Future scenarios for socio-ecological production landscape and seascape

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Introduction

Sustainable use of biodiversity and ecosystem services are among the key agendas of the UN Sustainable Development Goals (SDGs) (CBD 2014; UNEP.IRD 2016; Wood et al. 2018). To pursue this, the core research agendas for sustainability science include the following: (1) co-designing future scenarios and visions of social–ecological system with a participatory approach, (2) integrating indigenous and local knowledge (ILK) systems into both scientific knowledge and future scenarios of biodiversity and ecosystem services, and (3) the formulation of actions to transform society toward a more sustainable future (Miller et al. 2014; Schneider and Rist 2014; Kishita et al. 2016).

In 2016, the fourth plenary of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) approved a summary for policy makers of the methodological assessment of scenarios and models

of biodiversity and ecosystem services. The report defined “scenarios” as representations of possible futures for one or more components of a system, such as for drivers of change in nature and nature’s benefits, and alternative policy or management options. Likewise, “models” were defined as qualitative or quantitative descriptions of key components of a system and of the relationships that exist between those components. This report advocates for widespread use of scenarios to resolve the uncertainties in decision-making process, and further guides scientists and experts regarding the use of scenarios and models in the assessment of biodiversity and ecosystem services. Particularly, IPBES has identified the development of scenarios as a key to aid decision makers in identifying potential implications of different policy options, and to choose a desired path for future transition. Nevertheless, despite widespread advocacy, the current scientific disclosure evidently lacks long-term scenario approaches (Kok et al. 2017). Moreover, to reflect the future socio–ecological dynamics of biodiversity and ecosystem services, IPBES also emphasized the integration of ILK into the scenario building process, by engaging the substantial diversity of local contexts through participatory processes.

To meet this challenge, the authors launched a new project in 2016 named “Predicting and Assessing Natural Capital and Ecosystem Service (PANCES)”. The aim of this project is to develop an integrated assessment of social–ecological systems to predict and assess natural and socio-economic values of natural capital and ecosystem services in Japan under plausible alternative scenarios (including differing socio-economic conditions and policy options) (PANCES website: <http://pances.net/top/>). PANCES also promotes multilevel governance of natural capital to maintain and improve “inclusive wellbeing” and demonstrate the integrated assessment model at both national and local scales, with implications in Japan and beyond.

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Aims and scope of special feature

This special feature (SF) introduces the updated science-policy issues ranging from (a) biodiversity and ecosystem services (BES) scenarios and modeling, (b) reviews and case studies on local to regional scale scenario building and analysis, (c) capacity development for BES scenarios and modeling, and (d) examples of policy formulation using BES scenarios and modeling. This SF also intends to mobilize and activate researchers and policy makers to strengthen their partnership and to promote scenario approaches at local and national scales.

The SF starts with a set of papers from the PANCES project, and it extends to introduce external contributions from across the world broadly outlining the following themes:

- Critical analyses of the state-of-the-art and good practices of using scenarios and models in assessments, and design and implementation of policies relevant to BES (IPBES 2016).
- Effective use of scenarios and models across a broad range of decision-making contexts and scales, particularly focusing on landscape sustainability (IPBES 2016).
- Participatory scenario building in collaboration with indigenous people and local communities (IPLC).
- Integration/combination of climate and ecosystem scenarios.
- Understanding and explaining the important relations and feedback between components of coupled social–ecological systems through scenarios and modeling studies.
- Building human and technical capacity to facilitate the development and utilization of scenarios and models.
- Future changes in interaction between terrestrial and marine ecosystem services.

Nation-wide and local case studies from Japan

PANCES project develops national scale future scenarios for exploring potential changes in natural capital and ecosystem services, as well as human wellbeing, up to 2050 using key direct and indirect drivers, including demographic changes, economic globalization and technological innovation (Saito et al. 2018). Four national scale future scenarios are created for Japan through a two-round Delphi survey, namely “Natural capital-based compact society”, “Natural capital-based dispersed society”,

“Produced capital-based compact society”, and “Produced capital based dispersed society”, in addition to the business-as-usual scenario with qualitative storylines and a visual illustration of the developed scenarios. Matsui et al. (2018) project residential and working population at national scale under the proposed four scenario narratives using a gravity-based allocation algorithm in a spatially explicit manner. Similarly, Shoyama et al. (2018) translate the same narratives into nation-wide land use and land cover (LULC) maps using the Multi-Layer Perceptron Neural Network (MLP-NN) model. The spatial resolution of both the population and land use maps were set to 1 km.

Hashimoto et al. (2018) downscaled the PANCES scenarios and applied it to the Noto peninsula of Japan to quantitatively explore how alternative development pathways influence future land-use patterns, biodiversity and ecosystem services, particularly considering the declining population trend and subsequent underuse of social–ecological production landscapes. They employed the MLP-NN model for land-transition potential modelling and InVEST in an integrated manner to analyze synergies and trade-offs for five vital ecosystem services at a spatial resolution of 100 m. In contrast to downscaling of the national scenarios, Kabaya et al. (2018) investigate future land use and ecosystem services through participatory scenario building techniques and spatial ecological–economic modelling in Sado island, Japan. Both Noto peninsula and Sado island were designated as Globally Important Agricultural Heritage System (GIAHS) by FAO in 2011. While top-down expert driven scenarios are explored in Noto peninsula, bottom-up participatory approach is applied for scenario building in Sado island with participation of multiple local stakeholders. In addition, Haga et al. (2018) apply the PANCES scenarios to the Bikanbeushi River Watershed in Northern Japan to simulate the vegetation dynamics in species composition, age structure, and biomass—considering the impacts of forest and pasture land management using LANDIS-II model (a forest landscape model). Hori et al. (2018) explore people’s apprehension on PANCES scenarios by investigating the preferences for natural capital-based and produced capital-based ecosystem services in Noto peninsula and Tokyo using questionnaire survey. Furthermore, under the PANCES project, several innovative methodological approaches were applied to assess natural capital and ecosystem services, both at the national scale and the local scale. For instance, to measure the mountain-driven cultural ecosystem services, Aiba et al. (2018) investigate the associations between various landscape attributes and monthly hiking records of 1953 mountains in Japan, crowdsourced from a social networking service for hikers. Similarly, Kubo et al. (2018) apply Best–Worst Scaling (BWS) to understand residents’ anxieties about potential incidents caused by climate change in Amami islands, Japan through interviews

and questionnaire survey. Oguro et al. (2018) investigate the relationship between pollinator dependence and production stability of 40 crops in Japan and examine how pollination services contribute to stable crops production. Using the inclusive wealth approach, Ikeda and Managi (2018) estimate the future inclusive wealth and human well-being in Japan using sustainability indices, relying upon shared socioeconomic pathways (SSPs) for 2015–2100.

Case studies from around the world

The special feature also covers case studies from around the world, including watershed, large river delta, forests and other socio-ecological production landscapes. Based on comprehensive literature review on accounting natural capital and ecosystem services, Islam et al. (2018) provide the value of the natural capital in 140 nations by adopting the inclusive wealth approach. Sahle et al. (2018) model and examine future land use management effects on ecosystem services in the Wabe River catchment of the Gurage Mountain chain landscape, Ethiopia using Land Change Modeler and InVEST's scenario generator. Capitani et al. (2018) apply a participatory scenario development framework in two parts of the Eastern Afromontane Biodiversity Hotspot: Taita Hills in Kenya and Jimma rural area in Ethiopia with participation of local stakeholders to envision adaptation scenarios under projected climate changes by mid-twenty-first century. They assessed the potential impacts of these pathways on land use and land cover. Through a case study in the Canadian Arctic, Falardeau et al. (2018) propose a novel set of methods for participatory scenario planning designed to explore what 'positive futures' could mean to different populations under growing impacts from environmental and social change, and how positive outcomes can be achieved. DasGupta et al. (2018a) narrate an empirical research conducted for developing four alternative socio-ecological scenarios for the Indian Sundarban delta—a UNESCO world heritage site—based on 'Story and Simulation (SAS) approach' (Alcamo 2008). To identify the future landscape sustainability, they built four short-term, landscape-scale scenarios for 2030 and identified the plausible alternative mangrove future of the delta.

Scenario archetypes and implications for sustainable development goals

The SF also presents findings of the systematic literature review of biodiversity/ecosystem services scenario exercises from the Asia-Pacific region. DasGupta et al. (2018b) reviewed 61 contemporary scenario studies and explored their typology and multiple scenario attributes, including

their contributions to the SDGs. The study was conducted as part of the IPBES Asia Pacific regional assessment of biodiversity and ecosystem services and provided a critical insight into the research achievements, gaps and challenges. Using the Global Scenario Group (GSG) scenario archetypes (see Hunt et al. 2012) the authors classified the contemporary regional and sub-regional scenarios under six alternative development pathways, namely. 'Policy reform', 'market forces', 'eco-communalism', 'new sustainability', 'break down' and 'fortress world'. The authors also provide a critical insight into the research gaps in BES scenario research from a regional perspective and outline future research direction of BES scenario research in the region.

Conclusions

There is a strong scientific consensus that the provisioning of biodiversity and ecosystem services form the ultimate basis of future sustainable societies (Costanza et al. 2016; DasGupta et al. 2018b). As the global communities embrace the sustainable development goals (SDGs) to deliver the desired transitions towards sustainability, understanding of alternative development pathways and their implications on biodiversity and ecosystem services remain critical. Scenarios can help identifying appropriate policies that will result in a sustainable transformation, which is essential to achieve the SDGs at national and local scales. As presented in this special feature (SF), the PANCES project developed future scenarios at the national and local scales for Japan to explore likely changes in natural capital and ecosystem services, as well as human well-being, up to 2050. It used the key direct and indirect drivers including climate change, depopulation, and aging, as well as globalization and technological innovation to envision the likely alternative futures. At the same time, this SF contains articles written by not only the PANCES project members but also external experts who provide three case studies from Africa and Asia. Hence, this SF is expected to make significant contribution to the existing knowledge of BES scenario studies, including methodological development, innovation and policy integration, while strengthening national and sub-national scenario research in line with IPBES recommendation. The future scenario studies presented in this SF can provide useful insights and practical implications to ensure the transformation towards sustainable development in harmony with nature and should encourage similar studies from around the world.

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