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**IPBES workshop on modelling Nature Futures scenarios**

**Task force on scenarios and models**

**under the 2030 IPBES rolling work programme**

Online, 12-15 January 2021

## **Report of the IPBES task force on scenarios and models on its workshop on modelling Nature Futures scenarios under the 2030 IPBES rolling work programme**

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## DISCLAIMER

The IPBES Bureau and Multidisciplinary Expert Panel (MEP) authorized a workshop on modelling Nature Futures scenarios that was organized by the task force on scenarios and models online from 12 to 15 January 2021. This workshop report and any recommendations or conclusions contained therein have been prepared by the task force on scenarios and models and reviewed by all workshop participants. It has not been reviewed, endorsed or approved by the IPBES Plenary.

## Executive summary

This document provides the report of the workshop on modelling Nature Futures scenarios that was held online from 12 to 15 January 2021, organized by the IPBES task force on scenarios and models under the IPBES 2030 rolling work programme. It includes a summary of the discussions on the usability of the Nature Futures Framework and contributions to its methodological guidance for catalysing the development of the next generation of scenarios.

The objectives of the workshop were to seek feedback and contributions from the modelling community on the draft Nature Futures Framework and its methodological guidance and to discuss future engagement for further development and application of the Nature Futures Framework to support IPBES assessments on biodiversity and ecosystem services.

Many participants recognised the wide range of applications which the Nature Futures Framework offers to discuss value perspectives on positive human-nature relationships in order to make a desired future feasible. Participants also acknowledged that applications of the Nature Futures Framework could help identify options for interventions to support the achievement of policy goals such as the Sustainable Development Goals or targets under the post-2020 global biodiversity framework, and could support the upcoming IPBES nexus and transformative change assessments<sup>1</sup>.

Throughout the four days of the workshop, important observations and recommendations were made on the operationalisation of the Nature Futures Framework in modelling. Specific recommendations for adjustments to modelling methods which would allow them to accommodate the concepts highlighted by the Nature Futures Framework, included:

- (a) Better integration between different fields of modelling;
- (b) Combining quantitative with qualitative approaches;
- (c) Using social indicators to allow the incorporation of feedback loops;
- (d) Incorporating cross-scale linkages;
- (e) Representing different values and their relationship to norms;
- (f) Diversifying data sources; and
- (g) Analysing multiple pathways to reach envisioned positive futures.

Participants suggested multiple options for ways in which the modelling community could tackle the challenges of modelling Nature Futures scenarios, including engagement with the task force to generate quantitative values across the value perspectives of the Nature Futures Framework and initiating a community of practice where modelling teams interact and share intermediate outcomes. Other suggestions included producing publications on how to use the Nature Futures Framework in different contexts, including visualisations such as a flow chart of possible modelling steps, as a source of information for potential users of the Nature Futures Framework.

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<sup>1</sup> Thematic assessment of the interlinkages among biodiversity, water, food and health (nexus assessment) and thematic assessment of the underlying causes of biodiversity loss and the determinants of transformative change and options for achieving the 2050 Vision for Biodiversity (transformative change assessment).

## Introduction

In decision IPBES-7/1, the Plenary of IPBES established the task force on scenarios and models for the implementation of objective 4 (b) of the rolling work programme up to 2030, to support policy through the advanced work on scenarios and models of biodiversity and ecosystem functions and services.

The IPBES task force on scenarios and models, in accordance with its draft deliverables and proposed work plan, is working on further developing the Nature Futures Framework (NFF) to allow the scientific community to develop new scenarios for future IPBES assessments, and for the modelling communities to develop models to quantify the impact of such scenarios on biodiversity and nature's contributions to people. Based on the draft description of the NFF and its methodological guidance, the task force conducts a series of consultations with relevant stakeholders and modelling communities in the period up to the ninth session of the IPBES Plenary. These consultations are intended to collect feedback on the usability of the NFF and contributions to its methodological guidance for catalysing the development of the next generation of scenarios. The NFF will then be presented to the IPBES Plenary at its ninth session, together with related methodological guidance.

As part of this process, the task force on scenarios and models organized the workshop on modelling Nature Futures scenarios that was held online from 12 to 15 January 2021. This workshop provided an opportunity to collect feedback on the usability of the NFF and contributions to its methodological guidance for catalysing the development of the next generation of scenarios.

The IPBES Multidisciplinary Expert Panel selected the participants in the workshop, based on a proposal from the task force. Participants included 30 experts selected from the pool of experts nominated by Governments and organisations in response to a call for nominations, 6 experts from ongoing IPBES assessments (assessments of the sustainable use of wild species, on values, and of invasive alien species) and scoping processes (for the 'nexus' and 'transformative change' assessments), as well as 14 resource persons representing modelling groups which contributed to the biodiversity and ecosystem services model intercomparison exercise conducted as input to the IPBES Global Assessment.

This workshop report was prepared by the technical support unit on scenarios and models and reviewed by the task force and all workshop participants.

Technical support to the workshop was provided by the technical support unit on scenarios and models, hosted by the Netherlands Environmental Assessment Agency (PBL).

## I. Objectives

The objectives of the workshop were to introduce the NFF to, and help catalyse the development of, scenarios and models for IPBES by, communities that develop and apply models of different types, scales and domains relevant to biodiversity and ecosystem services.

Specifically, the workshop was intended to:

1. Seek feedback and contributions from the modelling community on the draft NFF and its methodological guidance;
2. Discuss further methodological steps to enable modelling communities to simulate quantitative scenarios of nature, nature's contributions to people, and good quality of life, using the NFF at different scales; and
3. Discuss future engagement of the modelling communities in the further development and application of the NFF to support IPBES assessments and policies on biodiversity and ecosystem services.

## II. Organisation & main outcomes

The workshop ‘modelling Nature Futures Scenarios’ was opened by the Executive Secretary of IPBES, Anne Larigauderie, followed by a welcome by the co-chairs of the task force, Carolyn Lundquist and Shizuka Hashimoto, on Tuesday 12 January 2021 at 4 p.m. (CET). The workshop was held online and structured into two sessions of 1.5 hours on four consecutive days, including plenary and breakout group sessions. Comprehensive introductory material was provided to participants prior to the workshop. The agenda of the workshop is set out in annex I.

A main outcome of the workshop was that for many participants the Nature Futures Framework could help identify options for interventions to support the achievement of policy goals such as the Sustainable Development Goals and the targets under the post-2020 global biodiversity framework and could support the upcoming IPBES assessments on ‘nexus’ and ‘transformative change’. Participants also pointed to the possibility of using the NFF and its three value perspectives of ‘*nature for nature*’, ‘*nature as culture*’, and ‘*nature for society*’ (further descriptions provided in section III.A.), as a guide to identify concrete actions/strategies to achieve targets of the post-2020 global biodiversity framework, and the need for predictive models to link these actions to the targets.

Examples of specific modelling questions that the NFF would need to address were:

- (a) Where and when are land sparing or land sharing a more appropriate resource use strategy?
- (b) How to decide on the location or management of protected areas, multifunctional landscapes, or land-use intensification and conservation?
- (c) How does natural resource consumption in one part of the world displace ecological impacts to other parts of the world?

It was suggested that in applying modelling to answer some of the questions which the upcoming IPBES nexus and transformative change assessments may address, designing models that provide tractable answers should take priority over, for instance, modelling nexus interactions. Participants identified the following challenges and related questions relevant to the application of the NFF:

- (a) Inclusive coverage of the ‘*nature as culture*’ value perspective: How to contribute to the discussions and critiques of the limited representation of the ‘*nature as culture*’ value perspective in the post-2020 biodiversity framework, or to address the difficulty of upscaling indigenous and local knowledge to the global to sub-national scales for their use in scenarios at these levels?
- (b) Maintaining diverse value perspectives in modelling: How to translate the value perspectives of the NFF into a conceptualisation that best represents reality? Which indicators provided by models could be used for this exercise? In modelling, often one consensus view is assumed, which leads to the incorporation of only a single (often western) perspective into the model, and the application of the NFF would require moving beyond this approach. Conversely, commonly used model indicators and outputs may not translate readily across the NFF value perspectives, and further work would be required to integrate these outputs in the application of the NFF;
- (c) Inclusion of synergies and trade-offs: It was considered important to recognize trade-offs between value perspectives, as different value perspectives may aim for different visions for nature and society. Application of the NFF would need to explore how optimal actions would differ between two value perspectives, and whether there is a middle ground which would allow the achievement of both. Depending on the trade-offs, there may be different ‘winners’ and ‘losers’ across sectors of society. It was also considered critically important to search for new types of synergies. Compromise solutions may exist which simultaneously incorporate multiple values and satisfy, to a certain degree, different stakeholders’ demands;
- (d) Cross-scale linkages: The scale of analysis depends on the problem at hand, but analyses at the subnational scale were considered necessary, as existing scenarios at the global scale are assumption-based and do not reflect land-use change in practice. Participants pointed out that global scenarios should be developed as an accumulation of local scenarios

(incorporating all NFF value perspectives) in order to reflect their interdependence. However, it was noted that it would be difficult for sub-global case studies to account for teleconnections and telecoupling<sup>2</sup>;

- (e) Taking into account feasibility of scenarios: Participants pointed out that the upcoming IPBES nexus and transformative change assessments could also consider value perspectives beyond the nature-centred scope of the NFF and may want to carefully choose the levers of change they would assess. While scenarios consider all changes to be equally possible, the feasibility of achieving the envisioned futures through different levers would need to be taken into account. It was suggested that scenarios and models of different scales and foci could be used to enrich and test each other.

Throughout the workshop, breakout groups were organized, in which participants discussed different **tools** for operationalising the NFF in modelling. Outcomes included:

- (a) Combining existing models and methods: Many participants agreed that models and methods already exist that could be used in applying the NFF, and that combining and applying these existing tools presents a ‘low-hanging fruit’. A challenge in this exercise would be bringing different methods/models together and applying relevant observation data to evaluate results. Examples of available tools included:
  - i. Stakeholder engagement to build and test models using different approaches;
  - ii. The value perspectives of ‘*nature for nature*’ through to ‘*nature for society*’, which could be modelled using existing models, such as the GLOBIO-IMAGE<sup>3</sup> model series;
  - iii. Models operating at multiple scales which show evidence of different value perspectives of the NFF being emphasised in different locations and contexts, and thus allow for cultural perspectives to be captured;
  - iv. Models with constrained domains (which use standard drivers such as gross domestic product or population dynamics within Shared Socioeconomic Pathways (SSPs)<sup>4</sup>), which are aimed at specific outcomes like food security maximisation. A focus on such scenarios would, however, exclude potentially useful scenarios (and also dystopian options);
  - v. Ecosystem-based modelling;
  - vi. Integrated Assessment Models adapted to fit the purpose of the NFF;
  - vii. Conceptual models that bring together diverse elements (including cultural and relational value perspectives) through qualitative networks, in order to better reflect complex realities;
  - viii. Optimisation scenarios, where scenarios are optimised for specific criteria and more complex models are used to analyse ways to achieve them (e.g., by the Working Group on Integrated Ecosystem Assessment models of the International Council for the Exploration of the Sea);
- (b) Looking beyond quantification: Participants also recognised that in addition to adapting existing tools, it is also important to think beyond quantitative models and consider

<sup>2</sup> Telecoupling refers to socioeconomic and environmental interactions over distances. It involves distant exchanges of information, energy and matter (e.g., people, goods, products, capital) at multiple spatial, temporal and organizational scales. (IPBES Glossary)

<sup>3</sup> Global biodiversity model for policy support (GLOBIO) and Integrated Model to Assess the Global Environment (IMAGE)

<sup>4</sup> The Shared Socioeconomic Pathways, or SSPs, have been developed by the climate modelling community “to facilitate the collaboration of climate change researchers from a broad range of perspectives and disciplines to develop policy- and decision-relevant scenarios and explore the challenges and opportunities human and natural systems could face with additional climate change” (Ebi et al., 2014). They consist of a narrative storyline and a set of quantified measures of development that together describe plausible alternative trends in the evolution of society and natural systems (O’Neill et al., 2014).

qualitative tools such as mental models, especially when discussing pathways and transformative change.

Considering the challenges and complexities of applying the NFF in practice, participants suggested that the NFF should be operationalised in several different steps, including, clarifying the distinction between the different value perspectives, incorporating them into scenarios for use in IPBES assessments as well as other scenarios using existing models, and building new modelling processes. In order to further promote the application of the NFF, they suggested the development of a community of practice where modelling teams interact and share intermediate outcomes (e.g., like the Inter-Sectoral Impact Model Intercomparison Project and the World Water Quality Alliance).

### III. Summary of general discussions and presentations

#### A. Introduction to the Nature Futures Framework and methodological guidance

One of the two co-chairs of the task force, Shizuka Hashimoto, presented the development of the NFF, summarizing the pre-recorded presentation by the second task force co-chair Carolyn Lundquist. The IPBES Methodological Assessment of Scenarios and Models (IPBES, 2016) had clarified some of the limitations and challenges related to existing scenarios and models. Most global scenarios were limited to assessing the impact of drivers on biodiversity and ecosystem services and were often developed for other purposes, e.g., to describe climate change. Furthermore, only a few scenarios described ‘positive’ futures, while most others presented degradation or collapse. Moreover, most global scenarios lacked a participatory approach to embrace different visions or perspectives, including indigenous and local knowledge. Thus, there was a need for a more flexible framework to further catalyse the development of a new generation of scenarios to fill the gaps in existing scenarios and models and to better respond to policy-relevant questions on biodiversity and the sustainable use of ecosystem services and nature’s contributions to people.

The development of such a framework was initiated in response to the recommendations of the IPBES Methodological Assessment of Scenarios and Models (IPBES, 2016) through a series of consultations, stakeholder workshops, and meetings by the former IPBES expert group and current task force on scenarios and models.<sup>5, 6, 7</sup> This resulted in the NFF as a heuristic tool with underlying value perspectives that captures diverse and positive human-nature relationships in a triangular gradient applicable at different scales.<sup>8, 9, 10</sup> What is outside the borders of the NFF was seen as an unsustainable or undesirable future. Within the NFF, each corner represented different ‘extreme’ value perspectives. The ‘*nature for nature*’ corner had a strong orientation towards the intrinsic value of nature and space allocated for nature. The ‘*nature for society*’ corner placed a high value on instrumental values, reflecting nature’s contributions to people. The ‘*nature as culture*’ value perspective placed a high value on relational values for nature, and perceiving people as living in harmony, and/or being one with nature. On the gradient between the three most distinct perspectives at the three corners, a myriad of different configurations of different types of values for nature could be placed anywhere within the relative space of the NFF.

Task force member Paul Leadley presented the draft NFF methodological guidance document,<sup>11</sup> in which the task force explained how the NFF value perspectives could be translated into illustrative narratives and into quantitative or qualitative scenarios of desirable futures for nature and people. The illustrative narratives stemmed from thinking about diverse values and the kind of world that

<sup>5</sup> Lundquist et al. (2017), Visions for nature and nature’s contributions to people for the 21<sup>st</sup> century, NIWA Science and Technology Series Report No. 83, NIWA, New Zealand. 123 pp. (Report of the stakeholder workshop held in Auckland, New Zealand from 4 to 8 Sept 2017).

<sup>6</sup> PBL (2018), Report on the Workshop ‘Next Steps in Developing Nature Futures’. PBL Netherlands Environmental Assessment Agency, The Hague. 27 pp. (Report of the expert group meeting held in The Hague from 25 to 28 June 2018)

<sup>7</sup> PBL (2019), Report on the workshop ‘From visions to scenarios for nature and nature’s contributions to people for the 21<sup>st</sup> century’. PBL Netherlands Environmental Assessment Agency, The Hague. 47 pp. (Report of the expert workshop held in Vancouver, Canada, from 25 to 27 March 2019)

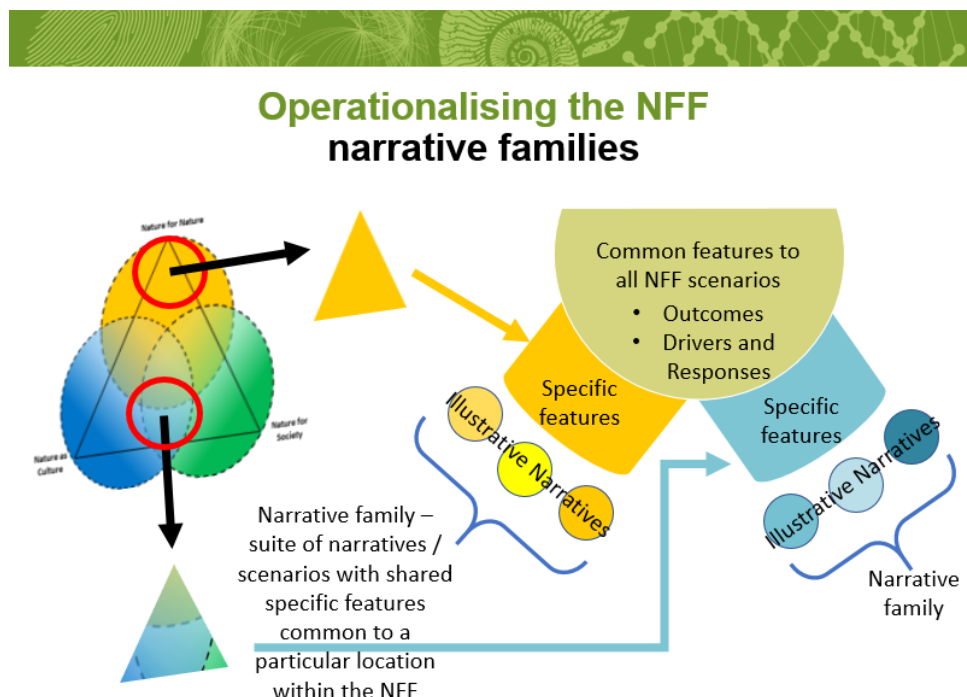
<sup>8</sup> PBL (2018), see footnote 6 for full reference.

<sup>9</sup> Pereira, L. M. et al. (2020), Developing multiscale and integrative nature–people scenarios using the Nature Futures Framework. *People and Nature*, 2(4), 1172–1195.

<sup>10</sup> Lundquist, C.J. et al., *A pluralistic Nature Futures Framework for policy and action*. Manuscript in preparation.

<sup>11</sup> At the time of the workshop, the methodological guidance was still in the form of an early draft.

would embody those values. These were described as rich elaborations of the NFF in terms of nature, nature's contributions to people, and other components and feedbacks of the IPBES conceptual framework.<sup>12,13 14</sup> All illustrative narratives derived from the NFF had shared characteristics referred to as 'common features', and were distinguished from one another by 'specific features'. 'Common features' were explained as descriptions of outcomes that characterize the future state of nature, nature's contributions to people, and good quality of life, or of direct drivers, indirect drivers, responses, and feedbacks between them. These 'common features' were deemed essential for ensuring coherence with the NFF and were common to all NFF value perspectives. 'Specific features', on the other hand, were explained as descriptions of outcomes, direct drivers, indirect drivers, responses and feedbacks, that were specific to a particular location within the NFF value perspective space. A group of narratives corresponding to a particular position within the NFF would form a 'narrative family', providing a means of classifying NFF-based scenarios and other existing scenarios into groups with similar assumptions to facilitate comparison and synthesis for IPBES and other assessments (see figure below, as presented during the workshop). The task force explained that there are multiple entry-points to using the NFF for building scenarios, whether based on creative brainstorming focusing on the value perspectives, or based on deductive development of models from the 'common' and 'specific features'. The methodological guidance document emphasised the flexibility of the NFF in building scenarios and models for different users to be applied in a wide range of contexts and scales.



The NFF and its methodological guidance document are planned to be open to a series of additional consultations with stakeholders and modelling communities in the course of the intersessional period 2021-22 (between the 8<sup>th</sup> and 9<sup>th</sup> IPBES Plenary sessions). These consultations are intended to collect feedback on the usability of the NFF and contributions to its methodological guidance for catalysing the development of the next generation of scenarios. The NFF will be presented to the IPBES Plenary at its 9<sup>th</sup> session (Q2, 2022), together with related methodological guidance. This

<sup>12</sup> PBL (2020), Report on the Workshop 'New Narratives for Nature: operationalizing the IPBES Nature Futures Scenarios'. PBL Netherlands Environmental Assessment Agency, The Hague. 41 pp. Available from: <https://www.pbl.nl/sites/default/files/downloads/pbl-2020-report-workshop-new-narratives-for-nature-4181.pdf>

<sup>13</sup> Díaz, S. et al., (2015), The IPBES Conceptual Framework — connecting nature and people. Current Opinion in Environmental Sustainability, 14: 1-16. <http://dx.doi.org/10.1016/j.cosust.2014.11.002>

<sup>14</sup> Durán, et al., Operationalising the Nature Futures Framework: Illustrative narratives for global nature scenarios. Manuscript in preparation.

workshop was the first of this series of workshops with the modelling community. Throughout the four days of the workshop, the task force welcomed comments of the participants.

#### **Main clarifications and discussion points raised:**

- (a) Clarification on the value perspectives within the NFF: The task force did not associate different probabilities and plausibility with different positions in the NFF. All were assumed equally plausible, and none of them was given higher priority than others. Although the value perspectives assumed that nature was valued, in reality, nature can be valued for many aspects, some of which did not directly result in positive outcomes for nature;
- (b) Clarification on modelling the Nature Futures scenarios: The exercise entailed showing that a specific scenario narrative could be achieved. However, many scenario components were challenging to produce with existing models, because they could not capture all NFF value perspectives via indicators, especially for the '*nature as culture*' value perspective. Therefore, much work was considered still required, concerning models and indicators. Alternatively, new models could be explored that would better address some of these value perspectives. The NFF forces a move away from strictly quantitative modelling towards other knowledge spaces. The role of novel models in the development of the NFF would thus be extensive;
- (c) Clarification on modelling the Nature Futures scenarios: The task force would not develop, but rather catalyse the development of new scenarios. Thus, the task force invited the modelling communities to engage;
- (d) Clarification on linking the Nature Futures scenarios to existing shared socioeconomic pathways (SSPs): Applying the NFF to (parts of) the existing SSPs provides an opportunity to implement the NFF at the global scale, by integrating the NFF value perspectives into the SSPs. Furthermore, this also allows linkages to existing modelling initiatives such as those organised through the Inter-Sectoral Impact Model Intercomparison Project<sup>15</sup>, which could facilitate an initial exploration of the NFF by the modelling communities.

#### **Additional clarifications and discussion points from the breakout groups:**

The breakout groups discussed the NFF in further detail in the context of the participants' own (modelling) work. Clarification points discussed in the breakout groups are summarized below:

- (a) Clarification on the purpose of the NFF: Based on the NFF value perspectives, Nature Futures provided a starting point to discuss many other values needed to make the desired future feasible. The NFF is a tool to discuss and negotiate the values that people hold. By building a scenario narrative, assumptions are made more explicit;
- (b) Clarification on the application of the NFF: The NFF is innovative as it combines different value perspectives on positive human-nature relationships. Applying the NFF to either construct new scenarios or to assess existing scenarios could be done, for example, for different goals (e.g., Sustainable Development Goals, goals under the post-2020 global biodiversity framework). An additional benefit of applying the NFF to existing scenarios is that this allows to explore implicit value perspectives or the absence of certain value perspectives in the analysis. The NFF is intended to offer flexibility for application in a highly diverse set of contexts in which it offers a structured language for the development of policy discussions around models;
- (c) Clarification on the value perspectives within the NFF: The corners of the triangle of the NFF do not represent desirable outcomes at the global level, if interpreted as a situation

<sup>15</sup> Inter-Sectoral Impact Model Intercomparison Project (ISIMIP): 'ISIMIP offers a framework for consistently projecting the impacts of climate change across affected sectors and spatial scales. An international network of climate-impact modellers contribute to a comprehensive and consistent picture of the world under different climate-change scenarios.' (<https://www.isimip.org/>)

where only one of the perspectives exists. At the local scale, more of the preference space could be explored, but some co-existence of all perspectives is required as the scale increases, to ensure the retention of the plurality of values. Even at the local level, the extreme corners may not be possible or desirable, due to potential trade-offs that their realisation may incur;

- (d) Clarification on the difference between the ‘nature for society’ and ‘nature as culture’ value perspectives: The ‘nature for society’ value perspective is focusing on instrumental values and material nature’s contributions to people, and the ‘nature as culture’ value perspective focusses more on relational values, cultural contexts and non-material nature’s contributions to people;
- (e) Clarification on modelling the Nature Futures scenarios: Modelling the Nature Futures scenarios could start with visions and back casting scenarios to create pathways from the present. They ought to be transformative and therefore reflect what would be different in the future compared to the present, by looking at the desired future. A challenge may be to identify ways to make the desired futures feasible; aggregating up to the global level would pose an additional challenge in this context;
- (f) Remark on the NFF methodological guidance document: Some participants expressed a desire for more concrete steps on using the NFF and making scenarios quantitative. For example, by further clarifying the process from building narratives, identifying drivers and indicators, to creating quantitative model outputs, or by providing more examples of the application of the NFF. Furthermore, the methodological guidance should reflect the need to capture remote effects in pathways.

## **B. Supporting the IPBES nexus and transformative change assessments using the Nature Futures Framework**

Presentations were given by Paula Harrison and Ana Paula Dutra de Aguiar on behalf of the group of experts assisting with the scoping of the IPBES nexus assessment<sup>16</sup> and by Kai Chan on behalf of the group of experts assisting with the scoping of the IPBES transformative change assessment<sup>17</sup> with the objective to facilitate the exploration of opportunities for future engagement of the modelling communities through the identification of case studies that would provide inputs to these assessments. While the mandate of the task force was limited to catalysing the further development of scenarios and models using the NFF, the task force would be happy to engage with modelling communities regarding the development of case studies that would ground and test the application of the NFF. The case studies would ultimately lead to published papers that could be used by the IPBES assessments. Studies that aim to provide input to the assessments should consider that the cut-off date for new reference insertions is expected after the second external review in 2023.

The nexus assessment was expected to critically assess past, present and possible future interlinkages among water, health, food, biodiversity and climate change, to inform the development of policies and actions with a particular focus on relevant Sustainable Development Goals, and the synergies and trade-offs between different response options. It was expected to compare the results of several scenarios against the global targets of the Sustainable Development Goals, the Paris Agreement, and others, and to capture which assumptions and direct and indirect drivers would lead closest to or furthest away from reaching these targets.

The transformative change assessment was expected to explain why transformative changes are relevant for a sustainable world. It would discuss visions of a sustainable world, levers and leverage points, how transformative change occurs, barriers to transformative change and how to overcome

<sup>16</sup> See the IPBES webpage for more information about the nexus assessment and the initial scoping document:

<https://ipbes.net/nexus>. At the time of the workshop, the scoping process was still ongoing and the presented draft scope subject to further development and subsequent approval by the Plenary.

<sup>17</sup> See the IPBES webpage for more information about the transformative change assessment and the initial scoping document: <https://ipbes.net/transformative-change>. At the time of the workshop, the scoping process was still ongoing and the presented draft scope subject to further development and subsequent approval by the Plenary.

those, as well as the roles and actions that different kinds of actors could take. The assessment was expected to be aimed at filling an existing gap, where many scenarios and models included behaviour change, implicitly assuming that such behaviour change would occur without specifying how that would be achieved. Behaviour was described as a function of multiple indirect drivers, and it was acknowledged as complex to bring about behaviour change. These aspects were considered crucial to making scenarios and pathways happen in terms of transformative change, but it was found that they were not part of the available models and scenarios. The transformative change assessment would specify them explicitly.

#### **Additional clarifications and discussion points from the breakout groups:**

Breakout groups discussed a set of draft overarching questions which the nexus and transformative change assessments could address from the perspective of the NFF and existing scenario modelling work, with the intention to refine those questions into more concrete case studies which could be taken forward (the list of draft questions as discussed at the time of the workshop are presented in annex III). The task force was interested in the feedback of the workshop participants on the extent to which the NFF and available tools could help to address the questions.

The discussions in the breakout groups addressed the following points:

- (a) Bias of the overarching questions towards the ‘nature for society’ value perspective: The draft overarching questions emerging from the scoping process of the nexus and transformative change assessments reflected a stronger focus on the ‘*nature for society*’ value perspective and less emphasis on the ‘*nature as culture*’ and ‘*nature for nature*’ value perspectives of the NFF;
- (b) Applying the NFF to the draft overarching questions: The modelling community may want to choose local, regional or “downscaled” models (e.g., ecosystem models) to address desirable local futures, which would differ for different regions regarding priorities and details underpinning them. The NFF could help implement a broader and more inclusive range of indicators representing biodiversity and nature’s contributions to people, and the relationship between biodiversity and human activities, beyond what was already represented. The key would be in identifying indicators that are most relevant at the local scale;
- (c) Clarifications on how the NFF relates to transformative change: The NFF enables thinking about transformative change by positioning humans as part of the natural system. The framework could support the identification of transformative pathways needed to achieve positive Nature Futures. For example, ‘Whole Earth’ versus ‘Half Earth’ visions<sup>18</sup> and scenarios would require transformations to be achieved;
- (d) Remark on applying the NFF to the overarching questions of the transformative change assessment: For modelling, it may be more important to be able to express the values inherent in many parts of the NFF in terms of actions of individuals, the public, and the private sector, rather than to distinguish different points in the NFF. Some values of responsibility could be placed in the ‘*nature for society*’ or in the ‘*nature as culture*’ value perspective. However, it is difficult to distinguish different points in the triangle with regard to behaviour change and societal change, when applying the NFF. Scenarios at different scales may relate to different values or different points in the NFF that together form an overarching overall pathway for transformation.

<sup>18</sup> The ‘Half Earth’ vision is a radical proposal to turn half of the Earth into a series of interconnected protected areas in an effort to save the living environment and humanity’s own survival, advocated by conservation scientists such as Wilson (2016), Noss et al. (2012) and Wuerthner et al. (2015). In contrast, the ‘Whole Earth’ vision proposes an equally radical alternative to achieve the same but through degrowth, governing of natural resources and ecosystems as global public goods, and cutting inequality in half to ensure people can live within ecological boundaries as part of nature, as formulated by Büscher et al. (2017).

## C. Role of indicators for modelling scenarios using the Nature Futures Framework

Co-chair of the former IPBES expert group on scenarios and models, and current task force member, Henrique Pereira, explained the possible use of models and indicators for Nature Futures, summarising pre-recorded presentations by himself, task force fellow HyeJin Kim, and task force member Sylvia Karlsson-Vinkhuyzen. Ideally, the use of NFF scenarios would identify and catalyse transformative change, resulting in positive futures for nature. A key challenge lay in developing indicators of data, information and knowledge that could be used to determine progress within scenarios toward positive futures for nature. A suite of types of indicators was presented, many of which would have different targets relating to different value perspectives within the NFF. These potential metrics included: institutional or governance targets (e.g., on protected areas, community-based management initiatives), changes in impacts or prevalence of direct drivers (e.g., relating to pollution, resource use, restoration), indicators of the state of nature (e.g., population size, abundance, threatened status), indicators of nature's contributions to people (e.g., on pollination, climate mitigation, food production), and of good quality of life (e.g., on mental and physical health, cultural heritage, stewardship). Further, the NFF aimed to capture how the 'human system' influenced the 'natural system' and how the 'natural system' influenced the 'human system', i.e., enabling scenarios to include social-ecological feedbacks between societal and natural indicators. It was recognised that far more indicators were already available to represent the '*nature for society*' and '*nature for nature*' value perspectives compared to the '*nature as culture*' perspective, and further developments could be focussed there.

Task force member Sylvia Karlsson-Vinkhuyzen, together with task force fellow HyeJin Kim, and task force members Henrique Pereira and Lilibeth Acosta-Michlik, identified preliminary indicators for developing scenarios with the NFF. For developing scenarios, indicators enable the modelling of scenario narratives using the NFF in both qualitative and quantitative terms. Preliminary indicators that could be used to illustrate or capture the essence of one or more scenarios derived from the NFF were presented. A review of the available indicators included the core indicators and highlighted indicators for use by the IPBES Global Assessment and Regional Assessments of Biodiversity and Ecosystem Services, Biodiversity Indicator Partnership indicators, (a subset of) Sustainable Development Goal indicators, and (a subset of) the Convention on Biological Diversity's Aichi target indicators. To address gaps in the availability of indicators to represent the '*nature as culture*' value perspective, the Indigenous Navigator and the Local Biodiversity Outlook 2 were consulted to select global-level indicators. In addition, Nature Futures indicators using the essential variables on biodiversity, ecosystem and ecosystem services were provided from the Essential Biodiversity Variables 2020 Initiative of the Group on Earth Observations Biodiversity Observation Network (GEO BON).

The following three-step approach to identifying indicators and variables for building scenarios using the NFF was presented<sup>19</sup>:

- 1) Developing narratives (future visualisations) to describe each scenario, including social-ecological feedbacks;
- 2) Capturing these in conceptual diagrams to identify essential indicators (recognising the 'common' and 'specific' features aligned with the IPBES conceptual framework) for drivers, state and benefits;
- 3) Building a quantitative and/or qualitative analysis for these features with models, by identifying essential variables, indicators and model types in conceptual diagrams.

The following clarification points were raised during the discussion:

- (a) Remark on the graphical representation of the NFF: There was a discussion on the graphical representation of the NFF. The perceptions of participants differed with regard to how the NFF should be represented graphically, especially in response to a three-dimensional representation presented during the workshop, showing a tri-rectangular tetrahedron with the base forming the triangle of the NFF. One suggestion was that indicators could serve more than one value perspective, thus creating much more commonality across the three value perspectives than was conveyed by the current

<sup>19</sup> Kim, et al. *Towards a better future for biodiversity and people: modelling the Nature Futures*. Manuscript in preparation.

representation. Another suggestion was to show a concave base instead of a flat NFF triangle, allowing the representation of synergies and trade-offs;

- (b) Clarification on the operationalization of the NFF: When applying the NFF, it was considered important to distinguish between desired outcomes, for example with regard to policies that would need to be put in place, and actions, which would be required to achieve those outcomes. Indicators could be grouped around those desired outcomes and potentially be given relative weights. Indicators were not necessarily connected to only one of the NFF value perspectives; rather, they could contribute to multiple value perspectives. Another way to use the NFF was for evaluating existing scenarios to understand how they scored on the different NFF value perspectives. Looking at the synergies across different value perspectives was considered essential to the scenario building exercise.

#### **Additional clarifications and discussion points from the breakout groups:**

The breakout groups deliberated on the possible application of (existing) indicators to identify which quantitative information case studies would need in order to apply the NFF. The consolidated policy-relevant questions, which served as starting points for breakout groups to explore the use of indicators, are set out in annex IV. The breakout groups highlighted important approaches that would need to be adopted or further developed:

- (a) Inclusive coverage of all NFF value perspectives: Participants noted again that only a limited number of indicators was available for the '*nature as culture*' value perspective, and that further development of indicators was needed in order to ensure coverage of all NFF value perspectives. They pointed out that cultural values tended to be perceived at a more local level. Comments also pointed to the limited availability of '*nature for society*' indicators; some '*nature for nature*' indicators could, however, be adjusted to fill the gaps;
- (b) Incorporation of qualitative indicators: Participants discussed the use of qualitative indicators to address questions of the nexus and transformative change assessments. Some pointed out that although qualitative, social-system or cultural indicators exist, they were often not used by the modelling community due to the lack of familiarity of experts with these tools. As the information used in the assessment would be largely qualitative (for example, suggestions were made to use or derive qualitative indicators from conceptual and fuzzy cognitive models which may not be quantifiable), more incorporation of qualitative information into quantitative studies would be needed. To do so, participants emphasised the need for engagement with communities of practice beyond the quantitative modelling community;
- (c) Indicators for change processes: Participants identified a need for indicators that represented the processes of change, rather than the outcomes or the state of nature, which typically were the focus of quantification using existing models. Also, as most indicators aimed to measure current states, it would not be possible to use them for modelling the NFF scenarios, which required representation of "the future we want". Considering anticipated changes (potentially large scale), and how to measure them or their implementation could form the basis for the development of indicators of transformative change in the future. For developing the pathways of transformative change it would be important to consider unpredictable events, their risks, and the probability of these risks;
- (d) Linking indicators to underlying value perspectives: Participants raised the importance of making value perspectives explicit within the choice of indicators. They emphasised that some indicators, such as those focusing on the loss or the increase of a given species, could have a value structure embedded in them, which may influence the result when indicators are combined through, for instance, weighting. The increase or decrease of an indicator would thus require interpretation through a plural value perspective, also in terms of how they relate to targets and trajectories for particular value perspectives. This value-laden nature of indicators meant that the representativeness of the decision-making context would need to be made explicit when identifying the most useful indicators. This recognition was

based on the understanding that the outcomes of model development and application are influenced by the actors included in this process, who would choose indicators based on their underlying value perspectives. It was therefore suggested to focus more strongly on the validation of indicators in order to ensure that they represent what was intended under different conditions;

- (e) Indicators for equity: Related to values, it was suggested to include indicators of equity to ensure that transparency and human dimensions were considered in the application of the NFF. Benefits obtained from resources retained within a country (or within a group of people, as opposed to them appropriating resources from others) were mentioned as an example for a potential indicator of equity.

## **D. Opportunities for engagement towards the second workshop on modelling Nature Futures scenarios**

One of the two co-chairs of the task force, Shizuka Hashimoto, presented a list of potential case study topics that the organizing team extracted from the discussions on the policy-relevant questions held on day 3 of the workshop. The case studies would serve as opportunities for engagement towards the second part of the workshop, for interactions amongst the modelling community, and to identify potential funding sources, as presented in annex V.

In the discussion, it was clarified that, moving forward, the work by the IPBES task force on scenarios and models on catalysing the further development of scenarios and models for future IPBES assessments should become a community-driven project to support the IPBES assessments.

### **Additional clarifications and discussion points from the breakout groups:**

- (a) The ‘high seas and coastal areas’ breakout group: The group discussed the futures of marine ecosystems fisheries under SSP 1<sup>20</sup>, and the difficulty of applying the NFF in other SSPs. The group agreed that it would be interesting to find a way to use the NFF in less utopian features. A challenge was identified in defining the climate and economic drivers (e.g., GDP, population growth) needed to envision future pathways for marine systems, as these were not pre-defined within the NFF. The group concluded that to build scenarios that incorporate these uncertain drivers, the NFF needed to be applied with a more detailed definition of the context;
- (b) The ‘urban systems’ breakout group: The group discussed how urban planning could support sustainable urban futures and how the NFF value perspectives could help build future scenarios. Many similarities between the different NFF value perspectives and other existing sustainable city models were found. For example, the eco-city model was linked to the value perspective of ‘*nature for society*’, and the biophilic cities model was related to the ‘*nature for nature*’ value perspective;
- (c) The ‘freshwater’ breakout group: The group discussed how to better represent freshwater in modelling exercises within global environmental assessments, and how to develop studies that would feed into the upcoming IPBES assessments. A three-stage approach was discussed that started with creating a conceptual model to better understand how the NFF applied to freshwater systems at the global scale. The second part of the discussion focused on indicators set out in the preliminary tables of indicators presented by the task force, and those used by different communities. The group discussed which of these indicators were currently in use, and how those related to the NFF, particularly looking at indicators for the ‘*nature as culture*’ value perspective. As part of these first two stages, the group explored

<sup>20</sup> The SSPs are characterised by different combinations of low to high degrees of socioeconomic challenges to climate change mitigation and adaptation. The resulting set consist of SSP1: Sustainability – Taking the Green Road (Low challenges to mitigation and adaptation); SSP2: Middle of the Road (Medium challenges to mitigation and adaptation); SSP3: Regional Rivalry – A Rocky Road (High challenges to mitigation and adaptation); SSP4: Inequality – A Road Divided (Low challenges to mitigation, high challenges to adaptation); and SSP5: Fossil-fueled Development – Taking the Highway (High challenges to mitigation, low challenges to adaptation) (Riahi et al., [2017](#))

case studies and projects to understand what the Nature Futures value perspectives mean, as a step towards possible future work utilising the NFF;

- (d) The ‘invasive alien species’ breakout group: The group discussed the importance of including different sectors, components, stakeholders etc. into modelling and scenario-building exercises to broaden the focus beyond purely natural sciences. Particularly for invasive alien species, it was deemed crucial to consider the various stakeholders and the different groups of people involved, because many of them could have very different perceptions of the same species in the same site. The group concluded that the NFF would be very helpful in such contexts, because it included different values and perceptions;
- (e) The ‘SSPs scenarios and impact modelling on Sustainable Development Goals’ breakout group: The group discussed the possibility of setting up a virtual workshop towards the third quarter of 2021, for which a large community of people working with the SSPs at a global, sub-global and at regional scale would be invited. Part of the workshop would focus on analysing the existing SSPs and seeing how they fit into the NFF, and the benefits and limitations of trying to apply them to the NFF. Such an exchange was expected to lead to a better understanding of the relationship between the SSPs and the NFF. Furthermore, the group discussed that the workshop could be used to think about narratives based on the NFF, while focusing on the SSPs context and their application, looking at the synergies and trade-offs between the Sustainable Development Goals, and what is needed to attain the goals of the post-2020 global biodiversity framework;
- (f) The ‘Sustainable Development Goals/Convention on Biological Diversity indicators to explore synergies and trade-offs amongst multiple goals/targets of the post-2020 global biodiversity framework’ breakout group: The group recognised the need to consider multiple pathways to reach different goals and the need for predictive models that link actions under the Convention on Biological Diversity to the goals. They interpreted the NFF as a possible guide to decide which concrete actions or strategies could be followed to achieve the goals. However, the gap in suitable indicators to represent the ‘*nature as culture*’ value perspective was identified as a challenge. It was suggested to focus on the local level due to the absence of global level indicators to capture the ‘*nature as culture*’ value perspective. Furthermore, the group highlighted the need to use existing information from SSPs to apply the NFF and to identify systemic shifts;
- (g) The ‘agent-based modelling and other innovative approaches’ breakout group: The group recognised the strength of the NFF in effectively capturing value perspectives on the interactions between nature and people. However, they emphasised the need for models to address other value perspectives to better understand how people influence biodiversity and ecosystem services across multiple scales. It was pointed out that processes beyond human-nature relationships play out at different scales, while interacting between scales and between individual agents. If such interactions could be captured in models, it was expected to better link the relationships between indirect drivers and direct drivers, thus filling a significant gap in modelling capacity.

## IV. Next steps

During the workshop, various participants expressed interest in exploring the use of the NFF in potential case studies listed in annex V. Throughout the four days of the workshop, important observations and recommendations were made on the operationalisation of the NFF in modelling. Participants recognised that models were key to identifying the implications of decision-making and agreed to focus on showcasing transformative change through the use of the NFF. Particular improvements needed for modelling methods to accommodate the concepts highlighted by the NFF were identified:

- Broadening modelling applications: Participants suggested that better integration between different fields of modelling would be critical, such as between natural and social sciences,

between terrestrial and marine models, and between quantitative and qualitative models. They recognised that while many tools were already available, collaboration would be needed to establish concrete linkages between them. Ideas proposed for cross-cutting modelling exercises included cultural preference modelling, modelling temporal dynamics of terrestrial impacts on the ocean, modelling trophic cascading effects, and collecting statistical data on the use of ecosystems through citizen science or mobile phone data. It was recognised that new or better tools would also need to be developed, for instance to capture the important role of biodiversity in enabling ecosystem functions for the ‘*nature for society*’ value perspective (insurance, option value, etc). The incorporation of broader facets of biodiversity within the consideration of drivers and outputs was also suggested, such as the impacts of invasive alien species. Process-based models were suggested as useful options for incorporating socio-ecological systems complexity within modelling exercises.

- Combining quantitative and qualitative approaches: Applying qualitative or fuzzy models was suggested as a way forward to better capture qualitative indicators, and to be able to integrate them with more conventional, quantitative modelling frameworks. However, participants also cautioned that the use of qualitative indicators should not be regarded as a stepping stone towards quantitative modelling, but rather as a mixed method that requires engagement with social scientists. Interest was expressed among participants in attempting to incorporate cultural value perspectives into these models.
- Incorporating social-ecological feedbacks: Participants recognised that modelling the NFF would need to include the use of social indicators (e.g., effect of the loss of ecosystem services on the wellbeing of local communities who depend on agriculture). Social indicators were expected to allow the incorporation of feedback loops into models, and to help understand the co-dependencies among ecological changes and socioeconomic changes (e.g., access to health/education, household income, finance, increase of vulnerability). These feedbacks were also recognised as important to account for across the different NFF value perspectives (e.g., how improvement for an indicator under one value perspective impacts indicators under other value perspectives).
- Incorporating cross-scale linkages: Participants recognised the need to apply models at different scales in order to capture scientific knowledge on links between different components of social-ecological systems and feedbacks. They emphasised that modelling scenarios using the NFF would need a highly integrative, dynamic modelling framework that includes reciprocal feedbacks between value change and changes in nature, and which makes the scale of application explicit. Linking across scales was also deemed necessary to make use of existing tools. Telecoupling was highlighted as an important cross-scale aspect requiring considerations beyond local conditions and policies, to include sources of demand, land use responses, and supply-demand connections and flows.
- Incorporating governance: Representing values and their relationship to norms was raised as an important challenge in modelling the NFF. Participants signalled that the right set of tools to represent such relationships was not available, as models of institutional behaviour and policy were lacking. Better translation of the relationships between direct and indirect drivers of change on biodiversity loss was deemed necessary, including representation of human behaviour that underpins decisions on resource use. Modelling of governance systems and individual behaviour was identified as a low-hanging fruit which could contribute to great progress in modelling social-ecological systems.
- Diversifying data sources: Participants suggested that refinement and diversification in data sources would be necessary as a basis for progress in modelling methods. They noted that data sources would need to cover the impacts of different fine scale land uses on biodiversity and ecosystem services, including cultural landscapes, and integrate different types of information such as indigenous and local knowledge.
- Analysing pathways: Participants noted that existing modelling tools were applied to conventional scenario development methods by projecting trends into the future, but that (quantitative) pathways and back casting tools were lacking. It was thus suggested to create historical narratives for various locations using the NFF to infer from historical relationships between production activities and impacts on nature. Participants pointed to the need to

analyse multiple pathways to reach the envisioned positive futures, which would need models that can track complexity. It was also recognised that pathway analysis was needed to inform on how realistic the futures described with integrated assessment models and bending the curve analyses were, as well as to identify the key changes needed to achieve certain desired outcomes.

Reflecting on how the modelling community could proceed with tackling these modelling challenges, the participants noted various options.

- Starting from value perspectives or from a comprehensive modelling framework: Participants agreed on the usefulness of engaging with the task force on scenarios and models to sketch narratives that could be transposed into scenarios, in order to follow the current sequence of Nature Futures scenario development, from future visioning, narrative formulation, scenario building, to modelling. They suggested that the sketched narratives would serve to run existing models, to generate quantitative values across the value perspectives. An alternative approach was also suggested, where the sequence would start from posing important modelling questions, which were addressed using an inclusive modelling framework to explore various scenarios. Participants noted that this would require a modelling ‘sand pit’ that is adaptive and flexible, and which would cover, but not necessarily be limited to, the NFF value perspectives or the narratives emerging from them.
- Community effort to bridge quantitative and qualitative modelling: Participants recognised that for models to be able to cover all NFF value perspectives, a continued exploration by the community is needed to bridge quantitative and qualitative methods in a follow up to the workshop. This bridging of approaches was deemed vital to ensure that scenario narratives are not developed in isolation of modelling frameworks, possibly resulting in difficulties to model them. Starting with quantifying what is currently possible to model, and then broadening to new modelling questions, was suggested as a reasonable approach. It was also suggested that the community continue exploring how the NFF value perspectives could relate to different types of modelling and modelling goals, beyond solely building Nature Futures scenarios. Producing a variety of publications on how to use the NFF in different contexts, including visualisations of the possible processes (e.g., flow diagrams), was welcomed as useful information for potential users of the NFF.

## V. Closing session

Closing remarks were given by the co-chairs of the task force on scenarios and models, Shizuka Hashimoto and Carolyn Lundquist, who thanked all participants for a very fruitful meeting and for their constructive input into the many discussion points to reach a common understanding on the way forward.

## Annex I - Agenda

### Agenda overview

| Date             | Tuesday 12 <sup>th</sup> January                                         | Wednesday 13 <sup>th</sup> January                                                            | Thursday 14 <sup>th</sup> January                                             | Friday 15 <sup>th</sup> January                                                                   |
|------------------|--------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|
| Time             | 16:00-19:30 CET                                                          | 16:00-19:30 CET                                                                               | 16:00-19:30 CET                                                               | 16:00-19:30 CET                                                                                   |
| Sessions         | 1 & 2                                                                    | 3 & 4                                                                                         | 5 & 6                                                                         | 7 & 8                                                                                             |
| Topic of the day | Introduction to the Nature Futures Framework and methodological guidance | Supporting the nexus and transformative change assessments using the Nature Futures Framework | Role of indicators for modelling scenarios using the Nature Futures Framework | Opportunities for collaboration towards the second workshop on modelling Nature Futures scenarios |

### Tuesday 12 January 2020, 16:00– 19.30 CET

| Time (minutes)                                                                                                                                                                                                                                                                                                                                                          | Agenda Item                                                                                                                                                                                                                                                                                                                          |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Objectives of Day 1</b>                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                      |
| <ul style="list-style-type: none"> <li>Introduce the NFF and its methodological development</li> <li><b>Ensure common understanding</b> on the NFF by all participants</li> <li>Solicit feedback on the NFF and methodological guidance for modelling</li> <li>Discussion and consensus on key areas for further development of the NFF to support modelling</li> </ul> |                                                                                                                                                                                                                                                                                                                                      |
| <b>Day 1 - Session 1: Introduction to the NFF and reaching a common understanding</b>                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                      |
| 15 min                                                                                                                                                                                                                                                                                                                                                                  | <b>Welcome</b> - by the TSU, co-chairs and the Executive Secretary <ul style="list-style-type: none"> <li>Introduction to the workshop objectives, agenda, etc.</li> <li>Opening statements from co-chairs and the Executive Secretary</li> <li>Short intro of participant composition – individual details in slide deck</li> </ul> |
| 15 min                                                                                                                                                                                                                                                                                                                                                                  | <b>Plenary</b> - Co-chairs presentation on the NFF <ul style="list-style-type: none"> <li>Focus on the framework and its underlying values</li> <li>Brief overview of the draft methodological guidelines and its link to modelling</li> </ul>                                                                                       |
| 20 mins                                                                                                                                                                                                                                                                                                                                                                 | <b>Plenary</b> – Clarification questions and discussion to ensure common understanding of the NFF value perspectives                                                                                                                                                                                                                 |
| 30 min                                                                                                                                                                                                                                                                                                                                                                  | <b>Breakout groups</b> – Brainstorm ideas of how the NFF is relevant to the participants' policy-relevant modelling <ul style="list-style-type: none"> <li>Slide deck for each breakout group</li> </ul>                                                                                                                             |
| 10 min                                                                                                                                                                                                                                                                                                                                                                  | <b>Plenary</b> – recap <ul style="list-style-type: none"> <li>Report back from Session 1 breakout groups and introduction to aims of Session 2</li> </ul>                                                                                                                                                                            |
| 30 min                                                                                                                                                                                                                                                                                                                                                                  | <b>Break</b>                                                                                                                                                                                                                                                                                                                         |
| <b>Day 1 - Session 2: Reaching a common understanding on the NFF methodological guidance</b>                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                      |
| 15 min                                                                                                                                                                                                                                                                                                                                                                  | <b>Plenary</b> - Introduction on the NFF methodological guidance <ul style="list-style-type: none"> <li>Diving deeper into the common and specific features, and illustrative examples</li> <li>Examples of how the NFF can be applied in different example use cases</li> </ul>                                                     |

| Time (minutes) | Agenda Item                                                                                                                                                                                                                                                       |
|----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 25 min         | <b>Plenary</b> - Clarification questions and discussion to ensure common understanding of the methodological guidance                                                                                                                                             |
| 30 min         | <b>Breakout groups</b> - The NFF methodological guidance <ul style="list-style-type: none"> <li>• Roundtable introduction of participants</li> <li>• Discussion around question: Feedback on the common and specific features</li> </ul>                          |
| 30 min         | <b>Plenary</b> – Brief feedback from each breakout group followed by general discussion <ul style="list-style-type: none"> <li>• Do we have the right set of tools?</li> <li>• How can it be improved or made more useful for your own modelling work?</li> </ul> |

### Wednesday 13 January 2020, 16:00– 19.30 CET

| Time (minutes)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Agenda Item                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Objectives of Day 2</b> <ul style="list-style-type: none"> <li>• Introduction to the needs of the <b>forthcoming nexus and transformative change assessments</b> in terms of scenario and modelling studies (as background to breakout group discussions)</li> <li>• Consider the policy-relevant questions that modelling communities could address using the NFF, based on questions to be addressed by the nexus and transformative change assessments</li> <li>• Identify topical or model-based groups for potential explorative case studies</li> <li>• Consider whether all relevant models are involved</li> </ul> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>Day 2 - Session 3: Forthcoming nexus and transformative change assessments</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| 30 min                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>Plenary</b> - Introduction to the nexus and transformative change assessment scoping documents <ul style="list-style-type: none"> <li>• Presentation on the nexus and transformative change assessment scope (nexus presented by Ana Paula Aguiar, transformative change presented by Kai Chan)</li> <li>• Panel discussion or Q&amp;A with the scoping representatives (TC: Kai Chan; Nexus: Ana Paula Aguiar and Paula Harrison), including timelines for contributions from modelling teams</li> </ul> |
| 15 min                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>Plenary</b> - Identifying policy-relevant questions linked to the nexus and transformative change assessment that participants could address with their models <ul style="list-style-type: none"> <li>• TF provides an initial set of 3-5 questions as a basis for a poll to kick-off discussions</li> <li>• Poll to see which questions participants recognise</li> </ul>                                                                                                                                |
| 30 min                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>Breakout groups</b> - Policy-relevant questions and models <ul style="list-style-type: none"> <li>• Participants discuss in small groups - <a href="#">slide-deck</a>.</li> <li>• What other policy-relevant questions should be added?</li> <li>• Which models can provide case studies that address the questions?</li> </ul>                                                                                                                                                                           |
| 15 min                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>Plenary</b> – Vote on clusters of case studies relevant to the nexus and transformative change assessments <ul style="list-style-type: none"> <li>• Participants look across all question/model sets and cast a vote on which they would like to discuss further</li> </ul>                                                                                                                                                                                                                               |
| 30 min                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>Break</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Day 2 - Session 4: Discussing explorative modelling case studies using the NFF</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| 10 min                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>Plenary</b> - Recap and introduction to breakout group <ul style="list-style-type: none"> <li>• Brief recap on Session 3 and introduction to aims of breakout groups, then move to breakout groups</li> </ul>                                                                                                                                                                                                                                                                                             |

| Time (minutes) | Agenda Item                                                                                                                                                                                                                                            |
|----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 hr 20 min    | <b>Breakout groups</b> - Possible case studies <ul style="list-style-type: none"> <li>To develop ideas on explorative modelling case studies using NFF that could contribute to the forthcoming nexus and transformative change assessments</li> </ul> |

### Thursday 14 January 2020, 16:00– 19.30 CET

| Time (minutes)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Agenda Item                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Objectives of Day 3</b> <ul style="list-style-type: none"> <li>Ensure a common understanding of the role of <b>indicators</b>, and review efforts to develop an initial set of indicators</li> <li>Kick off initial thinking on the model lability of the common/specific features (To what extent can existing models quantify the common and specific features? What are areas that cannot be quantified with existing models?)</li> <li>Identify which quantitative information case studies would need to apply the NFF</li> <li>How can we judge whether NFF scenarios are quantified or not?</li> <li>Discussion and synthesis on policy-relevant questions, modelling case studies and the needs of those case studies in relation to the NFF</li> </ul> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Day 3 - Session 5: Introduction to indicators work</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 40 min                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>Plenary</b> - Reporting back from breakout groups on explorative case studies <ul style="list-style-type: none"> <li>2-minute pitches from breakout groups on the case studies discussed</li> <li>Clarifications/Q&amp;A</li> </ul>                                                                                                                                                                                                                                                                                                 |
| 30 min                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>Plenary</b> – Introduction of the work on indicators <ul style="list-style-type: none"> <li>Presentations of the 3 tables of indicators (EBVs, ‘ready-to-use’ policy indicators, Indigenous Navigator indicators)</li> </ul>                                                                                                                                                                                                                                                                                                        |
| 20 min                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>Plenary</b> – pre-breakout group discussions <ul style="list-style-type: none"> <li>Can the modelers work with the 3 tables provided within the case studies discussed on Day 2?</li> <li>What kind of indicators do we need/can the modelers use to apply the NFF? What can the models provide?</li> </ul>                                                                                                                                                                                                                         |
| 30 min                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>Break</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Day 3 - Session 6: Discussions on possible indicators use in case studies</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 5 min                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <b>Plenary</b> - Recap on session 5 and introduction to aims of breakout groups, then move to breakout groups                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 1 hour                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>Breakout groups</b> - Building further on the case studies discussed on Day 2 <ul style="list-style-type: none"> <li>Discussion on the possible application of existing indicators, adjustments needed, and new developments needed: <ol style="list-style-type: none"> <li>To what extent can existing models quantify the common and specific features? What are areas that cannot be quantified with existing models?</li> <li>Identify what quantitative information case studies need to apply the NFF.</li> </ol> </li> </ul> |
| 25 min                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>Plenary</b> - Reporting back from breakout groups                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |

**Friday 15 January 2020, 16:00– 19.30 CET**

| <b>Time (minutes)</b>                                                  | <b>Agenda Item</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Objectives of Day 4</b>                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|                                                                        | <ul style="list-style-type: none"> <li>• Discussion and agreement on a work plan for future engagement - towards the second workshop (TBC, Q4 2021/Q1 2022), what can be done with the modellers for this intersessional period</li> <li>• Discuss potential activities for continuous engagement needed to achieve this</li> <li>• Identify opportunities for linking with other relevant activities/events</li> <li>• Possible case studies (groupings emerging from Day 2 onwards)</li> <li>• Possible product: tables of outputs per model types (represented at workshop) linked to the NFF</li> <li>• Next steps and closing</li> </ul> |
| <b>Day 4 - Session 7: Work plans until the next modelling workshop</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 15 mins                                                                | <b>Plenary</b> - Presentation by co-chairs on work plan for future engagement towards the second workshop                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 15 mins                                                                | <b>Plenary</b> – Q&A/discussions <ul style="list-style-type: none"> <li>• Q&amp;A / discussion</li> <li>• Identification of break out groups for developing work plans for explorative case studies</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                |
| 1 hr                                                                   | <b>Breakout groups</b> - Work plans <ul style="list-style-type: none"> <li>• Roadmaps toward concrete actions/targets, outputs per model types, setting up working groups to continue collaboration.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 30 min                                                                 | <b>Break</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Day 4 – Session7: Next steps and closing</b>                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 45 mins                                                                | <b>Plenary</b> - Recap <ul style="list-style-type: none"> <li>• Reporting back on work plans by nominated leaders of explorative case studies</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| 30 mins                                                                | <b>Plenary</b> - Discussion and consolidation of work plans <ul style="list-style-type: none"> <li>• Discussion and consolidation of work plans for the intersessional period, including opportunities to link with other relevant activities/events</li> </ul>                                                                                                                                                                                                                                                                                                                                                                               |
| 15 min.                                                                | <b>Plenary</b> - Wrap-up <ul style="list-style-type: none"> <li>• Next steps for the task force on scenarios and models to further develop the NFF based on feedback received</li> <li>• Next steps for continued engagement</li> </ul> <p><b>Closing statement</b> by co-chairs</p>                                                                                                                                                                                                                                                                                                                                                          |

## Annex II - List of participants

| NOMINATED PARTICIPANTS                    |                                                                                                                                                                  |
|-------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Name                                      | Affiliation                                                                                                                                                      |
| <b>Akçakaya, Resit</b>                    | Stonybrook University, Turkey                                                                                                                                    |
| <b>Akinyemi, Felicia Olufunmilayo</b>     | University of Bern, Switzerland                                                                                                                                  |
| <b>Ausseil, Anne-Gaelle (apologies)</b>   | Manaaki Whenua Landcare Research, New Zealand                                                                                                                    |
| <b>Balkovic, Juraj</b>                    | International Institute for Applied Systems Analysis, Austria                                                                                                    |
| <b>Bundy, Alida</b>                       | Fisheries and Oceans, Canada                                                                                                                                     |
| <b>Calamari, Noelia</b>                   | National Institute of Agriculture Technology, Argentina                                                                                                          |
| <b>Castro Diaz, Ricardo</b>               | Universidade Federal do Rio Grande, Colombia                                                                                                                     |
| <b>Garcia, Claude</b>                     | Centre de coopération internationale en recherche agronomique pour le développement (CIRAD), France                                                              |
| <b>Hernández, Gladys (apologies)</b>      | Centro de Investigaciones de la Economía Mundial (CIEM), Cuba                                                                                                    |
| <b>Hui, Cang</b>                          | Department of Mathematics, Stellenbosch University, South Africa                                                                                                 |
| <b>Janssen, Annette B. G.</b>             | Wageningen University, the Netherlands                                                                                                                           |
| <b>Kok, Kasper</b>                        | Wageningen University and Research, the Netherlands                                                                                                              |
| <b>Larsen, Morten Andreas (apologies)</b> | Technical University of Denmark                                                                                                                                  |
| <b>Liu, Yunhui</b>                        | Agricultural University, China                                                                                                                                   |
| <b>Luque, Sandra</b>                      | INRAE National Research Institute on Agriculture, Food & the Environment, France<br>TETIS Unit Land, environment, remote sensing and spatial information, France |
| <b>Marín, Mauricio</b>                    | Universidad del Desarrollo, Chile                                                                                                                                |
| <b>Maury, Olivier</b>                     | Institut de recherche pour le développement (IRD), France                                                                                                        |
| <b>Metzger, Jean Paul</b>                 | University of Sao Paulo, Brazil                                                                                                                                  |
| <b>Oliveira, Bruno</b>                    | University of São Paulo, Brazil                                                                                                                                  |
| <b>Pandit, Pranav</b>                     | University of California One Health Institute, USA                                                                                                               |
| <b>Perez, Natalie</b>                     | Consejo Nacional de Ciencia y Tecnología (CONACyT), Mexico                                                                                                       |
| <b>Pintar, Valentino</b>                  | Ministry Economy and Sustainable Development, Croatia                                                                                                            |
| <b>Pulatov, Bakhtiyor</b>                 | State Committee for Ecology and Environment Protection of the Republic of Uzbekistan                                                                             |
| <b>Rashleigh, Brenda</b>                  | US Environmental Protection Agency, USA                                                                                                                          |
| <b>Rising, James</b>                      | London School of Economics and Political Science (LSE), UK                                                                                                       |
| <b>Rounsevell, Mark</b>                   | University of Edinburgh, UK                                                                                                                                      |
| <b>Salako, Gabriel</b>                    | Kwara State University, Nigeria                                                                                                                                  |
| <b>Santika, Truly</b>                     | Natural Resources Institute, University of Greenwich, UK                                                                                                         |

|                                  |                                                                                                       |
|----------------------------------|-------------------------------------------------------------------------------------------------------|
| <b>Schwarz, Nina (apologies)</b> | University of Twente, the Netherlands                                                                 |
| <b>Seebens, Hanno</b>            | Senckenberg Biodiversity and Climate Research Center, Germany                                         |
| <b>Shannon, Lynne</b>            | University of Cape Town, South Africa                                                                 |
| <b>Stehfest, Elke</b>            | PBL Netherlands Environmental Assessment Agency, the Netherlands                                      |
| <b>Visconti, Piero</b>           | International Institute of Applied Systems Analysis (IIASA), Austria                                  |
| <b>Yamakita, Takehisa</b>        | Agency for Marine-Earth Science and Technology, Japan                                                 |
| <b>Yousefpour, Rasoul</b>        | University of Freiburg, Germany                                                                       |
| <b>Yue, TianXiang</b>            | Institute of Geographical Sciences and Natural Resources Research, Chinese Academy of Sciences, China |
| <b>Zambrana Torrelío, Carlos</b> | EcoHealth Alliance, USA                                                                               |

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## RESOURCE PERSONS

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### For integrated assessment models

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|------------------------|--------------------------------------------------------|
| <b>Popp, Alexander</b> | Potsdam Institute for Climate Impact Research, Germany |
|------------------------|--------------------------------------------------------|

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### For BES-SIM models

#### (Biodiversity and Ecosystem Services Scenario-based Intercomparison of Models)

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|                                    |                                                                                                       |
|------------------------------------|-------------------------------------------------------------------------------------------------------|
| <b>Arneth, Almut</b>               | Karlsruhe Institute of Technology, Germany                                                            |
| <b>Ferrier, Simon</b>              | Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia                       |
| <b>Guerra, Carlos</b>              | Martin Luther University Halle-Wittenberg, Germany                                                    |
| <b>Harfoot, Mike</b>               | UNEP Word Conservation Monitoring Centre (WCMC)                                                       |
| <b>Haverd, Vanessa (apologies)</b> | Commonwealth Scientific and Industrial Research Organisation (CSIRO) Oceans and Atmosphere, Australia |
| <b>Hickler, Thomas</b>             | Senckenberg Research Institute, Germany                                                               |
| <b>Jetz, Walter (apologies)</b>    | Yale University, USA                                                                                  |
| <b>Johnson, Justin (apologies)</b> | University of Minnesota, USA                                                                          |
| <b>Leclère, David</b>              | International Institute of Applied Systems Analysis (IIASA), Austria                                  |
| <b>Martins, Ines</b>               | University of York, UK                                                                                |
| <b>Marques, Alexandra</b>          | PBL Netherlands Environmental Assessment Agency, the Netherlands                                      |
| <b>Ohashi, Haruka</b>              | Agriculture, Forestry and Fisheries Research Council, Japan                                           |
| <b>Purvis, Andy</b>                | Natural History Museum, UK                                                                            |
| <b>Rondinini, Carlo</b>            | Sapienza University of Rome, Italy                                                                    |
| <b>Schipper, Aafke</b>             | PBL Netherlands Environmental Assessment Agency, the Netherlands                                      |
| <b>Thuiller, Wilfried</b>          | Laboratoire d'Ecologie Alpine (LECA), France                                                          |

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**LIAISON EXPERTS**


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|                                                                                                                        |                                                                   |
|------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------|
| <b>Chan, Kai (transformative change assessment scoping liaison expert)</b>                                             | University of British Columbia, Canada                            |
| <b>Dutra de Aguiar, Ana Paula (nexus scoping assessment liaison expert and scenarios and models task force member)</b> | Instituto Nacional de Pesquisas Espaciais (INPE), Brazil          |
| <b>Harmackova, Zuzana (values assessment liaison expert)</b>                                                           | Global Change Research Institute of the Czech Academy of Sciences |
| <b>Harrison, Paula (nexus assessment scoping liaison expert and scenarios and models task force member)</b>            | Centre for Ecology & Hydrology, UK                                |
| <b>Lenzner, Bernd (Invasive Alien Species assessment liaison expert)</b>                                               | University of Vienna, Austria                                     |
| <b>Tittensor, Derek (sustainable use assessment liaison expert)</b>                                                    | Dalhousie University, Canada                                      |

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**MEMBERS OF THE TASK FORCE ON SCENARIOS AND MODELS**


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|                                                   |                                                                                                                                               |
|---------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Abbasov, Rovshan (MEP member) (apologies)</b>  | Department of Geography and Environment, Khazar University, Azerbaijan                                                                        |
| <b>Beard, Douglas (Bureau member) (apologies)</b> | United States Geological Survey, USA                                                                                                          |
| <b>Diaw, Mariteuw Chimere (MEP member)</b>        | African Model Forests Network (AMFN) Secretariat, Cameroon                                                                                    |
| <b>Hashimoto, Shizuka (co-chair)</b>              | University of Tokyo, Japan                                                                                                                    |
| <b>Lundquist, Carolyn (co-chair)</b>              | National Institute of Water and Atmospheric Research and the University of Auckland, New Zealand, USA                                         |
| <b>Acosta-Michlik, Lilibeth</b>                   | Global Green Growth Institute, Seoul, Republic of Korea                                                                                       |
| <b>Bosch Pereira, Laura</b>                       | Centre for Complex Systems in Transition, Stellenbosch University, South Africa and Stockholm Resilience Centre, Stockholm University, Sweden |
| <b>Ahmed, Khaled Allam</b>                        | Nature Conservation Sector, Ministry of Environment, Egypt                                                                                    |
| <b>Armenteras, Dolors</b>                         | Universidad Nacional de Colombia                                                                                                              |
| <b>Cheung, Wai Lung</b>                           | Institute for the Oceans and Fisheries, The University of British Columbia, Canada                                                            |
| <b>Denboba, Mekuria Argaw</b>                     | Addis Ababa University, Ethiopia                                                                                                              |
| <b>Durán, América Paz</b>                         | Instituto de Ecología y Biodiversidad, Santiago, Universidad de Chile                                                                         |
| <b>Gasalla, Maria</b>                             | Universidade de Sao Paulo, Brazil                                                                                                             |
| <b>Halouani, Ghassen</b>                          | Galway-Mayo Institute of Technology, IFREMER (Institut Français de Recherche pour l'Exploitation de la Mer), France                           |
| <b>Jyothis, Sathyapalan</b>                       | National Institute of Panchayati Raj, India                                                                                                   |

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|                                         |                                                                                                               |
|-----------------------------------------|---------------------------------------------------------------------------------------------------------------|
| <b>Karlsson-Vinkhuyzen, Sylvia</b>      | Wageningen University, the Netherlands                                                                        |
| <b>Kim, HyeJin</b>                      | German Centre for Integrative Biodiversity Research (iDiv), Germany                                           |
| <b>Kuiper, Jan</b>                      | Stockholm Resilience Centre, Stockholm University, the Netherlands                                            |
| <b>Leadley, Paul</b>                    | Universite Paris-Sud, France                                                                                  |
| <b>Miller, Brian</b>                    | United States Geological Survey, USA                                                                          |
| <b>Pereira, Henrique</b>                | German Centre for Integrative Biodiversity Research (iDiv) Martin Luther University Halle-Wittenberg, Germany |
| <b>Peterson, Garry</b>                  | Stockholm Resilience Centre, Stockholm University, Sweden                                                     |
| <b>Pichs Madruga, Ramon (apologies)</b> | Centre for World Economy Studies (CIEM), Cuba                                                                 |
| <b>Saysel, Ali Kerem</b>                | Boğaziçi University Institute of Environmental Sciences, Turkey                                               |
| <b>Shulbaeva, Polina</b>                | Indigenous Women's Biodiversity Network                                                                       |
| <b>Yu, Dandan</b>                       | Nanjing Institute of Environmental Sciences (NIES), Ministry of Ecology and Environment (MEE) of China        |

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#### **IPBES SECRETARIAT**

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##### ***Bonn Secretariat***

|                    |                        |
|--------------------|------------------------|
| Larigauderie, Anne | Executive Secretary    |
| Schiele, Simone    | Head of work programme |

##### ***Technical Support Units***

|                        |                                                 |
|------------------------|-------------------------------------------------|
| Alkemade, Rob          | Technical support unit for scenarios and models |
| Khabjane, Zhour        | Technical support unit for scenarios and models |
| Klein Goldewijk, Kees  | Technical support unit for scenarios and models |
| Krijgsman, Amanda      | Technical support unit for scenarios and models |
| Okayasu, Sana          | Technical support unit for scenarios and models |
| Schoolenberg, Machteld | Technical support unit for scenarios and models |
| Niamir, Aidin          | Technical support unit for knowledge and data   |

## **Annex III - Overarching questions of the nexus and transformative change assessments discussed in workshop day 2**

Overarching questions of the nexus assessment (as addressed at the time of the workshop):

- (a) How do past and current approaches to the production and use of water, food and energy, and their interactions, impact on/interact with biodiversity and nature's contributions to people, including the disadvantaged and indigenous peoples and local communities? How will climate change interact with and modify the role of nexus elements? What is the role of cultural uses in this interaction?
- (b) What is the role of biodiversity and nature's contributions to people in human health and well-being? How is that role mediated and/or impacted by water, food or energy production and supply, consumption, climate change and/or their interactions?
- (c) How can synergies among the Sustainable Development Goals be maximized to enhance biodiversity and resolve conflicts between development and biodiversity conservation?
- (d) What are the various policy/management and financial options, for conserving and sustainably using biodiversity, nature's contributions to people and human health while implementing an integrated and sustainable water/food/energy system? How can these policy/management options also improve climate change resilience and reduce greenhouse gas emissions?
- (e) What are the components of a successful<sup>21</sup> integrated management system for water/food/energy designed to minimize negative impacts to biodiversity, nature's contributions to people, climate change and human health? How can biodiversity contribute to and enhance the resilience and adaptability of food and bioenergy production systems? How can progress be measured towards equitability and sustainability of access to relevant components of biodiversity and nature's contributions to people, including among indigenous peoples and local communities? Which indicators can be used to track progress toward goals and targets, how effective are the indicators of the monitoring framework of the post-2020 global biodiversity framework and the 2030 Agenda at capturing the nexus interactions and what options exist for improvement?

Overarching questions of the transformative change assessment (as addressed at the time of the workshop):

- (a) What are transformative changes, and how do they relate to current approaches to managing biodiversity and ecosystem services?
- (b) How can deliberate and emergent transformative change be used to achieve the global objectives mentioned above?
- (c) How do different groups envision a sustainable world where the 2050 Vision for Biodiversity has been achieved in the context of the Sustainable Development Goals? What do these visions and the underlying values imply for transformative changes across sectors and systems?
- (d) What future scenarios and pathways could lead to the transformations needed to achieve the global objectives mentioned above? Which levers and policies in these scenarios and pathways are central to enabling the needed transformations?
- (e) What enables and accelerates transformative change and what can policymakers, decision-makers, managers, stakeholders, citizens and businesses and organizations do to use and further transformative change to meet relevant local, national and international goals in an equitable, just and participatory manner leaving no one behind?
- (f) Which obstacles and challenges impede transformative change toward a sustainable world, how might they change over time, scale and context, and how can they be overcome?

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<sup>21</sup> "Success" is described as a system having minimal impacts on biodiversity.

- (g) Which options and roles do policymakers, decision-makers, managers, stakeholders, citizens and businesses and organizations have to foster change toward achieving the global objectives mentioned above and how might these options and roles change over time and context?
- (h) How can options be combined in pathways to allow achieving the global objectives mentioned above?
- (i) What are the most important knowledge gaps to address regarding the underlying causes of biodiversity loss in order to achieve transformative change and the global objectives mentioned above, and how can these knowledge gaps be addressed?
- (j) What communication, education and other strategies can be used to educate the intended users of this assessment about transformative change toward a sustainable world?

## Annex IV - Policy relevant questions of workshop day 3

Policy relevant questions consolidated from workshop day 2, discussed in the breakout groups of day 3:

- 1) *How can moving towards the different Nature Futures contribute to the achievement of the SDGs, targets of the post-2020 global biodiversity framework, and Paris Agreement, and what are the potential trade-offs and synergies between different SDGs in different areas of the NFF?* The question is about end points and what kind of trade-offs and synergies, in terms of SDGs, exist in different parts of the NFF;
- 2) *What are the ecological functions and their contributions to people of assemblages of species and habitats in different Nature Future?* The second question is about the benefits of the relationship between nature and nature's contributions to people. What kind of cultural functions and conditions do we see? For example, different goals, different types of forest management, different types of cultural management and so on.
- 3) *Which responses/interventions are central to enabling the transformations needed to achieve the 2050 Vision for Biodiversity, the SDGs and the Paris Agreement in the different Nature Futures? And how do responses or interventions differ based on socio-economic and political contexts?*
- 4) *What are the diverse/plural perspectives [at different scales/levels] of a sustainable world where the 2050 Vision for Biodiversity has been achieved in the context of the SDGs? What do these visions and the underlying values imply for transformative changes across sectors and systems?* This is about management interventions and how they may be different across Nature Futures and social-economic contexts.
- 5) *How to include footprint/remote effects in different Nature Futures? How do we understand interactions between scales in the context of a transformative future?* This question is about the remote effects of communities.
- 6) *What types of transformative changes and associated pathways are required to reach different or all Nature Futures?* This question is about pathways including behavioural changes and indirect drivers.

## Annex V - Potential case studies of applications of the Nature Futures Framework (NFF)

This annex reflects the work carried out in the breakout groups of day 4. It is organised into nine general sections as identified by the workshop participants. The topics stated in brackets [ ] highlight the ideas suggested by participants as potential case studies, with different levels of detail and/or progress, and should be regarded as work in progress.

### Potential case study: Application of the NFF in geographic/ecosystem contexts - case of the High Seas and Coastal areas

*Case study leader: not yet identified*

|                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|-------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Place/system                                    | Marine- fisheries, coastal, high seas.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Core topic                                      | Climate and socio-economic implications on marine biodiversity and ecosystem services, specifically high seas governance, fitting into a policy context of biodiversity and areas beyond national jurisdiction.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Timescale of the scenario                       | not specified yet                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Status of current projects / activities / ideas | <p>[Overfishing]</p> <ul style="list-style-type: none"> <li>• Description: model exploited marine ecosystems</li> <li>• Scale: oceans, seas</li> <li>• Model: Fish-MIP (Fisheries and Marine Ecosystem Model Intercomparison Project) models:               <ul style="list-style-type: none"> <li>○ OSMOSE (Object-oriented Simulator of Marine Ecosystems)</li> <li>○ Atlantis (a marine ecosystem model)</li> <li>○ EcoTroph (a trophic-level based ecosystem model to assess fishing impacts and fisheries interactions)</li> <li>○ Ecopath with EcoSim (a free ecological/ecosystem modeling software suite with three main components: Ecopath – a static, mass-balanced snapshot of the system; Ecosim – a time dynamic simulation module for policy exploration; and Ecospace – a spatial and temporal dynamic module primarily designed for exploring impact and placement of protected areas)</li> <li>○ APECOSM (Apex Predators ECOSystem Model).</li> </ul> </li> </ul> |
|                                                 | <p>[Marine ecosystems and fisheries]</p> <ul style="list-style-type: none"> <li>• Description: modelling incentives and motivations (which could be driven by a combination of policies, subsidies, governance, etc.) around the use of fisheries</li> <li>• Scale: oceans, seas</li> <li>• Leader of team: Derek Tittensor</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|                                                 | <p>[Overfishing]</p> <ul style="list-style-type: none"> <li>• Description: Atlantic case studies e.g., under the projects Triatlas (link to Fish-MIP scenarios) and Mission Atlantic (link to Integrated Ecosystem Assessments)</li> <li>• Scale: Atlantic Ocean</li> <li>• Model: Tri-Atlas (Tropical and South Atlantic climate-based marine ecosystem prediction for sustainable management, Mission Atlantic (project to develop and systematically apply Integrated Ecosystem Assessments at Atlantic basin scale)</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|                                                 | <p>[Overfishing]</p> <ul style="list-style-type: none"> <li>• Description: One Ocean Hub (UK-based): global case studies, including Fiji, South Africa, Ghana</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |

|  |                                                                                                                                                                                                                                                                                                                                                    |
|--|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  | <ul style="list-style-type: none"> <li>Scale: global, local</li> </ul>                                                                                                                                                                                                                                                                             |
|  | <p>[Coastal areas]</p> <ul style="list-style-type: none"> <li>Description: Coastal area of Japan, under <a href="#">PANCES (Predicting and Assessing Natural Capital and Ecosystem Services) project Theme 3</a></li> <li>Scale: local</li> <li>Model: PANCES (Predicting and Assessing Natural Capital and Ecosystem Services) project</li> </ul> |

**Potential case study: Application of the NFF in geographic/ecosystem contexts - case of urban systems**

*Case study leader: not yet identified*

|                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                       |
|-------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Place/system                                    | Global scale and city scales such as Leipzig (Germany), State of Sao Paulo, particularly the city of Sao Paulo (Brazil), city of Toluca (Mexico), city of Addis Ababa (Ethiopia), city of Beijing (China).                                                                                                                                                                                                            |
| Core topic                                      | Depends on the city; e.g., air pollution, mental health, flood plain degradation.                                                                                                                                                                                                                                                                                                                                     |
| Timescale of the scenario                       | not specified yet                                                                                                                                                                                                                                                                                                                                                                                                     |
| Status of current projects / activities / ideas | <p>[Toluca]</p> <ul style="list-style-type: none"> <li>Description: City of Toluca: a large remote footprint, water scarcity, air pollution, and relic ecosystems being fragmented and destroyed because of urbanization. How can planning support sustainable urban futures? The case study will explore normative scenarios based on the NFF to support sustainable urban futures.</li> <li>Scale: local</li> </ul> |
|                                                 | <p>[Sao Paulo]</p> <ul style="list-style-type: none"> <li>Description: City or State of Sao Paulo: mental health and non-transmissible diseases (spatial distribution of diseases and green infrastructure) - how to apply nature-based solutions to improve health conditions, inequity?</li> </ul>                                                                                                                  |
|                                                 | <p>[Beijing]</p> <ul style="list-style-type: none"> <li>Description: City of Beijing: air pollution, water shortage and pollution, shrinking of agricultural land, little green in the city, high pressure from traffic, historical sites; different nature perspectives could be used in managing different parts of the city.</li> </ul>                                                                            |
|                                                 | <p>[Addis Ababa]</p> <ul style="list-style-type: none"> <li>Description: City of Addis Ababa: pollution (solid waste and water pollution), urban expansion, violation of urban plans, uncontrolled settlement in remaining green areas, water supply.</li> </ul>                                                                                                                                                      |
|                                                 | <p>[Leipzig]</p> <ul style="list-style-type: none"> <li>Description: City of Leipzig: degradation of the floodplain forest due to lack of natural forest regime, urban densification, loss of urban gardening culture, intensive agriculture around the city.</li> </ul>                                                                                                                                              |

**Potential case study: Application of the NFF in geographic/ecosystem contexts - case of Freshwater systems**

*Case study leader: Jan Kuiper and Aafke Schippers*

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|-------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Place/system                                    | Freshwater and wetlands                                                                                                                                                                                    |
| Core topic                                      | The core discussions centred around the 'nature as culture' value perspective of the nature futures framework, and the inclusion of freshwater in scenarios and models of biodiversity ecosystem services. |
| Timescale of the scenario                       | not specified yet                                                                                                                                                                                          |
| Status of current projects / activities / ideas | not specified yet                                                                                                                                                                                          |

**Potential case study: Application of the NFF in thematic/topical contexts - case of invasive alien species**

*Case study leader: not yet identified*

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|-------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Place/system                                    | Invasive alien species (IAS) in the context of social-ecological systems.                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Core topic                                      | Qualitative global and continental scenarios of IAS, socio-ecological feedbacks shaped by IAS including leverage points for trade and agricultural systems.                                                                                                                                                                                                                                                                                                                                       |
| Timescale of the scenario                       | 2050                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Status of current projects / activities / ideas | [InvasiBES: Future impacts of invasive alien species] <ul style="list-style-type: none"> <li>• Description: Development of future scenarios of impacts and management of invasive alien species</li> <li>• Scale: Regional to global</li> <li>• Leader of Team: Dr Belinda Gallardo, Spain</li> </ul>                                                                                                                                                                                             |
|                                                 | [AlienScenarios: Development and application of alien species scenarios] <ul style="list-style-type: none"> <li>• Description: Quantification of future scenarios of drivers of alien species introductions and development of models to simulate trajectories of alien species accumulations and impacts</li> <li>• Scale: Continental to global</li> <li>• Model: Various; mostly statistical models</li> <li>• Leader of Team: Prof. Franz Essl, Austria; Dr Hanno Seebens, Germany</li> </ul> |
|                                                 | [Social-ecological feedbacks] <ul style="list-style-type: none"> <li>• Description: Developing quantitative global and continental scenarios of IAS, looking at social-ecological feedbacks shaped by IAS from different NFF perspectives</li> </ul>                                                                                                                                                                                                                                              |

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|  | <ul style="list-style-type: none"> <li>• Scale: Lake Victoria</li> </ul> |
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**Potential case study: Application of the NFF in Shared Socioeconomic Pathways (SSPs) scenarios and impact modelling on sustainable development goals (SDGs) and the post-2020 global biodiversity framework**

*Case study leader: not yet identified*

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|-------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Place/system                                    | Global                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Core topic                                      | How could the NFF bring additional thinking to a lot of things that are going on with the SSPs, and also try to bridge this link between what's going on here [in the workshop/work of the task force] and things that are going on with the SSPs, like the inter-model comparisons.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Timescale of the scenario                       | not specified yet                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Status of current projects / activities / ideas | <p>[Land use]</p> <ul style="list-style-type: none"> <li>• Description: to try-out the NFF using recent scenarios, such as SSP1, Bending the Curve, Post-2020 work of PBL. Explore these pathways.</li> <li>• Scale: global</li> <li>• Model: IAMs (e.g., IMAGE)</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|                                                 | <p>[Bending the Curve]</p> <ul style="list-style-type: none"> <li>• Description: PBL has worked on 'Bending the curve' focusing on different implementations of conservation addressing the nexus food biodiversity climate. A similar scenario study is starting at the scale of The Netherlands.</li> <li>• Scale: global</li> <li>• Model: IMAGE</li> <li>• Leader of team: Elke Stehfest, Detlef van Vuuren</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|                                                 | <p>[Policies and strategies]</p> <ul style="list-style-type: none"> <li>• Description: to evaluate ex-ante European Union (EU) member state policies and strategies (including their National Biodiversity Strategies and Action Plans (NBSAPs), Nationally Determined Contributions (NDCs) and land-use policies, e.g. Common Agricultural Policy (CAP) implementation) to assess the extent to which they achieve the EU green deal goals for 2030 (related to mitigation/adaptation, biodiversity conservation, sustainable food production and forestry). It will also create normative scenarios, designed to achieve the EU green deal, by simulating actions and policies in addition and/or alternative to those that are doing or have committed to do.</li> <li>• Scale: national</li> <li>• Model: BIOCLIMA project (Microbial Biodiversity - climate feedbacks during environmental crises in semi-enclosed basins: lessons from the Late Miocene)</li> </ul> |

**Potential case study: Application of the NFF to consider sustainable development goals (SDGs) and Convention on Biological Diversity (CBD) indicators to explore synergies and trade-offs amongst multiple goals/targets of the post-2020 global biodiversity framework**

*Case study leader: Lilibeth Acosta, and Piero Visconti and HyeJin Kim*

|                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|-------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Place/system                                    | Terrestrial, at least global and IPBES sub-regions.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Core topic                                      | Synergies and targets for the nexus and transformative change assessments from the perspective of the NFF. Also, looking into innovative indicators, like green growth or measuring ecosystem accounting for natural habitat.                                                                                                                                                                                                                                                                                                                                                                                       |
| Timescale of the scenario                       | not specified yet                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Status of current projects / activities / ideas | <p>[SDGs and policy options]</p> <ul style="list-style-type: none"> <li>• Description: Global Green Growth Institute (GGGI)'s simulation tool (strength in SDGs and policy options), Biodiversity and Ecosystem Services Scenario-based Intercomparison of Models (BES-SIM) and 'Bending the Curve' (focus on CBD and biodiversity with multiple modelling tools) - assessing, synergies, co-benefits, trade-offs across goals with complementing strength</li> <li>• Model: GGGI's simulation tool</li> </ul>                                                                                                      |
|                                                 | <p>[species diversity - biodiversity offsetting]</p> <ul style="list-style-type: none"> <li>• Description: Exploring the relative importance of satellite-derived descriptors of production for multi-species diversity modelling oriented towards restoration scenarios ('nature for nature' perspective of the NFF) to improve the multifunctional role of artificial temporary wetlands to avoid pesticides flows in agricultural areas</li> <li>• Scale: local to regional</li> <li>• Model: Dynamic Habitat Index (DHI) coupled species distribution model.</li> <li>• Leader of team: Sandra Luque</li> </ul> |
|                                                 | <p>[Species abundance]</p> <ul style="list-style-type: none"> <li>• Description: how management approaches for each nature future framework perspective can lead to different functional properties and benefits can be assessed by linking those models with economic and social models that convert those functional properties and the species abundances into indicators of economic value, health risk, inspirational value, etc. (Eisenhauer et al. 2019, Cheung &amp; Sumaila, 2008).</li> <li>• Scale: local/regional</li> <li>• Model: Trophic web models</li> </ul>                                       |
|                                                 | <p>[Pollinators]</p> <ul style="list-style-type: none"> <li>• Description: different pollinators achieving different goals. Model bee diversity as key pollination service.</li> <li>• Scale: local</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                      |
|                                                 | <p>[Reforestation]</p> <ul style="list-style-type: none"> <li>• Description: reforestation (and other habitat restoration, e.g., wetlands) addressing both climate change and biodiversity</li> <li>• Scale: local</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                       |
|                                                 | <p>[Teleconnections]</p> <ul style="list-style-type: none"> <li>• Description: teleconnections at different scales</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |

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|  | <ul style="list-style-type: none"> <li>Scale: regional, continental</li> </ul>                                                                                                                                                                                                                                                                                                                                                                |
|  | <p>[CBD]</p> <ul style="list-style-type: none"> <li>Description: analysing historical reporting to e.g., CBD to infer NFF direction and SDG reporting to interactions with synergies/trade-offs with SDG progress</li> </ul>                                                                                                                                                                                                                  |
|  | <p>[Waste]</p> <ul style="list-style-type: none"> <li>Description: Converting waste to charcoal has provided a good options for reducing pressure on wood resources in experimental case studies in Nigeria</li> <li>Scale: local</li> </ul>                                                                                                                                                                                                  |
|  | <p>[World2050]</p> <ul style="list-style-type: none"> <li>Description: regional integrated assessments</li> <li>Scale: regional</li> <li>Model: AgMIP (Agricultural Model Intercomparison and Improvement Project)</li> <li>Leader of team: FABLE (Food, Agriculture, Biodiversity, Land-Use, and Energy) consortium (<a href="https://www.foodandlandusecoalition.org/fable/">https://www.foodandlandusecoalition.org/fable/</a>)</li> </ul> |

**Potential case study: Application of the NFF to model drivers of transformative change (Qualitative-quantitative linkages including ILK and further elaboration of the ‘nature as culture’ value perspective of the NFF)**

*Case study leader: not yet identified*

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|-------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Place/system                                    | Global, regional and local level                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Core topic                                      | Transformative change in various ways and unpacking the value perspective ‘ <i>nature as culture</i> ’ in the visions of the future, and also in how to model the responses. This work could focus on indirect drivers, such as the values of governance systems.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Timescale of the scenario                       | not specified yet                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Status of current projects / activities / ideas | <p>[The Earth system/global Coupled model of the global land-ecosystem-climate system]</p> <ul style="list-style-type: none"> <li>Description: Integrating an agent-based models of land use agents at the sub-national scale (CRAFTY - Competition for Resources between Agent Functional Types) with a global land use and trade model (PLUM - Participatory Land Use Model), a dynamic global vegetation model (LPJ-Guess, a process-based dynamic vegetation-terrestrial ecosystem model), a general ecosystem model (Madingley) and a climate system emulator (IMOGEN – an intermediate complexity model to evaluate terrestrial impacts of a changing climate)</li> <li>Scale: global</li> <li>Model: LandSyMM (Land System Modular Model)</li> <li>Leader of team: Mark Rounsevell</li> </ul> <p>[Social-ecological production landscapes]</p> <ul style="list-style-type: none"> <li>Description: Social-ecological production landscapes in smallholder farming regions such as South West Nigeria)</li> <li>Scale: local</li> <li>Model: CLUMondo (a forward-looking spatial and multi-scale dynamic land allocation model)</li> <li>Leader of team: Felicia Olufunmilayo Akinyemi</li> </ul> |

**Potential case study: Application of the NFF with agent-based models and other innovative approaches to develop scenarios of socio-ecological systems**

*Case study leader: 9 leads to be specified*

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|-------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Place/system                                    | Case studies ranging from the global to the regional and local scale.                                                                                                                                                                                                                                                                                                                                |
| Core topic                                      | Telecoupled impacts across the globe. How do these agent-based models push forward in a way to capture both interactions and responses in social systems and how they interact with ecological systems?                                                                                                                                                                                              |
| Timescale of the scenario                       | 2050/2100                                                                                                                                                                                                                                                                                                                                                                                            |
| Status of current projects / activities / ideas | <p>[Amazon River]</p> <ul style="list-style-type: none"> <li>• Description: assessing social-economic effects derived from the co-dependencies among food systems in a North-South Global context: The Amazon River Basin trade-offs and synergies in the NFF.</li> <li>• Scale: local/regional</li> <li>• Model: Amazon River Basin Cross-scale model</li> <li>• Leader of team: Ricardo</li> </ul> |
|                                                 | <p>[Use of wildlife]</p> <ul style="list-style-type: none"> <li>• Description: Human-animal interactions and perceptions of appropriate use of wildlife</li> <li>• Scale: Regional models (Possible wildlife trade-sector generally)</li> <li>• Leader of Team: Kai Chan</li> </ul>                                                                                                                  |
|                                                 | <p>[Disease transmission]</p> <ul style="list-style-type: none"> <li>• Scale: Global (plus regional case studies)</li> <li>• Leader of Team: Pranav Pandit</li> </ul>                                                                                                                                                                                                                                |
|                                                 | <p>[marine ecosystems and fisheries]</p> <ul style="list-style-type: none"> <li>• Description: modelling incentives and motivations (which could be driven by a combination of policies, subsidies, governance, etc.) around the use of fisheries.</li> <li>• Scale: Global (national scale and with case study countries)</li> <li>• Leader of Team: Derek Tittensor</li> </ul>                     |
|                                                 | <p>[Supply and demand changes]</p> <ul style="list-style-type: none"> <li>• Description: How can the types of changes (in supply and demand) and actions required to arrive at positive biodiversity futures (no specific NFF) be realized within different countries.</li> <li>• Scale: Multilevel (across governance levels)</li> <li>• Leader of Team: Mike Harfoot</li> </ul>                    |
|                                                 | <p>[Biodiversity conservation]</p> <ul style="list-style-type: none"> <li>• Description: Multilevel regulatory framework for biodiversity conservation anchored in the CBD</li> <li>• Leader of Team: Sylvia Karlsson-Vinkhuyzen</li> </ul>                                                                                                                                                          |
|                                                 | <p>[People's behaviours and risk perception]</p> <ul style="list-style-type: none"> <li>• Description: How people's behaviours and risk perception affect the decisions on nature/forest use, especially regarding climate change and biodiversity</li> <li>• Scale: Swiss Alps</li> </ul>                                                                                                           |

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|  | <ul style="list-style-type: none"> <li>• Leader of Team: Rasoul Yousefpour</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|  | <p>[Integrate non-economic values]</p> <ul style="list-style-type: none"> <li>• Description: Exploration of novel methods/ideas/approaches to better integrate non-economic values into models of biodiversity change (i.e., how can multiple axes of behavioural motivation, including valuing '<i>nature as culture</i>', be integrated into models with feedback to biodiversity)</li> <li>• Leader of Team: Derek Tittensor</li> </ul>                                                                                                                                                                                                                                                                                                                                                                    |
|  | <p>[Land use]</p> <ul style="list-style-type: none"> <li>• Description: land use modelling</li> <li>• Model: CRAFTY</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|  | <p>[The Earth system/global Coupled model of the global land-ecosystem-climate system]</p> <ul style="list-style-type: none"> <li>• Description: Integrating an agent-based models of land use agents at the sub-national scale (CRAFTY - Competition for Resources between Agent Functional Types) with a global land use and trade model (PLUM - Participatory Land Use Model), a dynamic global vegetation model (LPJ-Guess, a process-based dynamic vegetation-terrestrial ecosystem model), a general ecosystem model (Madingley) and a climate system emulator (IMOGEN – an intermediate complexity model to evaluate terrestrial impacts of a changing climate).</li> <li>• Scale: global</li> <li>• Model: LandSyMM (Land System Modular Model)</li> <li>• Leader of team: Mark Rounsevell</li> </ul> |