



PANCES

Predicting and Assessing Natural Capital and Ecosystem Services
through an Integrated Social-Ecological Systems Approach

PolicyBrief No.4 Jul. 2020

Theme 4

Deepening the evaluation
and governance of
natural capital
and ecosystem services





Theme 4

Deepening the evaluation and governance of natural capital and ecosystem services

Introduction

The establishment of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) reflected the need to enhance the interface between science and policy, including through the construction of a conceptual framework for assessment in this field and an approach to make the framework operational. In parallel with this, the group of nearly 100 experts across Japan has started the national scale scenario analysis of nature and ecosystem services to help the government to revise the existing National Biodiversity Strategy and Action Plan. The IPBES Global Assessment Report published in May 2019 indicated that the ongoing loss of biodiversity on a global scale might jeopardise the achievement of the Aichi Biodiversity Targets, as well as the Sustainable Development Goals (SDGs), the 2050 Vision for Biodiversity and the Paris Agreement adopted under the UN Framework Convention on Climate Change (UNFCCC), among others. However, many of the insights presented in the IPBES Global Assessment do not directly apply to Japan due to its declining birth rate, and dwindling and ageing population, where declining utilisation (underuse) of nature is considered to be one of the drivers causing biodiversity loss. In line with the global efforts of assessing nature and ecosystem services, it is of vital importance to conduct assessments and gain a future perspective in light of the unique social and economic conditions of Japan. Based on the findings so far of the Predicting and Assessing Natural Capital and Ecosystem Services through an Integrated Social-Ecological Systems Approach (PANCES) project, which is funded by the Environment Research and Technology Development Fund (S-15) from the Ministry of the Environment, Japan, this Policy Brief sets out comprehensive policy recommendations with a view to building future scenarios and integrated model of social-ecological systems on national and regional scales, in particular.

Policy recommendation 1

From the results of the estimates of the willingness to pay (WTP) amounts to maintain 13 areas of natural capital in Japan as a whole, including agricultural land, forests, and sea areas, it was confirmed that there are regional differences that cannot be explained solely by socioeconomic attributes that normally are important determinants of WTP, such as household income, and the nearness of goods, services, and living spaces. To implement policies to improve natural capital and ecosystem services, it is necessary to pay attention to this diversity. In addition, it was found that WTP tends to be higher when the subjective importance of goods and services, and the frequency of visits to them, are higher. In particular, this tendency was expressed by the fact that among the natural capital of agricultural land, forests, and sea areas, the WTP for seaweed beds was found to be the lowest. This indicates that to effectively preserve goods and services with which the degree of familiarity is low, it is important to promote environmental education and related measures.

▶ page
4

Policy recommendation 2

It was confirmed that in rural communities, there is a positive correlation between local-specific ecosystem services (particularly cultural services) and identity utility as local residents (the utility that can be obtained from being a member of a local community). Therefore, local-specific traditional events, outdoor recreation that utilizes an area's unique natural environment, and the promotion of environmental education may increase the residents' identity utility and mitigate the population outflow from rural communities.

▶ page
6

Policy recommendation 3

Recreation activities that are familiar to the general public include cherry blossom viewing, autumn leaf viewing, and digging for clams, but to a fairly large extent, people's usage of such forms of nature are affected by seasonal changes, such as the coloring and distribution of the vegetation and the time they are available. By developing a model to estimate the relationship between people's leisure consumption activities and the natural environment, it will be possible to predict the effects that environmental changes that may occur in the future will have on leisure consumption activities.

▶ page
7

Policy recommendation 4

It is important to evaluate the benefits of the linkages between terrestrial and aquatic ecosystems. For fishery and other production activities in sea areas, it is necessary to have a sufficient primary production, and some of them is closely related to the land use in the catchment area that flows into it. In Hiroshima Bay, which is a production area for oyster aquaculture, the economic value of oyster production, which is maintained by preserving the forest in the Ota River basin that corresponds to the catchment area, is much higher than the conservation costs. To investigate effective watershed management, it is important to conduct governance that comprehensively considers the natural and societal connections between terrestrial and aquatic ecosystems.

▶ page
8

Policy recommendation 5

Our analysis of the governance of biodiversity conservation, which covered all municipalities in Japan, describes the policy-making processes characterised by ideocratic approaches drawn from rationality, such as those involving the Ministry of the Environment (MOE), and the implementation processes in agriculture characterised by responsive approaches, prioritising short-term benefits such as wildlife hazard management. To develop further biodiversity policies, a comprehensive system should be formed in which the national government deploys the policy measures currently covered by specific government ministries and local governments; for instance, the national government could establish a headquarters for biodiversity conservation in the Cabinet.

▶ page
9

Policy recommendation 6

A survey of the factors contributing to the formulation of Local Biodiversity Strategies and Action Plans (LBSAP) shows that the MOE's Regional Biodiversity Activities Support Project significantly contributed to the formulation of the LBSAP. The survey also shows that municipalities with more influential environmental experts were more likely to set up LBSAP. As the survey suggests that lack of biological knowledge and manpower is the major reason for the absence of LBSAP in a municipality, dispatching experts and providing financial support to small- and medium-sized municipalities will help to effectively overcome this problem.

▶ page
10

Policy Recommendation 1

1. Policies to improve natural capital and ecosystem services that take into consideration regional differences as well as disparities within the natural capital

The conservation of natural capital, as the foundation for maintaining the well-being and sustainability of the human race, has in recent years attracted the attention of researchers and policy makers throughout the world (Managi and Kumar, 2018). Within Japan, focusing on the Fifth Basic Environment Plan decided by the Cabinet in April 2018, we see that it frequently mentions natural capital, which had hardly been mentioned at all in the basic environmental plans up to that time. This shows that interest in natural capital has been rising in recent years.

One method of promoting sustainability is to ascribe monetary value to the natural capital that constitutes the environment, as well as the ecosystem systems derived from this capital. Many researchers have estimated citizens' willingness to pay (WTP) for the conservation of a variety of natural capital, including specified-area forests, agricultural land, coral reefs, sea areas, and mangrove forests. Several studies, including the one by Managi and Kumar (2018), have conducted a meta-analysis of these individual studies based on the benefit-transfer method, and have attempted to comprehensively ascribe value to a wide range of natural capital. However, there has been little research that has calculated the value of natural capital to individual countries, and there have been no comprehensive estimates of the value of natural capital that consider regional characteristics as seen in Japan's agricultural land, forests, and sea areas.

In this study, the WTP to maintain the natural capital of Japan as a whole, including its agricultural land, forests, and sea areas, and the factors for this, are analyzed. A questionnaire survey was conducted among 7,556 people living throughout Japan, and they were asked what the maximum amount of money was that their respective household would pay, in the form of a credit card payment, to maintain 13 items of

natural capital: paddy fields, upland fields, orchards, pastures, plantations, natural forests, coastal disaster prevention forests, mangrove forests, coral reefs, tidal flats, seaweed beds, sandy beaches, and fishing grounds. From the analysis of the factors, it was found that the WTP for the conservation of practically all of the items was significantly affected by gender, age, household size, household income, frequency of visits to the target areas, and the subjective importance ascribed to the target item by the respondent. Also, the WTP to maintain seaweed beds was relatively low in comparison to those of the other items, which may be due to the low level of awareness about seaweed beds' ecosystem services. In cases such as this, is necessary to raise awareness of the ecosystem services provided by natural capital, including through environmental education.

From an analysis of the regional differences in Japan's eight regional administrative divisions, it was found that some regional differences cannot be explained solely by the explanatory variables adopted for the factor analysis (Fig. 1). For example, despite the fact that in the Hokkaido region, the average annual household income ranks seventh out of the eight regions, its WTP was relatively high for nearly all the conservation items. Even for natural capital, which is often distributed in the southern regions, and for which the frequency of visits by the Hokkaido respondents is low, such as coral reefs and mangrove swamps, it ranked second for the WTP to maintain it, behind only the Kanto region, where the average annual household income is high. This suggests that people in Hokkaido have a uniquely high awareness of the environment. To effectively maintain natural capital, it is necessary to implement policies to improve natural capital and ecosystem services that take into consideration these kinds of regional differences.

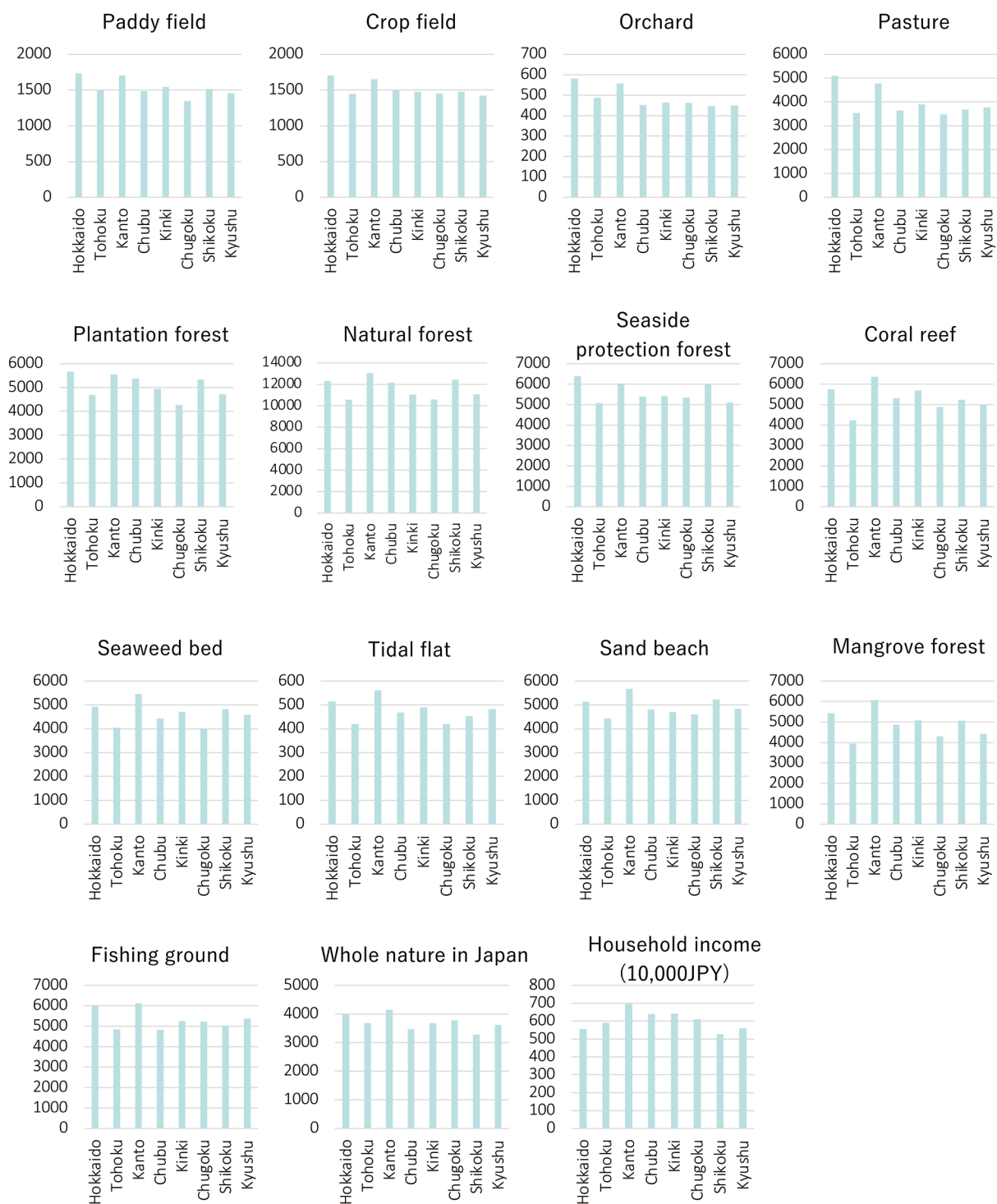


Fig. 1 The mean WTP for maintaining natural capitals by region (JPY/%/year)

Policy Recommendation 2

2. Mitigating population outflow from rural communities by improving identity utility as local residents

Population outflow from rural communities is continuing. The background to this trend is thought to be the comparative advantage of cities in aspects such as convenience of daily life, employment, and income. On the other hand, some residents do not wish to move to cities. Rather than asking the question, “Why do people move to cities?” a better question would be, “Why do some people continue to live in rural areas?” This would be a useful point of discussion when investigating measures to mitigate population outflow from rural communities.

In this study, as one of the reasons people continue to remain in rural communities, the focus is placed on the identity utility that they enjoy from being a member of their community (Akerlof & Kranton [2000], hereafter, ID utility). It seems the higher the social status of the person in the community to which he or she belongs, the higher their ID utility; it is also higher if the person is in harmony with the social norms of their community. The higher the ID utility accorded to a resident living in a rural community, the greater the welfare loss if that person moves to a city. It is considered highly likely, therefore, that such people will remain in the area in which they currently live. Another important point of discussion is how their use of the abundant ecosystem services in rural communities is connected to this ID utility.

To verify the above hypothesis, online surveys were conducted among the residents of 64 medium-population municipalities in fiscal 2017, and 645 municipalities that had been designated as depopulated areas in fiscal 2018. In this survey, a living place choice experiments among respondents’ home communities and Tokyo’s 23 wards were conducted.

The main results of the analysis are summarized as follows. (i) In the evaluation of the social status (attractiveness) of each living place in the choice set, the attractiveness of the home communities was lower than the evaluation of Tokyo, but the evaluation of

the harmony between the respondent’s lifestyle and his/her home community’s social norm was higher than for Tokyo. (ii) Those respondents frequently using the local-specific cultural services tended to highly evaluate the attractiveness and harmony of their home communities. In the results of the choice experiments, (iii) for those respondents who highly evaluated the attractiveness and harmony of their home communities, there was a high probability that they would not choose to move to Tokyo and would stay in their current living places. (iv) The relationship of (iii) was stronger for respondents frequently using of local specific cultural services.

From the above, it was confirmed that residents who use local-specific cultural services have high values for attractiveness and harmony of their home communities, which are the explanatory variables for the ID utility function as local residents (ii), and that those coefficients in their local resident’s ID utility function are also high (iv). Therefore, the use of cultural services has a positive relationship with the ID utility of residents of rural communities in a double pathway. Although this is nothing more than a correlational result, we might be able to say that, for mitigating the population outflow from rural communities, it would be effective to promote local specific traditional events and outdoor activities that utilize the area’s unique natural environment, and to provide environmental education.

In the context of the scenario analysis of Theme 1, residents who use local-specific cultural services do not want to move to Tokyo or another big city, so it can be said that economic welfare, which is maintained in the population dispersion-type scenario, is high. From the above hypothesis, promoting the use of local-specific cultural services in each communities may increase the comparative advantage of the dispersal scenario compared to the concentrated-population one.



Policy Recommendation 3

3. The need for economic valuations of the natural environment as seen from people's leisure consumption activities

Recreation that is familiar to the general public includes cherry blossom viewing, autumn leaf viewing, and digging for clams, but to a fairly large extent, people's usage of such forms of nature are affected by seasonal changes, such as the coloring and distribution of the vegetation and the time they are available. It is important to develop a model to estimate the relationship between people's leisure consumption activities and the natural environment to predict the effects that environmental changes that may occur in the future will have on leisure consumption activities.

In this study, as a first attempt, with 835 autumn leaf viewing locations in Japan as the targets of the study, direct estimates of utility—namely, how much recreation value was ascribed to each of the locations by tourists residing in the various prefectures—are shown quantitatively. For this, the optimal transport theory framework was used, and a model was constructed that reformulates the discrete choice model based on utility maximization as a linear programming problem. Mobile data was used to calculate the probabilities that tourists would select

the various destinations, and the utility to rationalize the discrete choice model was directly derived from the choice probabilities. The results indicate that in large cities and cities with tourist attractions, people are attracted to urban parks and scenic spots in the city in urban areas with good access, while in regional areas, people still find value in the various locations even if traffic conditions to access them are somewhat poor, such as outlying forests and valleys. Next, based on the findings obtained from the above preliminary research, by incorporating the utility that people get from visiting each location and information about the natural attributes (such as changes to the coloring and distribution of vegetation, and to their seasonality), the economic value of these natural attributes were derived.

Developing an analysis tool to clarify the value that people find in natural attributes through their leisure consumption activities would seem beneficial when searching for new methods of regional promotion that consider environmental changes that may occur in the future.



Policy Recommendation 4

4. Estimating the benefits from linkages between terrestrial and aquatic ecosystems

Rain benefits forests and agricultural land, and the organic matter, sediment, and nutrients that flow into rivers from these areas serves as the foundation that supports the abundance of biota in estuaries through physical, chemical, and biological processes. This circulation of materials from the land to the sea has been the foundation of our lives (Likens & Bormann 1974). However, the flow has become less visible and there are concerns that, as a result, these linkages are being modified and fragmented (Yamashita & Tanaka 2008). To prevent this modification and fragmentation of ecosystems, it would seem helpful to clarify the benefits of the linkages between terrestrial and aquatic ecosystems, and to make people aware of their importance.

As an effort to clarify the benefits of the linkages between terrestrial and aquatic ecosystems, the focus was placed on the relationship between oyster aquaculture in Hiroshima Bay and land use in the Ota River basin, which is its catchment area, and the effects that changes in land use are having on human activities carried out in the coastal area was quantitatively measured. The main findings obtained from the analysis were as follows. The optimal amount of phytoplankton differs depending on the growth stage of the oyster, but in general, the basic production capacity tends to be insufficient. Primary production of the inner area of Hiroshima Bay is affected by the forests in the Ota River basin, but this effect is not expressed immediately but appears gradually over a long period of time.

Based on the above findings, we examined the effects of forest degradation and rising water temperature on oyster production under some different scenarios, assuming the ratio of forest cover changes as -0.053% per year (high scenario equivalent to decreasing ratio at the watershed in the last 40 years), -0.026% per year (medium scenario equivalent to in more recent years), and $\pm 0\%$ (status quo scenario with complete forest conservation), while the rising water temperature by 2100 as $+3.64^{\circ}\text{C}$ (high scenario reflecting RCP8.5 projection, $+2.13^{\circ}\text{C}$ (medium

scenario based on an increasing ratio at the bay in the last 40 years), $+1.04^{\circ}\text{C}$ (low scenario based on an increasing ratio in the sea near Japan in the last century), and $\pm 0^{\circ}\text{C}$ (status quo scenario). We consider all combinations of forest degradation and rising water temperature to capture the potential interactive impacts of land use and climate on the provision of ecosystem services across systems. The obtained results are given in Fig 2. If it were not for adequate forest conservation, oyster production would decrease by $25.9\%–33.0\%$ by 2100. In addition, we calculated a specific shadow value of forest associated with oyster production as 14.1–29.2 million yen ha $^{-1}$. Considering that the opportunity cost of conserving a hectare of forest is approximately 4.80 million yen, this suggests that the social benefits brought about by improving the primary production in the inner area of Hiroshima Bay by conserving forests in the catchment area will exceed its opportunity cost. When aiming to conduct comprehensive river basin management, it is essential to take into consideration the linkages between terrestrial and aquatic ecosystems.

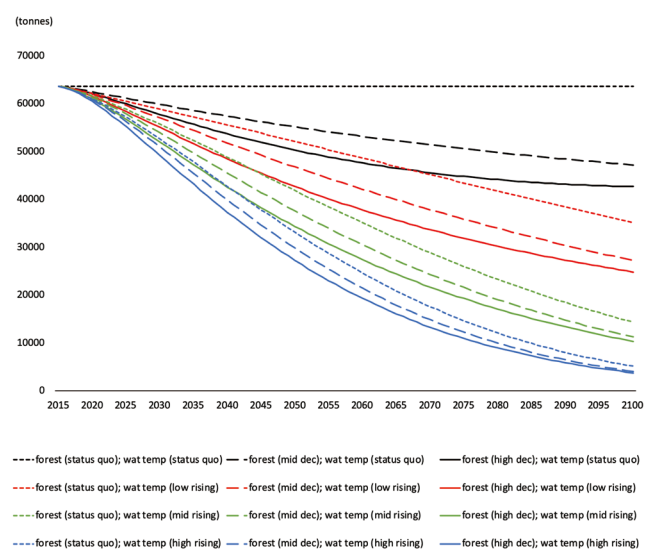


Fig. 2

Effects of forest degradation and rising water temperature on oyster aquaculture production

Policy Recommendation 5

5. Forming a system to strongly promote biodiversity policy through the national government

Biodiversity-related policies involve not only the Ministry of the Environment (MOE) but also multiple other government ministries, such as the Ministry of Agriculture, Forestry and Fisheries (MAFF) and the Ministry of Land, Infrastructure, Transport and Tourism. The National Biodiversity Strategies and Action Plan (NBSAP) explicitly regulates their engagement. In addition to biodiversity conservation, local governments are involved in various other related activities, such as wildlife hazard management and ecological approaches to disaster prevention and mitigation. Besides, actors such as national governments including Japan's, environmental specialists, international NGOs, multinational corporations, and international organisations including the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) engage in efforts at an international level. Multi-level Governance (MLG) as a set of these efforts involving those international, national, and local characterises biodiversity policy (see Fig. 3), in which collaborations between actors in each level is key for an effective policy.

Our nation-wide survey collected significant data on the specific measures deployed by municipalities, which often directly implement biodiversity policies on-site; it revealed the incoherent approaches of the municipalities and the characteristics of the policies in different contexts, such as in terms of relevant sections, policy coordination, and the degree of cooperation between the stakeholders involved. For example, in fields such as wildlife hazard management and hunting and fishing regulations, which are often under the agricultural section, responsive (bottom-up) measures that need the request of stakeholders and coordination between different interests are likely to be implemented. Elsewhere, ideocratic (top-down) measures based on rationality and science are more likely to be implemented in fields often overseen by sections specialising in biodiversity, such as environment-related planning, education and PR activities, research, and biodiversity protection and conservation activities.

What our analysis reveals is that biodiversity governance differs across municipalities, depending on the policy measures, the approaches of the responsible sections, and the relationship between the respective municipality and government ministries: e.g. policy-

making processes characterised by ideocratic approaches based on rationality perspectives (MOE's processes), or agricultural implementation processes characterised by responsive approaches that emphasise short-term benefits, such as wildlife hazard management. To further enhance development policies in such a complex field, this study shows that it is necessary to strive for network governance and comprehensively integrate diverse policies at a higher level while addressing the specific issues of each policy.

In particular, to develop biodiversity-related policies, establishing a headquarters for biodiversity in the Cabinet will be an effective approach, comprehensively promoting the policies through the national government under the leadership of the MOE, and building a system that pursues and enhances inter-sectional cooperation and policy coordination among national government ministries and local governments. Specifically, as inter-ministerial collaboration between important government ministries including the MOE and the MAFF (as in wildlife hazard management) is key for future successful biodiversity conservation policies, a comprehensive set of measures that strive for collaboration is strongly required, which includes awareness-raising campaigns and the creation of support and evaluation systems. (See Fig. 3; the olive arrow indicates responsive measures, the orange one does ideocratic measures, and the red one does measures for network governance.)

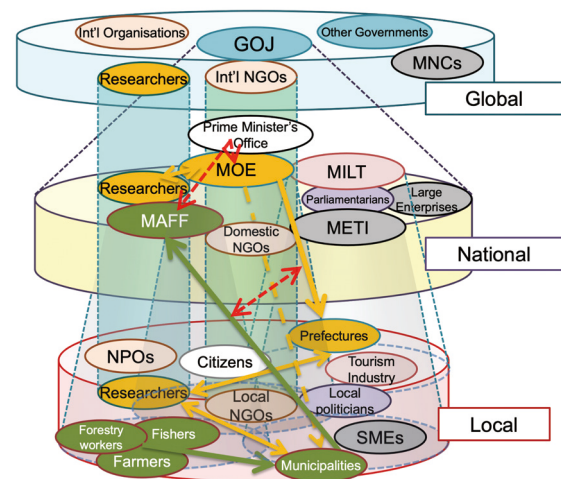


Fig. 3 MLG in Japan's biodiversity conservation

Policy Recommendation 6

6. Supporting municipalities on LBSAP formulation

With the Basic Act on Biodiversity promulgated in 2008, local governments are obliged to make efforts to formulate LBSAP. However, given the current financial difficulties, municipalities do not necessarily prioritise biodiversity conservation, and at the end of March 2017 only 4% of them had formulated LBSAP.

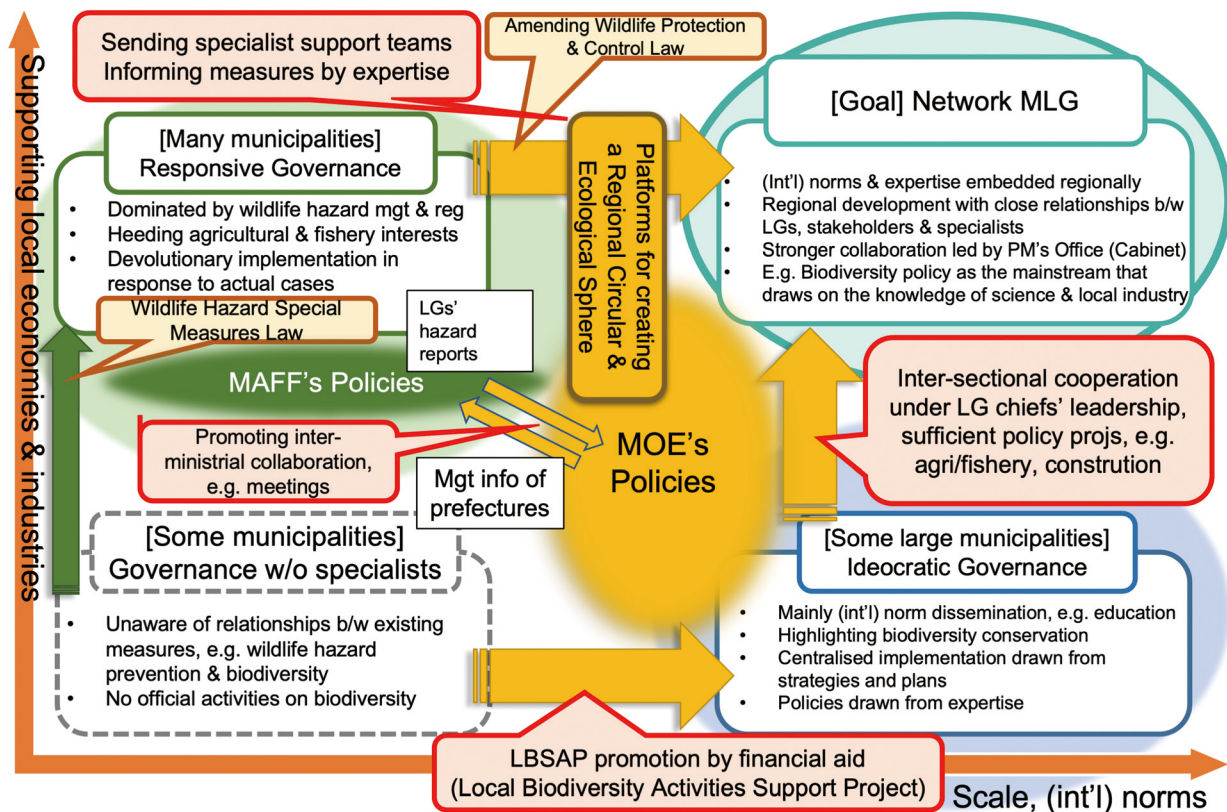
This research analyses the factors influencing LBSAP formulation by examining a survey aimed at municipalities with the questionnaire. The analysis reveals that the number of municipalities formulating LBSAP increased statistically significantly in the financial years in which the MOE implemented the Regional Biodiversity Activities Support Project, compared to the financial years in which the project was not deployed. The project was found to be significantly effective even when taking into account the influence of other factors such as demography and financial resources.

The research also finds that municipalities with more staff, larger non-urban areas, and greater involvement of environmental experts in the formulation process are more likely to set up LBSAP. However, this study reveals that, although municipalities with more administrative capacity due to larger manpower and with larger non-urban areas that require conservation are more likely to formulate LBSAP, the relationship between these two factors is inversely proportional. The scale of manpower is strongly proportional to the population size, and more urbanised municipalities tend to have larger human and financial resources and establish a specific sections to formulate LBSAP. They embrace ideocratic governance approaches in Figure 4. Elsewhere, municipalities with large nature-abundant non-urban areas have fewer staff despite their extensive administrative requirements. They are responsive municipalities in which existing agriculture and fisheries sections often oversee biodiversity conservation. Hence, there are concerns that in municipalities with fewer staff and abundant wild areas the level of administrative services on natural environment conservation could fall below the

appropriate level.

According to the questionnaire, 67% of municipalities without LBSAP cited a lack of specialist knowledge on living things and staff shortages as the major reasons for the absence of LBSAP, which were the prime and second reasons for the failure of LBSAP formulation. Against this background, there is a high probability that substantial support in financial, expertise, and human resources would encourage small- and medium-sized responsive municipalities to formulate LBSAP. Also, multi-level governance drawn from effective network governance can be realized if LBSAP formulation fostered by this type of support attracts the attention of the heads of municipalities and other political elites and promotes potential policy collaboration on other relevant issues such as those regarding industries and economics, resulting in synergetic mutual benefits.

Since the research findings and concomitant consideration elaborated above suggest that providing financial support and expertise to small- and medium-size municipalities is very likely to effectively contribute to LBSAP formulation and the prioritisation of biodiversity policies as a mainstream sector, we recommend the adoption of specific measures, including the development of a permanent framework for support.



(Note) Those in red speech bubbles generated verified policy outcomes.

Fig. 4 The typology of modes of biodiversity governance





References

- Akerlof, G.A., and Kranton, R.E. (2000) "Economics and Identity," *The Quarterly Journal of Economics*, 115 (3), 715–53.
- Managi, S. and Kumar, P. eds. (2018) "Inclusive Wealth Report 2018: Measuring Progress Towards Sustainability". Routledge.
- Likens, G.E. and Bormann, F.H. (1974) "Linkages between Terrestrial and Aquatic Ecosystems," *BioScience*, 24 (8), 447–456.
- Yamashita, H. and Tanaka, M. (2008), "The Linkages between Forests, Rivers, and Seas, and Biological Production in Estuaries and Coastal Areas," Kouseisha-kouseikaku Corporation.

Acknowledgement

This Policy Brief is intended to contribute to policy-making based on the findings of 'Predicting and Assessing Natural Capital and Ecosystem Services through an Integrated Social-Ecological Systems Approach (PANCES)', a Strategic Research and Development Area (JPMEERF16S11540) project financed by the Environment Research and Technology Development Fund of the Environmental Restoration and Conservation Agency of Japan (ERCA).

Authors

Juri Hori, Kyohei Matsushita, Fumihiro Yamane, Yuki Oda, Shigerukaki Masahiro, Junya Kumagai, Mihoko Wakamatsu, Asano Kota, Kosuke Oyama, and Shunsuke Managi

Inquiries: info@pances.net

Environment Research and Technology Development Fund, Strategic Research and Development Area (S-15)
Predicting and Assessing Natural Capital and Ecosystem Services through an Integrated Social-Ecological Systems Approach (PANCES)
PANCES Policy Brief, No. 4 (July 2020)

<http://pances.net/>