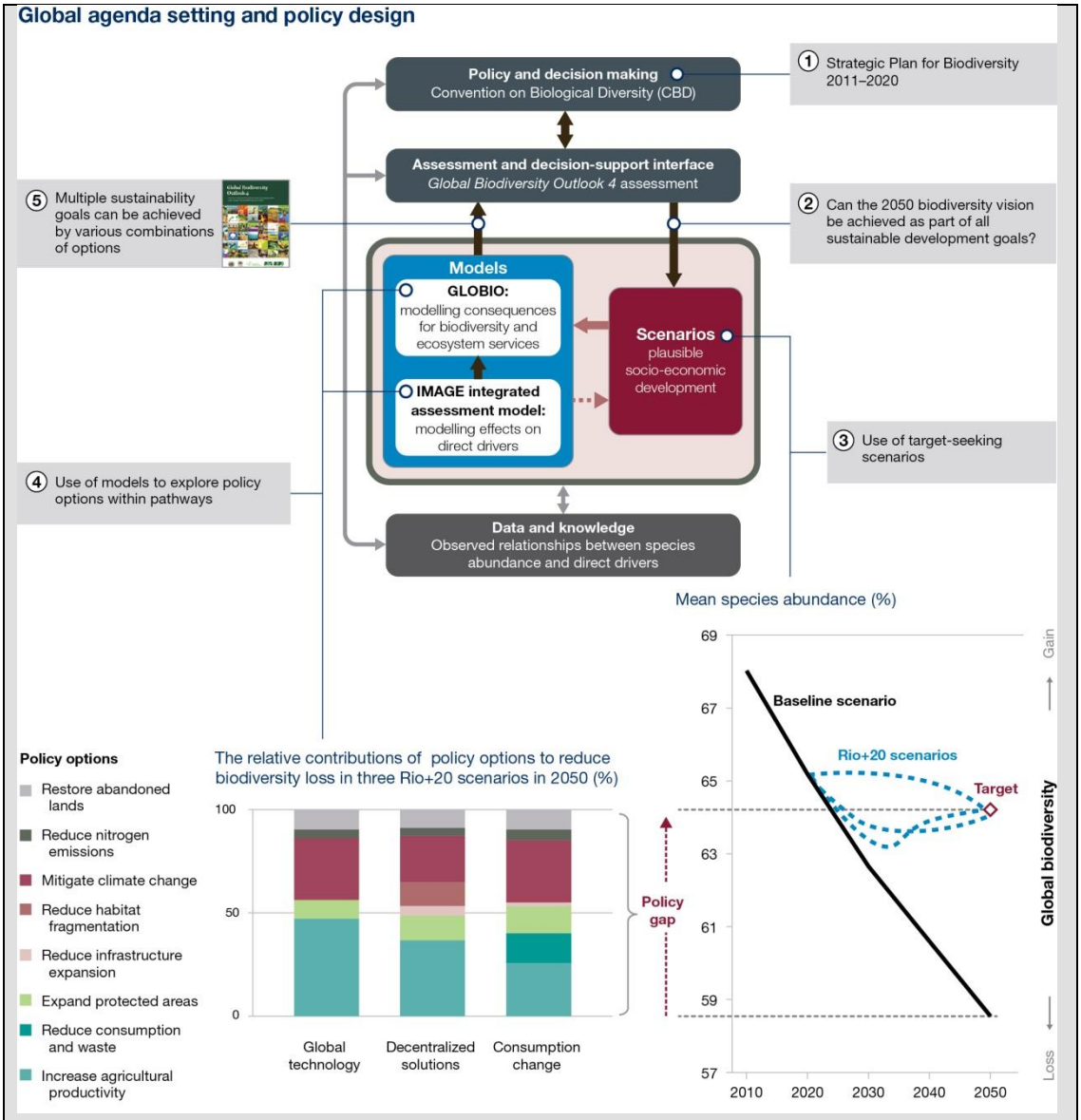

Figure SPM.3 – This figure shows an example of the use of scenarios and models for agenda setting and policy design in the Global Biodiversity Outlook 4 assessment of the Convention on Biological Diversity to evaluate the Strategic Plan for Biodiversity 2011–2020 (step 1). The Global Biodiversity Outlook 4 used many types of scenarios and models and relied heavily on target-seeking scenarios to explore scenarios for attaining multiple international sustainability objectives by 2050. The targets in those scenarios included keeping global warming to below 2°C (United Nations Framework Convention on Climate Change), halting the loss of biodiversity by 2050 (Strategic Plan for Biodiversity 2011–2020) see bottom left-hand graph) and eradicating hunger (Millennium Development Goals) (step 2). Three plausible scenarios for achieving these multiple sustainability objectives were explored. The bottom right-hand graph illustrates how these scenarios differ from a business-as-usual scenario in terms of impacts on global biodiversity (step 3). The IMAGE Integrated Assessment Model (http://themasites.pbl.nl/models/image) was used to evaluate scenarios of indirect drivers and to model the relationships between indirect and direct drivers. Impacts on terrestrial biodiversity were modelled using the GLOBIO3 biodiversity model (http://www.globio.info/). The bottom left-hand graph shows the relative contributions of indirect drivers to halting biodiversity loss by 2050 compared to the business-as-usual scenario (step 4). The Global Biodiversity Outlook 4 report indicates that multiple targets can be achieved and was an important factor in discussions at the twelfth meeting of the Conference of the Parties to the Convention on Biological Diversity, which ended with additional commitments for action and funding to achieve the Aichi Biodiversity Targets (step 5). See box 1.1 in chapter 1 for additional details and references.

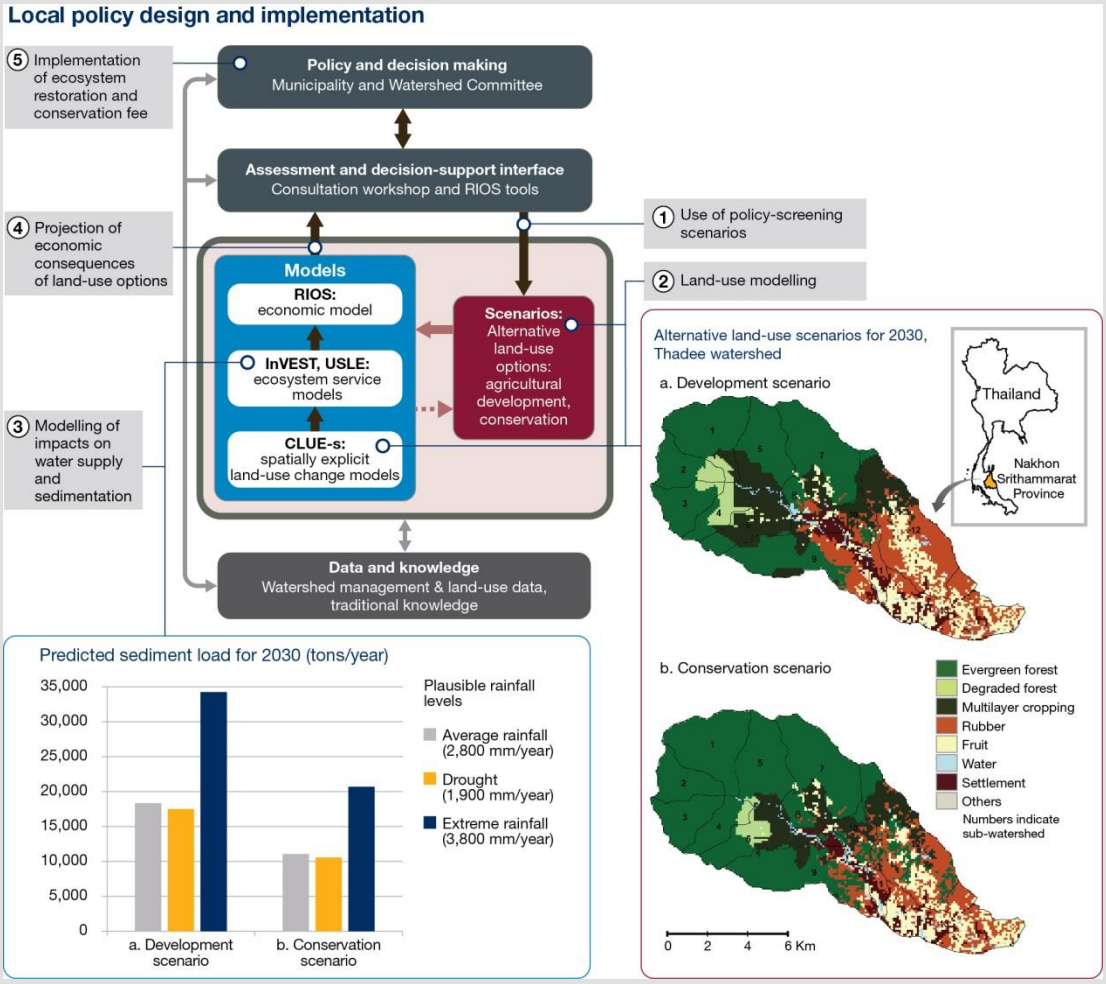

Figure SPM.4 – This figure shows an example of the use of scenarios and models in support of policy design and implementation. This case is in the Thadee watershed in southern Thailand, where the water supply for farmers and household consumption has been degraded by the conversion of natural forests to rubber plantations. Policy-screening scenarios (step 1) based on local datasets and knowledge were developed by stakeholders and scientists to explore plausible future land uses (step 2). Models were then used to evaluate the effects of three plausible rainfall levels on sediment load in rivers as a result of soil erosion and on other ecosystem services (step 3). The conservation scenario was foreseen to produce substantially less sedimentation than the development scenario with rapid expansion of rubber plantations and crops. The economics component of the Resource Investment Optimization System (RIOS) tool was then used to translate these effects into economic costs and benefits (step 4). A decision-support component of the RIOS tool was used by scientists and local decision makers to identify areas where forest protection, reforestation or mixed cropping could best be implemented. The municipality has agreed to find means of collecting a conservation fee based on payments for watershed services to fund these activities (step 5). See box 1.2 in chapter 1 for additional details and references. Source: Trisurat (2013).[54] For further information on modelling tools used in the study see:

http://www.naturalcapitalproject.org/invest/
http://www.naturalcapitalproject.org/software/#rios
http://www.ivm.vu.nl/en/Organisation/departments/spatial-analysis-decision-support/Clue/index.aspx

[54] Trisurat, Y., 2013: *Ecological Assessment: Assessing Conditions and Trends of Ecosystem Services of Thadee watershed, Nakhon Si Thammarat Province (in Thai with English abstract). Final Report submitted to the ECO-BEST Project.* Bangkok, Faculty of Forestry, Kasetsart University.

Table SPM.1 – Illustrative and non-exhaustive list of applications of scenarios and models of biodiversity and ecosystem services to agenda setting, policy design and implementation at global to national scales
(For full list, see table 1.1, chapter 1.)

	Global Biodiversity Outlook 4 (2014)	**Intergovernmental Panel on Climate Change fifth assessment report, working groups II and III (2014)**	**Millennium Ecosystem Assessment (2005)**	**United Kingdom National Ecosystem Assessment (2011)**	**Strategic environmental assessment of hydropower on the Mekong mainstream**	**South African fisheries management**
Maximum spatial extent	Global	Global	Global	National: United Kingdom	Regional: Analysis covers Cambodia, China, Laos, Thailand and Viet Nam	National: Coastal fisheries of South Africa
Time horizons	Present–2020, 2050	2050, 2090 and beyond	2050	2060	2030	Present–2034 updated every 2–4 years
Position in policy cycle	Agenda setting, policy formulation	Agenda setting	Agenda setting	Agenda setting	Policy formulation and implementation	Policy implementation
Authorizing environment	Assessment requested by parties to the Convention on Biological Diversity	Assessment requested by member countries of the Intergovernmental Panel on Climate Change	Initiated by scientific community, then welcomed by the United Nations	Recommended by the United Kingdom House of Commons as a follow-up to the Millennium Ecosystem Assessment	Strategic environmental assessment carried out for the Mekong River Commission	Evaluation carried out by the South African Department of Agriculture, Forestry and Fisheries
Issues addressed using scenarios and models	Are the Aichi Biodiversity Targets likely to be attained by 2020? What is needed to achieve the strategic vision for 2050 of the Convention on Biological Diversity?	How might future climate change impact biodiversity, ecosystems and society?	What are plausible futures of biodiversity and ecosystem services?	What changes might occur in ecosystems, ecosystem services and the values of these services over the next 50 years in the United Kingdom?	Evaluate social and environmental impacts of dam construction, especially in the main stream of the Mekong river	Implementation of policy on sustainable management of fisheries
Scenarios and models of direct and indirect drivers	Statistical extrapolations of trends in drivers up to 2020* Goal-seeking scenarios and models for analyses up to 2050 ("Rio+20 scenarios", see figure SPM.3) Analysis of a wide range of published exploratory	Emphasis on exploratory scenarios for impact studies (Intergovernmental Panel on Climate Change Special Report on Emissions Scenarios)* Strong focus on models of climate change as direct drivers, some use of associated land use scenarios. Emphasis on target-seeking scenarios for climate modelling and	Exploratory scenarios using four storylines* Models of direct drivers from the IMAGE integrated assessment model*	Exploratory scenarios using six storylines* Emphasis on land use and climate change drivers	Policy screening scenarios using several dam development schemes Emphasis on economic growth and demand for electricity generation as main indirect drivers Climate change scenarios also assessed	Goal-seeking scenarios focus on identifying robust pathways for sustainable catch

	Global Biodiversity Outlook 4 (2014)	Intergovernmental Panel on Climate Change fifth assessment report, working groups II and III (2014)	Millennium Ecosystem Assessment (2005)	United Kingdom National Ecosystem Assessment (2011)	Strategic environmental assessment of hydropower on the Mekong mainstream	South African fisheries management
	and policy-screening scenarios at local to global scales	climate change mitigation analysis (representative concentration pathways)*				
Models of impacts on nature	Statistical extrapolations of trends in biodiversity indicators up to 2020* Analysis of wide range of published correlative and process-based models Emphasis on impacts of a broad range of drivers on biodiversity	Analysis of a wide range of published correlative and process-based models Emphasis on impacts of climate change on biodiversity and ecosystem functions	Correlative models (e.g., species-area relationships) Emphasis on impacts of a broad range of drivers on biodiversity	Correlative model of species response (birds) to land use Qualitative evaluation of impacts of land use and climate change on ecosystem functions Emphasis on habitat change as an indicator of environmental impacts	Estimates of habitat conversion based on dam heights, habitat maps and elevation maps Estimates of species level impacts based on dam obstruction of fish migration and on species-habitat relationships	Population dynamics models of economically important fish Recently added models of indirectly impacted species (e.g., penguins) Use of ecosystem-based models under consideration
Models of impacts on nature's benefits	Analysis of published studies Focus on ecosystem services from forests, agricultural systems and marine fisheries Little evaluation of direct links to biodiversity	Analysis of wide range of published studies Little evaluation of direct links to biodiversity except in marine ecosystems	Estimates of some ecosystem services (e.g., crop production, fish production) from the IMAGE integrated assessment model	Qualitative and correlative models of ecosystem services Focus on correlative methods for estimating monetary value Emphasis on monetary valuation, except for biodiversity value	Empirical estimates of fisheries impacts based on reduced migration and changes in habitat Diverse methods for estimating changes in water flow and quality, sediment capture, cultural services, etc.	Estimates of total allowable catch based on fish population models

	Global Biodiversity Outlook 4 (2014)	Intergovernmental Panel on Climate Change fifth assessment report, working groups II and III (2014)	Millennium Ecosystem Assessment (2005)	United Kingdom National Ecosystem Assessment (2011)	Strategic environmental assessment of hydropower on the Mekong mainstream	South African fisheries management
Participation of stakeholders	Debate and approval by parties to the Convention on Biological Diversity Dialogues between scientists and the secretariat and representatives of parties to the Convention on Biological Diversity during assessment process	Debate and approval by member countries of the Intergovernmental Panel on Climate Change Little involvement of stakeholders in scenarios development	Dialogues with stakeholders during scenario development	Consultation of stakeholders during scenario development Adopted by "Living With Environmental Change" partnership of government and non-government stakeholders	Extensive dialogue involving multiple Governments, expert workshops and public consultations	Consultation between Governments, scientists and stakeholders during development of management strategy and setting of total allowable catch
Decision support tools	None	None	None	None, but tools are being developed	Strategic environmental assessment methods (see chapter 2)	Management strategy evaluation (see chapter 2)
Outcomes	Extrapolations may have contributed to Convention on Biological Diversity parties making nonbinding commitments in 2014 to increase resources for biodiversity protection	Key documents underlying negotiations under the United Nations Framework Convention on Climate Change, commitments of countries to climate mitigation to be discussed in December 2015	Increased awareness of the potential for substantial future degradation of biodiversity and ecosystem services	Contributed to natural environment white paper and influenced the development of the biodiversity strategy for England	The Mekong River Commission recommended a ten-year moratorium on mainstream dam construction, but 1 of 11 planned dams is under construction in Laos	Fisheries widely considered to be sustainably managed Hake fishery certified by the Marine Stewardship Council
Strengths	Novel use of extrapolations for near-term projections Clear decision context and authorizing environment	Reliance on common scenarios and models of drivers provides coherence Clear decision context and authorizing environment	One of the first global-scale evaluations of future impacts of global change on biodiversity	Focus on synergies and trade-offs between ecosystem services and on monetary evaluation	Clear decision context and authorizing environment Strong involvement of stakeholders	Clear decision context and authorizing environment Policy and management advice clear and updated regularly
Weaknesses	Focus on global scale limits applicability to many national and local decision contexts	Weak treatment of drivers other than climate change, large spatial scales and distant time horizons limits usefulness for policy and	Very limited set of scenarios and models explored Decision context	Heavy reliance on qualitative estimates of impacts of drivers Biodiversity at species level weakly	Highly context-specific, especially the empirical models used, and therefore difficult to generalize or	Highly context-specific Several key drivers (e.g., climate change) not considered

	Global Biodiversity Outlook 4 (2014)	**Intergovernmental Panel on Climate Change fifth assessment report, working groups II and III (2014)**	**Millennium Ecosystem Assessment (2005)**	**United Kingdom National Ecosystem Assessment (2011)**	**Strategic environmental assessment of hydropower on the Mekong mainstream**	**South African fisheries management**
	Lack of common scenarios and models of drivers makes analysis across targets difficult	management concerning biodiversity and ecosystems	unclear and authorizing environment weak	represented (only birds)	extrapolate to larger scales Mekong River Commission recommendations non-binding	
References	Secretariat of the Convention on Biological Diversity (2014), Kok et al. (2014), Leadley et al. (2014), Tittensor et al. (2014)	Fifth assessment report of working groups II (2014) and III (2014) of the Intergovernmental Panel on Climate Change	Millennium Ecosystem Assessment (2005)	United Kingdom National Ecosystem Assessment (2011), Watson (2012), Bateman et al. (2013).	International Centre for Environmental Management (2010), chapter 2, ngm.nationalgeographic.com/2015/05/ mekong-dams/nijhuis-text	Plaganyi et al. (2007), Rademeyer et al. (2007), chapter 2
Notes	** Methods developed for Global Biodiversity Outlook 4*	** Developed in support of the Intergovernmental Panel on Climate Change assessment process*	** Developed for the Millennium Ecosystem Assessment*	** Developed for the United Kingdom National Ecosystem Assessment*		

High-level message 2: Many relevant methods and tools are available, but they should be matched carefully with the needs of any given assessment or decision-support activity and applied with care, taking into account the uncertainties and unpredictability associated with model-based projections.

Key finding 2.1: Effective application and uptake of scenarios and models in policymaking and decision-making requires close involvement of policymakers, practitioners and other relevant stakeholders, including, where appropriate, holders of indigenous and local knowledge, throughout the entire process of scenario development and analysis (figure SPM.5). Previous applications of scenarios and models that have contributed successfully to real policy outcomes have typically involved stakeholders starting at the initial phase of problem definition and have featured frequent exchanges between scientists and stakeholders throughout the process. This level of involvement has often been achieved most effectively through the use of participatory approaches {1.4.2, 2.4, 2.6, 3.2.1.2, 4.3.2, 5.5.3, 7.4, 7.5, 7.6.2, 8.4}. See guidance point 2 under "Guidance for science and policy" for suggested actions addressing this finding.

Figure SPM.5 – Major steps of interactions between policymakers, stakeholders and scientists, illustrating the need for frequent exchanges throughout the process of developing and applying scenarios and models. Each step involves interactive use of models and data (grey arrows) and requires information flow between models and data (green arrows). This is depicted as a cycle, but in many cases these steps will overlap and interact. See 8.4.1 and figure 8.1 in chapter 8 for details. Photos by PBL Netherlands Environmental Assessment Agency, Thinkstock, KK Davies and **IISD/ENB (**http://www.iisd.ca/ipbes/ipbes3/12jan.htm**)**

Key finding 2.2: Different policy and decision contexts often require the application of different types of scenarios, models and decision-support tools, so considerable care needs to be exercised in formulating an appropriate approach in any given context (figure SPM.6; tables SPM.1 and SPM.2). No single combination of scenarios, models and decision-support tools can address all policy and decision contexts, so a variety of approaches is needed {1.5, 2.2, 2.3, 2.4, 3.2.2, 3.2.3.2, 3.5, 4.2, 4.3, 5.3, 6.1.2}**.** See guidance point 1 under "Guidance for science and policy" for suggested actions addressing this finding.

Table SPM.2 - Illustrative and non-exhaustive examples of major models of ecosystem services, highlighting differences in important model attributes and therefore the need for care in choosing an appropriate solution in any given context. "Dynamic" models are capable of projecting changes in ecosystem services over time, while "static" models provide a snapshot of the status of ecosystem services at one point in time. See chapter 5 for detailed descriptions of these models, discussion of additional models and references.

Tool	Model Type	Spatial and temporal extent	Ease of use	Community of practice	Flexibility	Reference
IMAGE	Process	Global, dynamic	Difficult	Small	Low	Stehfest et al., 2014
EcoPath with EcoSim	Process	Regional, dynamic	Medium	Large	High	Christensen et al., 2005
ARIES	Expert	Regional, dynamic	Difficult	Small	High	Villa et al., 2014
InVEST	Process and correlative	Regional, static	Medium	Large	Medium	Sharp et al., 2014
TESSA	Expert	Local, static	Easy	Small	Low	Peh et al., 2014

Key finding 2.3: The spatial and temporal scales at which scenarios and models need to be applied also vary markedly between different policy and decision contexts. No single set of scenarios and models can address all pertinent spatial and temporal scales, and many applications will require linking of multiple scenarios and models dealing with drivers or proposed policy interventions operating at different scales (figure SPM.6; table SPM.2). Assessment and decision-support activities, including those undertaken or facilitated by the Platform, will require short-term (ca. 5–10 years), medium-term and long-term (2050 and beyond) projections. Platform assessments will focus on regional and global scales, but should also build on knowledge from local-scale scenarios and models. The use of scenarios and models in assessments and decision support more broadly (beyond the Platform) requires applications at a wide range of spatial scales. Techniques for temporal and spatial scaling are available for linking across multiple scales, although substantial further improvement and testing of them is needed {1.5, 2.2, 2.4, 3.2.2, 3.2.3.2, 3.5, 4.2, 4.3, 5.4.6, 6.4.1, 8.4.2}. See guidance point 3 under "Guidance for science and policy", and Platform guidance point 2 under "Guidance for the Platform and its task forces and expert groups", for suggested actions addressing this finding.

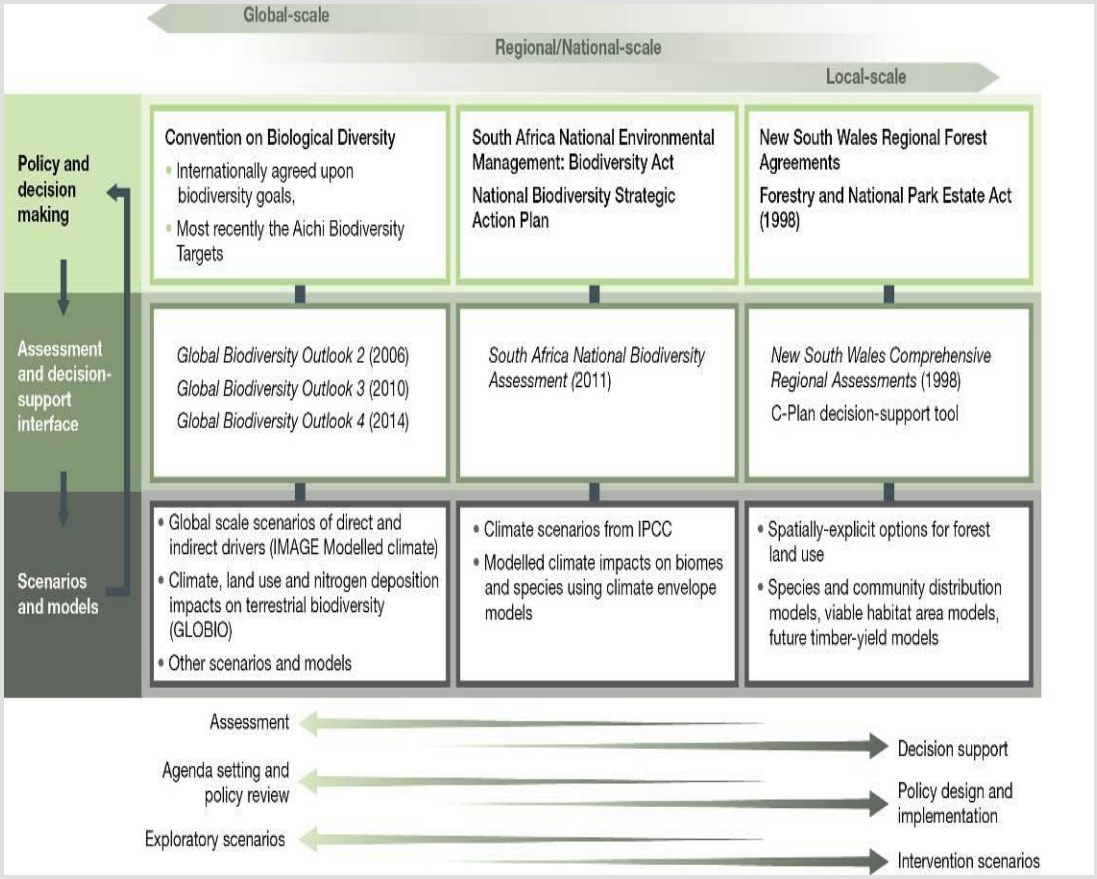

Figure SPM.6 – Examples of the use of scenarios and models in agenda setting, policy design and policy implementation relating to the achievement of biodiversity targets across a range of spatial scales. The diagram indicates the typical relationships between spatial scale (top arrows), type of science-policy interface (upper set of arrows at bottom), phase of the policy cycle (middle set of arrows at bottom) and type of scenarios used (lower set of arrows at bottom). See figure 2.2 in chapter 2 for further details and references.

Key finding 2.4: Scenarios and models can benefit from the mobilization of indigenous and local knowledge because such knowledge can fill important information gaps at multiple scales and contribute to the successful application of scenarios and models to policy design and implementation. There are numerous examples of the successful mobilization of indigenous and local knowledge for scenario analysis and modelling, including scenarios and models based primarily on such knowledge (box SPM.1). However, substantial efforts are needed to broaden the involvement of such knowledge. Improving mobilization of indigenous and local knowledge will require efforts on several fronts, including the development of appropriate indicators, mechanisms for accompanying knowledge holders, collection of such knowledge and its interpretation into forms that can be used in scenarios and models and translation into accessible languages {1.2.2.2, 1.6.2, 2.2.1, 4.2.3.1, 7.4.3, 7.4.4, 7.5.4, 7.6.3, 7.6.5}. See Platform guidance point 4 under "Guidance for the Platform and its task forces and expert groups" for suggested actions addressing this finding.

Box SPM.1. Incorporation of indigenous and local knowledge into models informing decision-making. Bolivia's National Programme of Conservation and Sustainable Utilization (PNCASL) for the customary harvest and conservation of caiman (*Caiman yacare*) illustrates a case study of successful integration of indigenous and local knowledge into biodiversity models to inform policy options. Previously, harvest quotas were estimated based on broad scale estimates of relative abundance from scientific surveys, with substantial variation between regions. Following increasing engagement of local communities in PNCASL, new biological, socio-economic and cultural indicators of species health and abundance were developed and trialled. One of the first trials took place in the Indigenous Territory and National Park Isiboro Sécure (TIPNIS), where traditional knowledge on the status of caiman was incorporated into the development of robust indicators to inform resource quotas for customary harvest in this protected area. Traditional resource users participated in workshops where they defined concepts, harmonized criteria and conceptualized traditional knowledge of caiman habitats and territories into spatial maps. Models for estimating population abundance were adapted to make use of indigenous techniques suggested by the communities and to incorporate qualitative indicators such as individuals' perceptions of changes in caiman abundance, e.g., accounting for information from statements such as "there are a lot more caiman than before". The process was repeated with communities across the TIPNIS territorial region and yielded a combined caiman population estimate for the protected area based on local knowledge. This estimate was used to develop a national-scale predictive model of abundance, which then informed national, regional and local policy options for improving the sustainable management of caiman harvesting. Resulting management plans for indigenous territories and protected areas have been recognized as contributing to increases in caiman abundance in areas where they had been locally depleted and in reducing illegal hunting. See box 7.1 in chapter 7 for additional details and references.

Key finding 2.5: All scenarios and models have strengths and weaknesses, and it is therefore vital that their capacities and limitations be carefully evaluated and communicated in assessment and decision processes. Sources and levels of uncertainty should also be evaluated and communicated (tables SPM.1 and SPM.2). Strengths and weaknesses may depend on the specific decision support context for which scenarios and models are being used and are related to aspects such as spatial and temporal extent, types of model inputs and outputs, flexibility and ease of use, among others. Uncertainty in scenarios and models arises from a variety of sources, including insufficient or erroneous data used to construct and test models; lack of understanding, or inadequate representation, of underlying processes; and low predictability of the system (e.g., random behaviour) {1.6, 2.3.3, 2.6, 4.3.2, 4.6, 5.4.6.6, 6.5, 8.4.3}. See guidance point 4 under "Guidance for science and policy", and Platform guidance point 5 under "Guidance for the Platform and its task forces and expert groups", for suggested actions addressing this finding.

High-level message 3: Appropriate planning, investment and capacity-building, among other efforts, could overcome significant remaining challenges in developing and applying scenarios and models.

Key finding 3.1: Currently available scenarios, including those developed by previous global-scale assessments, do not fully address the needs of Platform assessments due to incomplete consideration of relevant drivers, policy goals and intervention options at appropriate temporal and spatial scales. See box SPM.2 for further explanation of this finding, particularly in relation to the scenarios assessed by the Intergovernmental Panel on Climate Change and their derivatives {1.6.1, 3.4.2, 3.5, 8.4.2}. See Platform guidance point 2 under "Guidance for the Platform and its task forces and expert groups", for suggested actions addressing this finding.

Box SPM.2 – Scenarios in the context of the Intergovernmental Panel on Climate Change and their relationship to the Platform

Intergovernmental Panel on Climate Change assessments, the Millennium Ecosystem Assessment, Global Biodiversity Outlook 2, the Global Environmental Outlook and the Global Deserts Outlook have used related global storylines to generate scenarios. Regional assessments under the Millennium Ecosystem Assessment and the Global Environmental Outlook, as well as the national components of the Global Environmental Outlook such as those carried out for the United Kingdom, China and Brazil, have used globally consistent regional variants of existing storylines.

Intergovernmental Panel on Climate Change scenarios and pathways are developed in close collaboration with the scientific community. The scenarios of the Special Report on Emissions Scenarios from the year 2000, which were long employed by the Panel, have given way to a new framework based on the representative concentration pathways and shared socioeconomic pathways developed by the scientific community. Representative concentration pathways are constructed from radiative forcing values of greenhouse gases and represent a range of plausible futures corresponding to a strong mitigation assumption, two intermediate stabilization assumptions and one high emissions assumption. Newly formulated shared socioeconomic pathways explore a wide range of socioeconomic factors that would make meeting mitigation and adaptation more or less difficult (O'Neill et al., 2014.)[55]

The Intergovernmental Panel on Climate Change assesses relevant scenarios and pathways available from science and in their current form the resulting scenarios pose a number of challenges for use in Platform assessments, including (i) an incomplete set of direct and indirect drivers needed to model impacts on biodiversity and ecosystem services (e.g., invasive species and exploitation of biodiversity); (ii) adaptation and mitigation strategies that focus on climate change (e.g., large-scale deployment of bioenergy), sometimes to the detriment of biodiversity and key aspects of human well-being; and (iii) a focus on long-term (decades to centuries) global-scale dynamics, which means that the scenarios are often inconsistent with short-term and sub-global scale scenarios. Biodiversity and ecosystem services therefore require specific efforts in the development of scenarios, including further collaboration efforts.

Close collaboration between the Platform, the Intergovernmental Panel on Climate Change and the scientific community would provide the opportunity to build on the strengths of the new shared socioeconomic pathways scenarios and at the same time match the needs of the Platform (See Platform Guidance Point 2 for further discussion of the benefits of this potential collaboration.)
For more information see chapters 3.4.2 and 8.4.2.

Key finding 3.2: There is a wide range of models available with which to assess impacts of scenarios of drivers and policy interventions on biodiversity and ecosystem services, but important gaps remain. They include gaps in (i) models explicitly linking biodiversity to nature's benefits to people (including ecosystem services) and good quality of life; (ii) models addressing ecological processes on temporal and spatial scales relevant to the needs of assessment and decision-support activities, including Platform assessments; and (iii) models anticipating, and thereby providing early warning of, ecological and socio-ecological breakpoints and regime shifts {1.6.1, 4.2, 4.3, 5.4, 8.3.1}. See guidance point 3 under "Guidance for science and policy" for suggested actions addressing this finding.

Key finding 3.3: Scenarios and models of indirect drivers, direct drivers, nature, nature's benefits to people and good quality of life need to be better linked in order to improve understanding and explanation of important relationships and feedbacks between components of coupled social-ecological systems. Links between biodiversity, ecosystem functioning and ecosystem services are only weakly accounted for in most assessments or in policy design and implementation. The same applies for links between ecosystem services and quality of life and integration across sectors. Given that, it is currently challenging to evaluate the full set of relationships and feedbacks set out in the Platform's conceptual framework {1.2.2.1, 1.4.3, 4.2.3.4, 4.3.1.5, 4.4, 5.4, 6.3, 8.3.1.2}. See guidance point 3 under "Guidance for science and policy" for suggested actions addressing this finding.

[55] O'Neill, B.C., Kriegler, E., Riahi, K., Ebi, K.L., Hallegatte, S., Carter, T.R., Mathur, R. and van Vuuren, D.P., 2014: A new scenario framework for climate change research: the concept of shared socioeconomic pathways. *Climatic Change*, **122**(3): 387-400.

Key finding 3.4: Uncertainty associated with models is often poorly evaluated and reported in published studies, which may lead to serious misconceptions – both overly optimistic and overly pessimistic – regarding the level of confidence with which results can be employed in assessment and decision-making activities. While many studies provide a discussion of the strengths and weaknesses of their modelling approach, most studies do not provide a critical evaluation of the robustness of their findings by comparing their projections to fully independent data sets (i.e., data not used in model construction or calibration) or to other types of models. This greatly reduces the confidence that decision makers can and should have in projections from models {1.6.3, 2.3.3, 3.3, 3.4, 3.5, 4.6, 5.4, 6.5, 7.2.2, 8.3.3, 8.4.3}. See guidance point 4 under "Guidance for science and policy" for suggested actions addressing this finding.

Key finding 3.5: There are large gaps in the availability of data for constructing and testing scenarios and models, and significant barriers to data sharing remain (figure SPM.7). The spatial and temporal coverage and taxonomic spread of data on changes in biodiversity, ecosystems and ecosystem services is uneven. Similarly, there are large gaps in data for indirect and direct drivers, and there are often spatial and temporal mismatches between data on drivers and on biodiversity and ecosystem services. Much progress has been made in mobilizing existing data on biodiversity, ecosystem services and their drivers, but barriers to data sharing still need to be overcome and major gaps in the coverage of existing data filled {1.6.2, 2.6, 5.6, 7.3, 7.6.4, 8.2.1, 8.2.2}. See guidance point 5 under "Guidance for science and policy" for suggested actions addressing this finding.

Key finding 3.6: Human and technical capacity to develop and use scenarios and models varies greatly between regions. Building capacity requires the training of scientists and policy practitioners in the use of scenarios and models and improving access to data and user-friendly software for scenario analysis, modelling and decision-support tools. Rapidly growing online access to a wide range of data and modelling resources can support capacity-building {2.6, 4.7, 5.6, 7.2, 7.6.1}. See guidance point 6 under "Guidance for science and policy", and Platform guidance point 3 under "Guidance for the Platform and its task forces and expert groups", for suggested actions addressing this finding.

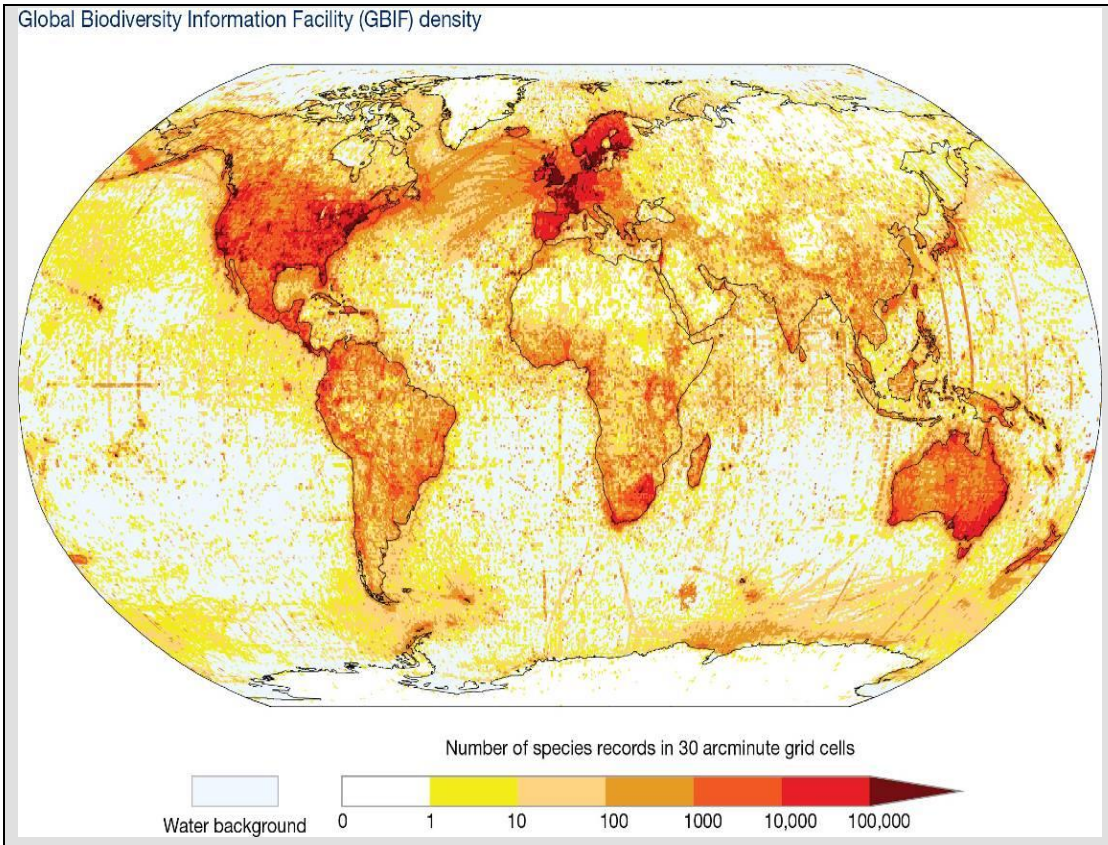

Figure SPM.7 – An example of spatial bias in the availability of biodiversity data. The map depicts the spatial distribution of species records currently accessible through the Global Biodiversity Information Facility. Colours indicate the number of species records per 30 arcminute (approximately 50 km) grid cell. These data are frequently used for model development and testing. Source: www.gbif.org. See 7.3.1 and figure 7.3 in chapter 7 for details and discussion.

Guidance for science and policy

The following lessons from best practices for building greater understanding of, strengthening approaches to and making more effective use of scenarios and models were identified:

Guidance point 1: Scientists and policy practitioners may want to ensure that the types of scenarios, models and decision-support tools employed are matched carefully to the needs of each particular policy or decision context. Particular attention should be paid to (i) the choice of drivers or policy options that determine the appropriate types of scenarios (e.g., exploratory, target-seeking or policy screening); (ii) the impacts on nature and nature's benefits that are of interest and that determine the types of models of impacts that should be mobilized; (iii) the diverse values that need to be addressed and that determine the appropriate methods for assessing those values; and (iv) the type of policy or decision-making process that is being supported and that determines the suitability of different assessment or decision-support tools (e.g., multi-criteria analysis and management strategy evaluation) {1.5, 2.2, 2.4, 3.2.2, 3.2.3.2, 3.5, 4.3.2, 6.1.2}.

Guidance point 2: The scientific community, policymakers and stakeholders may want to consider improving, and more widely applying, participatory scenario methods in order to enhance the relevancy and acceptance of scenarios for biodiversity and ecosystem services. This would include broadening the predominantly local-scale focus of participatory approaches to regional and global scales. Such an effort would facilitate the dialogue between scientific experts and stakeholders throughout the development and application of scenarios and models. Broadening participatory methods to regional and global scales poses significant challenges that will require greatly increased coordination of efforts between all actors involved in developing and applying scenarios and models at different scales {2.2, 2.3, 2.4, 2.6, 3.2.1.2, 7.4, 7.5, 7.6.2, 7.6.3, 8.4}.

Guidance point 3: The scientific community may want to give priority to addressing gaps in methods for modelling impacts of drivers and policy interventions on biodiversity and ecosystem services. These gaps are identified in chapter 8 of the assessment, with additional information about them provided in chapters 3–6. Work could focus on methods for linking inputs and outputs between major components of the scenarios and modelling chain, and on linking scenarios and models across spatial and temporal scales. High priority should also be given to encouraging and catalysing the development of models, and underpinning knowledge, that more explicitly link ecosystem services – and other benefits that people derive from nature – to biodiversity, as well as to ecosystem properties and processes. One means of achieving this would be to advance the development of integrated system-level approaches to linking scenarios and models of indirect drivers, direct drivers, nature, nature's benefits to people and good quality of life to better account for important relationships and feedback between those components (figure SPM.8). That could include encouraging and catalysing the extension of integrated assessment models, already being employed widely in other domains (e.g., climate, energy and agriculture), to better incorporate modelling of drivers and impacts of direct relevance to biodiversity and ecosystem services {1.2.2.1, 1.6.1, 3.2.3, 3.5, 4.2.3.4, 4.3.1.5, 6.2, 6.3, 8.3.1}.

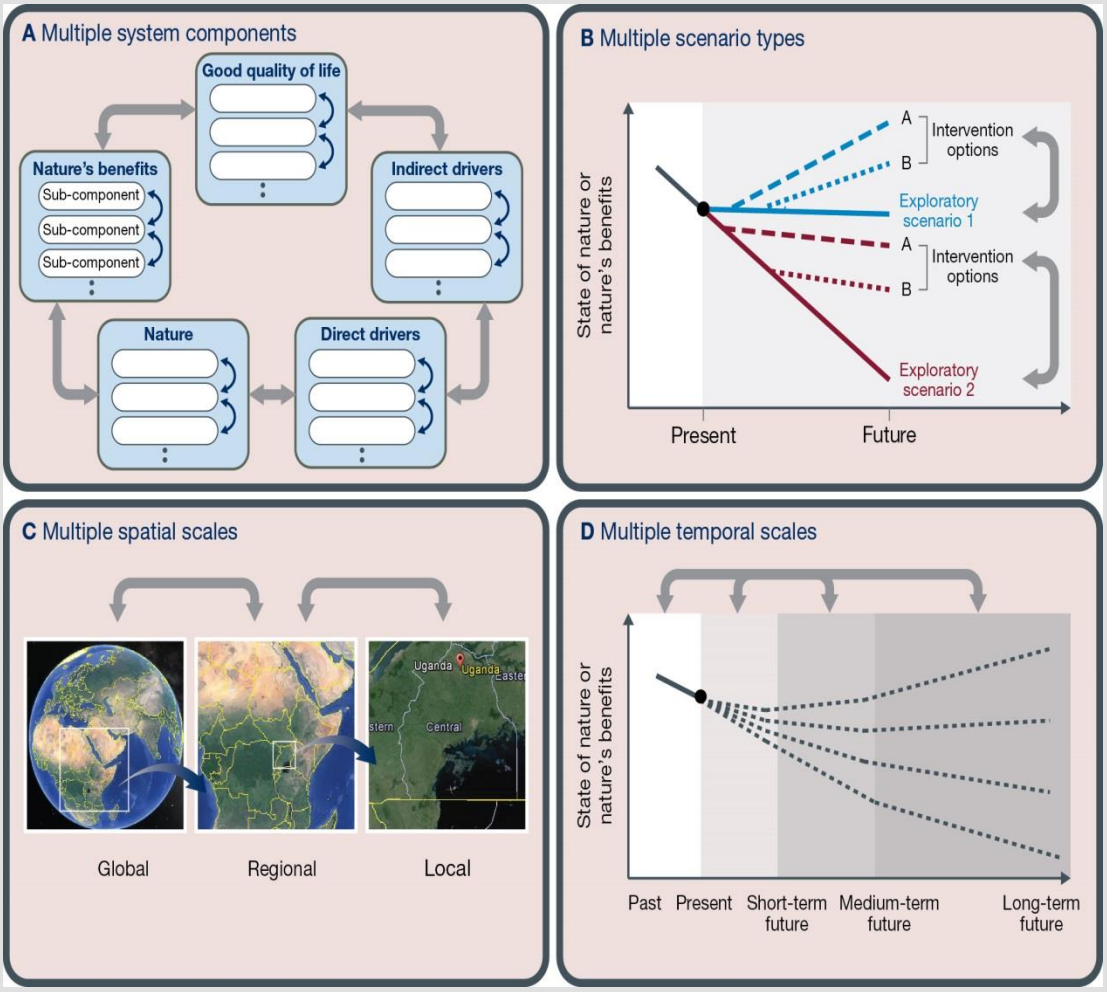

Figure SPM.8 – **Linking scenarios and models in four key dimensions**: system components, scenario types, spatial scales and temporal scales, with the thick grey arrows indicating linkages within each dimension. Panel A illustrates linkages between scenarios and models across the different components of the conceptual framework (thick grey arrows) as well as between their sub-components (thin blue arrows; for example linking biodiversity with ecosystem function sub-components of nature). Panel B shows ways in which different types of scenarios, such as exploratory and intervention scenarios, can be linked. Panel C indicates linkages across spatial scales from local to global. Panel D illustrates the linking of the past, the present and several time horizons in the future (dashed lines indicate a range of exploratory scenarios). Two or more of these dimensions of linkages can be used in combination (e.g., linking different types of scenarios across spatial scales). See chapter 6.2 and figure 6.1 for details.

Guidance point 4: The scientific community may want to consider developing practical and effective approaches to evaluating and communicating levels of uncertainty associated with scenarios and models, as well as tools for applying those approaches to assessments and decision-making. This would include setting standards for best practices, using model-data and model-model inter-comparisons to provide robust and transparent evaluations of uncertainty and encouraging new research into methods of measuring and communicating uncertainty and its impact on decision-making {1.6.3, 2.3.3, 3.5, 4.6.3, 6.5, 7.2.2, 8.3.3, 8.4.3}.

Guidance point 5: Data holders and institutions may want to consider improving the accessibility of well-documented data sources and working in close collaboration with research and observation communities (including citizen science) and communities working on indicators to fill gaps in data collection and provision. In many cases, this will coincide with efforts to improve the collection of and access to data for quantifying status and trends. However, models and scenarios need additional types of data for development and testing that should be taken into account when developing or refining monitoring systems and data-sharing platforms {1.6.2, 2.6, 3.5, 6.3, 6.4, 7.3, 7.6.4, 8.2}.

Guidance point 6: Human and technical capacity for scenario development and modelling may need to be enhanced, including through the promotion of open, transparent access to scenario and modelling tools, as well as to the data required for the development and testing of such scenario and modelling tools (table SPM.3). This can be facilitated through a variety of mechanisms, including by (i) supporting training courses for scientists and decision makers; (ii) encouraging rigorous documentation of scenarios and models; (iii) encouraging the development of networks that provide opportunities for scientists from all regions to share knowledge, including through user forums, workshops, internships and collaborative projects; and (iv) using the catalogue of policy support tools developed by the Platform to promote open access to models and scenarios, where possible in multiple languages {2.6, 4.7, 7.1.1, 7.2, 7.6.1}.

Table SPM.3 - Capacity-building requirements for the development and use of scenarios and models of biodiversity and ecosystem services. See chapter 7.1.1 and figure 7.1 for details.

Activity	I. Capacity-building requirements
Stakeholder engagement	Processes and human capacity to facilitate engagement with multiple stakeholders, including holders of traditional and local knowledge
Problem definition	Capacity to translate policy or management needs into appropriate scenarios and models
Scenario analysis	Capacity to participate in the development and use of scenarios to explore possible futures and in policy and management interventions
Modelling	Capacity to participate in the development and use of models to translate scenarios into expected consequences for biodiversity and ecosystem services
Decision-making for policy and management	Capacity to integrate outputs from scenario analysis and modelling into decision-making
Accessing data, information and knowledge	Data accessibility Infrastructure and database management Tools for data synthesis and extrapolation Standardisation of formats and software compatibility Human resources and skill base to contribute to, access, manage and update databases Tools and processes to incorporate local data and knowledge

Guidance for the Platform and its task forces and expert groups

Platform guidance point 1: Experts planning to employ scenarios and models in Platform thematic, regional and global assessments may want to consider maximizing the benefit derived from analysing and synthesizing results from existing applications of policy-relevant scenarios and models. Even where the timing of future Platform assessments, including the global assessment, allows for the development of new scenarios (see Platform guidance point 2) any such development needs to build on, and complement, the effective analysis and synthesis of existing scenarios and models. Experience from previous assessments on the global and regional scales suggests that the full cycle of new scenario development through to final analysis of impacts based on modelling requires several years of effort to generate results of sufficient rigour and credibility for the purposes of Platform assessments. Experts involved in regional and thematic assessments already under way should therefore focus on working closely with other relevant Platform deliverables and the wider scientific community to harness the power of new approaches to analysing and synthesizing best available exploratory, target-seeking and policy-screening scenarios on the global, regional, national and local scales. The approaches adopted for the four regional assessments should be coherent enough to enable the collective contribution of results to the global assessment while still allowing for significant regional differences {1.5.1, 3.2.2, 3.2.3, 3.5, 8.4.2}.

Platform guidance point 2: The Platform may want to consider encouraging and working closely with the wider scientific community to develop a flexible and adaptable suite of multi-scaled scenarios specifically tailored to its objectives. This would mean adopting a relatively long-term strategic view of catalysing the development of scenarios that meet its needs and would involve working closely with the scientific community to articulate criteria guiding the development of new scenarios by that community. Table SPM.4 summarizes several criteria that are important for the specific needs of the Platform (see also figure SPM.8), many of which go well beyond the criteria underlying the current development of other scenarios such as the shared socioeconomic pathways

being catalysed by the Intergovernmental Panel on Climate Change (box SPM.2). The Platform would, however, benefit from close collaboration and coordination with regard to ongoing activities within the scientific community developing the shared socioeconomic pathways. The advantage of using the shared socioeconomic pathways as a common resource for the Platform and the Panel include saving of effort, increasing consistency and improving aspects of the pathways that would be of mutual benefit for the Platform and the Panel. Developing a full suite of interlinked scenarios as outlined in table SPM.4 would require catalysing research on a variety of types of scenarios on multiple spatial and temporal scales. This should therefore be viewed as a long-term objective {3.5, 4.7, 8.4.2}.

Platform guidance point 3: In order to overcome barriers to the use of scenarios and models, it is important that the Platform continue to support and facilitate capacity-building within the scientific community and among policymaking and decision-making practitioners. The Platform task force on capacity-building could play a vital role in achieving this by helping to build human and technical capacity, specifically targeting the skills needed for the development and use of scenarios and models. Such engagement should link, where appropriate, with relevant networks and forums that are already established within the scientific and practitioner communities. The Platform should also set high standards of transparency for all scenarios and models used in its assessments or promoted through the deliverable on policy support tools and methodologies {2.6, 3.2.2, 3.2.3, 3.5, 6.1, 7.2, 7.4.1, 7.5.4, 7.6.1, 7.6.2}.

Platform guidance point 4: Because of the highly technical nature of scenarios and models, it is preferable that all of the Platform deliverables involve experts with knowledge of the utility and limitations of scenarios, models and decision-support tools. This point can be addressed by encouraging the nomination and selection of experts familiar with scenarios and models, keeping in mind that expertise is needed across the various classes of models and scenarios. Owing to the diversity and often highly technical nature of scenarios and models, the Platform task forces and expert groups should also refer to the methodological assessment and the associated evolving guide on scenarios and models and should seek advice and support from relevant specialists involved in Platform deliverables, including the task force on knowledge, information and data. Due to the importance of indigenous and local knowledge to the objectives of the Platform, particular consideration should be given to mobilizing experts with experience in formulating and using scenarios and models that mobilize indigenous and local knowledge, including participatory approaches. Experts involved in Platform deliverables should work closely with the indigenous and local knowledge task force in implementing those approaches. Broader use of participatory scenario methods in work undertaken or promoted by the Platform is one potentially important pathway for improving the contribution of indigenous and local knowledge {2.6, 3.5, 6.1, 6.4, 7.4.3, 7.4.4, 7.5.4, 7.6.3, 7.6.5}.

Platform guidance point 5: The Platform should consider putting in place mechanisms to help experts involved in Platform deliverables utilize scenarios and models and communicate results effectively. The experts involved in Platform assessments will need to critically analyse and synthesize scenarios and models operating on different scales, so they are likely to require assistance. Many experts involved in Platform deliverables will also need guidance in evaluating and communicating the capacities and limitations of scenarios and models employed in those activities, along with the types, sources and levels of uncertainty associated with resulting projections. To that end, the task force on knowledge, information and data and those involved in the ongoing work on the evolving guide for scenarios and models and other relevant deliverables should consider developing practical guidelines for evaluating and communicating capacities, limitations and uncertainties associated with scenarios and models {2.6, 3.2.1.1, 3.2.2, 3.2.3, 3.3, 3.4, 3.5, 4.7, 6.1, 6.3, 6.4, 6.5, 7.2.2, 8.3.1.3}.

Platform guidance point 6: Scenarios and models can potentially be promoted through all Platform deliverables, so the implementation plans for deliverables should be reviewed to ensure that they reflect such potential. Effective use of scenarios and models in policy formulation and implementation will require embedding those approaches within decision-making processes across a wide range of institutional contexts and scales. The Platform can help to achieve this by complementing the use of scenarios and models in regional, global and thematic assessments with the promotion and facilitation of their uptake by other processes beyond the Platform through its task forces on capacity-building, indigenous and local knowledge, and knowledge, information and data, as well as its deliverable on policy support tools and methodologies and the evolving guide on scenarios and models {1.1, 2.1, 2.5, 3.2.2, 3.2.3, 3.5, 6.1, 7.4.2, 7.5.3}.

Table SPM.4 – Important characteristics of scenarios that could be catalysed by IPBES in support of its activities. The framework for these scenarios might consist of a family of inter-related components rather than a single set of scenarios. These components could rely heavily on existing scenarios and scenarios being developed in other contexts, with a strong emphasis on participatory methods and on developing tools for creating and analysing linkages between spatial scales, across temporal scales and between different types of scenarios (i.e., exploratory vs. intervention scenarios) as outlined in Figure SPM.8. See 3.2.1, 3.2.2 and 3.5 for further details.

Characteristics of an ideal suite of Platform scenarios	**Why important**	**Examples**
Multiple spatial scales	Different drivers of change operate on different spatial scales. The relative importance of drivers also varies greatly across localities, countries and regions. Including regional, national and local scales improves opportunities for capacity building.	Southern Africa Ecosystem Assessment, European Union "OPERAS" and "OPENNESS" projects.
Multiple temporal scales	Decision-making often requires both short-term (c. 10 years or less) and long-term (multiple decades) perspectives. Most international environmental assessments have focused only on longer time scales.	Global Biodiversity Outlook 4 (see table SPM.1)
Multiple scenario types	Exploratory, target-seeking and policy-screening scenarios address different phases of the policy cycle.	Global Biodiversity Outlook 4 (primarily focused on exploratory and target-seeking scenarios)
Participatory	Engaging actors in the development of scenarios contributes significantly to capacity-building in the science-policy interface and creates opportunities for engaging with indigenous and local knowledge.	Best examples are on local to national scales (see table SPM.1, figure SPM.4)
Strong interactions with scenario development under way in other sectors	It is important to avoid duplication of efforts and over-mobilization of scientists and policy makers. Taking advantage of strong complementarities would be beneficial for all parties involved.	Ties with shared socioeconomic pathway activities for global scenarios (see box SPM.2) in support of the Intergovernmental Panel on Climate Change Links to other initiatives working with multi-scale scenarios

Annex V to decision IPBES-4/1

Terms of reference for the further development of tools and methodologies regarding scenarios and models

A. Rationale and objectives

1. The assessment of scenarios and models is a methodological assessment. It represents the first phase of the Platform's work on scenarios and models (decision IPBES-2/5, annex VI). It was initiated in order to provide expert advice on "the use of such methodologies in all work under the Platform to ensure the policy relevance of its deliverables" (decision IPBES-2/5, annex I). It is one of the first products of the Platform because it lays the foundations for the future use of scenarios and models in the regional and global thematic assessments and all the future work of the Platform.

2. A follow-up phase now needs to be initiated, in response to the Plenary's request, to facilitate the provision of advice to all the expert teams, in particular those working on the thematic, regional and global assessments on the use of scenarios, and to catalyse the further development of scenarios and models.

B. Proposed work

3. Further work on scenarios and models will include the following activities:

(a) Activity 1: Provide expert advice to relevant expert groups of the Platform, in particular those currently undertaking assessments, on the use of existing models and scenarios to address the current needs of the Platform;

(b) Activity 2: Catalyse the development of scenarios and associated models by the broader scientific community for the future work of the Platform.

4. The further work on scenarios and models, being critical to all the Platform's assessments, would start immediately following the fourth session of the Plenary of the Platform and continue until the end of the first work programme.

Activity 1: Provide expert advice on the use of existing models and scenarios to address the current needs of Platform

5. All assessments of the Platform include the assessment of existing work on scenarios and models for the relevant respective regions or themes in order to provide insight into the future of biodiversity and ecosystem services.

6. Four sub-activities need to be performed to make this work possible: (a) facilitate access to the relevant literature on scenarios and models; (b) facilitate access to the relevant scenario outputs; (c) coordinate the use of scenarios and models in order to allow comparisons among regional, global and thematic assessments; and (d) further develop the evolving guide on the use of scenarios and models:

(a) Facilitate access to the relevant literature: a database of existing literature on scenarios and models will be established and maintained, providing source material for the syntheses undertaken in the course of the thematic, regional and global assessments at the local, national, subregional and regional scales. The database will include peer reviewed papers and publically available reports and will also encourage practitioners and experts to share non-published or difficult-to-access reports, including on indigenous and local knowledge, in any language. The database will be set up in close collaboration with the task force on knowledge and data;

(b) Facilitate access to the relevant scenario outputs: the scientific community will be encouraged to make its outputs, such as maps and databases, readily available to the Platform's experts. Mechanisms being developed under the auspices of the Platform, such as the catalogue of policy support tools and methodologies (deliverable 4 (c)) and the knowledge and data repository (deliverable 1 (d)), will be used as potential starting points to establish a web-based platform for scenarios and models outputs;

(c) Coordinate the use of scenarios and models: this will be done through several physical and virtual workshops (organized in close cooperation with the task force on capacity-building), involving experts performing work on scenarios for the relevant chapters of the various ongoing assessments;

(d) Further develop the evolving guide on the use of scenarios and models: an evolving guide will be produced and maintained, in close collaboration with those developing the catalogue of

policy support tools and methodologies (deliverable 4 (c)), building on chapter 6, on using scenarios and models in assessment and decision support, of the Platform's guide on assessment (deliverable 2 (a)) and on the methodological assessment of scenarios and models (deliverable 3 (c)).

Activity 2: Catalyse the development of scenarios and associated models by the broader scientific community.

7. Ongoing and future activities of the Platform will lead to the identification of gaps in scenarios and models. These gaps will need to be filled to advance knowledge in this field at many levels, to enlarge the body of knowledge for future assessments of the Platform. In addition, new scenarios, specific to the needs of the Platform, will need to be developed by the scientific community. The Platform will not generate this new knowledge, but will catalyse its production:

(a) Catalyse the filling of gaps in knowledge on scenarios and models: the gaps identified in the assessment report on scenarios and models, as well as future gaps identified through the work of the Platform, will need to be communicated to the scientific community so that they can be addressed;

(b) Catalyse the development for future use by the Platform of new scenarios of direct and indirect drivers: as highlighted in the scenario and model assessment, there are no existing scenarios that fully meet the needs of the Platform. The generation of these new scenarios should be catalysed by the Platform, in collaboration with research centres working on relevant scenarios. That would include, as outlined in the summary for policymakers, working in collaboration with researchers developing the shared socioeconomic pathways being catalysed by the Intergovernmental Panel on Climate Change;

(c) Follow-up activities on both existing and new scenarios will include capacity-building aimed at improving the uptake and use of scenarios and models by a broad range of policymakers and stakeholders. This should involve working with the capacity-building task force (deliverable 1 (a)) and policy support tools and methodologies (deliverable 4 (c)) and in-kind support for encouraging the development of a curriculum and network of training courses and for scenarios and models (see IPBES/4/INF/22 for an example of work that has already been catalysed by the Platform) and workshops where scientists, policymakers and stakeholders lay out strategies for mobilizing scenarios and models for decision-making.

8. These activities will be carried out in close collaboration with the task force on knowledge and data (deliverable 1 (d)) in the context of the dialogues to be convened by this task force to catalyse the generation of new knowledge and fill knowledge gaps.

C. Institutional arrangements for undertaking work on scenarios and models

9. To ensure continuity, this work will be implemented by an expert group consisting of 20–25 members from among the co-chairs, coordinating lead authors and lead authors of the current scenario assessment expert group, as well as from among the scenario experts selected for the regional or thematic assessments. The final composition of the expert group will be decided in accordance with the approved rules of procedure and will be approved by the Multidisciplinary Expert Panel. Potential gaps in expertise will be filled using the procedure for filling gaps. This expert group will cooperate fully with the task forces on capacity-building, indigenous and local knowledge systems, and data and knowledge.

10. The technical support unit based at the Netherlands Environmental Assessment Agency, which provided support for the production of the methodological assessment on scenarios and models, will continue its work until the end of the first work programme.

D. Schedule of work

11. The schedule for this work is set out in the table below. Elements in bold indicate activities that will require funding from the trust fund or in-kind support above and beyond the in-kind contribution of the Government of the Netherlands.

	Actions and institutional arrangements
2016	Selection of the expert group by the Multidisciplinary Expert Panel Initiation of activity 1 (a): facilitate access to relevant literature on scenarios and models Initiation of activity 1 (b): facilitate access to scenarios and models outputs Initiation of activity 1 (c): coordinate the use of scenarios and models within the Platform Initiation of activity 1 (d): further develop the evolving guide on the use of scenarios and models Initiate activity 2 (a): catalyse the filling of gaps in knowledge on scenarios and models Initiate activity 2 (b): catalyse the development of new scenarios Initiate activity 2 (c): capacity-building to improve the uptake of scenarios and models **Meeting of the expert group on the evolving guide** **Workshop of the expert group, other scientists and stakeholders to identify and address gaps**
2017	Progress report on activities 1 and 2, including on support of the global assessment All activities continue throughout the year **Workshop of the expert group, other scientists and stakeholders on developing new scenarios for the Platform**
2018	**Presentation of the work of the expert group at the sixth session of the Plenary** **All activities continue throughout the year**
2019	**Final report of the expert group on all activities**

E. Cost

12. In line with the agreement on the financial and budgetary arrangements (decision IPBES-4/2) the budget allocated to the activities described in this annex is to remain within an envelope of $200,000 for the 2016–2017 biennium.

13. The PBL Netherlands Environmental Assessment Agency hosts the technical support unit for the methodological assessment and the further development of scenarios and models, including in-kind support. In addition, partner organizations will be providing funding to complement funding by the trust fund to support the travel of participants.

Annex VI to decision IPBES-4/1

Scoping for the methodological assessment regarding diverse conceptualization of multiple values of nature and its benefits, including biodiversity and ecosystem services (deliverable 3 (d))

I. Scope, rationale, utility and assumptions

A. Scope

1. The objectives of the proposed methodological assessment are to assess: (a) the diverse conceptualization of values of nature and its benefits, including biodiversity and ecosystem services (provisioning, regulating and cultural) consistent with the Platform's conceptual framework;[56] (b) the diverse valuation methodologies and approaches; (c) the different approaches that acknowledge, bridge and integrate the diverse values and valuation methodologies for policy and decision-making support; and (d) knowledge and data gaps and uncertainties.[57]

B. Geographic boundary of the assessment

2. The assessment will enable valuation to be incorporated into decision-making at any geographic scale from local to global.

C. Rationale

3. At present, the design of governance, institutions and policies rarely takes into account the diverse conceptualization of multiple values of nature and its benefits to people.[58] The advantages of taking into account the diversity and complexity of these multiple values include: (a) making visible the different types of values and the wide spectrum of benefits derived from nature; (b) choosing and designing appropriate valuation methodologies and approaches; (c) identifying and addressing inherent conflicts that may arise due to different perspectives on values and valuation; (d) empowering individuals and groups whose voices are typically unheard or not attended to in discussing values; and (e) providing a wide, balanced, view of the mechanisms contributing to the construction of value from existing multiple values that extends the use of valuation beyond conventional economic approaches. Valuation, if carried out in a context-sensitive way, can be a significant resource for a range of decision makers, including Governments, civil society organizations, indigenous peoples and local communities, managers of terrestrial and marine ecosystems and the private sector, in making informed decisions.

4. Therefore, a critical evaluation of the strengths and weaknesses of the concepts and methodologies regarding the diverse conceptualization of multiple values of nature (including biodiversity and ecosystem structure and functioning) and its benefits (including ecosystem services) will provide the knowledge base for guiding the use of existing policy support tools and the further development of such tools, and will assist in the assessment of sources of information for assessments, taking into account different world views, cultural traditions and national policy frameworks and circumstances. The assessment will take into account the degree of confidence of the values and valuation methods.

5. This assessment will build upon the revised preliminary guide for the methodological assessment regarding the diverse values of nature and its benefits.[59] The preliminary guide did not critically assess different valuation methodologies or approaches to how to integrate and bridge, where appropriate, the diversity of values, or how different world views and values have been included in decision-making or have led to the evaluation of policy support tools and policy options. The assessment, which will also take into account experiences learned during the regional and thematic assessments, will result in revised practical guidelines.

6. The assessment and revised guidelines will facilitate the undertaking, in a consistent manner, of Platform assessments and other activities. The assessment and revised guidelines should also facilitate

[56] Decision IPBES-2/4, annex.

[57] Using the Platform's confidence framework in the Platform's guide on assessments (IPBES/4/INF/9).

[58] The conceptual framework defines the term "nature and its benefits to people" and its use in the context of the Platform (decision IPBES-2/4, annex).

[59] (IPBES/4/INF/13).

national assessments and national and international policy formulation and implementation, including with regard to the Aichi Biodiversity Targets.

7. The assessment may catalyse the development of tools and methodologies for incorporating an appropriate mix of biophysical, social and cultural, economic, health and holistic (including indigenous and local community-based) values into decision-making by a range of stakeholders, including Governments, civil society organizations, indigenous peoples and local communities, managers of ecosystems and the private sector. The consideration of biophysical values, in accordance with the preliminary guide, will acknowledge, but will not involve a detailed assessment of, the mechanistic links between ecosystem processes and functions and the delivery of benefits to people, which are the subject of other assessments of the Platform.

8. This work will be directly applicable to the work of the Platform. It will help identify relevant gaps in knowledge, including scientific and indigenous and local community-based knowledge, and in practical policymaking as well as in capacity-building needs. In addition, it will highlight approaches and methodologies, including scenarios and models that are particularly helpful for acknowledging and bridging the diverse conceptualization of multiple values of nature and its benefits to people.

9. The assessment will be based on the recognition of culturally different world views, visions and approaches to achieving a good quality of life in the context of the conceptual framework of the Platform.

D. Assumptions

10. The work will be carried out by a multidisciplinary group of experts with a range of backgrounds such as, inter alia, anthropology, biology, communication science, ecology, economics, environmental science, geography, law, philosophy, political science, policy implementation, psychology, sociology and relevant fields of interdisciplinary inquiry, as well as stakeholders and practitioners relevant to biodiversity and ecosystem services decisions (e.g., business, Governments and non-governmental organizations) and holders of indigenous and local knowledge with a range of cultural traditions. These experts will be nominated by Governments and Platform stakeholders and selected by the Multidisciplinary Expert Panel in accordance with the procedures for the preparation of the Platform's deliverables and will build upon previous and ongoing relevant initiatives (see paragraphs 19 and 20).

II. Assessment outline

11. The assessment report will comprise a summary for policymakers and six chapters, each with an executive summary of the key findings and messages most relevant to decision makers.

12. Chapter 1 will consist of an introduction that makes explicit the relevance of a diverse conceptualization of values of nature and its benefits for governance and institutional and policy design in different decision-making contexts, as well as the links to the conceptual framework. The chapter will also provide an explanation of how it can be used in connection with the Platform's catalogue of policy support tools and methodologies[60] (deliverable 4 (c)).

13. Chapter 2 will, in accordance with the Platform's conceptual framework and the preliminary guide, assess the coverage of diverse conceptualizations of values with regard to nature and nature's benefits to people. The assessment will use scientific literature through, for instance, systematic reviews and meta-analysis. The assessment will also draw on qualitative case studies associated with indigenous and local knowledge, as well as practical policymaking, among other sources of information. This work will identify the way in which different world views associated with different types of values have been included in decision-making contexts. In accordance with the Platform's conceptual framework and the preliminary guide, values considered will focus on nature, nature's benefits to people and a good quality of life and will be intrinsic and instrumental (including, e.g., use and non-use values, bequest values, option values and relational values). The assessment will consider, inter alia, the values involved in situations of uncertainty and risks of catastrophic events.

14. Chapter 3 will assess different valuation methodologies and approaches, including (a) biophysical, social and cultural, economic, health and holistic (including indigenous and local community-based) and (b) approaches to the integration and bridging of different types of values. The perspective of different genders and generations will also be considered. It will be based on a broad review of valuation methodologies and approaches that have been applied in the different specialized sources of information. It will highlight those methods and approaches that allow for articulation,

[60] IPBES/4/INF/14.

integration and bridging among valuation approaches and the acknowledgement of the inherent differences between valuation approaches considering different world views and knowledge systems. Part of this will be the consideration of how different methods and approaches help in acknowledging and dealing with potential conflicts, synergies and trade-offs between the values of different aspects of nature to different stakeholders and sectors. Key findings will be identified, especially those related to assessing the links between different types of values according to different world views and those linking nature, nature's benefits and a good quality of life.

15. Chapter 4 will assess both quantitatively and qualitatively the main findings and lessons learned on valuation methodologies and approaches, covered in chapters 2 and 3, for decision-making and policymaking at different levels and in different contexts (including community, private, and public). This will allow for the identification of the most commonly used methods and the methods that may effectively be used under various constraints (e.g., financial or time constraints) for linking the diverse conceptualization of multiple values of nature and its benefits to governance, institutional and policy design. The chapter will also assess and interpret how valuation methodologies and approaches address various socially shared values, including those associated with different notions of intra-generational and intergenerational equity (including procedural, recognition and distributional aspects) as well as the methodological implications of addressing equity between social actors who value an entity (nature and its benefits, in this case) differently, even when agreeing on the types of values underlying the process of valuation. Special importance will be placed on those methods that have been regarded as successful by decision makers in particular contexts or at particular spatial, temporal or social-organization scales. Key findings will be identified, especially those related to the identification of policy support tools, such as scenarios and models, as will other approaches that have proven to be successful. It will also consider how ecosystem accounts have been incorporated into national policies and accounting and reporting systems, as well as relevant accounting standards as appropriate to national circumstances. It will also provide qualitative and quantitative information on how the inclusion of diverse values into decision-making contexts has been addressed across (a) spatial scales, (b) temporal scales, (c) social-organization scales and (d) types of stakeholders and the diversity among people, and on how the impacts of (a) environmental change, (b) social change and social learning, (c) power relations, (d) inclusion and agency and (e) institutions, both formal and informal, have affected the values at stake in decision-making processes. In addition, opportunities for decision-making through the uptake of lessons learned will be identified.

16. Chapter 5 will highlight knowledge and data gaps and uncertainties in terms of the bridging and integration of diverse conceptualizations of values of nature and its benefits to people into governance, institutional and policy design relevant to policymaking and decision-making. It will emphasize (a) the types of conceptualizations of the value of nature and its benefits to people that have not been explicitly addressed or have not been explicitly incorporated into decision-making; (b) the types of valuation approaches, as well as their articulation, integration and bridging, that are underdeveloped or have not been explicitly incorporated into decision-making; (c) the challenges that have hindered the incorporation of diverse conceptualizations of values of nature and its benefits in a range of decision-making and policymaking contexts and levels as well as their implications for sustainability; and (d) the implications for different stakeholders of applying a subset of values rather than the full suite of relevant biophysical, social and cultural, economic, health-related and holistic (including indigenous and local community-based) values when those values are at stake.

17. Chapter 6 will highlight capacity-building needs and the steps required to respond to those needs, including capacities for policy uptake, development and implementation. It will draw on the findings of previous chapters and emphasize the kinds of capacity-building needed for (a) the explicit acknowledgment of the different types of conceptualization of nature and its benefits; (b) the different types of valuation methodologies and approaches that are needed to reflect them; and (c) their explicit incorporation into decisions and policymaking at different levels and in different contexts.

III. Key information to be assessed

18. All sources of relevant information will be assessed, including peer-reviewed literature, grey literature, and indigenous and local knowledge.

IV. Operational structure

19. The operational structure will consist of a technical support unit (at least one full-time equivalent professional-level staff member and 1 full-time equivalent administrative staff member). The Multidisciplinary Expert Panel will select 2 or 3 co-chairs, 60 authors and 12 review editors, in accordance with the procedures for the preparation of the Platform's deliverables. The co-chairs and

the technical support unit will have proven abilities in facilitation to ensure the communication across disciplines and sectors, as well as the incorporation of different types of knowledge held by the participants.

20. The co-chairs will come from different backgrounds, i.e., biophysical/geographical, social sciences and the humanities, with strong experience in incorporating a diversity of values of nature and its benefits. Each of the chapters will include 2 or 3 coordinating lead authors, 7 or 8 lead authors and 2 review editors. The experts will come from among academia, key stakeholder groups and indigenous and local knowledge holders to ensure broad coverage of a diversity of world views. The authors will cover the five United Nations regions, a range of disciplinary backgrounds, and will be invited to lead different sections of each chapter.

21. The management committee will consist of the technical support unit, the co-chairs and one coordinating lead author per chapter, as well as two Panel and one Bureau members.

V. Process and timetable

22. The table below shows the proposed process and timetable for undertaking and preparing the methodological assessment report.

Time frame		*Actions and institutional arrangements*
Year 1	First quarter	The Plenary decides to launch the undertaking of the assessment
	First quarter	The chair, through the secretariat, requests, from Governments and other stakeholders, nominations of experts (co-chairs, coordinating lead authors, lead authors and review editors) to conduct the assessment based on the scoping report approved by the Plenary at its fourth session (approximately 10 weeks)
	Second quarter	The Panel selects the co-chairs, coordinating lead authors, lead authors and review editors using the approved selection criteria
	Second quarter	Establishment of the technical support unit, meeting of the management committee to plan the first author meeting, together with the technical support unit
	Third quarter	First author meeting to further develop the annotated outline and the sections and chapters, and assign writing roles and responsibilities
	Third quarter–Fourth quarter	Preparation of first draft of the assessment report
Year 2	First quarter	Expert peer review (six weeks)
	First quarter	Second author meeting to address the review comments in order to develop the second draft of the assessment report and first draft of the summary for policymakers
	First quarter-Second quarter	Preparation of the second draft of the assessment report and the first draft of the summary for policymakers
	Third quarter	Government and expert review process of the second draft of the assessment report and the first draft of the summary for policymakers (8 weeks)
	Third quarter	Third author meeting to address the review comments in order to develop the final draft of the assessment report and the final draft of the summary for policymakers
	Third quarter-Fourth quarter	Preparation of the final draft of the assessment report and the final draft of the summary for policymakers
	Fourth quarter	Submission of the final documents to the secretariat for editing and translation (12 weeks before the Plenary session)
	Fourth quarter	Submission of the assessment, including the summary for policymakers, to Governments for final review prior to the plenary session (6 weeks before the Plenary session)
	Fourth quarter	Submission of final Government comments on the summary for policymakers in preparation for the Plenary session
	Fourth quarter	Plenary session of the Platform

VI. Cost estimate

23. Discussions regarding the Platform's work programme budget indicated that the indicative cost of this assessment should not exceed $800 000. A revised cost estimate for this assessment will be presented at the fifth session of the Plenary, when the launch of the assessment will be reconsidered.

VII. Communication and outreach

24. The assessment report and its summary for policymakers will be published and the summary for policymakers will be available in the six official languages of the United Nations. These reports will be made available on the Platform's website (www.ipbes.net). In accordance with the Platform's communication strategy, relevant international forums will be identified with a view to presenting the findings of the report and its summary for policymakers. Such forums will include national and international scientific symposiums, and meetings of biodiversity-related multilateral environmental agreements, United Nations entities, the private sector and non-governmental organizations.

VIII. Capacity-building

25. Capacity-building activities will be undertaken in accordance with the implementation plan of the capacity-building task force (for example, the fellowship programme).

Annex VII to decision IPBES-4/1

[Draft terms of reference for the mid-term and final reviews of the effectiveness of the Platform

1. An internal midterm and independent external final review will be prepared, for consideration by the Plenary at its fifth and sixth sessions respectively.

A. Internal midterm review

2. The midterm review will be conducted in the form of an internal review, involving members of the Multidisciplinary Expert Panel, the Bureau and the secretariat, including its technical support units. The review will focus on administrative and operational aspects and on the effectiveness of the functions, procedures and institutional arrangements of the Platform. In so doing it will take into account the terms of reference for the final external review.

3. The internal review team will work predominantly remotely and will meet in the margins of the two meetings of the Multidisciplinary Expert Panel and Bureau scheduled in 2016. As an input to the review the internal review team will solicit the views of experts involved in work under the Platform, Governments, United Nations collaborative partner agencies, other strategic partners and stakeholders, by means of a survey.

4. The Multidisciplinary Expert Panel and Bureau, based on the findings of the internal review team, will prepare a report for consideration by the Plenary at its fifth session. The report should include recommendations related to the implementation of the remainder of the work programme. The report should also suggest further and more specific guidance on the terms of reference for the external final review.

B. Independent external final review

5. The final review will evaluate the effectiveness of the Platform as a science-policy interface. The final review will analyse the Platform with regard to its effectiveness, efficiency, relevance and impact, as measured against its objectives, operating principles, its four functions and its administrative and scientific functions as set out in document UNEP/IPBES.MI/2/9. It will also evaluate the efficiency of the Platform's delivery of the work programme and established support structures, as governed by its rules of procedure (see decision IPBES-1/1, annex) and the procedures for the preparation of Platform deliverables (see decision IPBES-3/3, annex I). This review will evaluate:

(a) The implementation of the four functions of the Platform;

(b) The operationalization of the Platform's operating principles;

(c) The effectiveness of the procedures for the development of the Platform's deliverables;

(d) The effectiveness of the institutional arrangements of the Platform, including the Plenary, the Bureau, the Multidisciplinary Expert Panel and the secretariat, including technical support units, the United Nations collaborative partnership arrangement and other arrangements with strategic partners, and their interactions and rules of procedure;

(e) Budgetary and fiscal rules, arrangements and practices.

6. The final review will be conducted by an independent team of five external reviewers, administered by a renowned international organization. The organization and the team of reviewers will be appointed by the Bureau prior to the fifth session of the Plenary, following an open call for nominations. Nominations will be invited in respect of organizations with relevant qualifications in conducting institutional reviews and a demonstrated track record working with science-policy interface issues. The members of the team of external reviewers should have all complementary expertise needed to undertake the review.

7. The final review will build on the internal interim review. The methods to be used by the evaluators are to include:

(a) The review of relevant documents and literature, both produced by the Platform itself, including the internal interim review, and by the relevant expert and stakeholder community;

(b) Surveys covering all relevant aspects of the Platform as a science-policy interface;

(c) Key informant interviews, including with members of the Bureau and the Multidisciplinary Expert Panel, the secretariat and technical support units, experts involved in the

work of the Platform, the United Nations collaborative partner agencies, other strategic partners, Governments and stakeholders;

(d) Focus group discussions on particular issues and aspects of the Platform, including issues related to indigenous and local knowledge systems, involving a representative range of relevant members of the Bureau and the Multidisciplinary Expert Panel, the secretariat and technical support units, experts involved in the work of the Platform, the United Nations collaborative partner agencies, other strategic partners, Governments and stakeholders;

(e) Direct observation during key meetings of the Platform in 2017, including meetings of the Plenary, the Multidisciplinary Expert Panel and the Bureau and task force and assessment expert group meetings;

8. The external team of evaluators will provide their services on a pro-bono basis. The requested budget of $250,000 is to support the costs of participation of the evaluators and those focus group workshop participants that are eligible for financial support.

The final review is to be produced in due time for consideration by the Plenary at its sixth session and is to inform the development of the work programme for the following period.]