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Satoyama–satoumi ecosystems and human well-being

Satoyama–satoumi ecosystems and human well-being: Socio-ecological production landscapes of Japan

Edited by Anantha Kumar Duraiappah, Koji Nakamura, Kazuhiko Takeuchi, Masataka Watanabe and Maiko Nishi

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Endorsements

"Satoyama–Satoumi *Ecosystems and Human Well-Being* speaks to issues of local, national, and global relevance. In many ways, *satoyama* and *satoumi* landscapes represent a microcosm of Japan and, more broadly, of the challenges of envisioning sustainability in an interlinked world. The fascinating history of *satoyamas* and *satoumis*, brought to life in this timely assessment, offers a unique window to the transformation of Japanese society and environment during the last 50 years. This assessment offers an opportunity for readers to reflect on the Japan's transforming relationship to the environment, its fast rate of urbanization, and the changing role of local knowledge in a period of intense inter-generational culture change. It will encourage readers to reflect more broadly on the multi-functional importance of rural and coastal landscapes to the future of urban areas, to food self-sufficiency and water security, and overall human well-being."

Eduardo S. Brondizio, Professor and Chair, Department of Anthropology, Indiana University, Bloomington, USA

"In my view, the Japan *Satoyama Satoumi* Assessment (JSSA) greatly elevates our understanding of how humans as an integrated part of nature may actively contribute to maintaining biodiversity and ecosystem functions in a production landscape. This assessment provides numerous examples of how humans interact with terrestrial-aquatic ecosystems (*satoyama*) and marine-coastal ecosystems (*satoumi*) in Japan over a period of 50 years and provides interesting scenarios for the future.

I warmly recommend this assessment to anyone interested in a deeper understanding of a sustainable use and governance of ecosystems and building resilience in social-ecological systems."

Thomas Elmqvist, Professor, Department of Systems Ecology and Stockholm Resilience Centre, Stockholm University, Sweden

"The 'working landscapes' of the world harbor a vast storehouse of natural and cultural services. In many places these rich mosaics of land use types are being converted to industrial agriculture, or abandoned, resulting in a loss of vital ecosystem services and cultural heritage that are not adequately accounted for in the valuation of national resources. This volume brings together an extraordinarily detailed evaluation of what has happened over the past half century to Japanese landscape mosaics, in the foothills and at the seashore, that are rich in physical, biological and cultural attributes and that have been managed as integrated systems in the past and that are now being abandoned. Using the Millennium Ecosystem Assessment conceptual framework, a strong case is made for the positive economic and non-economic values of the maintenance of these systems by new policies at the local as well as the national level."

Harold Mooney, Paul Achilles Professor of Environmental Biology, Stanford University, USA

"*Satoyama* landscapes account for approximately 60% of Ishikawa Prefecture's land area. *Satoyama* and *satoumi* landscapes provide a valuable habitat for many creatures, where the rich natural environment has been cultivated through people's daily livelihoods. They also offer beautiful scenery and nurture local culture and traditions. This book provides scientific evidence that will help develop and act on the strategies needed to pass on our precious *satoyama-satoumi* heritage to future generations."

Masanori Tanimoto, Governor of Ishikawa, Japan

"Increasingly the health of our ecosystems holds the key to our human well-being. *Satoyama* and *satoumi* landscapes offer a practical illustration of the interaction between humans and nature, and are a very timely concept for the increasingly urbanized world. Extending lessons and experiences from the Japanese landscapes, this book will help government officials, diplomats, business and industries, academia, and civil society around the world make better decisions for a sustainable future."

A. H. Zakri, Science Advisor to the Prime Minister of Malaysia, Malaysia

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Satoyama is a Japanese term for a mosaic of different ecosystem types – secondary forests, farm lands, irrigation ponds and grasslands – along with human settlements, which has been managed to produce bundles of ecosystem services for human well-being. *Satoyama* found largely in rural and periurban areas of Japan is a way of life; in other words a classical illustration of the symbiotic interaction between ecosystems and humans. This concept has been recently extended to *satoumi*, which constitutes marine and coastal ecosystems. However, the amount and quality of *satoyama* and *satoumi* have been rapidly declining due to various factors including increased rural–urban migration, land-use conversion and the abandonment of traditional agricultural cultivation. If this trend continues, vital services provided by *satoyama* and *satoumi* will be adversely affected.

The Japan *Satoyama Satoumi* Assessment (JSSA) is an assessment of *satoyama* and *satoumi* in Japan. The main objective of the JSSA is to provide scientifically-credible and policy-relevant information on the significance of ecosystem services provided by *satoyama* and *satoumi* and their contributions to economic and human development for the use of policy-makers. The preparation of the assessment began in late 2006 and the JSSA was launched in March 2007 upon the establishment of a board representing key "users" including those from national and local governments, academia and non-governmental organizations. The JSSA was designed around policy-relevant questions and users' needs, with a focus on the changes in ecosystem services for human well-being.

The transparent and open process led to the selection of a variety of assessment sites proposed by the interested stakeholders, which were grouped into five major clusters across Japan; namely, the Hokkaido cluster, Tohoku cluster, Hokushinetsu cluster, Kanto–Chubu cluster and the Western Japan cluster. The Western Japan cluster comprises of an additional sub-cluster that focuses on the Seto Inland Sea as *satoumi*; a general assessment of the *satoyama* in the whole region was also conducted. Applying the Millennium Ecosystem Assessment (MA) conceptual framework, each cluster and sub-cluster assessed the historical context, condition and trends, drivers of changes, and responses with a focus on the links between ecosystems and human well-being in terms of *satoyama* and *satoumi* in each locality. Furthermore, the national assessment was carried out concurrently allowing the synthesis of the findings from the cluster assessments and the informing of policy- and decision-making at the national level and beyond.

A series of six reports entitled "Experiences and Lessons from Clusters", presenting the findings of each cluster and sub-cluster of the JSSA, were produced in Japanese in March 2010. A *Summary for Decision Makers* prepared in both English and Japanese, presenting a synthesis and integration of the findings from the national assessment and the cluster assessments, was also prepared and disseminated at the tenth meeting of the Conference of the Parties to the Convention on Biological Diversity (CBD/COP-10) held in Nagoya, Aichi, Japan in October 2010. This book presents the technical findings of the national assessment as well as the summaries of the cluster and sub-cluster assessments.

The JSSA findings are expected to be used for local and national plans, strategies and policies, and various relevant activities in Japan, while they are also to contribute to international processes on the environment and development. The assessment, in particular, is intended to provide substantial inputs to the *Satoyama* Initiative, which is an international effort jointly initiated by the Ministry of the Environment of Japan and the United Nations University Institute of Advanced Studies (UNU-IAS) with the aim to promote socio-ecological production landscapes – drawing on lessons learnt from *satoyama* and *satoumi* in Japan. The international partnership for the *Satoyama* Initiative was established at the CBD/COP-10 to further extend the Initiative's reach through global cooperation among diverse organizations including government, non-government and community institutions, academic institutes and international organizations.

This book would not have been possible without the commitment of the more than 200 authors, stakeholders and reviewers who contributed their knowledge, creativity, information, time and effort to the assessment process. We would like to express our gratitude to the members of the

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We would also like to thank the members of the board and the Governmental Advisory Committee (listed in the contributors' list) for the guidance and oversight they provided to the assessment process. The contributions of former members of the board were instrumental in formulating the JSSA focus and process and these individuals include Hitoshi Arai, Habiba Gitay, Junichi Konno, Toshisuke Maruyama, Yoshihide Sanbe, Takashi Tunoda and Shigenobu Uchikawa. And, we would like to thank Kazuhiro Ueta for his contribution as a member of the Science Assessment Panel during 2007–2008.

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1

The Japan *Satoyama Satoumi* Assessment: Objectives, focus and approach

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1.1 Introduction

There has been a renewed interest in finding sustainable use of biodiversity since the release of the Millennium Ecosystem Assessment (MA) results in 2005 (MA, 2005a). The MA reported with a high degree of scientific confidence that humanity has seen unprecedented rates of biodiversity loss over the last 100 years and that this rate of loss can be expected to continue if immediate action is not taken. Many options have been put forward with a clear message being sent out that sustainable use has to be strengthened and conservation measures by themselves will be insufficient to reduce the rate of loss (MA, 2005b).

The MA also highlighted the critical role biodiversity plays in the production of ecosystem services and maintaining the resiliency of ecosystems. The resiliency of ecosystems will become highly critical as climate change and the frequency of extreme events increases and places higher levels of stress on ecosystems and their potential of producing ecosystem services which society depends on for its well-being and more importantly for its survival. This is true for both developed and developing countries because of the close interlinked nature of the global economy and societies today.

The shift from purely conservation activities to sustainable use increases the potential use of traditional practices in increasing the resiliency of local ecosystems and therefore the supply of ecosystem services for human well-being. The key question that arises in the use of these

Satoyama–satoumi *ecosystems and human well-being: Socio-ecological production landscapes of Japan, Duraiappah, Nakamura, Takeuchi, Watanabe and Nishi (eds), United Nations University Press, 2012, ISBN 978-92-808-1210-7*

traditional practices is if these traditional resource management styles can deliver the level of outputs that is required for the larger populations we have now and will have in the near future. The study presented here describes two such systems which have been used in Japan over the past few centuries. These systems, called *satoyama* and *satoumi*, describe the traditional land and coastal zone management regimes in Japan.

There is a renewed and growing interest within Japan to revive these traditional rural landscapes called *satoyama* and *satoumi* but within the context of modern Japan. A range of push and pull factors has caused this renaissance of these landscapes. The push factors have primarily been linked with the three crises which the National Biodiversity Strategy of Japan highlights for immediate attention (Ministry of the Environment, Japan, 2007). The first crisis relates to the loss of biodiversity, wetlands and forests caused by economic development and overexploitation. In contrast, the second crisis relates to changes in biodiversity and rural landscapes called *satoyama*, which are caused by abandonment and underutilization of land in the rural areas of Japan. The third crisis revolves around the introduction of invasive species, which has further caused a loss of native species within the Japanese landscape. The strategy emphasizes that the combination of all three crises spells disaster for Japanese biodiversity, ecosystems, and the services they supply if left to continue.

The pull factors on the other hand are driven by the increasing recognition of the general populace of the cultural heritage associated with *satoyama* and *satoumi* landscapes. In addition, the increasing demand for eco-tourism has been a driving factor for *satoyama* and *satoumi* renaissance.

However, irrespective of whether it is either a push or pull factor, there is increasing recognition that the decline in *satoyama* and *satoumi* will cause a decline in biodiversity as well as a loss in ecosystem services that might cause a decline in human well-being (Fukamachi et al., 2001). The common perception of Japan, by the rest of the world, is that it is a country where technology is the foundational base for its economic prosperity and well-being of its citizens. However, on the contrary, there is a strong tradition within Japan of respect for nature and the recognition of the supply of ecosystem services such as rice production, *sake* (rice wine) production, water provisioning, water purification, pollination, air quality regulation, eco-tourism and cultural relations, among many others, are very much part of Japanese culture and life.

The Japanese government has taken a serious view on the decline in biodiversity and some of the key ecosystem services in Japan. One of the many strategies suggested for reversing this decline is through the restoration of *satoyama* and *satoumi*. In addition to conservation of biodiversity, there is also a national drive to restore and maintain *satoyama* and *satoumi* landscapes as part of the national heritage. The Basic Environmental Plan developed by the Ministry of the Environment, Japan lays out 10 priority fields, of which four are focused on ecosystem services and biodiversity (Ministry of the Environment, Japan, 2006). Further, the Third National Biodiversity Strategy of Japan identifies the restoration and preservation of *satoyama* and *satoumi* as an integral part of the four basic strategies in its grand design for the next 100 years (Ministry of the Environment, Japan, 2007).

However, in order to ensure that the four priority fields out of the 10 for the Basic Environmental Plan as well as the four basic strategies for the grand design of the Third National Biodiversity Strategy of Japan are informed by credible science, the Japanese government (as part of its efforts to implement the National Biodiversity Strategy), initiated the *Satoyama* Initiative in 2007, to revitalize both the notion of a back-to-nature society and the concept of a symbiotic relationship between society and nature. This report provides the outputs of a detailed study of *satoyama* and *satoumi* and attempts to provide a scientific basis for the concept. It further proposes solutions to address crisis two. However, before we continue any further, it might be appropriate to say a few words on what *satoyama* and *satoumi* actually mean, to give the reader a basic understanding of how these two concepts have been defined in the past in Japanese literature and of the main issues at hand, which need a more in-depth analysis and are the basis of this report.

1.1.1 What are satoyama *and* satoumi*?*

Satoyama is a Japanese term for landscapes that comprise a mosaic of different ecosystem types including secondary forests, agricultural lands, irrigation ponds, and grasslands, along with human settlements.[1] These landscapes have been formed and developed through prolonged interaction between humans and ecosystems, and are most often found in the rural and periurban areas of Japan (see Chapter 2). It is estimated that *satoyama* comprises more than 40 per cent of Japan's total landmass (Ministry of the Environment, Japan, 2001). For instance, *satoyama* land in Ishikawa Prefecture accounts for more than 60–70 per cent of the total prefectural land area (Ishikawa Prefecture, 2004) and in Chiba it is estimated that approximately 58 per cent of the land is *satoyama* (Chiba Prefecture, 2008).

Satoyama landscapes in the past produced much of the food, fuelwood, timber and water for local communities. They also provided a way of life, illustrating the symbolic interaction between humans and the natural system. In many ways, they demonstrated how society had in the past used land in a sustainable manner to produce goods which society has reason to value. The mosaic approach adopted by *satoyama* implies a rich diversity of ecosystem types, with each system having a great variation of flora and fauna. In fact, many Japanese scientists have demonstrated that the disappearance of *satoyama* has caused a decline in biodiversity (Iida and Nakashizuka, 1995; Kameyama et al., 1994).

This concept of natural systems with human interaction in *satoyama* has been recently extended to *satoumi*, which includes coastal ecosystems, and is similar to *satoyama* in terms of its functions, use and prolonged interactive mechanisms. In general, *satoumi* refers to the coastal areas where human interaction has resulted in a higher degree of productivity and biodiversity (Yanagi, 2008). Despite the emphasis on different ecosystem types, both of them are centred on the links between ecosystem services and human well-being.

1.1.2 Values of satoyama *and* satoumi

Satoyama and *satoumi* possess numerous significant values, which are derived from their ecological, social, cultural and economic functions through the use of the ecosystem services flowing within these areas. Besides the role of being a home for humans, *satoyama* and *satoumi* pool the various ecosystems – including agro, forestry, wetlands, grassland, marine and coastal ecosystems – and biodiversity, to provide ecosystem services that contribute to human well-being. For instance, the ecosystems in *satoyama* and *satoumi* provide direct use values such as food, fibre, fuel-wood and water among others. At the same time, *satoyama* also produces a number of indirect use values that include flood and water regulation, water purification, cultural services and pollination among many others. Then there are option values, which might include the maintenance of *satoyama* for future generations as a source of their cultural heritage.

The values of these ecosystem services that contribute to human well-being differ across different social groups. For example, local communities value many of the direct uses like rice production, fishery production and water regulation much higher than urban residents who might be able to acquire these services from other sources. Urban residents, on the other hand, might place high values on the indirect uses such as climate regulation and cultural services. These different values of ecosystem services held by different social groups influence the perceptions and attitudes towards *satoyama* and *satoumi* and their use in preserving biodiversity and enhancing a sustainable supply of different ecosystem services. Recognizing and respecting these differences in perceptions and attitudes is important if *satoyama* and *satoumi* landscapes are to be used to reduce the rate of loss in biodiversity and maintain the sustainable supply of ecosystem services.

1.1.3 Crises and uncertainties of satoyama *and* satoumi

Recently, there have been extensive changes in the nature of *satoyama* and *satoumi* (Takeuchi et al., 2003). Various reasons for the change in *satoyama* and *satoumi* in Japan have been highlighted in the literature. The main factors, which are described in more detail in Chapter 3, are increased development and construction of infrastructure, abandonment of farms and overgrowth, declining economic value of agricultural, forest, and fishery products, global trade, the ageing workforce, depopulation, rural-urban migration, invasive alien species and issues associated with property rights.

For instance, global trade and competitive markets have affected Japanese agriculture, forest commodities and fishery products. Cheaper timber, rice or seafood from abroad is crowding out more expensive Japanese varieties. This trend is taking its toll on local farmers, foresters and fishing communities, who are increasingly reluctant to either cultivate the land and forests in the *satoyama* area or to engage in fishery activities, as they see little economic value in doing so. A question for this assessment to answer is whether these products can be made economically viable without breaking World Trade Organization (WTO) rules on fair trade?

In addition, an ageing population and a large rural-urban migration by the younger generations have caused a labour shortage for the management of agricultural land, forests and fishery operations. The shortage of local labour and the strict regulations on the use of foreign labour poses some real barriers to the revitalization of *satoyama* and *satoumi* landscapes and is an issue that will be addressed in Chapter 5.

Another important factor causing a decline in *satoyama* is land ownership. Land ownership has been privatized and has become subdivided among individuals through land successions, resulting in complications concerning the management of *satoyama* and *satoumi*. The existence of the registration of numerous landowners resulting from subdivision of a lot following the succession of property has hindered the sound management of the land for agricultural or forestry use due to differing interests among the owners. In addition, the increasing prevalence of absentee landlords in accordance with the increasing rural-urban migration has left many farms abandoned leading to deteriorating landscapes.

In addition to the factors described above, the impacts of climate change on biodiversity and ecosystem services in *satoyama* and *satoumi* are yet to be fully understood. There is also some debate about the extent to which humans should intervene to maintain *satoyama* that has been abandoned and is undergoing natural succession; causing old species to vanish and new species to emerge. Particularly, it is still questionable whether human intervention in *satoyama* and *satoumi* can increase biodiversity levels and enhance the conservation of ecosystems.

Chapter 3 attempts to synthesize the existing literature and case studies from various parts of Japan and present the main drivers of *satoyama* and *satoumi* changes as well as show whether this change has caused a loss in biodiversity and ecosystem services over the past 50 years. Chapter 4 will provide some thought on whether this loss is indeed a cause for concern and Chapter 5 will attempt to provide some guidance on the type of responses that might be used to restore *satoyama* and *satoumi* landscapes.

1.1.4 Universality and regional characteristics of satoyama *and* satoumi

Although *satoyama* and *satoumi* are Japanese terms, these mosaic types of ecosystems where human-nature interaction is central are not unique to Japan alone. Such landscapes are found throughout many regions of the world, though the issues might vary from one area to the other. Given the features of *satoyama* and *satoumi*, which typically embody a symbiotic relationship between ecosystems and humans to produce a bundle of ecosystem services for human well-being, it is an issue not only of significance to the local region, but also of international importance.

English does not have a word corresponding to *satoyama*. However, this idea is widely recognized in Asian countries. For example, there are words such as "*mauel*" in Korean and "*kebun-talun*" or "*pekarangan*" in Indonesian. Yabu (2009a, 2009b) has reported in *Satochi–Satoyama Culture* (Volumes I and II) that ecosystems and livelihoods present in agricultural villages in China and Korea are surprisingly similar to *satoyama* in Japan. Yabu (2009a, 2009b) suggests that "*satochi–satoyama* culture" could provide the basic foundation to conceptualize the sustainable use of biodiversity and ecosystem services.

However, it should be acknowledged that in many developing countries that are progressing economically, conservation and the sustainable use of biodiversity and ecosystem services are rarely taken into consideration. In many cases, landscapes have been altered. However, as issues of food security emerge and the stability of ecosystems in an era of climate change become important, the search for alternate land uses that encourage sustainability will increase. *Satoyama* and *satoumi* landscapes might offer such alternatives.

Lessons learnt from the Japanese experiences in *satoyama* and *satoumi* landscapes which emphasize the sustainable use of ecosystems for the delivery of ecosystem services for human well-being might offer a unique land and coastal zone management system, which could produce both conservation and development benefits for society. In some countries, it might be seen purely as a cultural heritage, while in others, it might offer opportunities that could contribute to both economic and human development. The real challenge lies in whether or not *satoyama* and *satoumi* can be scaled up and globalized such that they can deliver these economic and human development opportunities to local communities in developed and developing countries.

1.2 Objectives

There has been much discussion within Japan on the utility of *satoyama* and *satoumi* for human well-being and the prospects of adopting them for the sustainable use of ecosystems and improving the well-being of society. There have been a considerable number of studies within Japan on *satoyama* and *satoumi* each focusing on specific aspects of the above systems. There is, however, no single meta study that brings together all relevant existing information to provide an overview of the status of *satoyama* and *satoumi* in Japan, the main drivers of change, the relationship between *satoyama* and *satoumi* with ecosystem services, biodiversity and ecosystem functioning, possible options to reverse their declines, and the net benefits that they might bring to society. An integrated assessment offers one such approach to provide scientific credibility and policy-relevant information, which could be used to inform policymakers on the merits of the *satoyama* and *satoumi* systems for contributing to economic and human development through the sustainable use of ecosystems and the services they provide.

An integrated assessment was therefore designed to provide scientifically credible information on *satoyama* and *satoumi* landscape systems. The main objectives of the Japan *Satoyama Satoumi* Assessment (JSSA) are:

- To improve the understanding of the relationship between *satoyama* and *satoumi* with biodiversity, ecosystem services and human well-being. This is covered in Chapter 2.
- To provide policymakers in Japan with a sound and credible scientific basis for the *Satoyama* Initiative the government of Japan intends to launch in the International Year of Biodiversity and at the Tenth Meeting of the Conference of Parties (COP) to the Convention on Biological Diversity (CBD). Key lessons that can be transferred and/or scaled up to the international perspective are provided in Chapter 7.
- To establish credible baselines for a number of key ecosystem services provided by *satoyama* and *satoumi*. This is covered in Chapters 3 and 4.

– To provide information on possible future trends in ecosystem services provided by *satoyama* and *satoumi* under plausible futures. This is presented through four scenarios that are offered in Chapter 6.
– To identify sound policy responses to address the decline in ecosystem services through the use of *satoyama* and *satoumi* management in Japan. Suggestions on policy choices are provided in Chapter 5.

1.3 Approach

The ecosystem services conceptual framework developed by the MA is used as the underlying framework for the JSSA for the following three reasons:

– Human well-being is at the centre of analysis: The MA framework places human well-being at the centre of its causal analysis and captures the dynamic relationship between ecosystem services and the different constituents of human well-being (see Figure 1.1). The framework will therefore allow the study to analyse the different relationships that might occur between the different ecosystem services and the various constituents of well-being within *satoyama* and *satoumi*.
– Interdependency, synergies and trade-offs: The MA conceptual framework implicitly captures the interdependence of ecosystem services and the constituents of well-being (see Figure 1.2). The interdependency explicitly captures the trade-offs and synergies that might occur across ecosystem services and human well-being (Swallow et al., 2009). The framework therefore provides the opportunity to capture the complex interdependencies that might occur across the different ecosystem services offered by *satoyama* and *satoumi* and their contribution to the various constituents of well-being across different social groups.
– Spatial and temporal scales: The third reason is because of the explicit recognition of the different scales at which ecosystem functions occur and at which the services are delivered. For example, climate regulation occurs at the global scale, while food production occurs at a more local scale. However, the increase in rice production might increase the emissions of methane – a global warming gas – which has a direct impact on the global climate regulation ecosystem service. Similarly, the present changes in *satoyama* and *satoumi* might not cause a major change in the social relations among communities in this generation but might be significant in future generations, when there is no memory of such systems.

1.3.1 What is an assessment?

An assessment is a critical and objective evaluation of information used for guiding decisions on complex, often public issues, based around

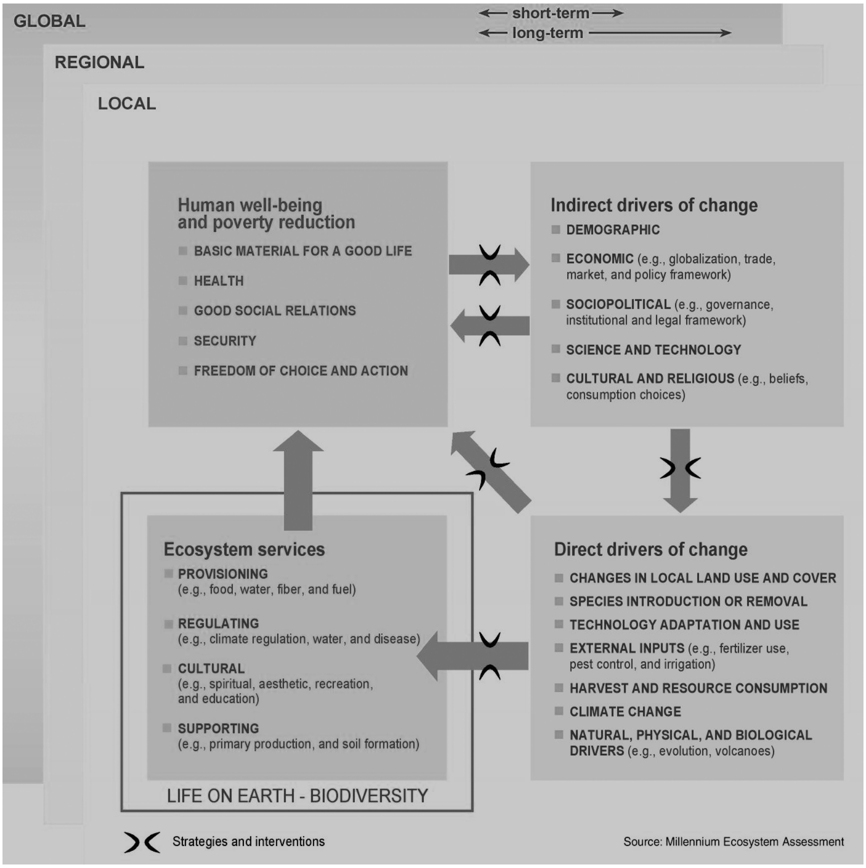

Figure 1.1 MA conceptual framework
Source: MA (2005a)

policy-relevant questions or those owned by users and stakeholders (MA, 2005c). As the particular aims of an assessment are to reduce complexity and add value, as well as to provide objective information for decision-making, it summarizes, synthesizes, and sorts out what we know and agree on, what we know but has multiple explanations, and what is not known. A team of experts from a broad range of disciplines conducts an assessment, and it requires an open, transparent, representative, and scientifically credible and accurate process.

1.3.2 Millennium Ecosystem Assessment (MA)

The Millennium Ecosystem Assessment (MA) was the first comprehensive global assessment of the world's ecosystems. Kofi Annan, the former

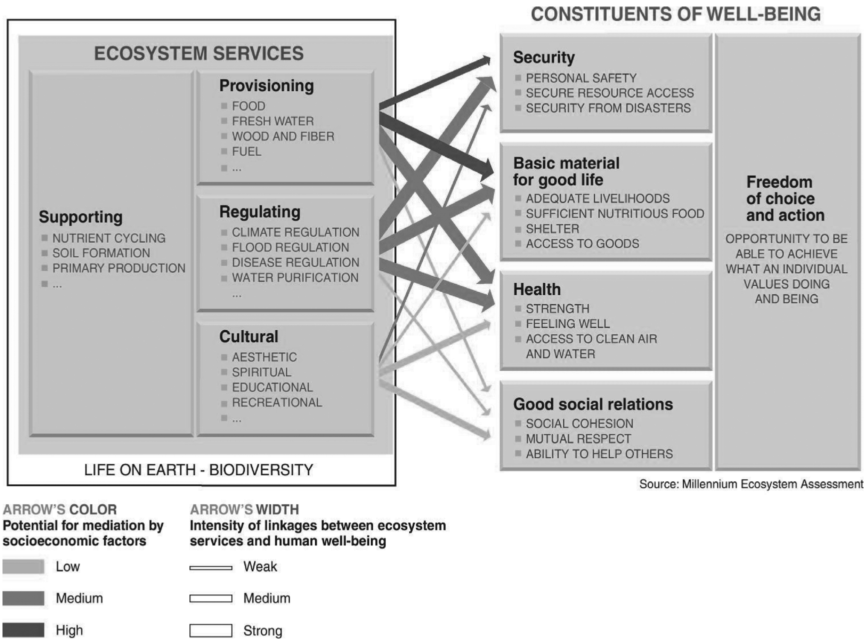

Figure 1.2 Relationships between ecosystem services and constituents of well-being
Source: MA (2005a)

Secretary General of the United Nations, commissioned the study in 2000. The study was initiated by the growing concern over the alarming loss of biodiversity and ecosystem services in many parts of the world and growing recognition by the scientific community that these continuing trends could jeopardize the achievement of the Millennium Development Goals (MDGs).

The MA focused on changes in ecosystem services and their consequences on the multi-dimensionality of human well-being[2] by defining ecosystem services as the benefits people obtain from ecosystems. It was intended to identify response options to achieve human development and sustainability goals, as well as to help build individual and institutional capacity to undertake integrated ecosystem assessments and to act on their findings. The MA was also a "multiscale" assessment, consisting of interlinked assessments undertaken at local, watershed, national, regional and global scales.

1.3.3 Scope of the Japan Satoyama Satoumi *Assessment*

The assessment looked at the condition and trends of ecosystems and ecosystem services over the past 50–60 years, beginning in the post war period. This time-frame was selected because of the numerous changes that had taken place in Japan within it, such as the energy revolution, scientific and technological advancement, rapid industrialization and expansion of the economy, which are all trends responsible in one way or another for the changes to *satoyama* and *satoumi*, and their ecosystems and related services.

Following the MA approach, the assessment employed an open and transparent process for its work, and made a call for assessment sites at the beginning of the assessment process to allow any interested stakeholders to be involved and propose sites to be assessed as part of the assessment process. This led to the consideration of the inclusion of a variety of assessment sites proposed by 19 interested organizations and groups (including more than 60 sites), extending north and south across Japan. However, to prevent producing 19 individual reports by different assessment teams, a nomenclature was introduced to organize the sites into five clusters. In addition to administrative and geographic heterogeneity, two critical variables; 1) ecological and climate component; and 2) demographic and socio-economic component (see Figure 1.3) were used to cluster the various sites submitted for consideration. Figure 1.3 gives the distribution of the sites proposed by the 19 groups.

Based on these criteria, the proposed sites were clustered into five major geographical groups (see Figure 1.4). However, due to practical reasons relating to the conducting of the assessment work (including the existing regional networks of scientists, the history of development and the ecosystem types that the assessment teams deal with), the modality of clustering was modified throughout the process. For instance, the Hokkaido and Northern Japan cluster was split into two clusters, as the history of regional development is very different in these two areas resulting in different appearances of *satoyama* and *satoumi* landscapes in each region. Also, as the local scientists' network expanded across the Kansai, Chugoku, Shikoku and Kyushu regions while one consortium of several stakeholders was forced to strongly focus their activities on *satoumi*, two original clusters were merged into one cluster in Western Japan with a smaller group focused on *satoumi* within it. The sites were finally grouped into five major clusters: 1) Hokkaido; 2) Tohoku; 3) Hokushinetsu; 4) Kanto–Chubu; and 5) Western Japan (with an additional Seto Inland Sea group); as shown in Figure 1.5. This final set of five clusters was used as the basis for the JSSA. Nevertheless, it has to be acknowledged that there were imbalances in the number of sites included in each cluster and the difference in characteristics and functions between *satoyama* and *satoumi*.

In addition, the cluster assessments were intended not only to inform the national assessment based on the diversity of *satoyama* and *satoumi* landscapes that are specific to the local social and ecological situations,

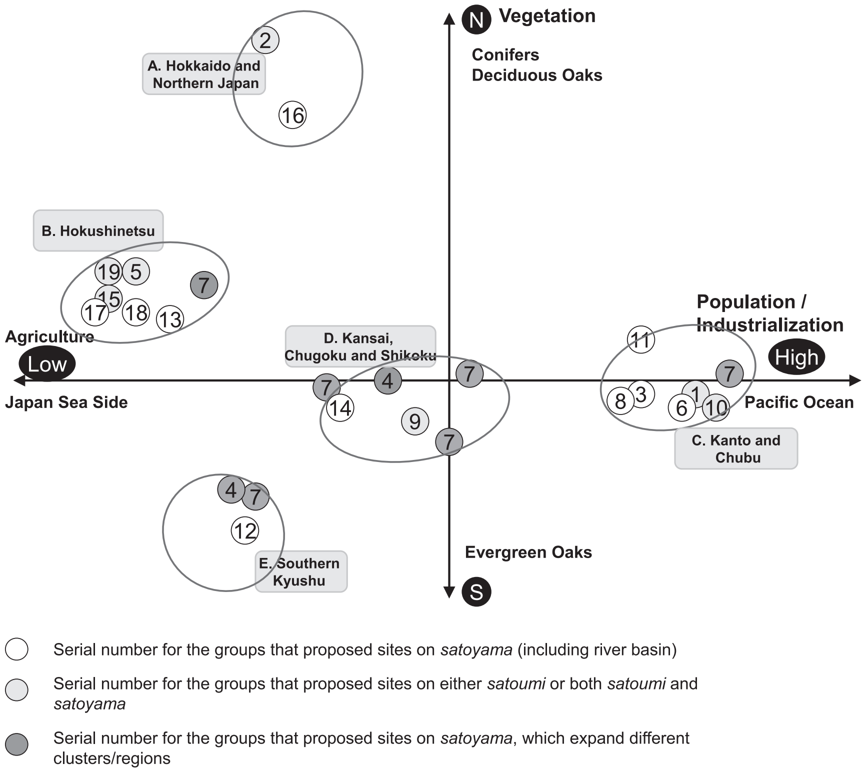

Figure 1.3 Critical variables
Notes: 1. Variable 1 (vertical line): Ecological and climate component.
2. Variable 2 (horizontal line): Demographic and socio-economic component.

but also to provide local stakeholders with a scientific basis that they require for decision-making. Therefore, each cluster also aimed to meet local stakeholders' needs in terms of scientific information, and to enhance the capacity of local stakeholders to undertake assessments and act on their findings.

1.4 Focus of assessment

Following the MA, the JSSA assessment was guided by a number of key questions to which relevant stakeholders (including national and local governments, non-governmental organizations [NGOs], businesses, civil society, etc.) wanted answers. Seven main questions were identified from the many questions put forward by the various stakeholders (Box 1.1).

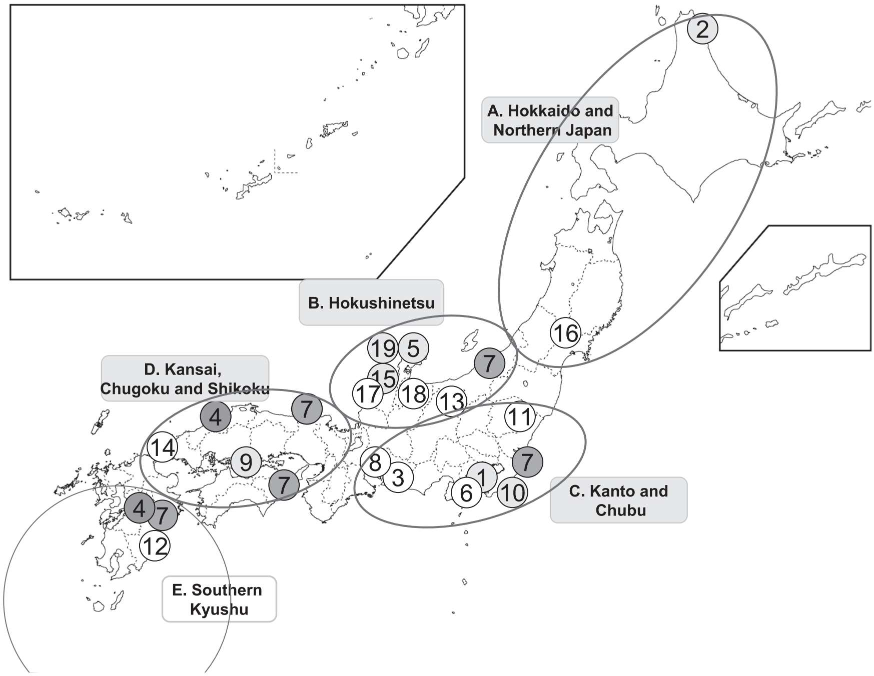

Figure 1.4 Clustering

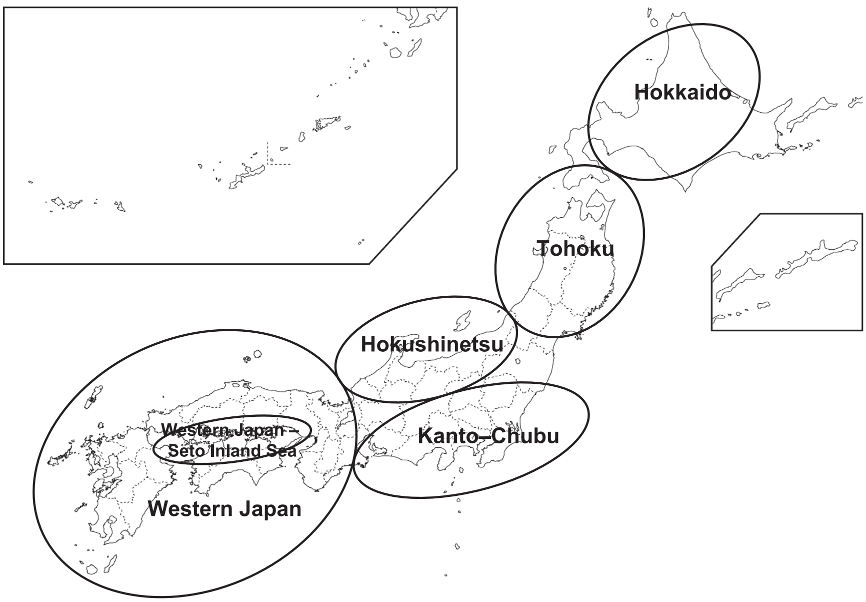

Figure 1.5 Final set of clusters

Box 1.1 Provisional user questions

User needs and questions

1. Which ecosystem services have changed the most with changes in *satoyama* and *satoumi*? (Condition and trends related)
2. How have changes in *satoyama* and *satoumi* affected human well-being, local and national economies and the functioning of ecosystems on all scales? (Links with human well-being)
3. What are the major threats to *satoyama* and *satoumi*? (Drivers of change)
4. How might *satoyama* and *satoumi* change in the future and what would the consequences be in terms of human well-being, economic development and ecosystem functioning on all scales? (Scenarios)
5. How can the findings generated by this assessment on *satoyama* and *satoumi* be used by various stakeholders at all levels for their decision-making process? (Responses)
6. What mechanisms should be used to communicate the assessment findings for maximum impact at all levels? (Outreach and dissemination)
7. What are the major gaps in information and knowledge that need to be addressed by future research? (Research needs)

1.5 The structure of this book

The structure of this book is as follows: the second chapter will present the conceptual framework used in the JSSA and will provide revised definitions of *satoyama* and *satoumi*. Chapter 3 will provide information on the conditions and trends of a range of key ecosystem services provided by *satoyama* and *satoumi* over the past 50–60 years and will examine key drivers of changes in *satoyama* and *satoumi* landscapes. Chapter 4 will highlight some of the key indirect and direct drivers responsible for changes in *satoyama* and *satoumi* and their impacts on ecosystem services. Chapter 5 will provide a typology of responses assessed in the JSSA, as well as further providing an overview of the type of responses used and how successful they were in addressing the decline in *satoyama* and *satoumi*. Chapter 6 will provide four plausible futures and information on how we expect *satoyama* and *satoumi* will change in the future under different future conditions. Chapter 7 will complete the book by identifying the key findings, uncertainties and gaps in our knowledge, and suggest potential areas for future research.

Furthermore, the findings of each cluster assessment, which serve as a base of the national assessment, are summarized in Chapters 8 to 13. The main components of each cluster summary include 1) the concept and definition of *satoyama* and *satoumi* landscapes, objectives, scope and approach, 2) historical and narrative context of management and use of *satoyama* and *satoumi* ecosystems prior to the 1950s, 3) condition and trends of ecosystem services and biodiversity of *satoyama* and *satoumi* ecosystems, and their impacts on human well-being, 4) drivers of changes in *satoyama* and *satoumi* landscapes, 5) responses to these changes in *satoyama* and *satoumi* landscapes, and 6) conclusions, on each cluster. A stand alone report was prepared for each cluster assessment, and the details of the cluster assessments can be found in the six cluster reports published as a series of "Experiences and Lessons from Clusters" in 2010 in Japanese.

Notes

1. Numerous groups and individuals have attempted to define *satoyama* from their own background and interests, and some refer to it as ecosystems, coppices and secondary forests, while others refer to it as rural landscapes including human settlements (Osumi and Fukamachi, 2001).
2. The constituents of human well-being include security, basic materials for a good life, health, good social relations and freedom of choice.

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2

Satoyama and *satoumi*, and ecosystem services: A conceptual framework

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2.1 Introduction

This chapter outlines the key concepts and assessment framework commonly used throughout this book. Section 2.2 provides a historical perspective of *satoyama* and *satoumi*, while Section 2.3 offers a definition for both. Details of recent changes in *satoyama* and *satoumi* and an overview of their ecosystem services are given in Sections 2.4 and 2.5. Both the assessment framework and approach used in the following chapters are explained in Section 2.6. The concept and approach for interlinkage analysis is reviewed and key interlinkages regarding ecosystem services and human well-being in *satoyama* and *satoumi* are identified in Section 2.7. Key findings of this chapter are then summarized in Section 2.8.

2.2 *Satoyama* and *satoumi*: *A historical perspective*

2.2.1 Satoyama

The earliest historical use of the word "*satoyama*" dates back to 1661, when the Saga domain (a feudal domain of today's Saga and Nagasaki Prefectures) issued the *Yamakatanitsukite Moushiwatashi Jojo* (Ordinance on Mountains). In this historical document, "*satoyamakata*" was among the three words which referred to the categories of land: "*denpata*" (agricultural fields), "*satoyamakata*" (areas of villages and mountains), and

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"*yamakata*" (areas of mountains) (Kuroda, 1990). In 1663, the Kaga domain (a powerful feudal domain in Kaga, Noto and Etchū Provinces of Japan – present-day Ishikawa and Toyama Prefectures) published the *Kaisakusho Kyuki* (a historical document that was compiled by the agricultural office of the Kaga domain). This document also described "*yamamawari-yaku*" (the duty of security patrol in the mountain areas) which consisted of "*okuyamamawari*" (patrol in the wild mountain areas) and "*satoyamamawari*" (patrol in *satoyama* areas) (Yamaguchi, 2003).

It is said that the first standalone use of "*satoyama*" dates back to 1759 (the Japanese year Horeki 9). In this year, the notion of linkages between mountains and society was emphasized when Hyoemon Teramachi stated that *satoyama* refers to the mountain areas that are close to villages, human habitations, and houses in the *Kisoyama Zourin* (Kiso Mountain Forest) (Tokoro, 1980). Teramachi served as the Assistant *Kiso Zaimoku Bugyo* (the Kiso regional magistrate who was responsible for the management and procurement of lumber for construction). It should be noted that in this definition, *satoyama* still does not imply the inclusion of society within the *satoyama* landscape as it presently does.

In the 1970s, Tsunahide Shidei, a forestry ecologist, revived the *satoyama* concept to address ecosystem–human interactions and used the definition as proposed by Teramachi. Shidei proposed that *satoyama* should refer to a woodland that is utilized as either a farm forest or firewood-charcoal forest. However, there was no common definition of the term *satoyama* across different regions of Japan. Therefore, in addition to *satoyama*, "*shihekirin*", "*jitsuzukiyama*" and "*satorin*" are known words for this type of woodland or forest (Inui, 2002). But the common theme running along all the definitions are that this type of woodland or forest was closely associated with land utilization in the surrounding areas. For example, fallen leaves and underbrush in the forest were converted to compost and returned to crop fields. Firewood and charcoal were used in households for fuel. Mushrooms and wild vegetables were also collected in the forest for human consumption.

However, over the past five decades with a decrease in agricultural landscapes, there has been a growing awareness of nature conservation. This trend has given a new definition to the word *satoyama*, which encompasses not only the rural society but also the general citizenry. In addition, the academic community has increasingly recognized the importance of the complex interrelationships across different ecosystem types that were part of the agricultural landscape. These ecosystem types included farm forests, grassland, farmland and human settlements. These recent developments have highlighted the notion of *satoyama* as a landscape comprised of a number of different ecosystem types working in harmony with society (Figure 2.1).

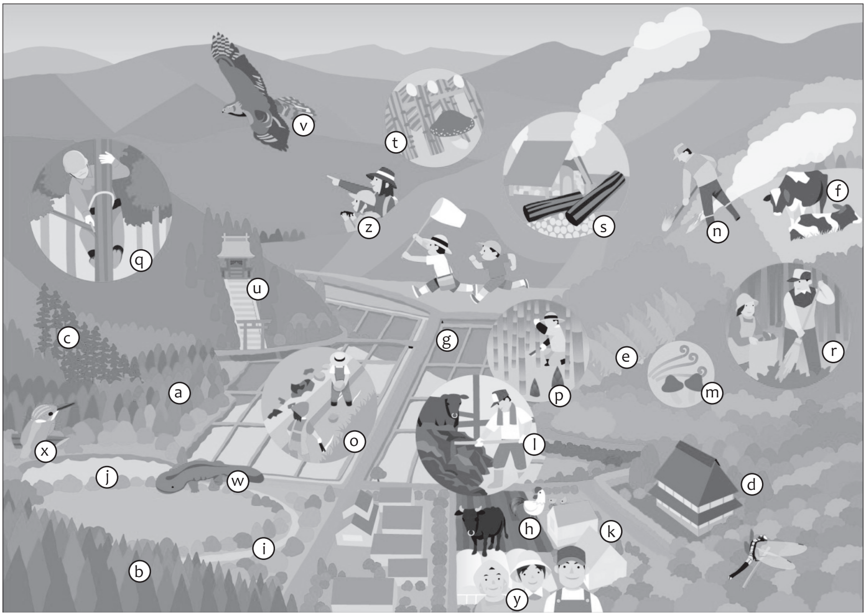

Figure 2.1 Concept and characteristics of *satoyama*
Notes: 1. a: coppice woodland for firewood and charcoal; b: coniferous plantation; c: *Pinus densiflora* (red pine) woods; d: homestead woodland; e: bamboo grove; f: grassland; g: rice paddy field; h: field; i: irrigation channel; j: irrigation pond; k: settlements; l: livestock (cattle and chicken); m: wild vegetables and mushrooms; n: prescribed burning of grassland; o: maintenance of irrigation channel; p: management of coppice woodland and bamboo grove; q: management of coniferous plantation; r: collecting leaves of deciduous woodland for manure production; s: charcoal burning; t: shiitake mushroom production; u: shrine; v: *Accipiter gentilis* (northern goshawk); w: salamander; x: *Alcedo atthis* (common kingfisher); y: farmers and foresters; z: hikers.
2. Please see the back of this book for a colour version of this figure.

This growing awareness of conservation has also prompted an increased emphasis on biodiversity conservation and protection in *satoyama* landscapes. Studies conducted since the 1990s have revealed that structural characteristics and human intervention in *satoyama* landscapes are closely related to the level of biodiversity. The mosaic structure of *satoyama* represents a structure of diverse land utilization. This mosaic pattern makes it possible for different flora and fauna to grow. It also realizes high biodiversity as a whole. In addition, some animal species require multiple heterogeneous habitats. A mosaic habitat with appropriate spatial dimensions meets this requirement (Washitani, 2003). Furthermore, studies have shown that moderate human intervention has provided habitats to relict species surviving from the ice age (Moriyama, 1988).

However, some studies have suggested that the landscape concept should be comprehensively known as "*satochi*" and be differentiated from "*satoyama*", which has been proposed as referring to woodlands including coppice woodlands and grasslands (Takeuchi, 2003). To add to the confusion (depending on the literature), other studies have suggested that the forest ecosystem type of *satoyama* should be referred to as "*satoyama-rin*" (*satoyama* forest), and "*satoyama*" should be used to refer to the broader landscape (Ishii, 2005). Table 2.1 summarizes the major historical changes and developments of this word.

2.2.2 Satoumi[1]

In 1842, the Sakura domain (feudal domain located in present-day Chiba Prefecture) issued the *Sakura Goryo Kaigan Kenchi Kiroku* (a report on the yields and an area survey of the seacoast areas of Sakura, which were owned by the Edo shogunate). In order to explain the spatial structures of the "coastal village" in the Tokyo Bay area, the report used words such as *kachi* (which means "walk" in old Japanese), *setsuki* (fish accumulating in shallow waters of a river and offshore areas), and *oki* (offing), and thus described the usage and management of fishery resources in the area (Takahashi, 1982).

In 1998, Yanagi (1998; 2005; 2007) proposed the concept of "*satoumi*" which refers to the spatial structure of coastal areas and the use and management of its fishery resources. According to Yanagi, "*satoumi*" refers to a "coastal sea area which has experienced an enhancement in biological productivity and biodiversity through human intervention". Specifically, the origins of the concept, *satoumi*, can be traced to the attempts by local communities to understand the relationship between human beings and the sea in the coastal areas of the Seto Inland Sea.

Based on this context, Nakamura (2003) has expanded the term "*satoumi*" to include the "conglomeration of coastal natural environments that are integrated with (*satoumi*) sea areas and which interact with neighbouring fishing villages and people's lives." Furthermore, *satoumi* has been also integrated with *satoyama* to create the concept of "*satoyamaumi*" (Nakamura, 2006a; 2006b). *Satoyamaumi* is a mosaic conglomeration consisting of the unified elements of human beings, nature, and culture. Not only do these elements encompass rice paddies and crop fields, which are highly controlled by human beings (particularly in human settlements), but they also include uncontrolled forest and sea areas. In addition, Field Science Education and Research Center, Kyoto University (2007) recently opened the "*Morisatoumi* Linkage Study"

Table 2.1 Main changes in descriptions and definitions related to *satoyama*

Definitions of *satoyama*	Woodland	Agricultural land use such as farmland and water channels	Complex landscape including settlements
Forestland which is connected to farmland and is easily available (Shidei, 1974).	✓		
Coppice woodlands where people have been engaged in slash-and-burn agriculture and collecting firewood, charcoal and *karishiki* (young leaves and young shoots collected in mountain areas and placed in crop fields as fertilizer) have been inextricably linked to human activities. Additionally, these coppices as *satoyama-rin* have formed an agricultural landscape unique to Japan, which can also be referred to as an "original landscape". At the same time, the coppice woodlands have provided habitats for animals and plants such as *Erythronium japonicum* (Japanese dogtooth violet "*katakuri*"), *Asarum nipponicum*, *Neozephyrus* spp., and *Luehdorfia japonica* (Japanese luehdorfia), which have survived since the time when the current laurel forests were still covered with deciduous trees (relict species) (Moriyama, 1988).	✓	✓	
Nature which has been formed through the combination of forests, adjacent rice paddies, fields, ridges, reservoirs and irrigation channels (Tabata, 1997).	✓	✓	
Traditional agricultural ecosystems which have been developed and maintained through human intervention within their diverse natural environmental elements. These elements are represented by hills and flood plains of the Japanese archipelago (Washitani, 1999).	✓	✓	✓

Table 2.1 (cont.)

Definitions of *satoyama*	Woodland	Agricultural land use such as farmland and water channels	Complex landscape including settlements
In contrast with wild nature, it is nature which has been maintained by human actions for specific purposes (Ibaraki Nature Museum, 2001).	✓	✓	
Landscape primarily consisting of forest which has been maintained through human intervention and in which local inhabitants have integrated themselves into and utilized its resources in order to maintain their daily life, self-sufficient agriculture and traditional industry (Osumi and Fukamachi, 2001).	✓	✓	✓
"Today, the word *satoyama* is used in various contexts, but it generally indicates a natural environment that is being managed and, therefore, its basic element can be represented as secondary nature . . . There are, however, different interpretations as to what elements can be included in the category of secondary nature. There is no doubt about including coppice and pine woodlands in this category because they are seen as typical plant communities . . . areas for thatch grass collection were regarded as very important and, therefore, these areas, too, can be included in *satoyama* landscapes" (Takeuchi, 2003: 10).	✓	✓	✓
In the vast lowland areas, such as the Kanto Plain, *satoyama* is comprised of lowland forests. In mountainous areas, however, *satoyama* refers to mountain forests in the vicinity of human habitations (Inui, 2002).	✓		

Table 2.1 (cont.)

Definitions of *satoyama*	Woodland	Agricultural land use such as farmland and water channels	Complex landscape including settlements
"The concept of a *satoyama* ecosystem . . . is extremely vague, and it could be better described as a set of forests, rice paddies and grassland, as well as animals inhabiting there. It is not appropriate to vaguely refer to all forest and grassland as *satoyama*, but is preferable to specifically designate these ecosystems as secondary forests (or coppice woodlands) and grasslands, for instance, and to comprehensively regard *satoyama* as an interacting system between human beings and the nature surrounding them" (Hiroki, 2002: 5).	✓	✓	✓
In a limited sense, *satoyama* refers to firewood–charcoal forests or farm forests. In a broad sense, it often encompasses an overall rural agricultural landscape including water systems for rice fields consisting of rice paddies, reservoirs and water channels; cropland, such as fields and fruit orchards; meadows for feeding; settlements; temple and shrine forests, and homestead forests; plantations; and sometimes remnant forests around urban areas (Ishii, 2005).	✓	✓	✓
Satochi–satoyama is an area where a unique natural environment has been formed through various human actions over a long period of time. It is a concept for an area consisting of secondary forest, plantations, farmland, reservoirs, grassland and other elements which surround human settlements (Ministry of the Environment, Japan, 2007).	✓	✓	✓

Table 2.1 (cont.)

Definitions of *satoyama*	Woodland	Agricultural land use such as farmland and water channels	Complex landscape including settlements
Satochi–satoyama is "a living space where a series of environmental elements – including water, air, soil, sites for harvesting/storing cogon grass, coppice woodlands, houses, barns, cow and horse stables, fields, orchards, bamboo forests, plantations, reservoirs, creeks, rice paddies, banks, and furrows – are interlinked." In coastal areas and near lakes, "*satoumi*" (*sato*-sea) and "*satoko*" (*sato*-lake) also form parts of *satochi–satoyama* (Yabu, 2009).	✓	✓	✓
Japan's *satoyama* is "the characteristic, managed landscapes which traditionally balanced productive agriculture with the sustainable use of natural resources". (Secretariat of the Convention on Biological Diversity, 2010)	✓	✓	✓

Notes: 1. Takeuchi (2003) distinguished between "*satoyama*" and "*satochi*", and defined *satochi* as a whole landscape encompassing *satoyama*, farmland, and villages.
2. The Third National Biodiversity Strategy (2007) and Yabu (2009) provided the definitions of *satochi–satoyama*, instead of those of *satoyama*.

course to establish a total management system for the overall area ranging from forest to sea. In this study, "*sato*" is considered to be an "ecosystem centred on human beings, who are concentrated in watershed areas and areas of river mouths".

The origin of the Seto Inland Sea as *satoumi* has a deep relationship with *satoyama*. Its scenic seacoast of white sand and pine trees previously represented the typical landscape of the Seto Inland Sea. This seacoast was formed with decomposed granite soil (weathered granite) generated from granitic bare mountains, which emerged as a result of cutting forest trees in the water catchment area to produce a massive amount of fuel for salt industry consumption. Pine trees resistant to infertile soil have been abundant on the decomposed granite beach. Additionally, the landscape of a series of nationally-known oyster farming areas and oyster rafts in Hiroshima Bay has also benefitted from the *satoyama* in the

Figure 2.2 Concept and characteristics of *satoumi*
Notes: 1. a: river; b: beach; c: tidal flat; d: coral reef; e: sea-grass bed; f: diverse fish and shellfish; g: plankton; h: nutrient matters and sand; i: oyster aquaculture; j: fishing settlements; k: pine trees; l: fishermen; m: sea bathing; n: shellfish gathering; o: angler; p: nature observation; q: urban area; r: *satoyama*.
2. Please see the back of this book for a colour version of this figure.

watershed area of the Ota River. This is because forest management and its methods have had a direct impact on the quality of the water in rivers and the watershed environment, which have impacted on the production of plankton which oysters feed on as well as the sea environment. The inland areas have also enjoyed benefits such as fishery products and salt. Therefore, there is an interrelationship between *satoyama* and *satoumi* through the products they generate.

S*atoumi* is still a new word. Therefore, the implications of this word are continuously changing. *Satoumi* initially referred to the "original conditions of the sea". However, this word has experienced a transformation, resulting in the representation of an "ideal relationship which should be created between human beings and the sea". Recently, the creation of *satoumi* has been adopted in Japan as a new ecosystem approach for the revitalization of the seas, as it has been incorporated into national policies, such as the Third National Biodiversity Strategy and the Strategy for an Environmental Nation in the Twenty-first Century. As such, the concept of *satoumi* has become widely used among the general public (Figure 2.2).

2.3 Definition of *satoyama* and *satoumi* within the Japan *Satoyama* and *Satoumi* Assessment

It is clear from the previous section that the terms *satoyama* and *satoumi* have evolved over time and greatly depend on the social and economic background of each specific time period.

Taking this historicity into consideration, we provide a definition that also includes advances made in the literature on ecosystems and their services, due to their close relationship with *satoyama* and *satoumi*.

Key elements that seem to emerge from the various definitions of *satoyama* and *satoumi* are:

- Ecosystem types
- Ecosystem goods and services
- Human-ecological interactions
- Management of ecosystems
- Landscapes

Drawing from these key elements, we define *satoyama* and *satoumi* landscapes[2] as dynamic mosaics[3] of managed socio-ecological systems producing a bundle of ecosystem services for human well-being.

The characteristics of *satoyama* and *satoumi* landscapes following the above definition are:

- *Satoyama* is a mosaic of both terrestrial and aquatic ecosystems comprised of woodlands, plantation, grasslands, farmlands, pasture, irrigation ponds and canals, with an emphasis on terrestrial ecosystems.
- *Satoumi* is a mosaic of both terrestrial and aquatic ecosystems comprised of seashore, rocky shore, tidal flats, coral reefs and seaweed/grass beds, with an emphasis on aquatic ecosystems.
- *Satoyama* and *satoumi* landscapes are managed with a mix of traditional knowledge and modern science (reflective of the socio-ecological contexts).
- Biodiversity is a key element for the resiliency and functioning of *satoyama* and *satoumi* landscapes.

In addition, the mosaics in *satoyama* mainly represent flat land utilization. In contrast, the mosaics in *satoumi* are characterized by the fact that they include three dimensional mosaic structures, such as fishing grounds and diverse ecosystems that vary depending on the depth of water in the coastal sea area.

2.4 Recent changes in *satoyama* and *satoumi*

2.4.1 Changes in satoyama *and* satoumi

There have been rapid declines and land use changes in *satoyama* and *satoumi* landscapes over the past 50 years. One example is the secondary forest of *Quercus serrata* (*konara* oak) as a key element of *satoyama* landscapes, which has been maintained through human activities. Currently, it has been maintained mainly for shiitake mushroom cultivation, yet still retains its firewood, charcoal and fertilizer production use in some areas as in previous times. This type of woodland is recognized as an important habitat for animals and plants living in *satoyama*. Nevertheless, its vegetation has undergone aggressive alteration in recent years (JSSA – Kanto–Chubu Cluster, 2010). This change is a result of land development projects since the early 1960s, such as housing construction and golf course development, and applies particularly to highlands and hills near metropolitan areas, e.g. Tokyo (Okutomi, 1998; Yamada, 1989; Taniyama, 1991).

Over the last 20 years, depopulation and ageing of rural populations have caused many of the surviving woods to be left unmanaged, resulting in further declines in *satoyama*. Bamboo groves have expanded and evergreen trees have increased, leading to drastic changes, such as reductions in some key ecosystem services. Farmers who maintained and managed *satoyama* woodland in the past became unable to continue doing so.

Since the late 1980s, an increasing interest in nature conservation and protection by urban societies prompted a revival of *satoyama* landscapes. According to The Nature Conservation Society of Japan (2002), there are more than 1,000 groups and organizations that provide various activities associated with *satoyama* including nature observation, conservation and research activities in Japan. Saito (2003) investigated 135 conservation, maintenance and management programmes of coppice woodlands in the Kanto region and found that only 12 were carried out before 1980 – many of them were found in the vicinity of urban areas in three prefectures: Saitama, Tokyo and Kanagawa. It was only in the 1990s that such activities spread to another 84 sites other than these three prefectures. The total activity area in the 1990s doubled compared to that in 1980. The analysis of nationwide activity in *satoyama* landscapes indicates that they have relatively flourished in municipalities in the vicinity of urban areas that are inhabited by several tens of thousands of people and are located within approximately 50 km of urban areas (Saito, 2005).

In recent years, green tourism, an overnight-stay type tourism activity that utilizes *satoyama* and *satoumi* landscapes as tourism resources, has been gradually promoted as a regional development measure instead of golf course and recreational facility development (Inoue et al., 1996; Saito, 1998). In Europe, words such as "rural tourism" or "agro-tourism" are commonly used, but "green tourism" is widely used in Japan (Muneta, 1997). Miyazaki (1997) points out that the word "green" implies sustainability and environmental conservation of agricultural communities. Most of the JSSA cluster reports addressed the recent expansion of green tourism in both *satoyama* and *satoumi*.

Satoumi landscapes have also been undergoing significant changes. Industrialization in Japan has accelerated landfill reclamation in coastal areas, resulting in a continuous decrease in the amount of good quality seashores. Typically, seacoasts surrounded by steep mountains have experienced the formation of culture which is different from that of *satoyama*. Their culture has been closely linked to regional fishing industries to maintain, more or less, a closed or self-sufficient (sustainable) economy, although there is wide variation within *satoumi* culture. The depletion of fishery resources in coastal areas has promoted the introduction of larger fishing boats and led to the development of offshore fishing. This has transformed the way in which communities exist and has caused a loss in cultural identity (JSSA – Seto Inland Sea Group of Western Japan Cluster, 2010).

In recent years, similar to the revaluation of *satoyama*, there has been a growing trend to point out the necessity for the revitalization and regeneration of coastal environments inhabited by people (*satoumi*). These activities have sought the formation of new types of communities led by the citizenry in urban areas and fishermen in rural areas.

2.4.2 Distribution of satoyama *and* satoumi *in Japan*

It is said that most *satoyama* landscapes are located between urban areas and *okuyama* (deep mountains). However, it is not easy to clearly define the distribution of *satoyama* landscapes in Japan and their approximate land area. This difficulty is attributed to the following factors: (1) different people have different definitions of *satoyama* as is indicated in Table 2.1., (2) the structure, pattern and special scale of *satoyama* systems depend on the social and economic background of each region, as described in the previous section, (3) it is difficult to establish quantitative criteria due to the interlinking border areas between *satoyama* and *okuyama* which is less significantly affected by human activities, or between *satoyama* and urban areas, and (4) there is no reliable scientific material which articulates the definitions of *satoyama* and its borders. In addition, although there is usually a certain amount of data and information on different areas and the characteristics of each ecosystem component of *satoyama* (i.e. woodlands, plantations, grasslands, farmlands, pasture, irrigation ponds and canals, etc.), the availability of such data and information varies in terms of its components. As the data and information on woodlands and farmlands are relatively rich, *satoyama* landscapes tend to be measured representatively by these two types of ecosystems.

In spite of these limitations, there have been some estimation attempts.

Tsunekawa (2003) estimates that *satoyama* accounts for approximately 22.1 per cent of national land area by defining *satoyama* (which refers to woodlands and meadows for feeding in Tsunekawa's definition) as "secondary forests and plantations" within the "*satochi* natural areas" according to the area category in the *Basic Environmental Plan* (Cabinet Decision in 1994). Here, the "*satochi* natural areas" refer to areas with a population density of 5,000–30,000 people per square kilometre or areas with a population density of less than 5,000 people per square kilometre and forest coverage of less than 80 per cent. The area of "secondary forests and plantations" is estimated based on the data in the "Degree of Human Disturbance of Vegetation" presented in the *Fourth National Survey on the Natural Environment* (Nature Conservation Bureau, Environment Agency, 1996). This data is third grid data (standard area grid data), of which the size of a cell is 30 seconds in longitude and 45 seconds in latitude (approximately 1 km square area). The "Degree of Human Disturbance of Vegetation" is an index of natural vegetation in which the various types of vegetation are grouped into 10 categories based on the vegetation type, human impact and the progression of succession. Secondary forest generally refers to a forest established after disturbance, such as human disturbance. In Tsunekawa's estimates, the data on forests categorized as level 6 (secondary forest) and level 7 (plantation) in the "Degree of Human Disturbance of Vegetation" were used.

Table 2.2 shows changes in the degree of human disturbance of vegetation based on the third grid data presented in the *National Survey on the Natural Environment*. This table indicates that the area of forest in Japan is between 67 and 69 per cent, suggesting no drastic change as a whole over 30 years since the 1970s. The ratio of the area of farmland is between 21 and 23 per cent and has almost levelled off since the late 1970s after experiencing a slight decline at that time.

In addition, the Forestry Agency (1978) designated approximately 62,000 km^2 of forest area as *satoyama* forest area in the "*Satoyama* Area Development and Conservation Plan Survey". This area accounts for approximately 25 per cent of the total forest area in Japan. Here, "broadleaf young forest area" is defined as the target forest area. Specifically, the target forest refers to planted forests consisting of national forests and private forests, excluding those in Hokkaido and Okinawa, which have been created primarily to produce firewood and charcoal.

Further, the "Survey and Analysis on *Satochi-Satoyama* in Japan (Interim Report)" used the term "*satochi-satoyama*" to refer to the area that includes secondary forest, farmland mixed with secondary forest, and secondary grassland, and estimated its area and distribution by analysing data from the *National Survey on the Natural Environment* (Ueda, 2002). As a result of the estimation, the land area of secondary forest turned

Table 2.2 Changes in the degree of human disturbance of vegetation based on the *National Survey on the Natural Environment* (1973–1998)

Degree of human disturbance (vegetation authenticity)	1st (1973)		2nd and 3rd (1978–79 and 1983–87)		4th (1988–92)		5th (1993–98)	
	No. of blocks of area grid	Composition ratio (%)	No. of blocks of area grid	Composition ratio (%)	No. of blocks of area grid	Composition ratio (%)	No. of blocks of area grid	Composition ratio (%)
Natural grassland (authenticity 10)	3,260	0.9	4,038	1.1	4,011	1.1	3,993	1.1
Forest (authenticity 9,8,7,6) (*1)	244,994	68.0	248,538	68.2	247,229	67.8	245,376	67.3
Natural forest and secondary forest (authenticity 9,8,7)	169,854	47.1	157,735	43.3	155,383	42.6	153,962	42.2
Plantation (authenticity 6)	75,140	20.9	90,803	24.9	91,846	25.2	91,414	25.1
Secondary grassland (authenticity 5,4)	12,876	3.6	11,676	3.2	12,124	3.3	13,159	3.6
Farmland (authenticity 3,2) (*2)	83,030	23.0	77,412	21.2	77,701	21.3	78,052	21.4
Urban area (authenticity 1) (*2)	15,597	4.3	21,172	5.8	21,847	6.0	22,430	6.2
Residential area surrounded by nature (authenticity 2)	4,394	1.2	6,331	1.7	6,427	1.8	6,431	1.8
Other (natural bare area, or unspecified area)	602	0.2	1,464	0.4	1,487	0.4	1,490	0.4
Japan (*3)	360,359	100.0	364,300	100.0	364,399	100.0	364,500	100.0
Open water	0	–	4,170	–	4,211	–	4,227	–
Japan	360,359	–	368,470	–	368,610	–	368,727	–

Source: Ministry of the Environment, Japan, *1st–5th National Surveys on the Natural Environment*. Available at: http://www.biodic.go.jp/kiso/vg/vg_kiso.html

Notes: 1. *1: “Forest” includes “natural forest and secondary forest” and “plantation”.

2. *2: “Farmland” excludes “residential area surrounded by nature” (authenticity 2), while “urban area” includes “residential area surrounded by nature” (authenticity 2).
3. *3: This excludes areas of open water.
4. Vegetation authenticity is an indicator of the degree of authenticity remaining in a community in terms of phytosociology. Authenticity is classified as one of 10 levels: 1) authenticity 10 is an area that forms a single layer plant society of natural vegetation (e.g. Alpine heathland, wind-exposed grassland or natural grassland); 2) authenticity 9 is an area that forms a multi-layer plant society of natural vegetation (e.g. *Picea jezoensis – Abies sachalinensis* association or *Fagus crenata* community); 3) authenticity 8 is an area that forms secondary vegetation, but is close to natural vegetation (e.g. *Fagus crenata – Quercus crispula* regenerating woodland, *Castanopsis* or *Quercus* coppice forest); 4) authenticity 7 is an area of secondary vegetation generally called secondary forest (e.g. *Castanea crenata-Quercus mongolica var. grosseserrata* community or *Quercetum acutissimo-serratae*); 5) authenticity 6 is a plantation forest (i.e. evergreen needle-leaved forest, deciduous needle-leaved forest or evergreen broadleaved forest); 6) authenticity 5 is a grassland composed of tall grasses (e.g. *Sasa* spp. community, *Miscanthion sinensis*); 7) authenticity 4 is a grassland composed of short grasses (e.g. Zoysion japonicae); 8) authenticity 3 is an orchard (e.g. fruit garden, mulberry field, tea garden or nursery garden); 9) authenticity 2 is an area that includes cultivated land (e.g. dry field or rice field) and residential areas with abundant greenery (surrounded by nature); and 10) authenticity 1 is an area where there is little vegetation (e.g. urban area or developed land).

out to be approximately 7,700,000 ha, equivalent to 21 per cent of the national land area. The estimate has also shown that *satochi-satoyama* areas including farmland areas account for approximately 43 per cent of national land. Additionally, the survey classified secondary forests into four types: *Quercus crispula* forest, *Q. serrata* (*konara* oak) forest, *Pinus denstiflora* (Japanese red pine) forest and coppiced *Castanopsis-Quercus* (chinquapin–oak) forest (Figure 2.3). As such, various regional characteristics are identified: in Hokkaido, Tohoku and Kanto, the percentage of *Q. crispula* forest is high; in Kinki, Chugoku and Shikoku, *P. denstiflora* (Japanese red pine) forest is dominant; and the coppiced *Castanopsis-Quercus* (chinquapin-oak) forest is concentrated in Shikoku and Kyushu (Figure 2.3).

Based on these results, the Third National Biodiversity Strategy (Ministry of the Environment, Japan, 2007: 46) states that "only secondary forest which is the core of *satochi-satoyama* accounts for approximately 20 per cent of the national land. If surrounding farmland areas are also included, the total *satochi-satoyama* area accounts for a broad area equivalent to approximately 40 per cent of the national land."

In contrast, there have been no definitions in regard to the spatial elements and ranges of *satoumi*. Hence, at this time, it is difficult to understand the distribution and land area of *satoumi*. Areas that have been defined as tideland and sea-grass beds are habitats for important biological organisms widely distributed in the seacoast neritic waters. Tideland, in general, refers to flat areas formed with politic-psammitic sediments which emerge at the time of low tide. It is also an important habitat for small animals, such as fish and shellfish, as well as migrant birds, e.g. Scolopacidae (sandpipers) and Charadriidae (plover). In addition, water quality purification is an important environmental conservation function of tideland. On the other hand, sea-grass beds are largely categorized into communities of algae such as *Sargassum* spp. (gulfweeds), *Eisenia bicyclis* ("*arame*") and *Ecklonia cava* distributed on the solid rocky reef bottom, or communities of flowering plants distributed on the sandy mud bottom. Not only are both types of communities important as sites for primary production, but these communities also function as habitats for a large number of animals (Nature Conservation Bureau of Environmental Agency, and Marine Parks Center of Japan, 1994).

Coral reefs are living animals with the ability to carry out photosynthesis. Thus, they require sunlight and form reefs at a shallow depth in the ocean, normally close to land. Often called "rainforests of the sea", coral reefs provide not only habitats for diverse species, but also natural resources for fisheries and tourism. In addition, widely-developed coral reefs provide shoreline protection by functioning as near-shore breakwater (Ministry of the Environment, Japan and Japan Coral Reef Society, 2004).

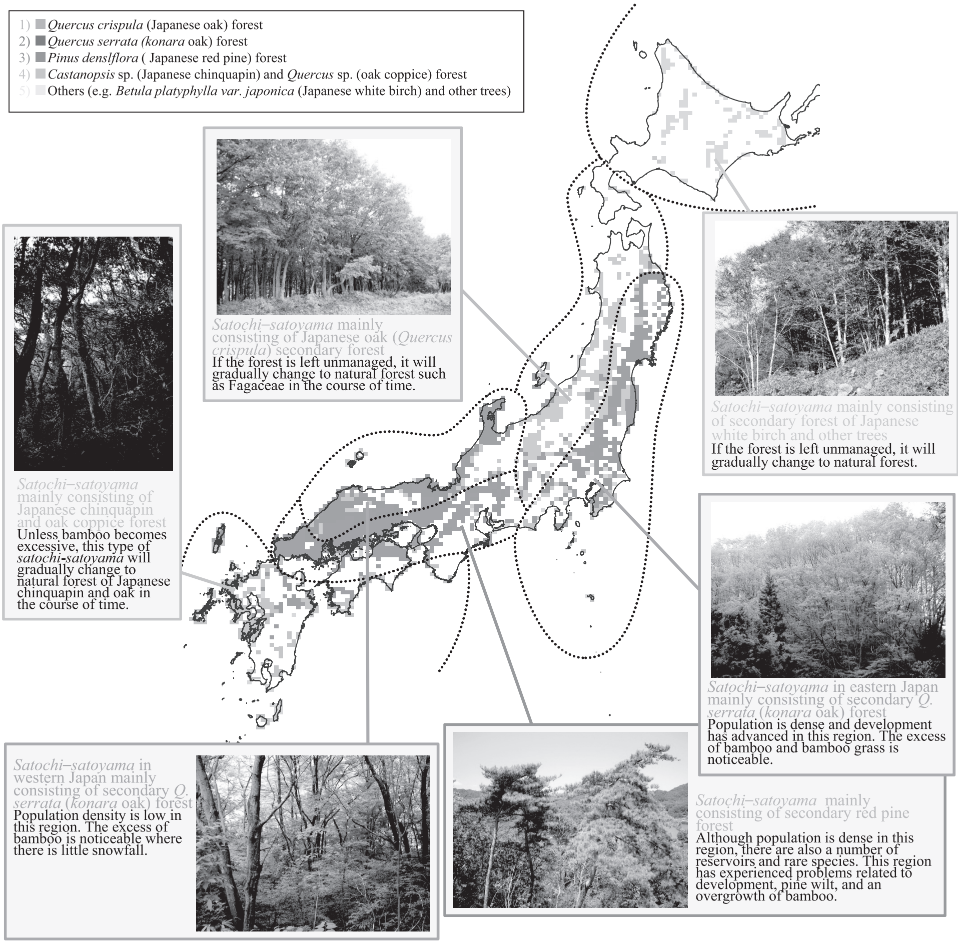

Figure 2.3 Distribution of *satochi–satoyama* according to secondary forest vegetation type
Source: *The 5th National Survey on the Natural Environment* (Nature Conservation Bureau, Ministry of the Environment, 2001); Survey and Analysis on *Satochi* and *Satoyama* in Japan (Interim Report), and *Satochi–satoyama* brochure (Nature Conservation Bureau, Ministry of the Environment, 2004). Photos provided by Japan Wildlife Research Center [1) *Q. crispula* forest, 2) *Q. serrata* forest, 3) *P. denslflora* forest, 5) *Betula platyphylla var. japonica* forest] and Toshihiko Nakamura [4) *Castanopsis* sp. and *Quercus* sp. Forest]
Note: Please see the back of this book for a colour version of this figure and an associated table.

Figures 2.4 and 2.5 show distribution maps of tideland and sea-grass beds in Japan, respectively. These maps were created by the “Survey on Marine Organisms Environment” of the *Fourth National Survey on the*

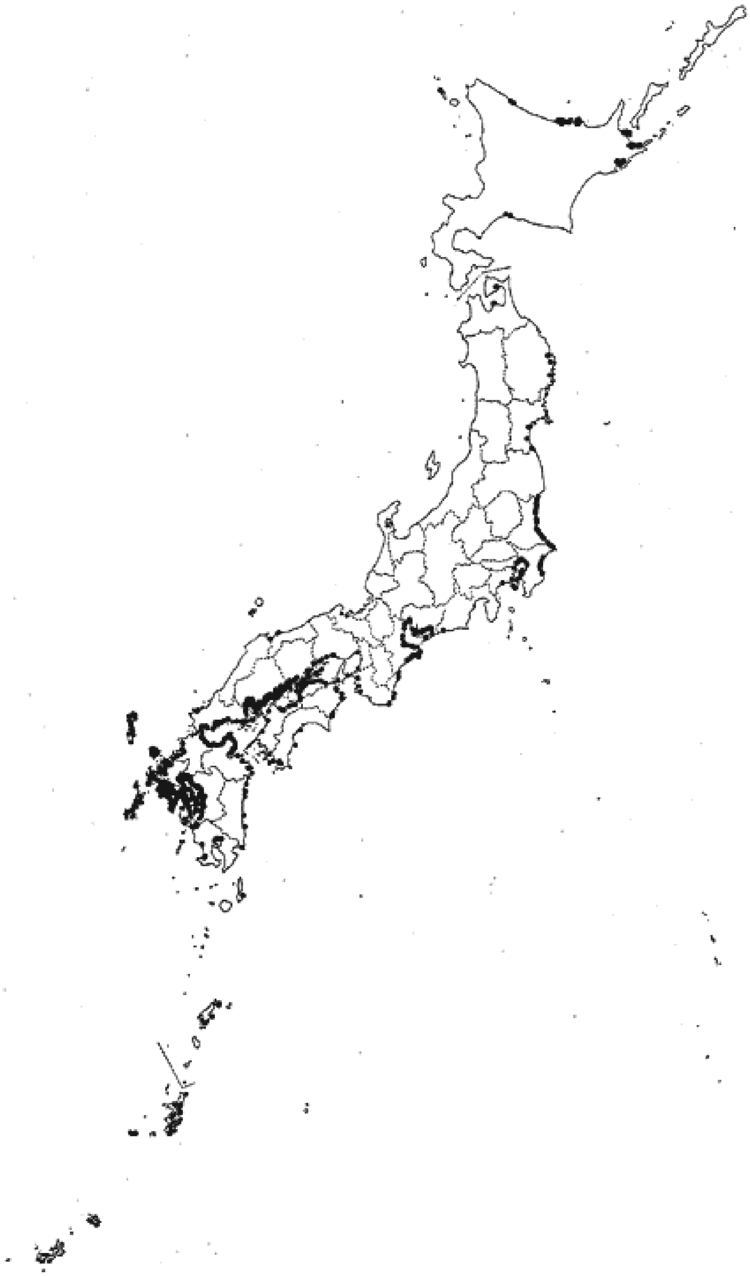

Figure 2.4 Distribution of tideland
Source: Nature Conservation Bureau, Environment Agency, and Marine Parks Center of Japan (1994)

Figure 2.5 Distribution of seaweed beds
Source: Nature Conservation Bureau, Environment Agency, and Marine Parks Center of Japan (1994)

Natural Environment (Nature Conservation Bureau of Ministry of the Environment, Japan, 1994). Figure 2.6 shows the distribution of coral reefs in Japan; the map was created by the "Survey on Marine Area" of the *Second National Survey on the Natural Environment* (Environmental Agency, Japan, 1980).

Satoumi culture often permeates neighbouring fishery villages along the same coastal shoreline; it has also contributed to the creation of rural cultures on a wider scale through harbour and trading. For example, there has been an interaction for fishery management between villages in Uchibo, Chiba Prefecture and villages in Kanagawa Prefecture located on the other side of Tokyo Bay (Takahashi, 1994). Therefore, we should assume

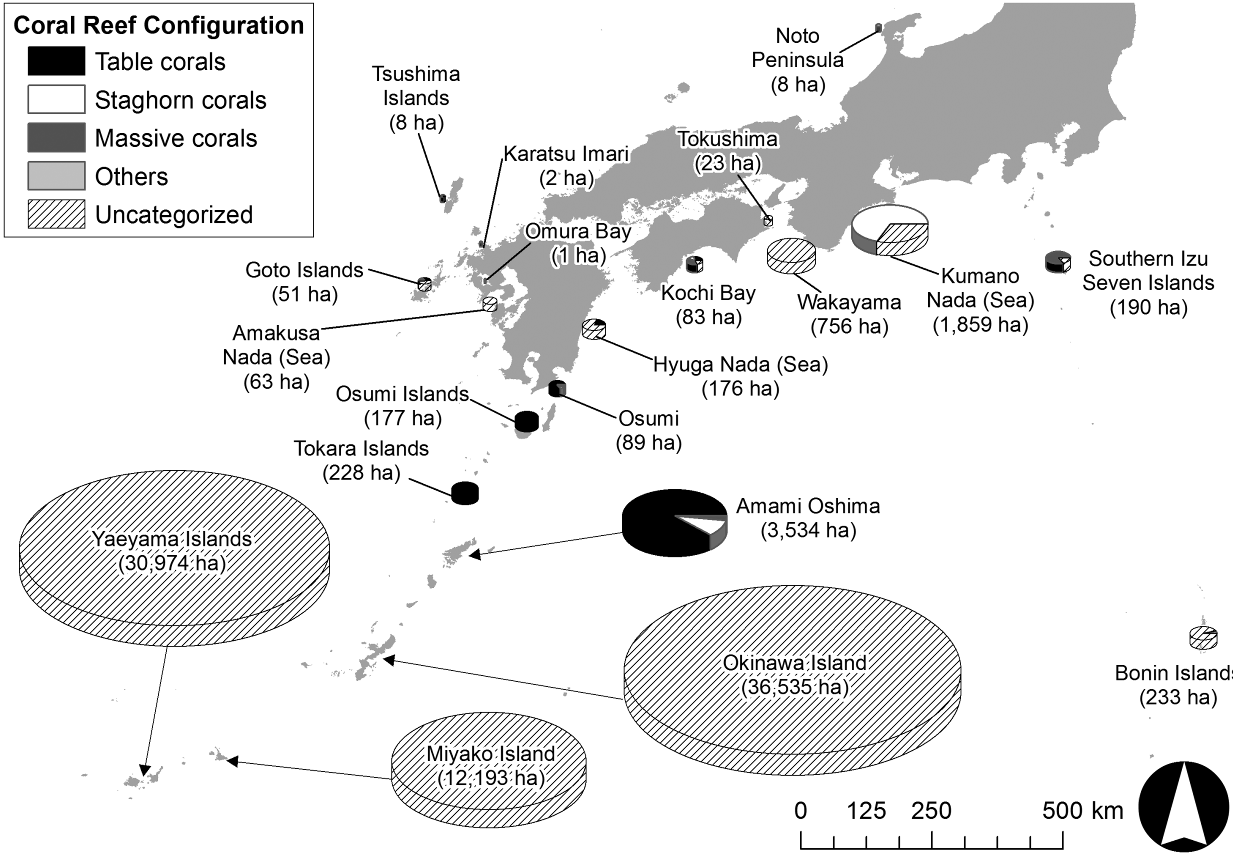

Figure 2.6 Distribution of coral reefs in marine waters
Source: Environmental Agency, Japan (1980)
Note: Unit: ha

that the spatial scale (boundary) of *satoumi* stretches beyond coastal boundaries in the ordinary sense.

2.5 Overview of ecosystem services provided by *satoyama* and *satoumi*

Satoyama and *satoumi* bring diverse ecosystem services. The composition of these ecosystem services varies depending on environmental conditions, local communities, history and culture in each region.

2.5.1 Supporting services and biodiversity

Rich biodiversity, which has been maintained by human activities in *satoyama* and *satoumi*, provides an important base for unique ecosystem structures and functions, which create various supporting services deriving a bundle of provisioning, regulating and cultural services for human well-being. The mosaic of various ecosystem types in a *satoyama* landscape including forest, farmland, reservoirs and water channels is a habitat for a wide variety of wildlife and has maintained rich biota and biodiversity. These characteristics are of special importance as a basis for multiple provisioning, regulating and cultural services that are provided by *satoyama* ecosystems as will be discussed below. The diversity of ecosystem mosaics supports ecosystem functions such as primary production, nutrient cycling (see Box 2.1), soil formation and habitat structure. Thus, various ecosystem services are generated in ecosystem mosaics through various processes and mechanisms. Similarly, in *satoumi* landscapes, various structures and biota in the coastal area form an important basis that enables the provision of various ecosystem services, including marine production and nutrient removal.

The Research Center for Agriculture and Nature published a document entitled "All Species of Organisms in Rice Fields" in February 2009. This document lists a total of 6,138 species (3,173 animal species, 2,136 plant species and 829 protists) (Kiritani, 2009). In addition, in Japan, approximately 50 per cent of the organisms that are listed in the Red Data Book are found in *satoyama* landscapes. Not only have *satoyama* landscapes provided a place for agriculture and forestry, as well as a human living space, but they also play an important role in nurturing biodiversity.

2.5.2 Provisioning services

A characteristic provisioning service in *satoyama* forests is the supply of charcoal and firewood as fuel, and prior to the fuel revolution, they were

Box 2.1 Resource use changes in *satoyama* landscapes and their impacts on nutrient cycles

It is conceived that changes in natural resource utilization by humans in *satoyama* ecosystems have made some sort of impact on biogeochemical cycles related to nutrients and organic matter. Although human use of charcoal and manure from *satoyama* was common and dominant through to the 1950s, a reverse in this trend was observed beginning in the 1960s caused by the rapid popularization of fossil fuels and chemical fertilizers causing the abandonment of *satoyama*. Recent research suggests that the abandoning of the management of *satoyama* landscapes altered material cycles, especially in secondary forests, and resulted in an increase in soil organic matter and nutrient pools. In other words, previous decreases in organic matter and nutrient cycles due to human over-use of *satoyama* ecosystems saw a favourable reverse due to underuse. However, the abandonment of forest management caused an increase in forest floor vegetation, which affected tree growth and nutrient availability adversely. The decrease in tree growth and nutrient uptake due to the absence of a regeneration of tree species in *satoyama* landscapes stimulated the growth of under-floor vegetation such as bamboo grasses, making secondary forest management more difficult. In addition, urbanization has indirectly affected forest ecosystems in *satoyama* landscapes, particularly in those close to urban areas, through air pollution and microclimate changes.

Satoyama ecosystems were originally maintained through continuous management using practices such as shrub cutting and litter removal, resulting in short interval but large exports of nutrients and organic matter from the ecosystem. However, nutrient and organic matter deficiency for vegetation and soil microbial populations caused by *satoyama* utilization suggest that these systems could become net absorbers of anthropogenic nutrients (derived by air pollution or other disturbances) through the active uptake of these nutrients by vegetation and microbes. This means that changes in *satoyama* utilization alter internal ecosystem biogeochemical processes such as nutrient retention and leaching. This indicates that both historical and/or current management and human use of *satoyama* affects the current properties of the ecosystem's supporting services through changes in the nutrient and material cycles of *satoyama* ecosystems.

Source: Shibata et al. (2009).

utilized, along with timber, as important livelihood resources. Additionally, other forest materials (fallen leaves, underbrush, etc.) were used as fertilizer prior to the 1960s when chemical fertilizer became widespread. Currently, the cultivation of *shiitake* mushrooms using trees, as well as rice paddies and vegetable fields, serve as important food provisioning services for both rural and urban areas.

Marine products in *satoumi* areas are key provisioning services, with rich fishing grounds, such as sea-grass beds and tidelands. Further, although imports of salt have drastically increased in recent years, salt production in *satoumi* still functions as an important provisioning service.

2.5.3 Regulating services

Some of *satoyama's* main regulating services include climate, water quality and disaster control. This occurs through the forest itself (carbon fixation, water quality and purifier functions); house and forest zone arrangements (windbreaks and temperature control); and reservoirs and rice paddies (flood prevention and nutrient recycling). Another important regulating service is that of pollination by pollinators inhabiting the ecosystem, as well as natural pest enemies for agricultural pest management.

Similarly, tideland *satoumi* areas regulate water environments in coastal areas through nutrient removal, such as nitrogen and phosphorus. In addition, diverse biological communities, such as sea-grass beds, are equipped with high carbon dioxide fixation capabilities and can provide climate control services.

2.5.4 Cultural services

Satoyama and *satoumi* are culturally embedded within Japanese society. The traditional knowledge used in managing these landscapes, as well as the cultural identity they provide for society in general, offers valuable cultural services such as cultural heritage, sense of identity, tourism, walking and recreation. *Satoyama* and *satoumi* have obvious, strong links to each region, influencing regional cultures, customs and established practices (see Box 2.2), which have formed the undercurrent of Japanese culture (Tadaki, 2008). In recent years, environmental education and ecotourism concerning the products that *satoyama* and *satoumi* provide have led to the creation of new industries, such as organic restaurants (Miyazaki, 1997; The Nature Conservation Society of Japan, 2002; Mishima, 2005; AMITA Institute for Sustainable Economics, 2006; Shikida et al., 2008; Tamamura, 2008).

Box 2.2 Rice cultivation and culture

Satoyama and *satoumi* have significant implications for culture. First of all, the Japanese word "*bunka*" is a translation of the English word "culture". "Culture" is a derivative of the word "cultivate". "Cultivating" activities include involvement and interaction with nature. *Satoyama* and *satoumi* have been created through these activities with nature. Hence, it would be fair to say that *satoyama* and *satoumi*, as well as human activities within them, comprise *satoyama* and *satoumi* culture. Human activities in connection with rice paddies are the most familiar *satoyama* and *satoumi* cultures in Japan (Figure 2.7). The Chinese character "*sato*" (里) consists of two other Chinese characters: "*ta*" (rice paddy; 田) and "*tsuchi*" (soil; 土). "*Ta*" is the most commonly-used Chinese character in Japanese family names ("National Ranking Database for Family Names in Japan", Shirooka Laboratory, Faculty of Humanities and Social Sciences, Shizuoka University).

Rice production involves various tasks ranging from rice planting, grass cutting and rice harvesting to the management of agricultural water. In order to complete these tasks, cooperative organizations such as "*yui*" (a cooperative system) and "*kou*" (a religious group) were created. These organizations facilitated cooperation with other people. Other products were also produced in rice paddies. "Rice bran" was used as fertilizer or for the production of Japanese pickles. "Rice straw" was used for various necessities such as roofing material, ropes and straw sandals. Furthermore, the rice paddy water environment served as a habitat for a number of biological organisms, which benefited from year-round warm and shallow water, as well as fertile soil. Together with the surrounding forest environment, it also supported the habitats of *Nipponia nippon* (Japanese crested ibis) and *Ciconia boyciana* (oriental stork). Thus, abundant biodiversity prospered and provided benefits to *Carassius* spp. (Crucian carp), *Misgurnus anguillicaudatus* (*dojo* loach), Vivipardiae (river snails) and seven spring herbs grown in the furrows, which also served as food for local communities.

In rice paddy production, the "god of rice paddies" was enshrined in the hope of agricultural fertility and in gratitude for harvests. The people believed that this god would come down to *sato* from the mountain in spring and return to the mountain after the autumn harvesting, thus becoming the "god of the mountain". Subsequently, various festivals and events were held which also included the worship of the "god of the water" as water is essential for rice production. This god was also enshrined in the hope of conserving water sources and preventing flood disasters, as well as in gratitude for the benefits of water.

Box 2.2 (cont.)

Thus, in *satoyama* and *satoumi*, people incorporated festivals and events into their daily lives through occupations which developed over a long period of time in harmony with nature. In this lifestyle, in addition to the feeling of awe inspired by nature, people learnt from nature and applied this learning to their everyday lives. Additionally, they established various cooperative systems to achieve a sustainable use of resources, using the land as a mosaic environment for production in various manners, which enabled the conservation of abundant biodiversity. These lessons from *satoyama* and *satoumi* cultures are important for the development of a sustainable society in the future.

Source: Written by Yuko Honda (Chiba Biodiversity Center) and Toshihiko Nakamura (Biodiversity Center, the Natural History Museum and Institute, Chiba).

2.6 Assessment framework

2.6.1 JSSA conceptual framework

The JSSA uses the MA conceptual framework (see Figure 1.1) as the underlying conceptual framework for its assessment. The MA hypothesizes that there are dynamic interactions between human beings and ecosystem elements and hence, changes in human conditions will bring about direct or indirect changes in ecosystems. These changes in ecosystems will conversely result in changes in human well-being.

A number of modifications were made to the MA conceptual framework to make it more applicable to the Japanese assessment, i.e. the addition of *satoyama* and *satoumi* landscapes (Figure 2.8). The original MA framework was revised to capture the impacts of the direct drivers (affected by the indirect drivers) on *satoyama* and *satoumi* landscapes which in turn caused changes in the supply of ecosystem services essential for the various constituents of well-being and then provided feedback to indirect drivers such as lifestyle transformation. Thus, changes in ecosystem services were captured explicitly through changes in *satoyam*a and *satoumi* landscapes.

The concepts of biodiversity, *satoyama* and *satoumi* are closely related. Biodiversity refers to the variety of life forms on Earth and the natural patterns including all kinds of ecosystems and their combination in land areas, ocean areas and other water areas. Diversity is a structural characteristic of ecosystems and the variety of ecosystems is one element of biodiversity which is generally identified at species, ecosystem and genetic

Figure 2.7 Relationship between abundant rice paddy environments and people involved in rice production

Notes: 1. Clockwise from top centre: Landscape richly endowed with nature in *yatsuda* (rice paddies at the bottom of valleys) in the northern part of the Boso Peninsula with a *N. nippon* (Japanese crested ibis) that used to inhabit the area; rice – Japan's staple food; full ears of rice; straw work; seven spring herb basket; rice planting festival at Katori Shrine (photographed by Minoru Kobayashi); illustration of the god of the water (*Benzaiten*), irrigation ponds and the *A. atthis* (common kingfisher) (illustrated by Kevin Short); the god of the water enshrined in a fountain.
2. Please see the back of this book for a colour version of this figure.

levels (Secretariat of the Convention on Biological Diversity, 2010). We can anticipate a variety of ecosystem services from abundant biodiversity. In addition, not only are ecosystem services important to human beings, but the existence of various species itself also represents intrinsic value (MA, 2003).

2.6.2 Conditions and trends

Table 2.3 shows the structure of ecosystem services provided by *satoyama* and *satoumi* that are to be analysed in this book (see Chapter 3). We have integrated the ecosystem services that have been analysed in the six

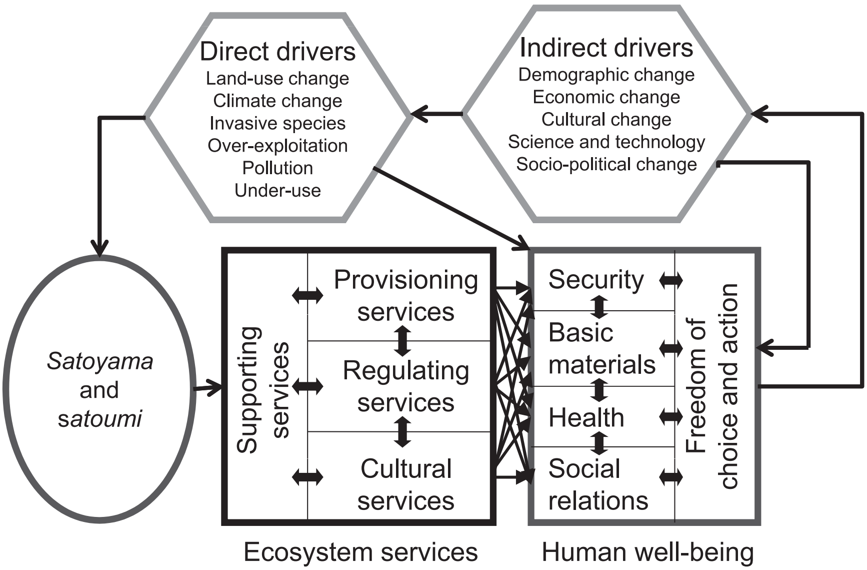

Figure 2.8 JSSA conceptual framework

cluster reports into a comprehensive list of ecosystem services (see Table A1). Based on this comprehensive list of ecosystem services, we have refined it and identified the ecosystem services from *satoyama* and *satoumi* for the national scale assessment (Table 2.3).

The assessment method for the conditions of ecosystem services varies depending on the type of each service. In order to fully assess the conditions of ecosystem services, it was necessary to take the stock, flow and resilience of ecosystem services into consideration (MA, 2005). In order to assess the conditions and trends of ecosystem services, the MA has ultimately adopted "human use" and "enhanced or degraded" (Table 2.4) to describe the condition and trends of the ecosystem services. "Human use" represents flow. "Enhanced or degraded" are used to evaluate stock and the conditions of resilience. *Satoyama* and *satoumi* have been maintained through continuous management by human beings. In this way, the balance between flow and stock has been intelligently maintained, allowing for sustainable use (flow) of ecosystem services from *satoyama* and *satoumi*. However, in recent years, mainly due to a decline in human use of *satoyama* and *satoumi*, an imbalance between flow and stock has arisen, with various issues emerging as a result in each region of Japan. However, there is no complete dataset that encompasses all lower-tier ecosystem service items covered in Table 2.3. For this reason, considering the availability of data for the assessment, including the utilization of

Table 2.3 Classification structure and indicators of ecosystem services from *satoyama* and *satoumi* for JSSA

Upper-tier	Middle-tier	Lower-tier	Indicators
Provisioning services	Food	Rice	Crop yields, size of area under cultivation, yield per 10 acres
		Livestock (meat, milk, etc.)	–
		Matsutake mushrooms	Production volume
		Marine fishery	Catches
		Maricultures	Catches
	Fabric	Material (timber)	Forestry production index number, standing tree store
		Firewood and charcoal	Forestry production index number
		Sericulture	Cocoon harvest, size of mulberry growing area
Regulating services	Air quality regulation		NOx, SOx concentration, amount of DSS aerosol and endocrine disruptors
	Local climate regulation		Temperature change, precipitation change
	Water regulation	Flood control	Total area of rice paddies, number of irrigation ponds
	Water purification		Total area of forests, amount of chemical fertilizer and pesticide used, sewage disposal service coverage ratio
	Soil erosion regulation	Farmlands and forests	Area of abandoned cultivated land, changes in forest types
		Coastal area (sediment control)	Sediment supply
	Pest control and pollination		Amount of pesticide used, area of abandoned cultivated land, changes in forest types

Cultural services	Spiritual	Religion (shrines, temples and religious rituals)	Number of shrines and temples, size of sacred groves
		Festivals	Number of festival types, use of plants as floral offerings
	Aesthetic	Scenery (landscape and townscape)	Number of applications for the Best 100 *Satoyama* Selection
	Recreation	Education (field trips, field observation and environmental education)	Number of people and NGOs working for *satoyama* conservation, the land area that is used for such activities, the number of hours children spend playing outdoors
		Game-hunting/fishing, gathering clams/wild vegetables	Number of participants (according to the Leisure Whitepaper), number of facilities
		Mountain climbing, sightseeing and green tourism	Number of participants (according to the Leisure Whitepaper) and number of facilities
	Art	Traditional crafts	Number of craftsmen, production volume, average age (indicating achievement in training of successors)
		Contemporary art	Number of professionals, production volume, average age (indicating achievement in training of successors)
Supporting services		Soil formation	Land cover, vegetation cover, farmland
		Photosynthesis	Primary production, carbon stock
		Nutrient cycling	Eutrophication/oligotrophication
		Water circulation	Changes in construction in the rivers, changes in artificial beaches

Table 2.4 Assessment items for changes in trends

Assessment items	Definitions in this book and comments
(1) Human use	Trends in the human use of ecosystem services (flow) over the past 50 years: – For provisioning services, an increase in the human consumption of services (e.g. greater food consumption) suggests that "human use" has increased. – In regard to regulating services and cultural services, an increase in the number of people that are affected by these types of services suggests that "human use" has increased.
(2) Enhanced or degraded	Trends in the stock and resilience of ecosystem services over the past 50 years: – For provisioning services, "enhancement" means an increase in service production. Service production increases as the result of changes in the land area from which the services can be provided (e.g. expansion of agriculture), or an increase in production yields per unit area. For example, an increase in biomass accumulation (stock) in coniferous forest plantation means an increase in available timber yields, and is considered "enhanced". On the other hand, if the current service usage exceeds sustainable levels, service production is considered "degraded". – For regulating services and supporting services, "enhancement" means that changes in these types of services bring greater benefits to a larger number of people. "Degradation" in regulating services and supporting services suggests a decrease in benefits that services bring about. This degradation is caused by a change in these types of services (e.g. a reduction of mangrove forests results in a decline in flood prevention benefits that ecosystems provide). It is also caused by human pressure on these types of services exceeding a limit (e.g. excessive water contamination beyond the water quality maintenance ability of ecosystems). – For cultural services, "degradation" means changes in ecological characteristics that can impair cultural benefits provided by the ecosystem (recreational, aesthetic and spiritual benefits, etc).

alternative indicators, we have evaluated each lower-tier ecosystem service and not attempted to evaluate ecosystem services at the middle-tier level.

Table 2.5 shows the direct drivers of changes in ecosystems and ecosystem services identified through the process of the JSSA including all cluster reports. In the context of the MA, a "driver" is any factor that changes

Table 2.5 Direct drivers that have brought about changes in ecosystem services

Direct drivers	Notes
Changes in land use	
Urbanization and development (sprawl development)	Expansion of urban land use such as housing land development, urban area development and urban waterfront area development
Loss of mosaic land use	Loss of mosaic land use in *satoyama* and *satoumi* due to factors such as expansive forest development, farmland restructuring, golf course development, port improvement and seacoast development
Underuse (including succession)	Expansion of abandoned cultivated farmland, and unmanaged (uncared for) coniferous forest plantations and bamboo forests, etc.
Overexploitation	Agricultural, forestry and fishery production beyond a sustainable level (including fishing)
Global/regional warming	– Increase in temperature and the sea surface due to climate change – Change in suitable production areas for agricultural, forestry and fishery products – Change in suitable habitats for wild animals – Heat-island phenomena
Increase in alien invasive species and wild animals	– Increase in alien species such as *Procyon lotor* (common raccoon), *Paguma larvata* (masked palm civet) and *Myocastor coypus* (coypu or nutria) – Increase in wild animals such as *Cervus nippon* (sika deer), *Sus scrofa* (wild boar) and *Phalacrocorax carbo* (great cormorant)
Pollution	– Water contamination due to agrochemical, domestic wastewater and industrial wastewater – Air pollution – Soil contamination due to chemical substances

an aspect of an ecosystem (MA, 2005). A “direct driver” unequivocally influences ecosystem processes and can therefore be identified and measured to differing degrees of accuracy. An “indirect driver” acts more diffusively, often by altering one or more direct drivers. The influence of an indirect driver is clarified only after recognizing the effect exerted by an indirect driver on a direct driver; often both operate synergistically. For example, a land cover change raises the possibility of the introduction of alien species.

Similar to the structure of ecosystem services in Table 2.3, we have comprehensively collated the direct drivers that have been highlighted in the six cluster reports. Based on this, we summarized the direct drivers, considering the importance and commonalities that are meaningful in understanding trends in changes across Japan. As multiple interacting drivers bring about changes in ecosystem services, it is not easy to strictly distinguish each driver and measure their individual effects (MA, 2005).

2.6.3 Scenario analysis

In the MA, scenario analysis was used to discuss and examine diverse changes and changes occurring in various directions, as well as possibilities of changes which ecosystems might follow in the future. It was also used to discuss responses to changes. Scenarios represent plausible alternative futures and indicate feasible consequences under specific hypotheses. Therefore, scenario analysis is often used as a systematic method to creatively examine a complicated and uncertain future. In the process of discussion, such as the selection of scenarios or drivers, it is possible to determine the option for ecosystem management in the future and select countermeasures. This makes it possible to promote specific examination and discussion regarding issues such as ecosystems that should be intensively preserved now and measures that should be implemented immediately (MA, 2003). JSSA is based on the methodology and structure of the scenario analysis in the MA, with Chapter 5 of this book focusing on the direct and indirect drivers that can bring about change in ecosystems as well as in people's attitudes and responses to nature and ecosystem services to draw four types of scenarios for *satoyama* and *satoumi* over a 40 year period to 2050. After defining the scenario storyline, changes in the ecosystem and ecosystem services, as well as future challenges accompanying the changes for each scenario, were projected.

2.6.4 Economic assessment

In the current situation, there are no tangible markets for all ecosystem services. Even if some were to exist, they would be incomplete (i.e. some of the effects of transactions in the markets would be external to the market) and would not be socially or ecologically desirable. For example, the creation of opportunities for ecotourism might create strong economic incentives to maintain regional ecosystem services (cultural services). On the other hand, if complementary agricultural policies are not implemented, this may degrade the ecosystems on which ecotourism depends. In addition to these trade-off relationships, it is impossible to deny that in many cases, development that has destroyed *satoyama-satoumi* ecosystems (through overuse), as well as cessation of management and the resulting abandonment (underuse) have resulted in a loss of the competiveness of ecosystem services in the free global trade of materials and food. This has resulted in an accompanying loss of economic value.

The JSSA analysed and examined changes in the economic value of ecosystem services (Chapter 4) with three main objectives: (1) to understand current conditions, (2) to derive potential values, and (3) to assess the viability of policy implementation.

2.6.5 Responses: Policy options and management

The MA evaluated the application and effectiveness of extensive response options for conservation, restoration and sustainable use of ecosystems, and the ecosystem services that they provide. As indicated in the MA conceptual framework, the implementation of different types of responses can impact on the relationship between indirect and direct factors as well as the influence of the direct drivers on the ecosystems, human ecosystem service requirements, and the changes in indirect factors resulting from the changes in people's lives (MA, 2005). The mechanisms necessary to accomplish these measures include laws, regulations, economic incentives, partnerships and collaboration, information and knowledge sharing. Public and private initiatives are also incorporated.

The JSSA provides a general overview of the responses that have been implemented regarding *satoyama* and *satoumi* in Japan in recent years (Chapter 5). At the same time, it evaluates the effectiveness of these responses. The assessment goes on to discuss the actions which should be taken in the future to realize sustainable management without degrading the ecosystem services of *satoyama* and *satoumi*. Using scenario analysis, Chapter 6 discusses viable countermeasures, as well as presenting suggestions and issues that should be considered when these countermeasures are implemented.

2.7 Interlinkage across ecosystem services and human well-being

2.7.1 Definition and approach to interlinkage

The concept of interlinkage has mainly been used in policy studies on complicated global environmental issues, being regarded as a concept to analyse relationships between policies, such as interlinkages between the different regimes for climate change, the ozone layer, biodiversity, and free trade (Ishii, 2006). However, in addition to the word, "interlinkage", words such as "interaction", "interplay" and "interconnection" have also been used. Various synonyms have been used to refer to interlinkage without clear distinction. Moreover, "interlinkage" originally had a conceptually broad meaning. The way to apply the concept and the context in which the concept is used are also diverse. Therefore, it is difficult to establish a common definition or a common analytical framework for interlinkages.

Generally, the interlinkage to be analysed need not be limited to policies and regimes, but can be broadened to include interlinkages between human society and ecosystems, between members/actors of a social system, and between ecosystem components. In this section, we will review current definitions and analysis techniques that are used when the focus is placed on the interlinkage between ecosystems, ecosystem services and human well-being.

In the report, *Protecting our Planet and Securing our Future* (Watson et al., 1998), interlinkage addresses the interconnections among different environmental issues such as climate change, biodiversity loss and desertification among others. Using this definition, the *Global Environmental Outlook 4* attempted to make an assessment of the interlinkages within and between the biophysical components of the Earth system, environmental change, the development challenges facing human society and the governance regimes developed to address such challenges (UNEP, 2007).

The United Nations University on the other hand has defined interlinkage related to ecosystems as follows: "the interconnections and functioning within and between ecosystems, and the inter-relation of human institutions with ecosystems" (Malabed et al., 2002). In addition, Duraiappah (in Iftikhar et al., 2007) formally discussed ecosystem service interlinkage and further defined interlinkage at three levels. This definition "relates to the interconnections not among environmental issues but among ecosystem services and also the interconnections among: (1) human well-being components such as health, income and security; and (2) the interconnections between ecosystem services and well-being components". At the same time, in close relation to the abovementioned three levels of interlinkage, Iflikhar et al. (2007) revealed the following four types of trade-offs and synergies between ecosystem services and human well-being:

1. Trade-offs and synergies among ecosystem services;
2. Trade-offs and synergies between the present and the future;
3. Trade-offs and synergies among stakeholders; and
4. Trade-offs and synergies across spatial boundaries.

Interlinkage exhibits direct proportional relationships and synergies in which both related factors are tied and simultaneously improve (or degrade). Moreover, it has inverse relationships (trade-off relationships) in which an improvement in one of the related factors causes a degradation in the other factor. Table 2.6 shows the patterns of interlinkage between distinct ecosystem services from the viewpoint of trade-offs and synergies.

Table 2.6 Trade-offs and synergies between ecosystem services

	Ecosystem Service A	
	Improved (enhanced)	Degraded
Ecosystem Service B		
Improved (enhanced)	Win–Win synergies	Trade-offs
Degraded	Trade-offs	Lose–Lose synergies

2.7.2 Interlinkage assessment framework and criteria

In this book, based on the MA conceptual framework, the previously defined interlinkage analysis concept for ecosystem services and human well-being, we have developed an assessment framework as indicated in Figure 2.9.

The MA (2005) has evaluated the interlinkage between ecosystem services and human well-being based on two criteria: the potential for mediation by socioeconomic factors and the intensity of linkage between ecosystem services and human well-being. The strength of the linkages and the potential for mediation differ in different ecosystems and regions. Regarding the potential for mediation, the MA (2005) explains, for example, that if it is possible to purchase a substitute for a degraded ecosystem service, then there is high potential for mediation.

In addition, as is pointed out in the previous section, interlinkage has tradeoffs and synergies. Hence, it is necessary to take this classification into consideration upon assessment. Furthermore, as is discussed by Iftikhar et al. (2007), upon assessment, it would be better to classify interlinkage by considering other dimensions of trade-offs and synergies (time, space and stakeholders).

2.7.3 Key interlinkages

Based on a previous study on the MA framework and ecosystem interlinkage (Iftikhar et al., 2007), this book suggests the following four types of interlinkage: (1) interlinkage between ecosystem services, (2) interlinkage between ecosystem services and human well-being, (3) interlinkage between time and space, and (4) interlinkage between responses (Figure 2.9, Table 2.7).

Each ecosystem service does not exist individually or independently. Instead, all ecosystem services mutually interact and exist in accordance with the regional environment, resources, times and social situations. For example, in order to maximize timber supply, it would be possible to

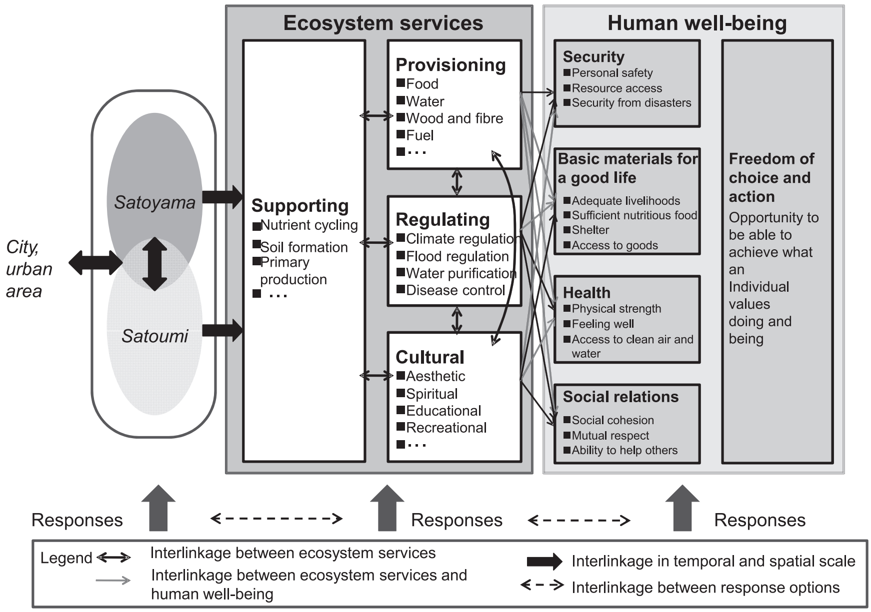

Figure 2.9 Conceptual diagram of interlinkages evaluated in JSSA

consider converting all forest in the region to coniferous forest plantations. However, in this case, the other provisioning services, regulating services, cultural services and supporting services would be somehow affected. Systematic conservation planning is one of the approaches to mitigate such tradeoffs between ecosystem services and to harmonize various demands for land use (Margules and Pressey, 2000). This approach has been applied to designing reserve systems.

In the MA framework, human well-being consists of four elements: “security”, “basic materials necessary for a healthy life”, “health” and “social relationships”, with “freedom of choice and action” being an integral part of all four categories (Figure 2.9). Relationships between ecosystem services provided by *satoyama* and *satoumi* have drastically changed with the times. Moreover, the patterns and the degree of such change has varied in each region. In addition, *satoyama* and *satoumi* are not discrete systems. Instead, on a mesoscale level of watershed areas, they are interrelated, complex systems. Thus, Table 2.7 includes temporal and spatial interlinkages. Furthermore, parties such as the national government, municipalities, companies and citizenry, have implemented a variety of measures for ecosystem service conservation, as well as direct and indirect driver control. As the assessment of responses will be discussed in detail in Chapter 5, in this section, we have summarized

Table 2.7 Key interlinkages in *satoyama* and *satoumi*

Classification	Key interlinkages	Chapter and section in this book
1) Interlinkages between ecosystem services provided by *satoyama* and *satoumi*	(1) Degradation of other ecosystem services due to excess use of provisioning services from *satoyama* and *satoumi* (2) Degradation and enhancement of other ecosystem services due to underuse of provisioning services from *satoyama* and *satoumi*	Chapter 4 4.2.1
2) Interlinkages between *satoyama–satoumi* ecosystem services and human well-being	(1) Enhancement of human well-being through improvement in food provisioning services in the agriculture, forestry and fisheries industries in *satoyama* and *satoumi* (2) Degradation of ecosystem services in *satoyama* in conjunction with enhancement in human well-being due to the energy revolution and fertilizer revolution (3) Degradation of supporting services in *satoumi* in conjunction with enhancement in human well-being due to development such as landfill reclamation in coastal areas	Chapter 4 4.4.1
3) Temporal and spatial interlinkages in *satoyama* and *satoumi*	(1) Degradation of current ecosystem services due to the exploitive use of past provisioning services in *satoyama* and *satoumi* (2) Degradation of ecosystem services in lower-reach *satoumi* ecosystems due to excess use of fertilizer to improve provisioning services in farmland in upper-reach *satoyama* ecosystems (3) Degradation of supporting services in *satoyama* and *satoumi* in areas that have experienced depopulation due to population movement into urban areas	Chapter 4 4.2.2
4) Interlinkages between responses in *satoyama* and *satoumi*	(1) Agricultural village policies, agricultural policies, and forest and forestry policies (2) Food security, as well as production control policies, on agricultural products and marine products (3) Natural environment conservation policies and resource recycling polices (e.g. biomass use promotion policy)	Chapter 5

interlinkage between responses in Table 2.7. For details of each interlinkage, see Chapters 4 and 5.

2.8 Key findings

Definition of satoyama *and* satoumi

We found that *satoyama* and *satoumi* landscapes can be defined as dynamic mosaics of managed socio-ecological systems producing a bundle of ecosystem services for human well-being.

Modification of the MA conceptual framework for JSSA

The JSSA uses the MA conceptual framework as the underlying conceptual framework for its assessment. A number of modifications were made to the MA conceptual framework to make it more applicable to the Japanese assessment. This included adding *satoyama* and *satoumi* into the conceptual framework of the MA (Figure 2.8). In this way, the direct drivers affected by indirect drivers cause changes in *satoyama* and *satoumi* landscapes, which subsequently results in changes in the supply of ecosystem services essential for various constituents of human well-being, and then provides feedback to indirect drivers such as lifestyle transformation.

Identification of major ecosystem services provided by satoyama *and* satoumi

We have integrated the ecosystem services that have been analysed in the six cluster reports into the comprehensive list of ecosystem services provided by *satoyama* and *satoumi* (Table A1). We have refined this list and identified the ecosystem services from *satoyama* and *satoumi* for the national scale assessment (Table 2.3).

Identification of interlinkages associated with ecosystem services from satoyama *and* satoumi *and human well-being*

We have developed the conceptual framework of interlinkage analysis on the basis of previous studies, and identified the following four types of interlinkage associated with ecosystem services from *satoyama* and *satoumi* and human well-being:

1) Interlinkage between ecosystem services in *satoyama* and s*atoumi*;
2) Interlinkage between *satoyama-satoumi* ecosystem services and human well-being;

3) Temporal and spatial interlinkage in s*atoyama* and *satoumi*; and
4) Interlinkage between responses in *satoyama* and *satoumi*.

Notes

1. For the word, *satoumi*, mentioned in this subsection, see applicable sections in the JSSA cluster reports (JSSA – Seto Inland Sea Group of Western Japan Cluster, 2010; JSSA – Hokushinetsu Cluster, 2010; JSSA – Kanto–Chubu Cluster, 2010)
2. See glossary.
3. See glossary.

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3

What are the key drivers of change and current status of *satoyama* and *satoumi*?

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3.1 Introduction

In this chapter, drivers related to *satoyama* and *satoumi* listed in Chapter 2 and their relationships with ecosystem services are discussed in greater detail. As introduced in Chapter 2, changes in *satoyama* and *satoumi*'s mosaic structure and underuse were added to the list of direct drivers of change. Due to a lack of quantitative data, direct drivers are simply given as "present or absent (unclear)".

As highlighted in Chapter 2, the supply of some ecosystem services has not really decreased in Japanese *satoyama* and *satoumi* landscapes, but human use has dropped for reasons other than a decreasing supply (see Box 3.1). For example, the stock of timber has increased but the actual use of timber has dropped. Therefore, to capture the dichotomy that arises in some cases between supply and use, Table 3.1 presents both improvement or deterioration of the supply, and changes in their use.

Overall, the supply of ecosystem services from *satoyama* and *satoumi* landscapes is rapidly diminishing. The major reason for this is not exploitation or over-use as in many other countries but their underutilization. Many indirect drivers ranging from globalization to demographic changes have been the main reasons for the under-use. Some ecosystem services have been maintained even though human use has decreased, such as timber, but others have decreased significantly, such as rice production, and the various components of cultural services. Further, the diversity within both *satoyama* and *okuyama* is being threatened in many parts of

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Table 3.1 Changes in ecosystem services, direct drivers and human well-being

Ecosystem services			Human use	Enhanced or degraded	Indicators, criteria	Direct Drivers: Changes in land use: Urbanization and development (sprawl development)	Direct Drivers: Changes in land use: Loss of a mosaic	Direct Drivers: Underuse (including succession)	Direct Drivers: Overexploitation	Direct Drivers: Global/regional warming	Direct Drivers: Exotic species	Direct Drivers: Pollution	Human well-being
Provisioning	Food	Rice	↘	→	Crop yields, size of area under cultivation, yield per 10 are	√		√		√			+/–
		Livestock	↗	↗	–								+
		Matsutake mushrooms	↘	↘	Production volume			√					+/–
		Marine fishery	↘	↘	Catches	√		√	√	√		√	+/–
		Mariculture	↗	NA	Catches	√						√	+
	Fabric	Material (timber)	↘	↗	Forestry production index number, standing tree store	√		√			√		+/–
		Firewood and charcoal	↘	↘	Forestry production index number	√		√					+/–
		Sericulture	↘	↘	Cocoon harvest, size of mulberry-growing area			√					+/–

Table 3.1 (cont.)

Ecosystem services			Human use	Enhanced or degraded	Indicators, criteria	Direct Drivers: Changes in land use: Urbanization and development (sprawl development)	Direct Drivers: Changes in land use: Loss of a mosaic	Direct Drivers: Underuse (including succession)	Direct Drivers: Overexploitation	Direct Drivers: Global/regional warming	Direct Drivers: Exotic species	Direct Drivers: Pollution	Human well-being
Regulating	Air quality regulation		↗	+/–	NOx, SOx concentration, amount of DSS aerosol and endocrine disruptor	√		√				√	+/–
	Local climate regulation		↗	+/–	Temperature change, precipitation change	√		√		√			+/–
	Water regulation	Flood control	↗	↘	Total area of rice paddies, number of irrigation ponds	√	√	√					+/–
	Water purification		↗	+/–	Total area of forests, amount of chemical fertilizer and pesticide used, sewage disposal service coverage ratio	√	√	√				√	+

Regulating	Soil erosion regulation	Farmlands and forests	↗	↘	Area of abandoned cultivated land, changes in forest types	√	√	√			√		+
		Coastal area (sediment control)	↗	↘	Sediment supply	√		√					–
	Pest control and pollination		↘	↘	Amount of pesticide used, area of abandoned cultivated land, changes in forest types	√	√	√					–
Cultural	Spiritual	Religion	↘	↘	Number of temples and shrines, size of sacred groves	√							–
		Festivals	↘	↘	Number of festival types, use of plants for flower offerings	√							–
	Aesthetic	Scenery	↘	↘	Number of applications for the Best 100 *Satoyama* Selection	√							–

Table 3.1 (cont.)

Ecosystem services			Human use	Enhanced or degraded	Indicators, criteria	Direct Drivers: Changes in land use: Urbanization and development (sprawl development)	Direct Drivers: Changes in land use: Loss of a mosaic	Direct Drivers: Underuse (including succession)	Direct Drivers: Overexploitation	Direct Drivers: Global/regional warming	Direct Drivers: Exotic species	Direct Drivers: Pollution	Human well-being
Cultural	Recreation	Education	↗	↘	Number of people and NGOs working for *satoyama* conservation, land area that is used for such activities, the number of hours children spend playing outdoors	√							+/−
	Recreation	Game-hunting/fishing, gathering clams/wild vegetables	↘	↘	Number of participants (according to Leisure whitepaper), number of facilities	√							−
		Mountain climbing, sightseeing and green-tourism	↗	↘	Number of participants (according to Leisure whitepaper), number of facilities	√							+

Cultural	Art	Traditional craft	↘	NA	Number of professionals, production volume, average age (that indicates achievement in training of successors)	√							–
		Contemporary Art	NA	NA	Number of professionals, production volume, average age (that indicates achievement in training of successors)								NA
Supporting		Soil formation			Land cover, vegetation cover, farmland								
		Photosynthesis			Primary production, carbon stock								
		Nutrient cycling			Eutrophication/ oligotrophication								
		Water circulation			Changes in construction in the rivers, changes in artificial beaches								

Table 3.1 (cont.)

Trends in ecosystem services		
Backed by data	Without any supporting data	Definition
↗	↗	A monotone increase (for human use column) or enhanced (for enhanced or degraded column) for the last 50 years
↘	↘	A monotone decrease (for human use column) or degraded (for enhanced or degraded column) for the last 50 years
→	→	No change (for human use column and enhanced or degraded column) for the last 50 years
+/–	+/–	Mixed (trend increases and decreases over past 50 years or some components/regions increase while others decrease)
NA	NA	Not assessed

The direct drivers that have influenced ecosystem services	
Code	Definition
√	The direct drivers that have influenced ecosystem services
	The direct drivers that have not influenced ecosystem services/unknown

Trends in the effect on human well-being	
Code	Definition
+	Enhanced in recent years
–	Degraded in recent years
+/–	Mixed (enhanced for some people/in some regions while degraded for others/in other regions)

Japan due to a rapid increase in the numbers of some wildlife species, such as *Cervus nippon* (sika deer). For example, *C. nippon* (sika deer) are expanding their habitat into high mountainous areas, such as the southern Japanese Alps, thereby damaging fragile vegetation. However, there is some contention as to the actual driver of this change in vegetation as some experts point to global warming for this loss in diversity. Climate change is affecting vegetation and simulataneously expanding the habitat areas of *C. nippon* (sika deer) because of changes in snowfall.

Environmental pollution was a serious issue from the 1950s to the 1970s, but it is somewhat improving. However, environmental benchmarks (e.g. nutrient enrichment) have not been met in many areas, and have remained steady.

3.2 Indirect and direct drivers

This section provides an overview of the indirect and direct drivers. Indirect drivers include population, economy, public policy, science and technology, and culture and religion. Key direct drivers were found to be changes in land use (development and loss of mosaic), underuse (including succession), overuse, regional/global climate change, invasive species and pollution.

3.2.1 Economy

After World War II, the Japanese economy grew rapidly, which in turn had significant impacts on the other indirect drivers of population, public policy, science and technology, and culture and religion. The industrialization and globalization of Japan caused a decline in domestic agricultural, forestry and fishery industries. For example, *Cryptomeria japonica* (Japanese cedar) and *Chamaecyparis obtusa* (Japanese cypress) forests were established immediately after World War II to meet the growing demand for timber. However, these tree plantations were abandoned once cheaper timber imports were found (Figure 3.2). The same trends were observed for other agricultural products, in particular rice (as shown in Figure 3.3). The increase in imports of forest and agricultural products coupled with a growing urban population were primary factors for the abandonment of farms and logging companies. The increase in imports was also found to have been an indirect driver of change due to the introduction of the direct driver – invasive species – through the discharge of ballast water by ships (JSSA – Kanto–Chubu, 2010).

Box 3.1 Transformation of ecosystem services around Aya over the past 50 years

The assessment used a case study of the areas surrounding the town of Aya (from the mountain-ringed region through the Oyodo River down to the estuary) to investigate changes in ecosystem services over the past 50 years and the drivers of changes. The case study focused on biodiversity (in natural forests and coniferous forest plantations), provisioning services (e.g. timber, charcoal, agricultural production and quantity of *Plecoglossus altivelis altivelis* [sweetfish; "*ayu*"] caught), regulating services (e.g. flow volume, soil conservation costs, river contamination and changes in the estuary boundary), and cultural services (e.g. sightseeing, various efforts in the town of Aya, eco-tourism and the restoration of a subtropical/warm-temperate evergreen broadleaved forest in Aya) to understand the changes in Aya over the past 50 years. In analysing the drivers of changes, we considered the unique historical background of Aya, which shifted to nature conservation policies that banned evergreen broadleaved forest cultivation, promoted recycling agriculture with organic farming at its core and encouraged resource utilization through tourism-related policies, and examined how these drivers have further affected human well-being. Utilized data include those contributed by each author, statistical data from the town of Aya and Miyazaki Prefecture, an agricultural and forestry census and a fishery census of Japan, and information on Aya's local history. The results are shown in Figure 3.1.

The town of Aya is located between the Aya Kita River and the Aya Minami River. It is located in the alluvial terrain (elevation of 20 m) in which both rivers reach the flatland, coming from the mountainous region centred around Mount Ohmori (1108 m). The hillside is a volcanic ash diluvial plateau. Therefore, the town has well-developed paddy fields and spring water, but often experiences flooding when typhoons approached. As a result, the town of Aya and Miyazaki Prefecture constructed the Aya River dam in 1953, allowing the townspeople to live stable lives and conduct agriculture. However, the river environment changed drastically which resulted in a reduction in the quantity of freshwater fish caught, including the golden sweetfish (*P.a. altivelis*). Also, the shift to forest plantations through expansive afforestation peaked in the 1950s, but policy in Aya left some evergreen broadleaved forests. As a result, the town's timber production was low compared to other regions (amount of forest plantation = 40 per cent, average in Miyazaki Prefecture = 60 per cent), but the remaining evergreen broadleaved forests served the town well in terms of tourism, which resulted in better economic performance of the locality. This led

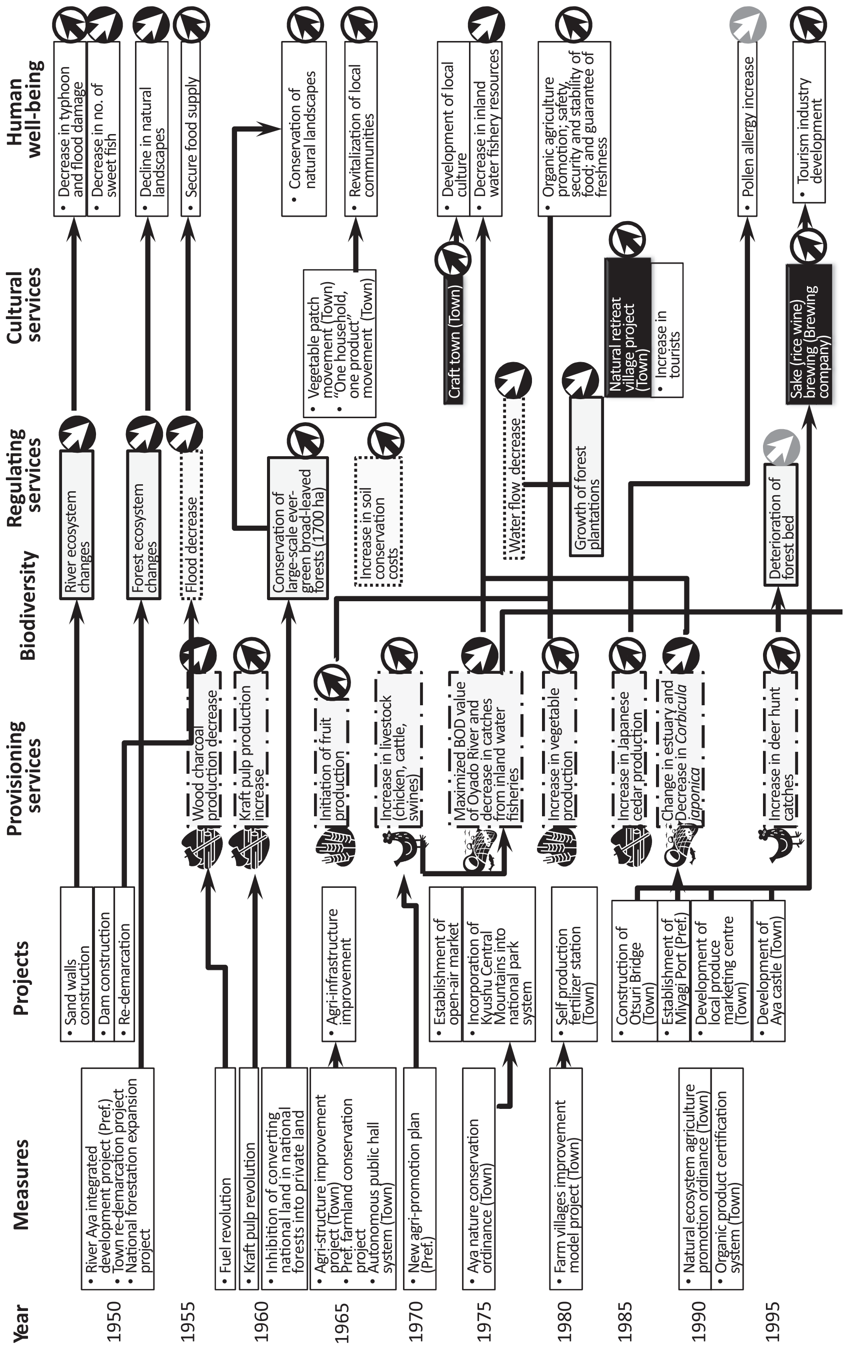
Box 3.1 (cont.)

to the restoration of a subtropical/warm-temperate evergreen broad-leaved forest in Aya (which started in 2005) and the establishment of a forest therapy base (which started in 2008). The promotion of organic farming in the town of Aya was initially developed in the 1970s. Manure is processed into liquid fertilizer, contributing to the Aya agricultural product brand; products that do not depend on chemical fertilizers. Organic farming has had direct and positive impacts on human well-being, such as contaminant regulation, food safety, reliability, stability and fresh products. This also had positive effects on local tourism. Regional planning seen in Aya is a good example of effectively utilizing that which appears to have no economic value, like the conservation of evergreen broad-leaved forests and promotion of organic farming, which led to enhanced human well-being, and concurrently created a successful brand name for the town of Aya.

3.2.2 Culture and religion

Economic growth markedly changed Japanese lifestyle and culture. Westernization of foods reduced rice consumption, essential in the Japanese traditional diet (Figure 3.3), which led to the underuse of paddy fields through rice production adjustment policies. Meat and milk consumption increased, but the use of grassland declined due to dependence on import feed (JSSA – West Japan Cluster, 2010). Similarly, oil and natural gas replaced wood and charcoal to support the rapid industrialization and modernization of Japan after World War II (JSSA – West Japan Cluster, 2010). In addition, demand for raw building materials cultivated in *satoyama*, such as straw and bamboo, decreased over this period. This in turn led to a decrease in the amount of land under *satoyama* management practices.

In addition to changing food habits and demand for modern westernized housing, changes in leisure also influenced *satoyama* landscapes. The introduction of golf and its popularity led to golf course developments in many *satoyama* landscapes causing a disruption to the mosaic structure unique to *satoyama*. In summary, cultural changes in the form of changing food habits, housing styles and leisure interests have had a profound effect on the demand for *satoyama* landscapes and the ecosystem services they supply. No major change occurred in religion according to the JSSA – Cluster Reports, but the JSSA – Kanto–Chubu Cluster (2010) pointed out that loss of respect for nature and the increasing demand for economic returns and efficiency led to overharvesting in some cases and abandonment of management practices – underuse – in other areas.



Year
Measures
Projects
Provisioning services
Biodiversity
Regulating services
Cultural services
Human well-being
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
• River Aya integrated development project (Pref.)
• Town re-demarcation project
• National forestation expansion project
• Fuel revolution
• Kraft pulp revolution
• Inhibition of converting national land in national forests into private land
• Agri-structure improvement project (Town)
• Pref. farmland conservation project
• Autonomous public hall system (Town)
• New agri-promotion plan (Pref.)
• Aya nature conservation ordinance (Town)
• Farm villages improvement model project (Town)
• Natural ecosystem agriculture promotion ordinance (Town)
• Organic product certification system (Town)
• Sand walls construction
• Dam construction
• Re-demarcation
• Agri-infrastructure improvement
• Establishment of open-air market
• Incorporation of Kyushu Central Mountains into national park system
• Self production fertilizer station (Town)
• Construction of Otsuri Bridge (Town)
• Establishment of Miyagi Port (Pref.)
• Development of local produce marketing centre (Town)
• Development of Aya castle (Town)
Wood charcoal production decrease
Kraft pulp production increase
Initiation of fruit production
Increase in livestock (chicken, cattle, swines)
Maximized BOD value of Oyado River and decrease in catches from inland water fisheries
Increase in vegetable production
Increase in Japanese cedar production
Change in estuary and Decrease in Corbicula japonica
Increase in deer hunt catches
River ecosystem changes
Forest ecosystem changes
Flood decrease
Conservation of large-scale ever-green broad-leaved forests (1700 ha)
Increase in soil conservation costs
Water flow decrease
Growth of forest plantations
Deterioration of forest bed
• Vegetable patch movement (Town)
• "One household, one product" movement (Town)
Craft town (Town)
Natural retreat village project (Town)
• Increase in tourists
Sake (rice wine) brewing (Brewing company)
• Decrease in typhoon and flood damage
• Decrease in no. of sweet fish
• Decline in natural landscapes
• Secure food supply
• Conservation of natural landscapes
• Revitalization of local communities
• Development of local culture
• Decrease in inland water fishery resources
• Organic agriculture promotion; safety, security and stability of food; and guarantee of freshness
• Pollen allergy increase
• Tourism industry development

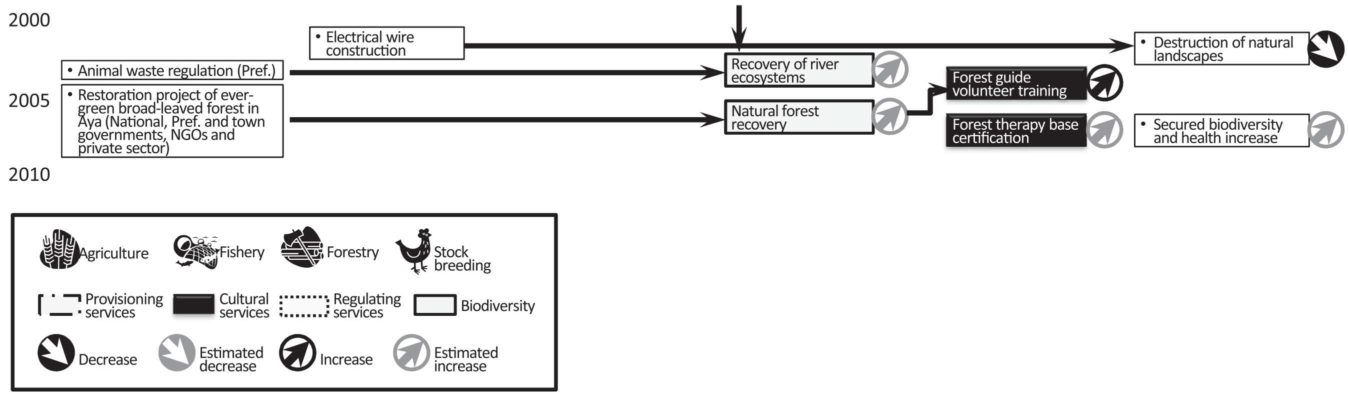


Figure 3.1 Transformation of the ecosystem services in the town of Aya and surrounding area over the last 50 years and drivers of changes

Figure 3.2 Imported timber
Source: Policy Planning Division of Forestry Agency (2008).

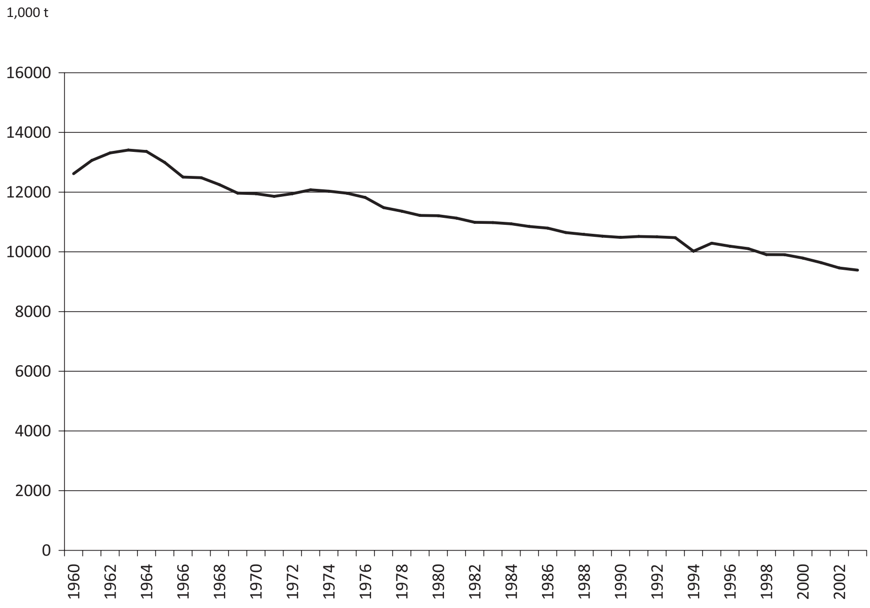


Figure 3.3 Rice supply for domestic consumption
Source: Ministry of Agriculture, Forestry and Fisheries, Japan (2009).

3.2.3 Science and technology

The focus on and respect for science and technology as a means to rebuild Japan after World War II led to the disappearance of traditional farming methods (see Box 3.2). Cattle and horses for ploughing and conveyance disappeared with the spread of tractors, and draft animal production changed to beef breed production and dairy husbandry. Farmland consolidation, soil/ground improvement, separation of irrigation and drainage canals, and preparation of farm roads also replaced many of the traditional farming methods employed in *satoyama* landscapes. The JSSA – Hokushinetsu Cluster (2010) highlights the increased use of chemical fertilizers and pesticides as a burden on the environment (pollution), although its use began to decrease around 1970.

In *satoumi* areas, the efficiency of fishing boats and related equipment increased, but this partially led to overfishing. The JSSA Hokushinetsu Cluster (2010) pointed out that port areas were expanded and breakwaters were extended with the upsizing of fishing boats. Fish farming and aquaculture industries with modern technology were also developed.

3.2.4 Population

With the economic growth and decline of the agricultural, forestry and fishery industries, residents of farming communities (mostly overlapping *satoyama*) began seeking involvement in commerce and industry (which was promoted also by group employment from rural villages after World War II). Mechanization of rice production shortened labour time and increased the time available for engaging in a side job (JSSA – Tohoku Cluster, 2010), and many people moved to urban areas with abundant commercial and industrial job opportunities (Figure 3.4). While the national population increased (94.30 million in 1960 to 127.77 million in 2005: National Census), population decline and ageing occurred in farming communities (Figure 3.5). Management of mountains, forests and farmland became difficult with the population decline, and this trend has been observed to be accelerating in certain regions.

On the other hand, population density has increased and urban areas have expanded (densely inhabited district is defined as several national census survey districts with a population density of about 4,000/km^2 or greater adjacent and the combined population per km^2 exceeding 5,000) (Figure 3.6). This development further extended to the coast lines, the prime example being their reclamation. For example, about 20 per cent of the shallow region 10 m or less in depth of the Seto Inland Sea was reclaimed (JSSA – Seto Inland Sea Group of Western Japan Cluster, 2010). In cities and neighbourhoods, water and air became polluted and during the high-economic growth period (middle of the 1950s – early

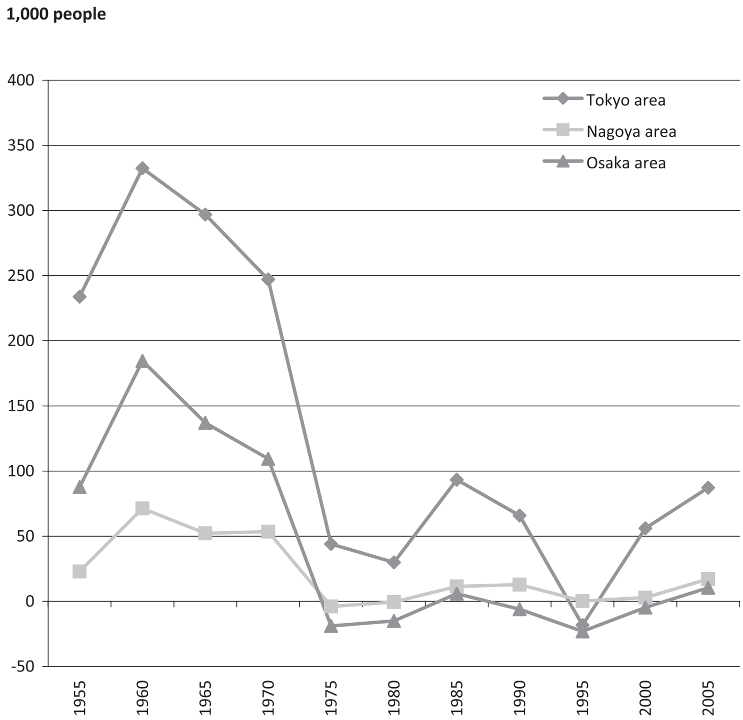


Figure 3.4 Excess population flow into three major urban areas
Source: Statistics Bureau, Ministry of Internal Affairs and Communications, Japan (2010a).

1970s), severe pollution associated with major pollution diseases, such as Minamata disease, occurred. However, with the improvement of sewage systems, water pollution was considerably reduced in some but not all regions. In Tokyo Bay for example, nitrogen levels are still high, but the overall water quality and sediment contamination have been improving (JSSA – Kanto–Chubu Cluster, 2010). A more recent phenomenon associated with the rapid growth of cities and the destruction of *satoyama* landscapes has been increasing temperatures in cities particularly during the summer months.

3.2.5 Public policy

Recent land use was greatly influenced by the City and Town Planning Act (1968), which prevented the unregulated development of cities and their surrounding areas to an extent. For example, diversion of farmland to residential land was promoted in areas designated for urbanization, while development was suppressed in controlled urbanization areas,

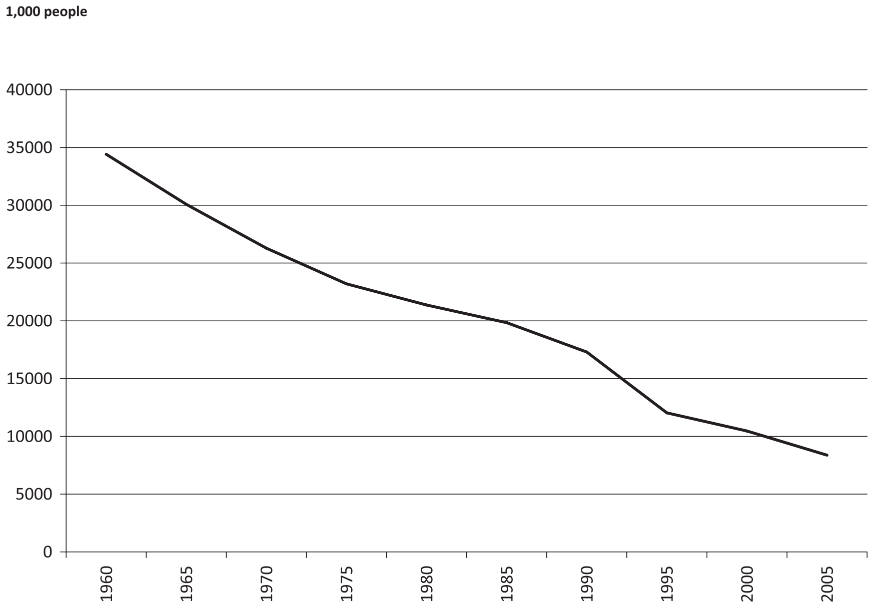


Figure 3.5 Farm households population
Source: Statistics Bureau, Ministry of Internal Affairs and Communications, Japan website http://www.stat.go.jp/data/chouki/index.htm.
Note: The statistics between 1995 and 2005 only include the population of commercial farmers' households.

although the preparation of public facilities was allowed. Similarly, the Act on Establishment of Agricultural Promotion Regions prevented the conversion of farmland for non-agricultural use in areas designated for farmland.

The rice production adjustment substantially affected agriculture. The JSSA – West Japan Cluster (2010) pointed out that rice production adjustment was a remote cause of the abandonment of cultivation in hilly and mountainous areas. In *satoumi* areas, fishery regulation affected the total quantity of catch allowed. Ironically, the Act on Development of Comprehensive Resort Areas (Resort Law), aiming at promotion of the resort industry, is frequently criticized for its destruction of nature.

3.3 Trend of changes in provisioning services and direct drivers

In this section, changes in provisioning services and the direct drivers responsible for these changes are explained. As described in Chapter 2,

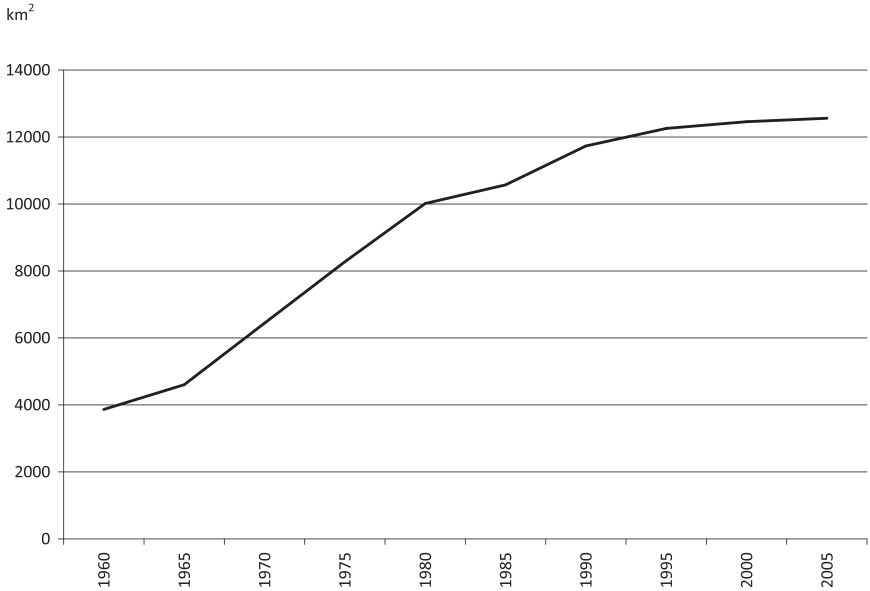


Figure 3.6 Area of densely inhabited districts
Source: Statistics Bureau, Ministry of Internal Affairs and Communications, Japan (2010b).

services are evaluated with regard to the following two viewpoints: "use by humans" and "improvement/deterioration of the ecosystem services".

3.3.1 Rice provisioning service

Almost all paddy fields are within *satoyama* landscapes. Currently, paddy fields are present everywhere from mountainous areas to flatland, but cultivated areas have recently been decreasing (Figure 3.7; 1 ha = 10,000 m^2). Corresponding to the excess provisioning of rice, expansion of rice fields has remained low since 1978 (Statistics Department, Minister's Secretariat, Ministry of Agriculture, Forestry and Fisheries, Japan, 2008). On the other hand, loss of *satoyama* land due to urban development was striking in large urban areas, while abandonment of cultivation was primarily witnessed in depopulated areas (JSSA – West Japan Cluster, 2010). This also applies to regions other than Western Japan. In the Kinki region, about 39 per cent of paddy fields present in the 1980s became urban areas (JSSA – West Japan Cluster, 2010), showing a typical example of paddy field loss due to urban development. Figure 3.8 shows the recent area of abandoned farmland (note that abandoned farmland is also

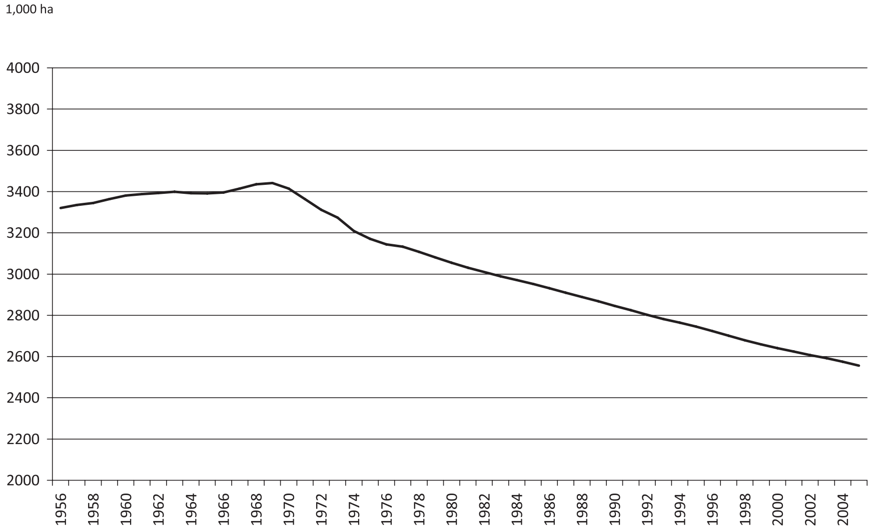


Figure 3.7 Cultivated area of rice field
Source: Statistics Department, Minister's Secretariat, Ministry of Agriculture, Forestry and Fisheries, Japan (2008).

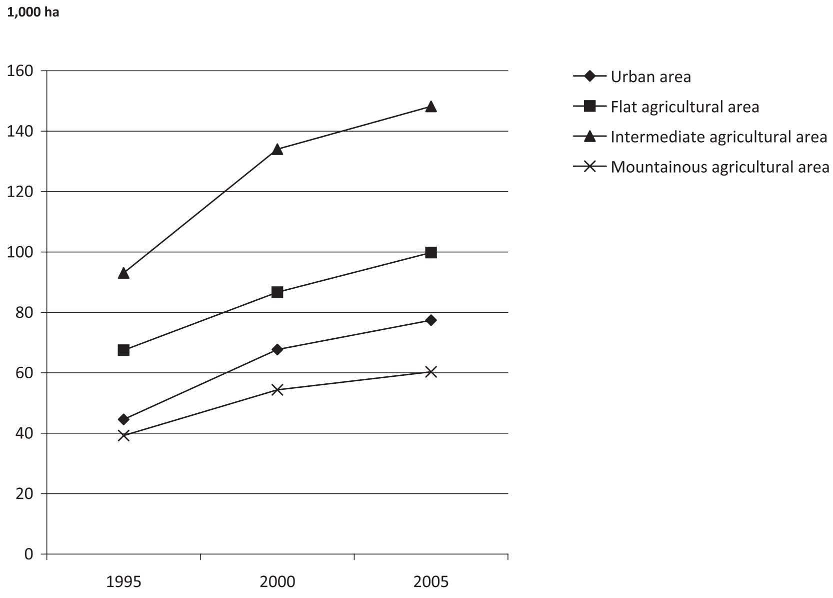


Figure 3.8 Area of abandoned farmland (including non-rice fields)
Source: Information Division of Minister's Secretariat, Ministry of Agriculture, Forestry and Fisheries, Japan (2007).

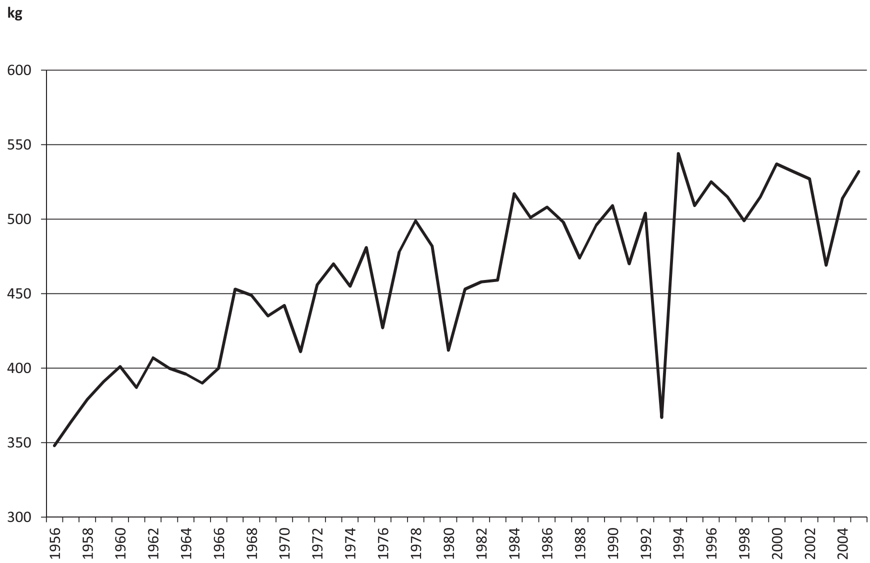


Figure 3.9 Rice yield per 10 are (1,000 m^2)
Source: Ministry of Agriculture, Forestry and Fisheries, Japan (2007).

present in urbanized areas), the restoration of which becomes difficult with time (Arita et al., 2003).

On the other hand, the paddy-field rice yields per 10 a (also called *tan* (1,000 m^2) (yield/*tan*)) increased through farmland consolidation and the use of chemical fertilizers and pesticides (Figure 3.9). However, the product of the cultivated area and the yield/*tan* (yield per 10a) did not change significantly (Figure 3.10), showing that the reduction of area under rice cultivation was balanced out by the increase in yield. Thus, it is hard to say whether or not the rice provisioning service capability of the ecosystem improved or deteriorated.

It was also noted that the crop yields of rice was decreasing, exceeding 14 million tons at peak levels but with present levels below 10 million tons (Figure 3.11). Figure 3.12 shows the area withdrawn from rice production adjustment (policy trimming rice production). The execution rate of this policy was nearly 100 per cent. However, a review of the rice production adjustment policy is currently in progress, so there is the possibility that this may change in the future.

The influence of climate change may become non-negligible in the future. On the assumption of a 2.8ºC temperature increase in Japan in 2050, compared to the temperature in 1990 (MIROC), rice yields will increase by 26 and 13 per cent in Hokkaido and Tohoku respectively, while a decrease of 5 per cent in Kinki and Shikoku is given in some pre-

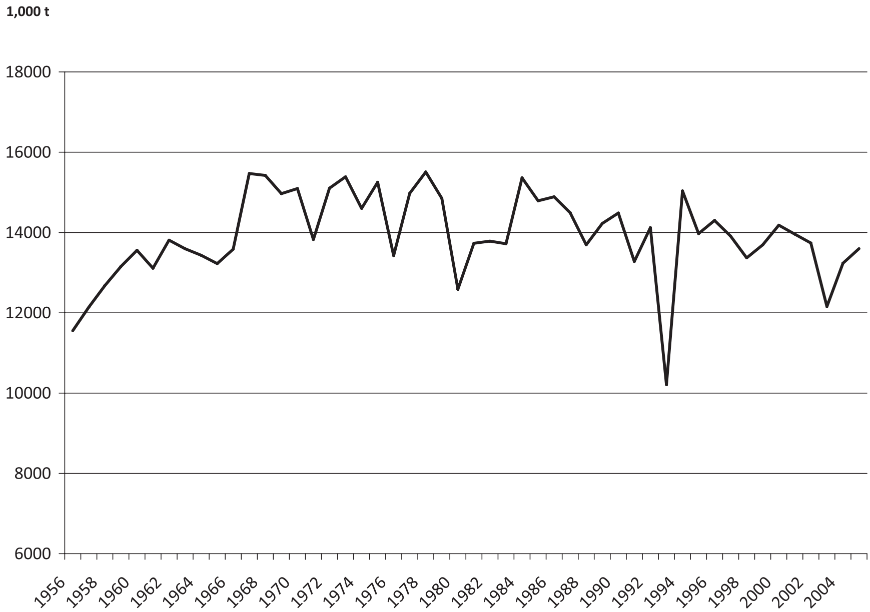


Figure 3.10 Cultivated area of rice field × yield/*tan* (10 are).

dictions (Comprehensive Impact Assessment Team, 2008). The JSSA – Hokushinetsu Cluster (2010) reported a decrease in the quality of rice caused by climate change.

In summary, the key direct drivers of changes in rice provisioning service are urban development, underuse and climate change.

3.3.2 Vegetable, wheat and fruit provisioning services

The area for growing vegetables was rapidly decreasing until about 1975 but stopped thereafter (Figure 3.13). In contrast, the area of fruit farms increased until about 1975 but continuously decreased thereafter and fell to about half of the peak (Figure 3.14).

Since there are many types of vegetables, the agricultural production index (API) (production in year 2000 = 100) is used to evaluate demand (Figures 3.15 and 3.16). As changes in the API reflect changes in production quantities, changes in API can be regarded as changes in demand. As Figure 3.15 shows, the production of wheat, beans and potatoes has decreased. Similarly, the production of vegetables and fruit increased during the 1960s and 1970s but then decreased. However, there was some variation across regions. For example, the JSSA – Kanto–Chubu Cluster (2010) revealed that the production of lettuces and strawberries

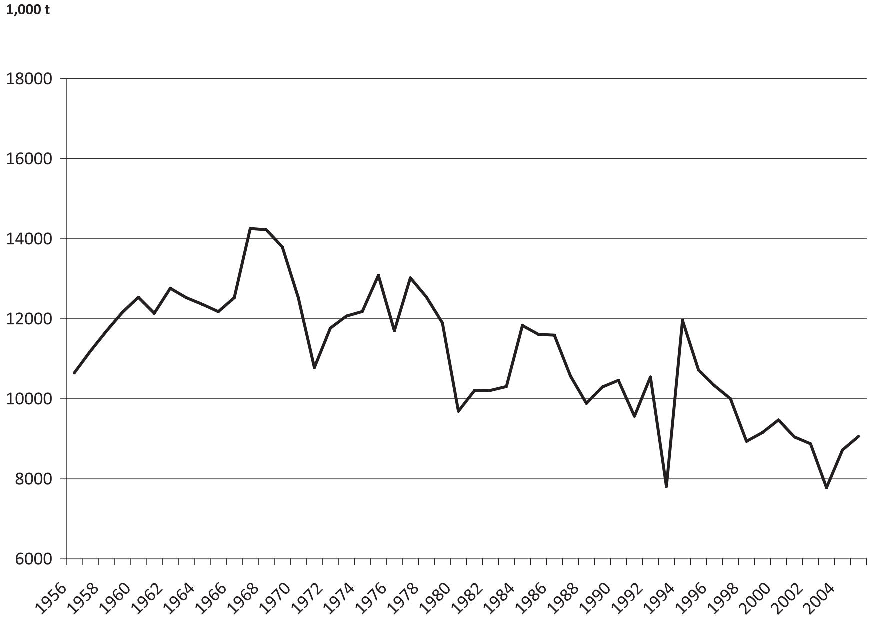


Figure 3.11 Crop of paddy-field rice
Source: Ministry of Agriculture, Forestry and Fisheries, Japan (2007).

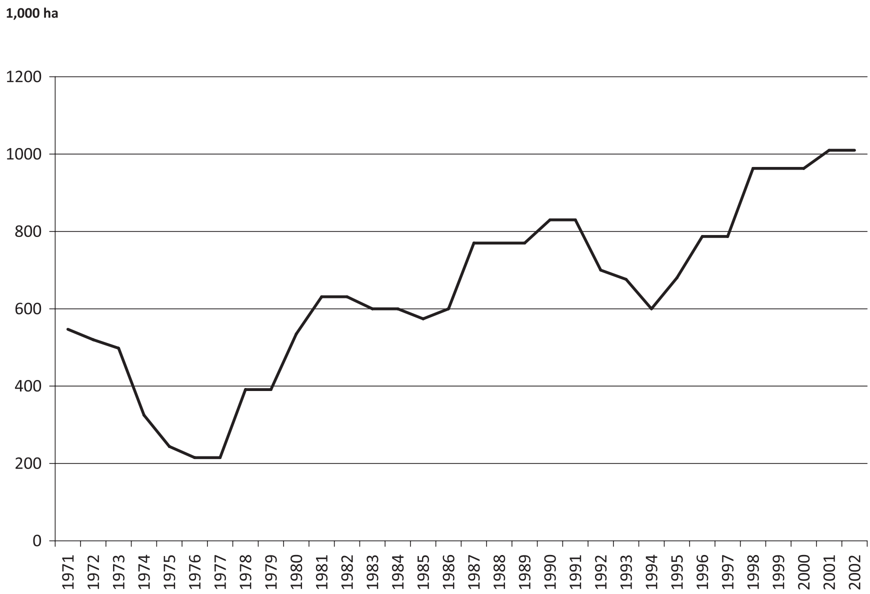


Figure 3.12 Target land area set by production adjustment
Source: Ministry of Agriculture, Forestry and Fisheries, Japan (2002).

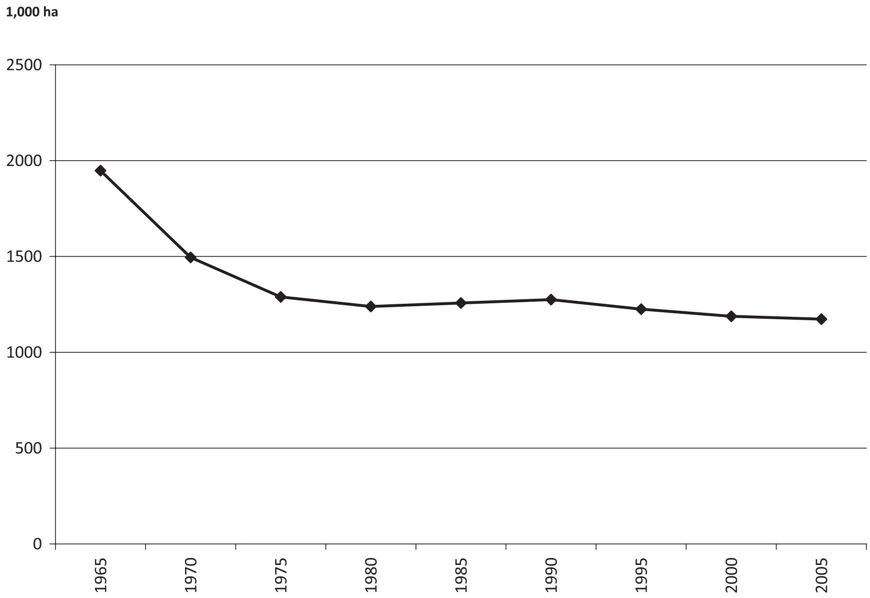


Figure 3.13 Cultivated area of vegetable fields
Source: Statistics Department, Minister's Secretariat, Ministry of Agriculture, Forestry and Fisheries, Japan (2008).

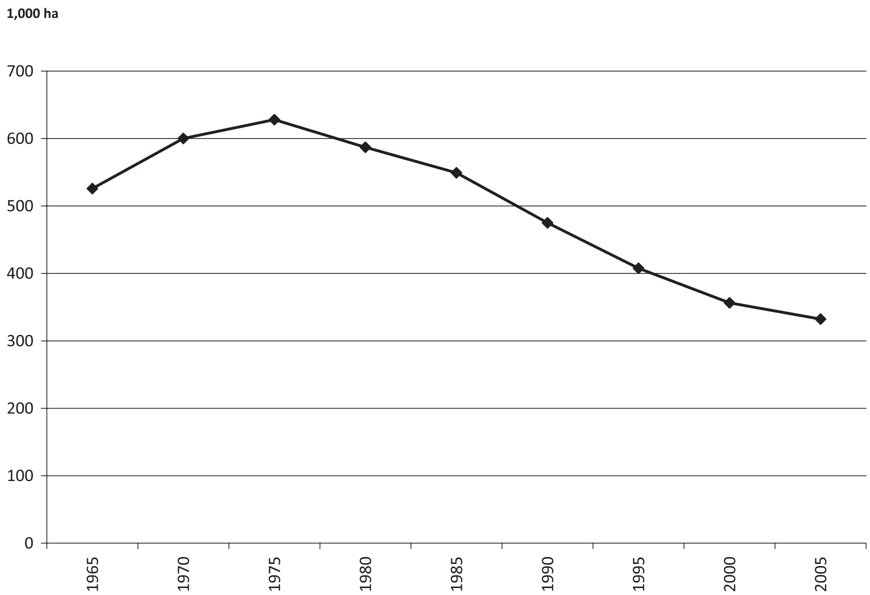


Figure 3.14 Cultivated area of fruit farm fields
Source: Ministry of Agriculture, Forestry and Fisheries, Japan (2008).

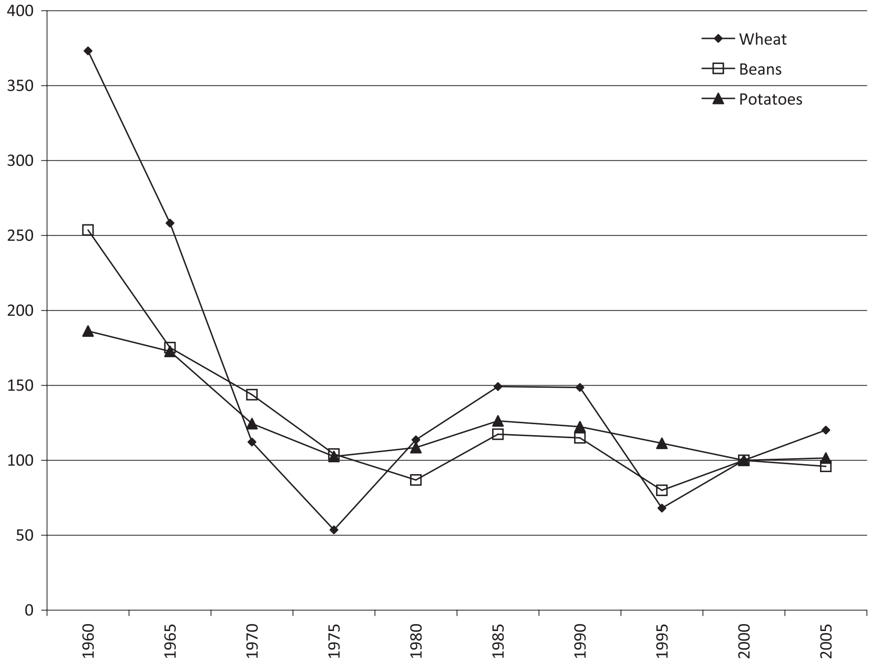


Figure 3.15 Agricultural production indices of wheat, beans and potatoes
Source: Minister's Secretariat, Ministry of Agriculture, Forestry and Fisheries, Japan (2006).

increased, while those of cucumbers and mandarin oranges decreased. Generally, vegetables are produced in the suburbs of large cities.

3.3.3 Livestock provisioning services

There are many types of "livestock", such as dairy cows, beef cattle, pigs, broilers and others, which offer numerous products (such as eggs, milk, meat, etc.). Overall changes (human use) in demand for livestock products are based on the API (production in 2000 = 100). Figure 3.17 shows that livestock production markedly increased, although there has been a slight decrease recently. Imports of beef increased significantly since the liberalization of beef imports in 1991. However, domestic cattle remain for high-grade products but feed is mostly met by imports[1].

3.3.4 Food provisioning services from mountain forests

The production of *matsutake* mushrooms has considerably decreased (Figure 3.18). The JSSA – Hokushinetsu Cluster (2010) revealed that the

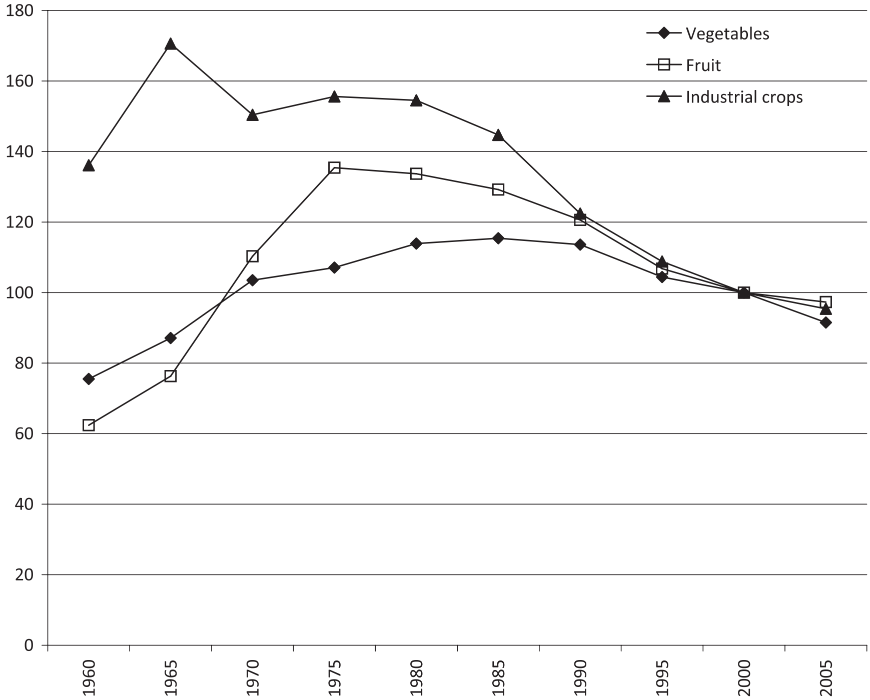


Figure 3.16 Agricultural production indices of vegetables, fruit and industrial crops
Source: Minister's Secretariat, Ministry of Agriculture, Forestry and Fisheries, Japan (2006).

collection of mushrooms, including *matsutake*, has become difficult due to the underuse of *Pinus densiflora* (Japanese red pine) forest. Therefore, although mushroom production has markedly increased according to the forestry production index (production in year 2000 = 100) (Figure 3.19), this amount includes cultivated mushrooms. Drawing on Figures 3.18 and 3.19, we can infer that wild mushroom production has decreased but overall mushroom production has increased because of a much higher amount of production in cultivated farms.

A recent problem concerns bamboo shoots. *Phyllostachys edulis* (moso bamboo) were introduced for the harvesting of their shoots. The JSSA – Hokushinetsu Cluster (2010) describes the expansion of *P. edulis* (moso bamboo) into planted conifer forests and second growth forests of broad-leaved trees in the Ishikawa Prefecture as the main driver of the destruction of these forests, causing drops in wild food supply and disrupting the *satoyama* landscape.

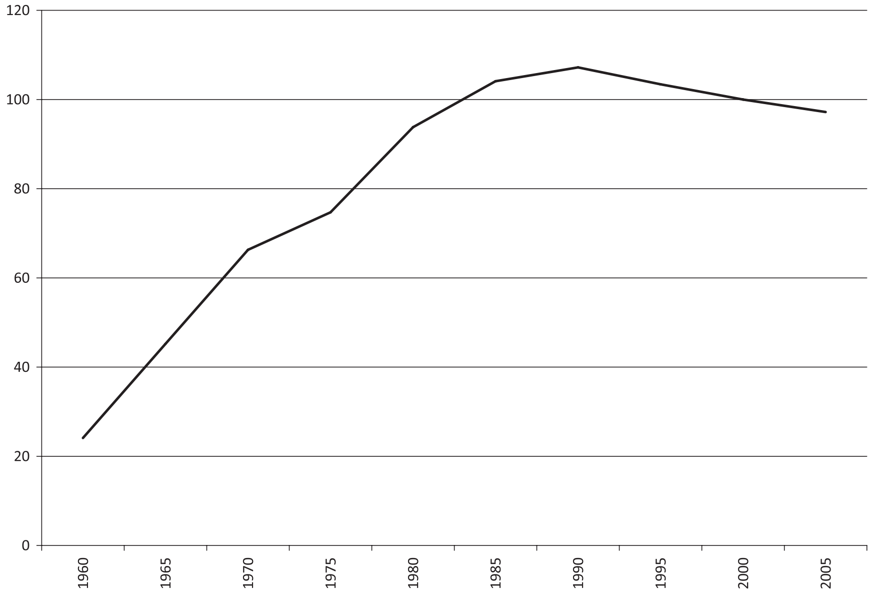


Figure 3.17 Agricultural production index of livestock
Source: Minister's Secretariat, Ministry of Agriculture, Forestry and Fisheries, Japan (2006).

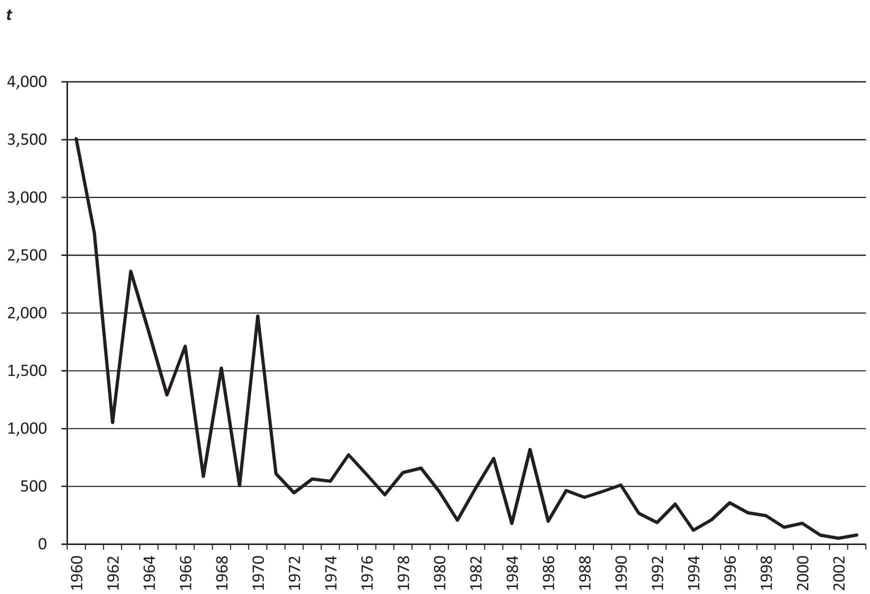


Figure 3.18 *Tricholoma* matsutake (S. Ito et Imai) Sing. (matsutake mushroom) production
Sources: Statistics Bureau, Ministry of Internal Affairs and Communications, Japan website http://www.stat.go.jp/data/chouki/index.htm.

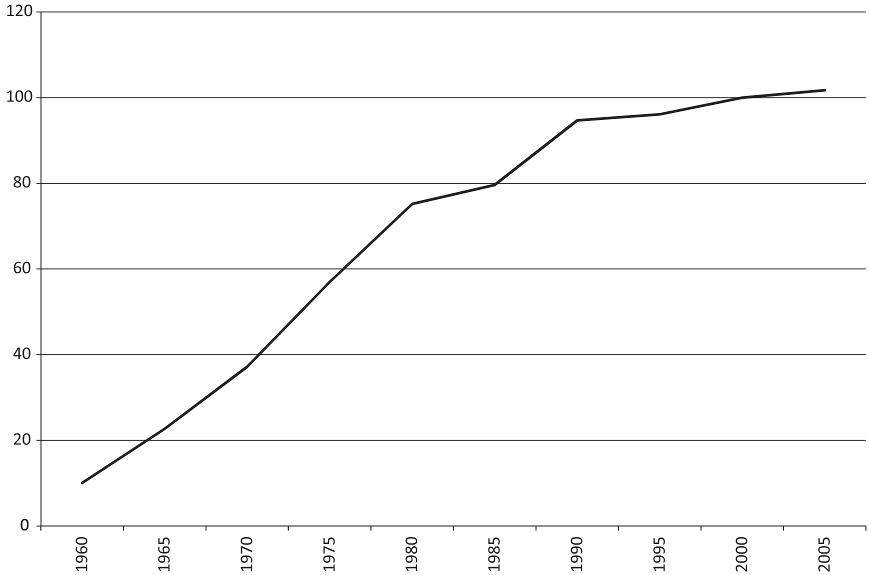


Figure 3.19 Forestry production index for total mushrooms
Source: Minister's Secretariat, Ministry of Agriculture, Forestry and Fisheries, Japan (2006).

3.3.5 Fishery product provisioning services

(1) Marine fishery in satoumi

Within *satoumi*, attention should be paid to coastal fisheries. Development, pollution and overfishing have been the key direct drivers causing the deterioration of marine fisheries. For example, the reclamation of the Seto Inland Sea destroyed seaweed beds and marine biology; and the sea sand extraction activities deprived the habitat for Ammodytes personatus (Japanese sand lance) (JSSA – Seto Inland Sea Group of Western Japan Cluster, 2010). However, pollution measured here by the frequency of red tides has been reduced by one third from the peak in 1976 in the Seto Inland Sea (Figure 3.20). Actions to increase fishery resources have been taken, such as fish farming of *Pagrus major* (red seabream), which started in 1963.

Coastal fishery catches are shown in Figure 3.21. Although the efficiency of fishing boats and related equipment increased, catches have recently been declining. For example, the fishing intensity of *P. major* (red seabream) in the Seto Inland Sea decreased due to regulation (prohibition of the capture of young fish); awareness of conservation; low fish price; and the reduction and ageing of fishermen. This has, therefore, enabled

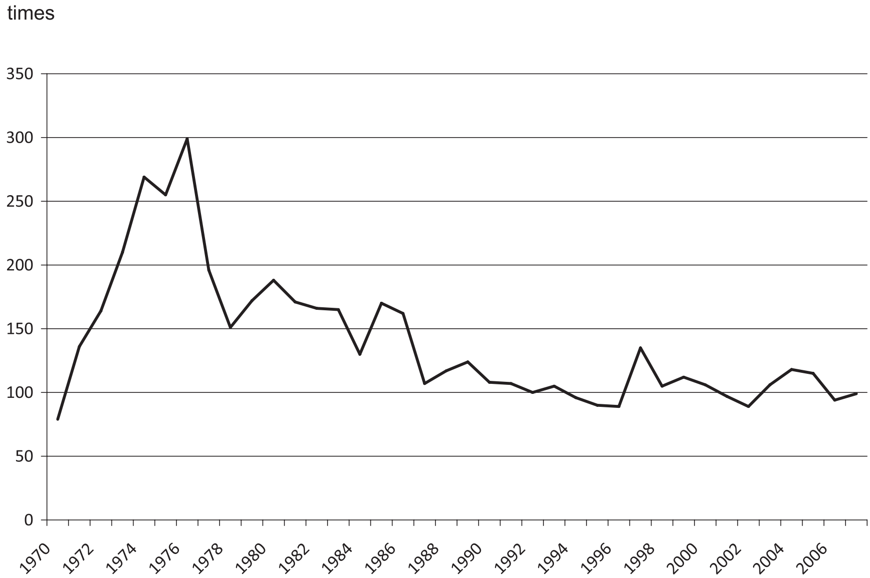


Figure 3.20 Frequency of red tides in the Seto Inland Sea
Source: Setouchi Net website
http://www.seto.or.jp/seto/kankyojoho/sizenkankyo/akasio.htm.

the recovery of the number of parent fish (JSSA – Seto Inland Sea Group of Western Japan Cluster, 2010).

The influence of climate change has recently been pointed out. For example, the *Clupea pallasii* (Pacific herring) catch is high during cold periods but low in warm periods. Based on the observational result of the water temperature for the past 100 years in the western costal side of Hokkaido, one of the major reasons for the decline in Spring-herring catches in Hokkaido is conceived to be the change in marine ecosystems as a consequence of the rise in sea water temperature (JSSA – Hokkaido Cluster, 2010). The *Seriola quinqueradiata* (Japanese amberjack) and *Scomberomorus niphonius* (Japanese Spanish mackerel) catches have increased, but the *Gadus macrocephalus* (Pacific cod) catch has decreased due to sea water temperature increase in Ishikawa Prefecture (JSSA – Hokushinetsu Cluster, 2010).

(2) Mariculture

Mariculture may be regarded as "development" of the sea and has considerably grown in recent times (Figure 3.22). A success story may be that of Kinki University, which succeeded in hatching *Thunnus orientalis* (Pacific bluefin tuna) in 2002. However, mariculture without proper management can cause coastal pollution resulting in red tides and the

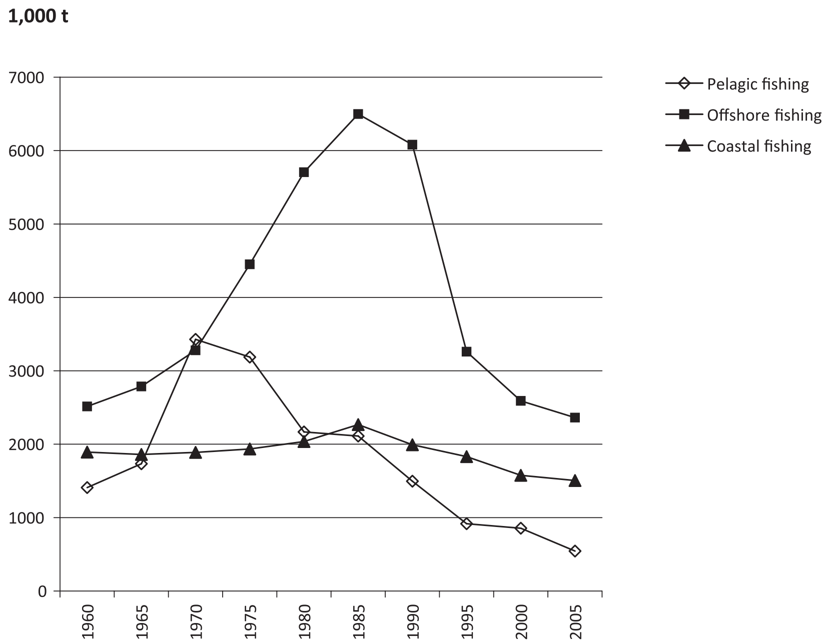


Figure 3.21 Marine fishery catch
Source: Yanotsuneta-Kinenkai (2006).

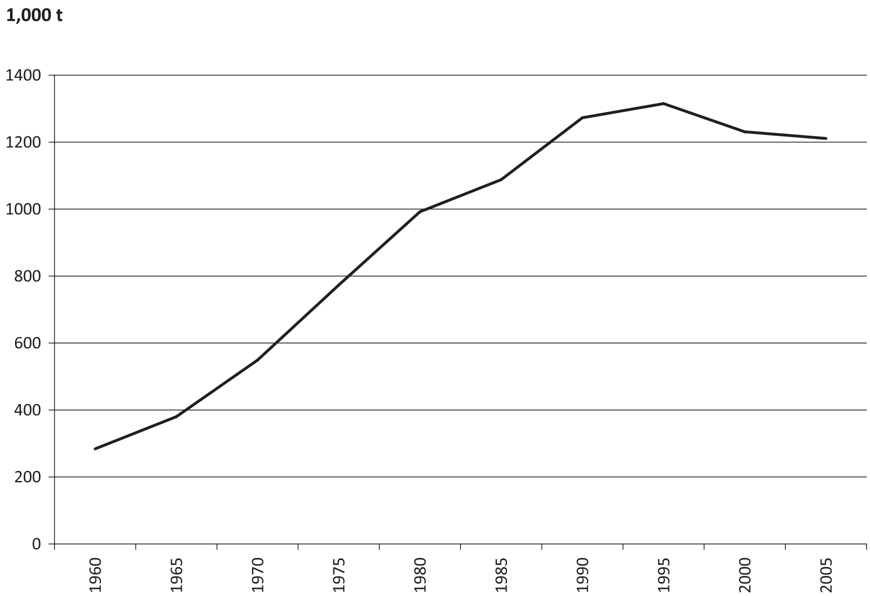


Figure 3.22 Mariculture fishery catch
Source: Yanotsuneta-Kinenkai (2006).

Figure 3.23 Freshwater fishery and freshwater mariculture catch
Source: Yanotsuneta-Kinenkai (2006).

eventual collapse of the coastal zone for producing ecosystem services including mariculture activities.

(3) Freshwater

Figure 3.23 shows the sum of the catches of freshwater fishery and those of mariculture. The JSSA – Hokkaido Cluster (2010) pointed out that salmonoids' river habitats have been affected by declining water quality and the fragmentation of basins by crossing structures such as dams. Lakes and ponds also have a problem of invasive non-native species, such as *Micropterus* spp. (black bass), which appears in the list of the "100 World's Worst Invasive Alien Species" compiled by the International Union for Conservation of Nature (IUCN).

3.3.6 Timber provisioning services

Changes in the use of conifers and broadleaved trees by humans are reviewed based on the forestry production index (production in year 2000 = 100) (Figure 3.24). The last 50 years have seen a continuous decline in the use of conifers, while the use of broadleaved trees increased until about 1970 but decreased thereafter. Log use for the cultivation of *shiitake* mushrooms has also fallen after peaking in 1984 (Statistics

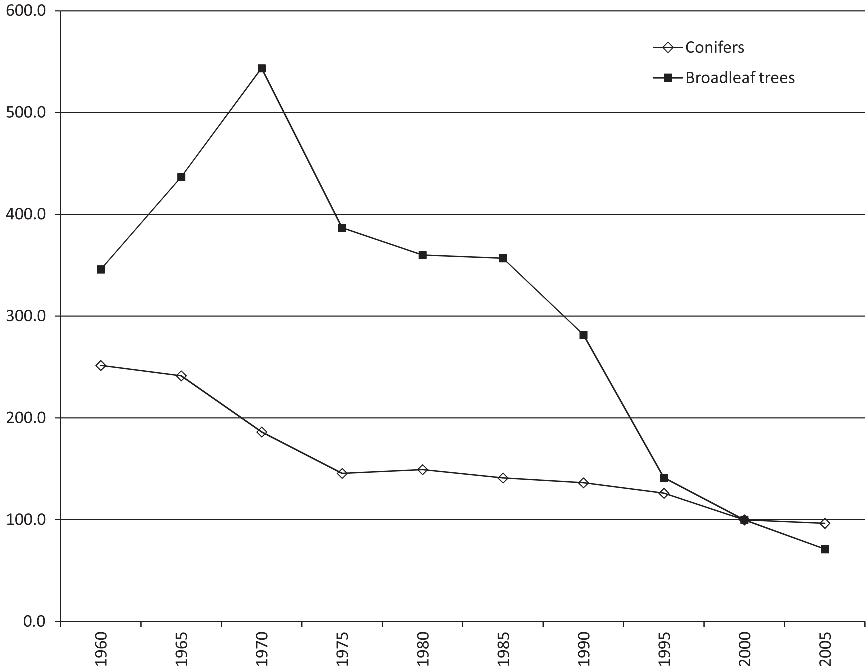


Figure 3.24 Forestry production index of wood
Source: Minister's Secretariat, Ministry of Agriculture, Forestry and Fisheries, Japan (2006).

Bureau, Ministry of Internal Affairs and Communications, Japan website [http://www.stat.go.jp/data/chouki/index.htm]).

However, it does not mean that the stock of forests and the supply of timber have decreased. In spite of the rapid conversion of forest land to golf courses in the mid-1970s for instance in Ishikawa Prefecture (JSSA – Hokushinetsu Cluster, 2010) and the introduction of pine wilt disease caused by *Bursaphelenchus xylophilus* (non-native pine wilt nematode) which, for instance, rapidly expanded in the 1980s and resulted in hitting a peak of affected forest area of 52,765 ha in Hiroshima Prefecture (JSSA – West Japan Cluster, 2010), the wood stock of forest plantations has continued to increase, based on an expansive reforestation strategy started in 1957 and continued to the late 1960s (see Figure 3.25).

Although human use has decreased, the provisioning service of timber has increased. Therefore, unlike situations witnessed in many developing countries, the supply of forests increased but the harvesting of trees for timber and other purposes dropped. This was primarily caused by the liberalization of the import of timber in the early 1960s, which consequently

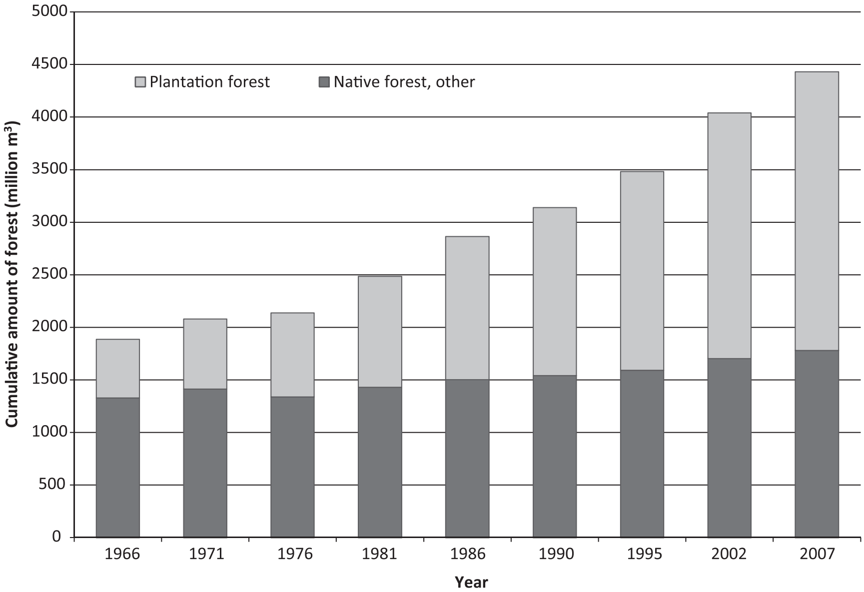


Figure 3.25 Standing tree store of Japanese forests
Sources: Ministry of the Environment, Japan, Japan Biodiversity Outlook Science Committee (2010).

brought about a massive inflow of cheaper imported timber causing a drop in demand for domestic timber. It is important to stress here that just an increase in the stock of forest and the supply of timber is not necessarily an improvement as might be expected. The loss of a specific type of managed forest, which in the past was in synergy with the rest of the landscape, caused a disruption to the mosaic nature of the *satoyama* landscape thus resulting in a disruption to the overall supply of a bundle of ecosystem services contributing to the well-being of local communities.

3.3.7 Firewood and charcoal provisioning services

Firewood and charcoal are typical provisioning services from *satoyama* landscapes. Before the mid-1950s, charcoal and fuel-wood were the primary forms of energy. For example, in the Seto Inland Sea region, bald mountains or nearly bald scrub forest were present in the Meiji Era (1868–1912) through to the 1950s in the concomitant presence of geological factors, such as granite and clay layers (JSSA – West Japan Cluster, 2010).

But the overuse trends witnessed prior to the 1950s saw a reversal after World War II, when Japan turned to modern forms of energy such as oil,

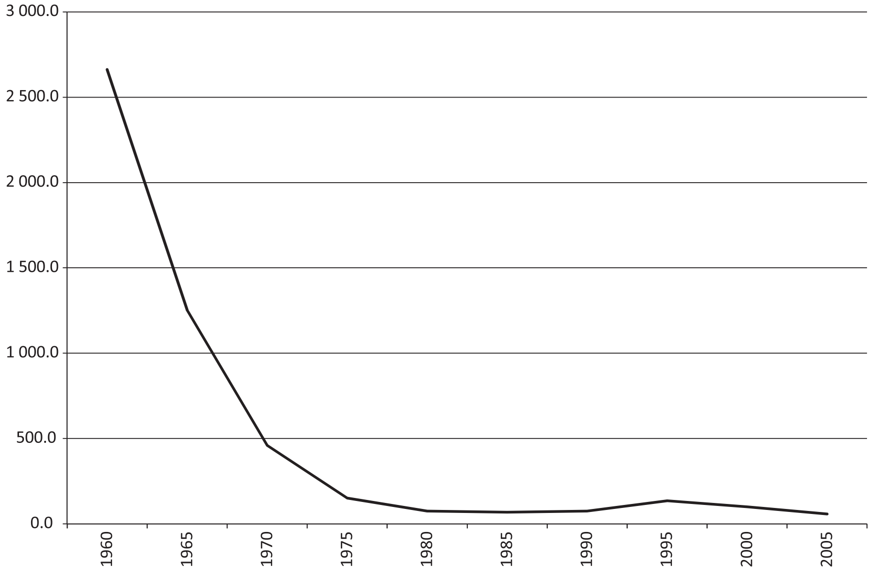


Figure 3.26 Forestry production index of firewood and charcoal
Source: Minister's Secretariat, Ministry of Agriculture, Forestry and Fisheries, Japan (2006).

natural gas and nuclear to drive its modern urbanization and industrialization process.

Figure 3.26 shows the forestry production index of firewood and charcoal. The use of firewood and charcoal by humans was rapidly decreasing until about 1975 with the index in 2005 being only 2 per cent of what it was in 1960. In addition, as most of the firewood-charcoal forests that had been used in the past were transformed to coniferous plantations (or otherwise were abandoned) (JSSA – Western Japan Cluster, 2010), it can be said that the total area of firewood-charcoal forests has decreased.

3.3.8 Sericulture provisioning services

The sericultural industry was an important source of foreign currency during the Meiji Era. However, the use of sericulture (silkworm cocoons) decreased drastically from its peak in 1969 (see Figure 3.27). Similar to timber, firewood and charcoal, this was due to a fall in demand for silk rather than declining ecological conditions affecting the cultivation of silkworms. Sericulture-supporting mulberry plantations were so common that a map symbol was established for them, but now, most are lost as is shown in Figure 3.28. JSSA – Tohoku Cluster (2010) reported that many mulberry plantations were replaced by orchards.

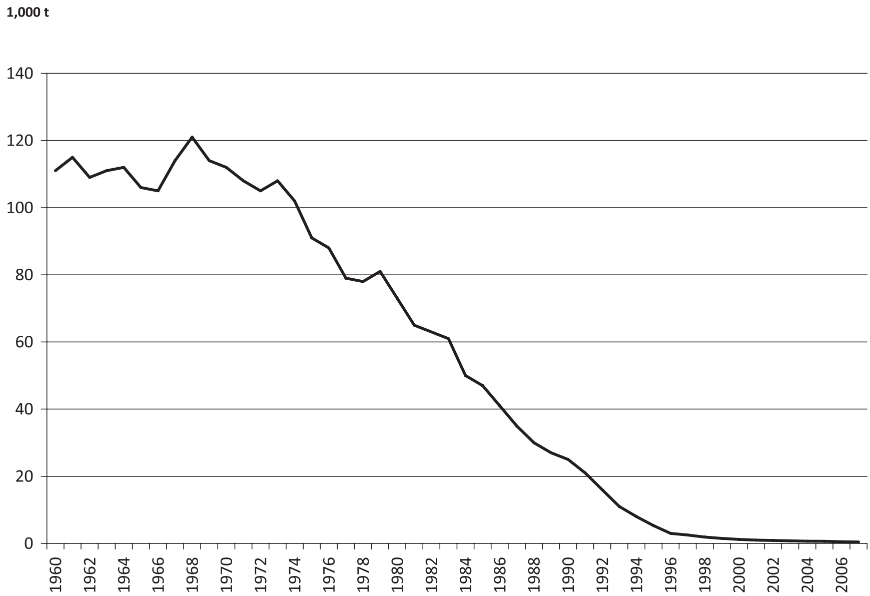


Figure 3.27 Cocoon harvest
Source: Agricultural Production Bureau, Ministry of Agriculture, Forestry and Fisheries, Japan (2009).

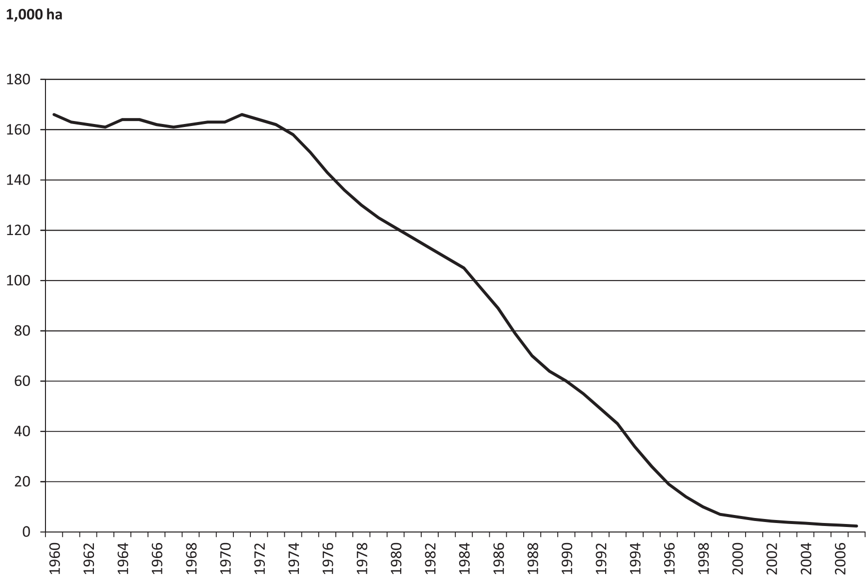


Figure 3.28 Mulberry-cultivation land area
Source: Agricultural Production Bureau, Ministry of Ministry of Agriculture, Forestry and Fisheries, Japan (2009).

Box 3.2 Japanese slash and burn agriculture expected to be handed on to future generations (see also Figure 3.29)

Slash and burn agriculture is still practiced in Japan, although not on a wide scale. This technology includes the clearing and subsequent burning of mountain forests in order to create agricultural land. Thereafter, certain crops are grown within a designated sequence and time period. Following the final harvest, the land is left to lie fallow to allow a return to natural forest conditions. One of such practices which is still performed today is the "*Natsuyabo*" in Shiiba Village, Miyazaki Prefecture.

An initial firing is carried out at the *Natsuyabo* before the *Bon* Festival (Japanese Buddhist custom to honour the departed spirits of the ancestors) in August. Although the fields appear unusable, this is not the case. Harmful insects are expelled and potassic nutrition is made available across the area by this firing. Initially, buckwheat and radish seeds are sown, with buckwheat seeds sown first so as to prevent soil erosion through root establishment. Cockspur and Hungarian grass are then planted in the second year; *azuki* beans in the third year; and soybeans in the fourth year. This sequence is meaningful as during the seasons in the third and fourth years, partial fertility is restored to the soil following the establishment of leguminous crops. From the second year, afforestation with *C. japonica* (Japanese cedar) and *Quercus acutissima* (sawtooth oak) is carried out.

A secondary effect is further provided by the burnt fields. Wild plants, such as Japanese royal fern, emerge when the earth's surface receives adequate amounts of sunshine. This new environment also creates a suitable hunting ground for wild animals, such as the *Sus scrofa* (wild boar). It contributes to the maintenance of rich ecological systems and rejuvenates the forest in general. As the nutrients from the leaf mold in the burnt fields can flow down to the sea and breed plankton there, external off-site benefits are further provided to downstream fishing activities.

3.4 Changes in regulating services and direct drivers of change

Regulating services are the benefits available from regulatory functions provided by ecosystem processes. These include services such as air quality regulation, climate regulation, water regulation, soil erosion regulation, water purification and waste treatment, disease regulation, pest regulation, pollination and natural hazard control among others.

Figure 3.29 Prescribed burn as part of slash and burn agriculture
Source: Photo provided by Atsushi Nagamatsu.

The regulating services within *satoyama* and *satoumi* landscapes, in many cases, are integrally interlinked with the provisioning services they provide through agriculture, forestry and fishery industries. Land use within *satoyama* landscapes in Japan has dramatically changed spatially and temporally corresponding to social, economical and ecological situations. For example, much of the forest cover in mountains disappeared from the end of the medieval period to the modern ages, as a result of excess use. Although much of these have recovered since the late twentieth century, the regulating services offered by the forests were lost during this time period as witnessed by the history of the attempts to restore these services through soil conservation and erosion and sediment control technologies. However, more interestingly, the transformation of agro-ecosystems over the past 50 years caused by modernized agriculture (i.e. large infrastructure improvement, mechanization, chemical materials, etc.) as well as the wasting and abandonment of management practices associated with the social structural changes (i.e. the fuel revolution, dietary habit changes, labour shortages, and population ageing, etc.) has had significant impacts on regulating services.

Generally, agricultural activities that cause drastic transformation of nature, provide enhanced, short-time provisioning services, while negatively affecting regulating services. Conversely, in the case of *satoyama* and *satoumi* landscapes – where rational actions to nature and agricultural, forestry and fishery businesses have been continuously conducted – regulating services could have been provided so as to supplement provisioning ones. Given that Japan is located within the Asian monsoon zone, land use centred on rice paddy agriculture has been employed for more than 2000 years under natural conditions of significant rainfall and frequent typhoon occurrence and precipitous geography with steep stream gradients. Therefore, it might be assumed that mechanisms for land security with attention to regulating services have already been provided.

The regulating services of agro-ecosystems – a key component of the mosaic structure of *satoyama* and *satoumi* landscapes – are provided in the form of joint products combined with agricultural products. The functions relating to regulating services have been evaluated as land conservation functions, and experimental quantitative evaluations have been made (Mitsubishi Research Institute Inc., 2001; Kato et al., 1997). However, since different regulating services are provided by agricultural lands and forests respectively, the conditions and trends of these services are presented separately below. The section on forests covers both natural and secondary forests (Science Council of Japan, 2001).

3.4.1 Air quality and climate regulation

(1) Air quality and climate regulation by agricultural land

Well-managed agricultural land has the ability to purify the atmosphere by absorbing and holding nitrogen and sulphur dioxide gases. Estimates of SO_2 and NO_2 quantities absorbed by paddy fields and upland fields are given at 49,000 metric tons (National Research Institute of Agricultural Economics, 1998). Kato et al. (1997) also evaluated the function of agricultural land to regulate the atmospheric concentration of NO_2 on a nationwide scale. They found that areas of high evaluation are distributed sporadically within the Pacific Belt zone (urbanization zone extending from Kanto region to Osaka and through Seto inland sea to Fukuoka along the Pacific coast), which is a source of pollution, as well as in large local cities (Figure 3.30), further concluding that agricultural land particularly in urban peripheral areas contributes to atmospheric purification.

The evapotranspiration function of agricultural land contributes towards the circulation of heat in the atmosphere. Paddy fields in particular demonstrate a high moderating effect on climate through surface evaporation. The Agriculture, Forestry and Fisheries Research Council Secretariat (1997) showed that the temperature in typical paddy land was of 0.5 to 1.3°C lower than bare fields in early July (summer), while it was of

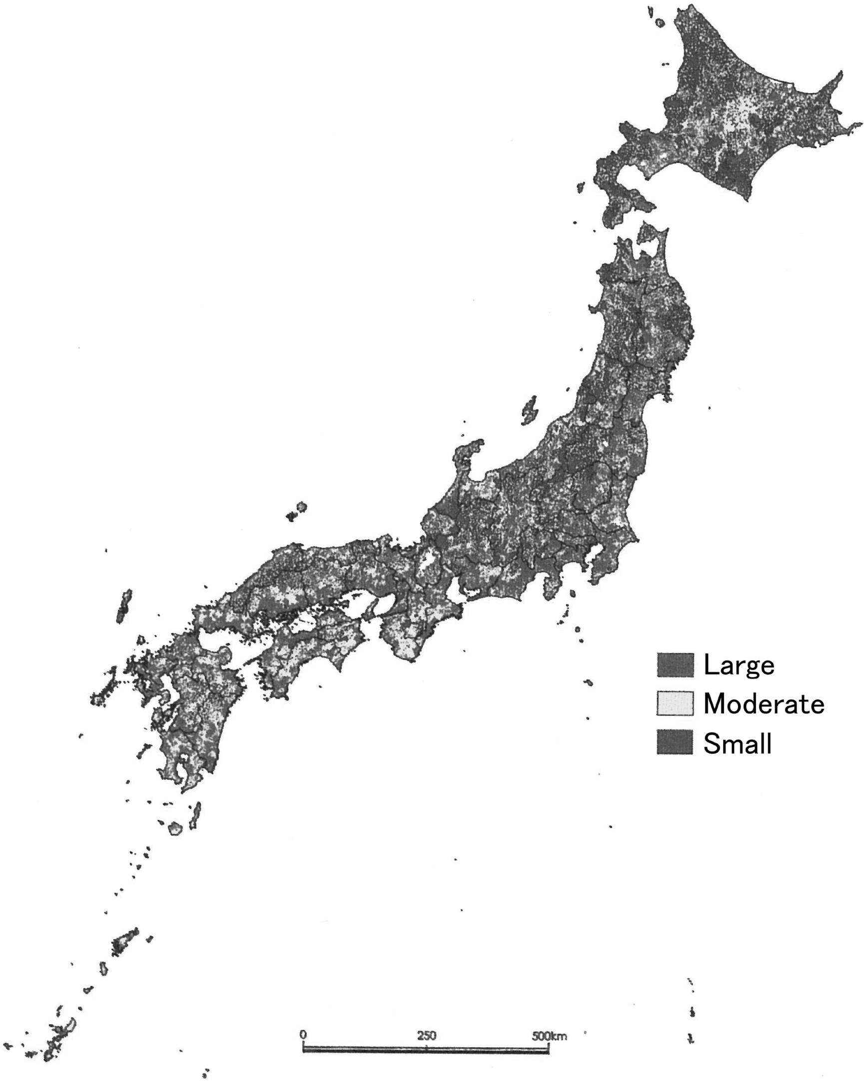


Figure 3.30 Air purification function of agricultural and forest lands in terms of NOS absorption quantity
Source: Kato (1998).
Note: Please see the back of this book for a colour version of this figure.

0 to 1°C higher in May (spring). In addition, irrigation water contributes to stabilizing evapotranspiration; recent reports show that the latent heat of evaporation – about 2.5 kJ – was reduced by agricultural and green land. Yokohari et al. (1997), Yokohari et al. (1998), and the National In-

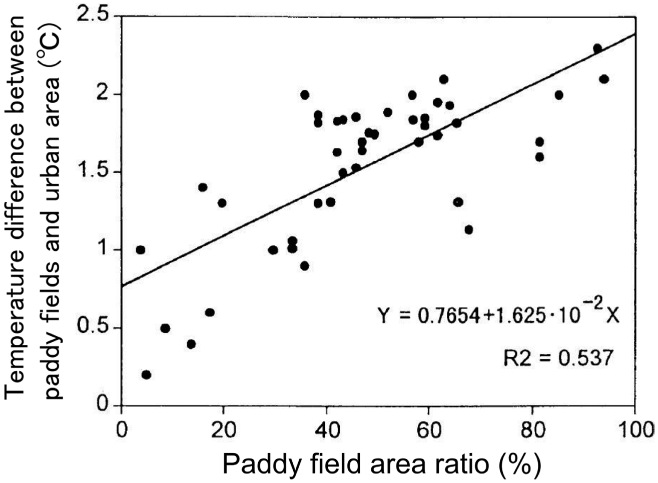


Figure 3.31 Relationship between paddy field area, and difference in temperature between paddy fields and urban areas
Source: Yokohari et al. (1998).

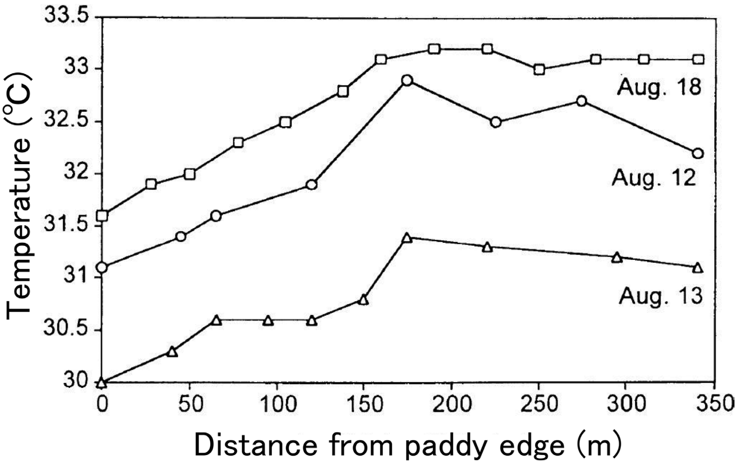


Figure 3.32 Relationship between distance from paddy edge and temperature
Source: Yokohari et al. (1998).

stitute for Agro-Environmental Sciences (1997) further show a temperature reducing effect by water in paddy fields in particular during the summer season in city areas (Figures 3.31 and 3.32).

The extent of greenhouse gas (GHG) emissions (such as carbon dioxide gas, methane, nitrous oxide, etc.) depends on the crop species, method of fertilizer application, as well as cultivation technology used. Among them, methane (CH_4) and nitrous oxide (N_2O), which have 23 and 296 times more impact per unit weight than carbon dioxide (CO_2) respectively, are especially important in agricultural activities. Agricultural land is regarded as a main source of N_2O, although crops absorb CO_2. Further, agricultural fields that have not been irrigated can act as sinks for CH_4, although irrigated land (e.g. water paddies) acts as an emission source for this GHG. It was estimated that 26 per cent of total CH_4 emissions (5.6 Tg CO_2) originated from paddy fields and 27 per cent of total N_2O emissions (6.1 Tg CO_2) were from crop fields in Japan (Greenhouse Gas Inventory Office of Japan, 2010).

(2) Climate regulation by forests

As a large amount of national land is occupied by forest (70 per cent) and specifically secondary forest (20 per cent), significant climate regulation occurs nationwide. Mature forests maintain a relatively nil balance concerning the generation and absorption of CO_2. On the other hand, continuously maintained fuel-wood forests and young plantation forests contribute to the absorption and fixation of CO_2 through CO_2 accumulation due to continuous growth. When the lumber production of such forests is taken into consideration, the period of carbon storage increases and further includes carbon retained within wood products. It is estimated that 80 million tons of CO_2 is absorbed by forests every year in Japan (Greenhouse Gas Inventory Office of Japan, 2010).

(3) Drivers of change

Climate regulation services are basically determined by phytomass. Therefore, land use change, reflecting vegetation change caused by urbanization and land abandonment, was a direct driver of change.

From 1998 to 2007, agricultural land was either abandoned or altered at a speed of approximately 33,000 ha per year. These changes included abandoned arable land (48.3 per cent), plantations (5.7 per cent) and urban areas (39.8 per cent). Phytomass increase via crop abandonment and/or plantations can enhance climate regulating services, while urbanized land can cause them to decline. In particular, farmland decline in urban areas is remarkable with 40 per cent of farmlands lost between 1992 and 2008 (Figure 3.33). As a result, urbanization and the decrease of agricultural land within cities contributed to a decline in regulating services, such as atmospheric purification and climate regulation.

On the other hand, the total area of forest in Japan did not cause any significant changes over the past 50 years. This seems to suggest that no large changes have occurred in air quality and climate regulation services of forests. However, the abandonment of managed secondary and young forests within *satoyama* landscapes was also known to be a major cause

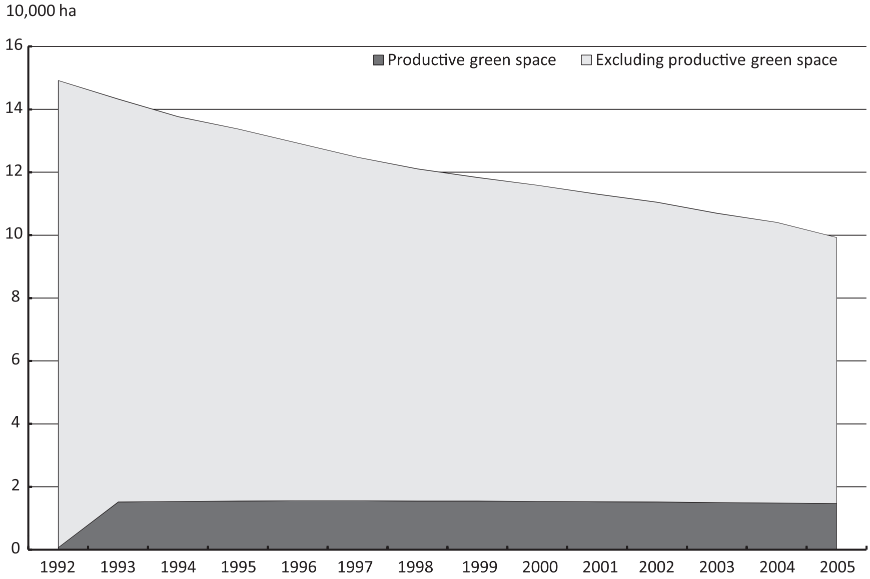


Figure 3.33 Changes in farmland within urbanization promotion areas (national data)
Source: Ministry of Agriculture, Forestry and Fisheries, Japan Website (2008)
Note: Created based on Ministry of Internal Affairs and Communications (1992–2005) *Overview of the Survey on Prices of Fixed Assets*. Tokyo: Ministry of Internal Affairs and Communications, Japan (in Japanese); and City and Regional Development Bureau, Ministry of Land, Infrastructure, Transport and Tourism, Japan (1992–2005) *Annual Report of Urban Planning*. Tokyo: Ministry of Land, Infrastructure, Transport and Tourism, Japan (in Japanese).

of decreases in the CO_2 sinks service, as absorption rates decline with increased forest age.

3.4.2 Water regulation

(1) Flood-prevention and ground water recharge functions by agricultural land

Paddy fields surrounded by levees are able to temporarily store rainwater and further prevent/alleviate floods by gradual downstream discharge. Upland fields will also temporally store rainwater through an increase in the degree of porosity of the surface soil and in the volume of water allowed into the field through cultivation. The total volume of water which can be stored in paddy fields (except in flatlands of low height) approximately ranges from 3.6 to 5.2 billion cubic metres, while agricultural "dry" field estimates range from 0.8 to 0.9 billion cubic metres.

(Mitsubishi Research Institute, Inc., 2001; National Research Institute of Agricultural Economics, 1998)

Much of the irrigation water used in paddy fields regulates river water flow and further stabilizes downstream flow. Deeply permeated water raises groundwater levels and is used as freshwater or industrial water, etc. at downstream locations. This contributes to stable livelihood and industrial activities within local areas by providing a low cost water source. Even upland soils, which are structurally composed of big grains, will facilitate rainwater permeation to the groundwater table level. An estimate of 16.2 billion cubic metres per year is given concerning the total volume of water permeation from paddy fields to subsurface layers, while groundwater recharge volumes by paddy fields and by upland fields are estimated to be 3.6 billion and 1.1 billion cubic metres respectively (Mitsubishi Research Institute, Inc., 2001). However, the results of a national evaluation on water retention functions indicated its dependence on particular geology types and surface layers as areas receiving high ratings for water retention capacity were the green tuff areas within the regions facing the Japan Sea, and woods and farms on geologically old mountains (Kato et al., 1997).

(2) Flood-prevention and ground water recharge functions by forests

The water retention function of forests has numerable effects including permeation of rainwater to the soil, shaving peak loads and stabilizing flow. Since rivers in Japan generally have quick water flows and small storage dam capacities, the water storage function provided by forests is extremely important. But forests also consume considerable quantities of water through evapotranspiration and river flows decrease during extended dry periods. Therefore, it could be said that the water resource storage function of forests is both established by and subject to Japan's natural conditions, i.e. high rainfall levels and many quick flowing rivers. The flood alleviating capacity of Japan's forested areas is estimated at being approximately 1.1 million cubic metres per second; and an estimate of the quantity of water permeation in these areas – used as the base for evaluating storage of water resources and water purification – is given at roughly 186 billion cubic metres per year (Forestry Agency, 2000; Mitsubishi Research Institute, Inc., 2001). However, an estimation which focuses only on secondary forests in *satoyama* landscapes has never been conducted (Forestry Agency, 2000; Mitsubishi Research Institute, Inc., 2001).

(3) Drivers of change

As the flood preventative function of paddy fields (capacity of water storage) is strongly influenced by the structure and strength of the farmlands and the levees around them, infrastructural improvements of these land areas can greatly contribute to enhancing this provided service. Given that cultivation tasks such as soil raking and shaping, as well as supplemental works such as finishing and compacting of the levees, should be routine maintenance practices, the continuous execution of good agricultural land management is essential for maintaining this service. It has been shown that peak flow is less whenever the ratio of the area of paddy fields in catchment areas is higher. For example, the peak flow of residential land is three to five times larger than that of paddy fields, with abandoned paddy fields having a two to three times higher peak flow rate than those which are cultivated. Likewise, simulations have shown that the abandonment of stepped rice paddy fields increases peak flow. Therefore, it can be said that both urbanization and abandonment of agricultural practices cause a reduction in flood prevention services. This has recently been seen in the frequent occurrence of urban floods resulting from light rainfall. Although the relationship between land use change in *satoyama* landscapes and the occurrence of natural disasters, such as floods, has been never investigated at the national scale, local scale studies have shown a relationship between decreased paddy field area along with increases in flood damage (Figure 3.34).

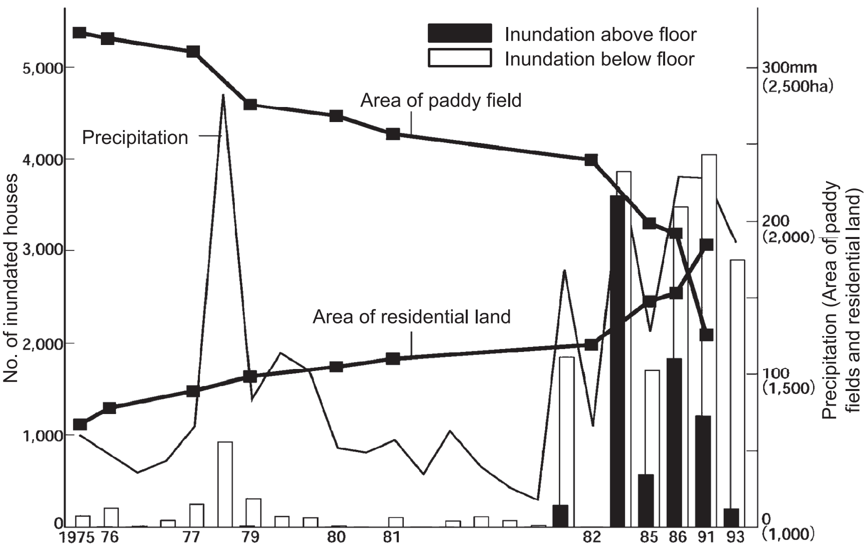


Figure 3.34 Changes in paddy field area and flood damage in the Koshigaya district of Saitama Prefecture
Source: Planning Division, Kanto Regional Agricultural Administration Office (1994); and Ministry of Agriculture, Forestry and Fisheries, Japan website http://www.maff.go.jp/j/nousin/noukan/nougyo_kinou/index.html.

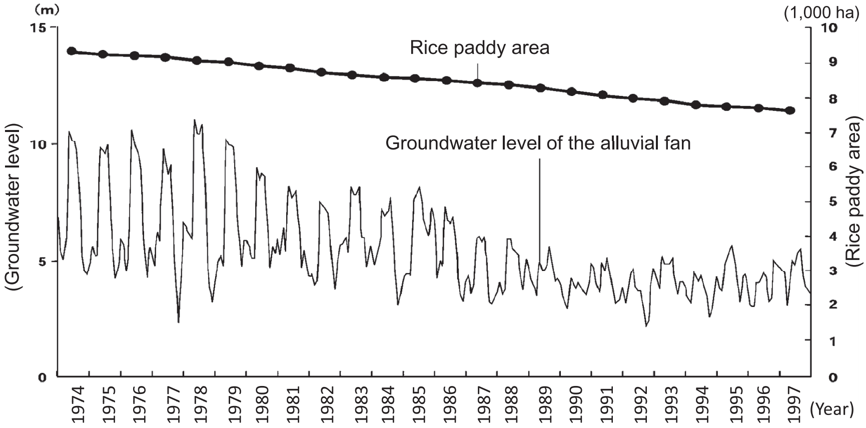


Figure 3.35 Relationship between groundwater level and rice paddy field area in the alluvial fan around the Tedori River, Ishikawa Prefecture
Source: Ministry of Agriculture, Forestry and Fisheries, Japan website http://www.maff.go.jp/j/nousin/noukan/nougyo_kinou/index.html.
Note: Prepared by Ministry of Agriculture, Forestry and Fisheries, Japan based on *Study of Groundwater Preservation*, Ishikawa Prefecture, and *Annual Statistics of Agriculture, Forestry and Fisheries of Ishikawa Prefecture*, Ministry of Agriculture, Forestry and Fisheries, Japan.

A decrease in paddy field area also lowers the subsurface water level of catchment areas. This lowers the irrigation function provided by subsurface water and as such, industrial water and freshwater for livelihoods is also reduced (Figure 3.35).

The water retention function of forests can be affected by forest cutting, land-cover conversion to plantation, growth of plantation forest and the thinning of planted forest. Forest areas throughout Japan have remained almost unchanged for about 50 years – until now. The attrition of forest area due to the development of agricultural land in Hokkaido and urbanization in the Kanto region, have been supplemented by establishing plantations using *C. japonica* (Japanese cedar) and *C. obtusa* (Japanese cypress) in Chugoku, Shikoku and Kyushu. According to classification data, broadleaved forest has been significantly decreasing, while mixed forest (i.e. forest formed with small plantations of conifers, replacing broadleaved forest) has increased in *satoyama* landscapes. The impacts on local water retention function due to these changes in forest physiognomy include decreased water permeation, increased surface water flow, increased peak flow and decreases in discharge rates during drought periods, all of which contribute to declines in the flood control function (thereby increasing risk of flooding in urban areas).

3.4.3 Prevention of soil erosion

(1) Sediment collapse prevention function and soil erosion prevention function of agricultural land

The sloped surface collapse prevention function of sloped agricultural land is the function that may be exerted by discovering collapse at the initial stage and repairing it. The number of cases in which sediment collapse has been repressed by the control of paddy fields is estimated to be roughly 1,700 per annum (National Research Institute of Agricultural Economics, 1998). Nationwide, it has been made clear that the districts of high evaluation are distributed within topologies which belong to precipitous terrain, as those centred in the mountain range zones of Hokkaido, Honshu and Shikoku (Kato et al., 1997; Kato, 1998; Figure 3.36).

The soil erosion prevention function varies depending on the type of agricultural land and method of management thereof. In the case of paddy fields, rainfall will not impact the surface of the soil under an irrigated state. Even in the case of sloped zones, as the soil face is flat, the soil erosion prevention function of paddy fields is very high compared to wasteland. Likewise in grass areas, as they are covered relatively well, the sediment discharge prevention function is favourable. However, it is hard to recognize the sediment discharge prevention function of farm fields and tree park lands, the weeding of which has been well managed compared to land covered with hogweed. A national evaluation of the soil erosion preventive function revealed that farmlands and forests in the southern part of Japan had a high value, which was caused by the distribution of fine-textured red-yellow soils combined with high rainfall (Kato et al., 1997; Kato, 1998).

(2) Sediment disaster preventive function of forests

Since almost all of the forests in Japan occupy sloped surfaces on mountainsides, collapse of the soil surface layer is prevented by the root system of the trees. Surface erosion is prevented by permeation of rainwater made possible by the protection offered by vegetation, fallen leaves and branches. As Japan has less flat than hilly/mountainous land, it is often the case that the lower section of sloped surfaces are used as human habitats. Here, the sediment disaster preventive function of forests is important for maintaining the safety of the people, specifically in mountainous *satoyama* regions. The Forestry Agency has estimated that the erosion prevention amount of forests in Japan could be as much as 5.161 billion cubic metres per year; and further, the areas where surface collapse has been prevented equate to roughly 96,393 ha per year (Forestry Agency,

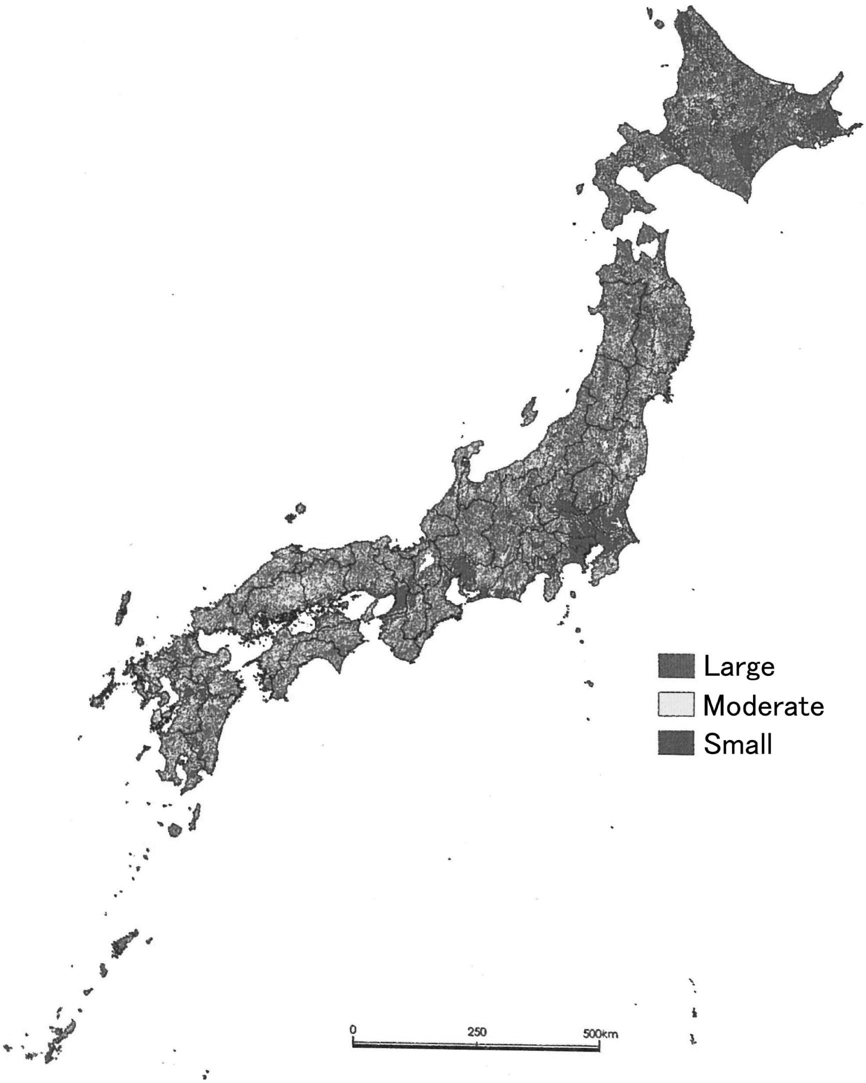


Figure 3.36 Erosion prevention functions of agricultural and forest land
Source: Kato (1998).
Note: Please see the back of this book for a colour version of this figure.

2000; Mitsubishi Research Institute, Inc., 2001). Additionally, forests contribute to the protection of agricultural land through reducing wind speed via windbreaks and/or coastal forest barriers (JSSA – Hokkaido Cluster, 2010; JSSA – Western Japan Cluster, 2010).

(3) Drivers of change

The cultivation base under the working soil layer in paddy fields enables the gradual permeation of irrigation and rain water, which prevents drastic increases in subsurface water levels. However, when cultivations cease, rapid permeation into groundwater sources occurs following heavy rains, subsequently leading to landslides and sediment collapse. The abandonment of land management, such as the repair of levees, also loosens the land surface, further increasing the risk of landslides (Chino et al., 1994). If any small collapse were to be overlooked, large collapses would be inevitable (e.g. Sato, 1996; Masumoto et al., 1997). Under a scenario that all the sloping paddy fields throughout Japan are abandoned, the annual amount of discharged sediment due to abandonment is estimated at about 53.25 million metric tons for paddy land and 1.23 million metric tons for dry land, based on the case study of the abandoned rice paddy fields (about 25 metric tons per hectare per year). As previously mentioned, the regulating service in connection with sediment collapse prevention and soil erosion prevention by agricultural land is significantly affected by abdication of land management practices.

From the above-mentioned results, it is clear that land abandonment could be a major driver of a reduction in the regulating services contributing to landslide and soil erosion prevention because these services are maintained through the repair and management associated with agricultural production. On the other hand, reforestation and promotion of succession of abandoned farmlands could enhance landslide and soil erosion prevention. However, in cases where the invasion and establishment of trees or other vegetation are prevented in the initial stages of succession or by plagiosere development, the occurrence of natural disasters would not be alleviated (National Institute for Agro-Environmental Sciences, 1995; Ohkuro et al., 1996).

In the case of upland fields, agricultural land reclamation could cause soil erosion. For example, red soil outflow into the coral reefs of Okinawa Prefecture was promoted by soil loss related to reclaimed land for sugar cane fields (e.g. Okamoto et al., 1992).

Maintaining the regulating services of sediment disaster prevention provided by forests is affected by forest cutting, land-cover conversion to plantation, growth of plantation forest and the thinning of planted forest. Even in the case of planted forests, if the forest is soundly managed, then the service provided from it could be almost the same as that from natural forests. However, negligent management and change of forest physiognomy have caused a deterioration of this service. Related to this, the effect bamboo has had on forests – which has rapidly expanded mainly in Western Japan – is yet to be made clear; there is a need for further studies (JSSA – Western Japan Cluster, 2010)

3.4.4 Water purification and waste treatment

(1) Water purification function of forest

The water quality purification function of forests is the function by which the quality of rainwater, which has passed through forests, is modified or maintained in a purified state. This is achieved by filtering pollutant materials; the buffering of soil; the chemical weathering of soil mineral; a denitrogenation effect in the saturated zone; preventing surface erosion in the A_0 layer (litters and humus); and forest floor vegetation, etc. Secondary forests in *satoyama* landscapes are also expected to have the same functions.

(2) Organic waste decomposition function of agricultural land

Agricultural land has a function to decompose organic matter with the microorganisms found in the soil. Since ancient times in Japan, it has been said that the circulatory system of organic matter is completed with the return of urine, livestock waste, etc. into agricultural land. Organic matter is changed to inorganic substance by the effects of microorganisms in paddy fields. Nitrogenous elements are absorbed by the crop plant, which are purified in the soil by having been converted into nitrogen gas. A study has shown that several hundred kilograms per hectare of nitrogen had been removed during the rice planting period; it is further known that a denitrogenation effect is available even within agricultural irrigation canals, swamps, irrigation ponds, etc. In the case of phosphorous, it is considered that almost all is absorbed or fixed in or to the soil (Mitsubishi Research Institute, Inc., 2001).

(3) Drivers of change

In agricultural land, especially farm fields hosting the intensive cultivation of vegetables and orchards, etc., serious contamination of water quality due to chemical fertilizers and pesticides has been reported. Therefore, excess input of chemical materials associated with agricultural modernization is a big factor in degrading the water purifying service. In addition to this, the old circulation system for organic matter has been compartmentalized by pervasion of sewage systems and deployment toward advanced cattle farming systems using imported animal feed, etc. (Mitsubishi Research Institute, Inc., 2001).

3.4.5 Prevention of disease

In Japan, no confirmed case exists where there is an increase in the incidence of infective disease associated with a transformation of ecosystems. There is a report showing that *Oncomelania nosophora* (the intermediate host of *Schistosoma japonica* that causes schistosomiasis), which lives on the mud in paddy ditches at the water's edge, has drastically declined as a result of water channel modifications and the use of shellfish killers. Consequently, no new case of *schistosomiasis* has been reported since 1978 (Mitsubishi Research Institute, Inc., 2001). As such, changes in *satoyama* and *satoumi* landscapes have not had any significant impact on disease prevention services offered by ecosystems.

3.4.6 Repression of harmful insects

It is estimated that in former agricultural ecosystems, natural enemies contributed to the repression of harmful insects; however, there is no quantitative data available for this. The service for repression of harmful insects by natural enemies is considered to have decreased due to the increased utilization of agricultural chemicals and pesticides. On the other hand, various adverse effects have occurred on peripheral agricultural land and downstream districts through management negligence in recent years. Examples include the overgrowth of hogweed that invades peripheral farmlands; becoming the generation source of plants such as *Salidago altissima* (Canada goldenrod) and *Typha domingensis* (Southern cattail) that cause hay fever; increases in pests such as Pentatomoidea (shield bugs), Caelifera (grasshoppers), field mice, moles, etc.; and larger mammals (e.g. *S. scrofa* [wild boar]) moving into areas of human habitation particularly in mountainous areas (Nakagawa, 1993).

3.4.7 Pollination

Entomophilous and allogamous crop plants need the pollination service provided by pollinators. Although little is known about this service in *satoyama* landscapes, recent studies have suggested that various insects living in *satoyama* landscapes play important roles in the pollination of allogamous crops. For example, the seed set ratio of buckwheat is increased by populations of *Apis cerana japonica* (Japanese honeybee) living in secondary forest around buckwheat fields, and those of Syrphidae (hoverflies) and *Bombus* spp. (bumble bees) living in grassland/wetland around buckwheat fields, respectively (Maeto, 2009). This suggests that the mosaic (spatially heterogeneous) structure of landscape components in *satoyama* such as woods, grasslands and wetlands, arranged nearby crop fields, contribute to enhancing the pollination service for crops. Therefore, simplification of such mosaic structures both by land reclamation and land abandonment might decrease this service in *satoyama*.

3.4.8 Alleviation of natural disasters

Almost all of the services mentioned above are deeply connected with the prevention of natural disasters, with the control of elements such as wind, waves, floods, sediment discharge, and soil erosion. In addition, functions are available for preventing avalanches, removing snow, and so on, for forests within heavy snow zones.

In any urban district, the open space function enables evacuation space whenever any disaster may occur or when disaster prevention may be required. It is known that at the time of the Great Kanto Earthquake in 1912, the people of Tokyo evacuated to neighbouring areas such as the Tama District or Saitama Prefecture, Chiba Prefecture and in particular, residents in the south section of Tokyo or Kawasaki City evacuated to pear tree forests in the catchment area of Tama River. This function which provides space for disaster prevention is essential, given that until now agricultural districts have been utilized for building temporary houses associated with such disasters including the Great Hanshin Earthquake and Miyake-jima Eruptions. Agricultural land within urban areas has decreased (Figure 3.33), thereby reducing this open space service.

3.5 Changes in cultural services and direct drivers

3.5.1 Traditional craftwork

Japanese traditional craftwork industries have been fully dependent on the products and traditional knowledge associated with *satoyama* landscapes; however, the decline of rural communities has led to the decline of many of such industries. The Act on the Promotion of Traditional Craft Industries (Law No. 57 enforced on 25 May 1974) promotes the uptake of traditional techniques and technologies by local communities for ensuring and enhancing traditional craft industries. This is done in order to enhance sustainable enterprise and further contribute to the sound development of local economies.

Among the traditional craftwork designated by the Minister of Economy, Trade and Industry under this Law, there are – designated by district – 21 products in the Tohoku Region, 27 products in the Kanto Region, 26 products in the Koshinetsu Region, 46 products in the Chubu Region, 37 products in the Kinki Region, 26 products in the Chugoku-Shikoku

Region and 33 products in the Kyushu-Okinawa Region. These products include: 33 fabric products, 11 dye products, four other fabric products, 31 China wares, 23 lacquer ware items, 21 wooden products, 14 metal work products, 16 Buddhist altars and objects, nine Japanese paper, nine writing materials, seven bamboo products, six precious stones and stone work products, eight dolls, 16 other craftworks, and three craftwork tools and materials. Not all products are related to *satoyama-satoumi* cultural services, but the raw materials are provided by *satoyama* for the main parts of fabric products, dye products, lacquerware, wooden products, Japanese paper and bamboo products. These can be considered as cultural services offered by *satoyama*.

Within the traditional craftwork industry, in total 34,000 enterprises were engaged in business with 288,000 employees in 1979. However, those numbers significantly decreased to 16,700 enterprises and 93,400 employees in 2006. The turnout of 540 billon Japanese Yen achieved in 1983, dropped to 177.3 billion Japanese Yen in 2006. Notably, the ratio of 28.6 per cent occupied by workers with age equal to or less than 30 years old in 1974, declined to 6.1 per cent in 2006 (The Association for the Promotion of Traditional Craft Industries http://kougeihin.jo/crafts/course/).

Current problems within the traditional craftwork industry, including declining labour force and raw material, were primarily caused by high economic growth from 1955 and the associated changes in lifestyle, employment situation and culture. The declining and ageing population in agricultural and mountain villages made the accessibility of needed raw materials (e.g. Japanese lacquer, lumber, bamboo material, Japanese paper making materials such as *Broussonetia kazinoki* x *B. papyrifera* [hybrid of paper mulberry] and *Edgeworthia chrysantha* [oriental paper bush], etc.) difficult. There was a strong correlation between labour supply and the accessibility of these products.

In the past, traditional social events (created mainly by agriculture and forestry related activities) incorporated the change of seasons. These events included five season-punctuated celebrations and New Year's Day to name a few, as well as the festive event for rogation of a rich harvest represented by summer and autumn festivals. However, such cultural events have declined along with the popularization and progress of Westernized lifestyles and urbanization. Plastic eating utensils, furniture made of coated plywood board or steel, etc., have come to be widely used through the new distribution system developed after World War II.

3.5.2 Spiritual value of satoyama *and* satoumi

From the total number of Special Natural Monuments and Natural Monuments designated by the Japanese government, 127 sites had been assigned to the plant communities (Agency for Cultural Affairs, Japan http://www/bunka/go.jp/bsys/). Among them are 34 sites with notifications such as shrine forest, forest on shrine/temple premises, and sacred indigenous dense woods (known as *Uguwan* and *Utaki* in Okinawa). These are not part of pristine forests but are sanctuaries in *satoyama* landscapes surrounded by villages and farmlands (i.e. forest areas with shrines and/or temples or commonly called sacred groves). These include the site in Yugawara Town, Ashigara-shimo District in Kanagawa Prefecture, for example, where sacred indigenous dense woods are kept enshrined as "gods of the mountain". According to regional classifications, there is one site in the Tohoku Region, two sites in the Kanto Region, three sites in the Koshinetsu Region, 11 sites in the Chubu Region, four sites in the Kinki Region, nine sites in the Chugoku-Shikoku Regions and five sites in the Kyushu-Okinawa Region. Notably in the cases of Niigata, Ishikawa, Aichi, Nara and Tottori Prefectures, each prefecture has three sites. Other than those sites, there are many others such as shrine forests, forests on shrine/temple premises and sacred indigenous dense woods which have been designated as natural monuments by local governments.

3.5.3 Recreation

Among other types of landscapes, *satoyama* and *satoumi* have recently been used for recreational purposes but quantitative data, which differentiate *satoyama* and *satoumi* landscapes from other recreational sites are not available.

(1) Physical landscape (scenic resources)

Under a partial revision of the Act on Protection of Cultural Properties executed on 1 April 2005, cultural landscape was defined as any landscape that has been formed by people's lives and regular vocations at the local level and local climate, and is essential for the understanding of Japanese livelihoods. Also, in accordance to this act, any special important site(s) can be selected as "Important Cultural Landscapes". As of 1 October 2009, 15 sites had already been selected as important cultural landscapes, including *satoyama* landscapes comprising terraced dry fields or terraced paddy fields. Cultural landscapes are different from native natural landscapes in that they cannot be maintained without continuous human activities/interventions. However, their maintenance has been made difficult by declining local communities. Currently, the cultural functions of the events for maintaining landscape, such as removing pond mud and cutting bottom grass, combined with recreation activities at the local level, such as breeding carp in irrigation pools, are being re-evaluated. Places exist where a new function to create a space for exchange of local community with urban residents has been added to the restoration of those events.

(2) Recreation (Figure 3.37; Figure 3.38)

According to the Leisure White Paper published by the Japanese Productivity Center (2009), the number of fishermen decreased from a peak of 20.2 million persons in 1998 to 10.7 million persons in 2005, although it slightly increased to 12.9 million persons in 2006. The peak was achieved by a boom in the fishing of *Micropterus* spp. (black bass) (e.g. *M. salmoides* [bigmouth bass] and *M. dolomieu* [smallmouth bass]) in freshwater in 1998. This boom was exacerbated by the media and others, which ultimately created significant social impacts that included the release of black bass through different lakes and ponds by fishing goods businessmen and fishing fans. However, the boom was short lived for a number of reasons. The feeding, cultivating, maintenance, transporting, importing, etc. of black bass – an invasive species – can lead to damage to ecosystems, local livelihoods, agriculture and fishery industries, etc. Subsequently, regulations were put in place by the establishment of the Invasive Alien Species Act (Act No. 78 executed on 2 June 2004) – where *M. salmoides*

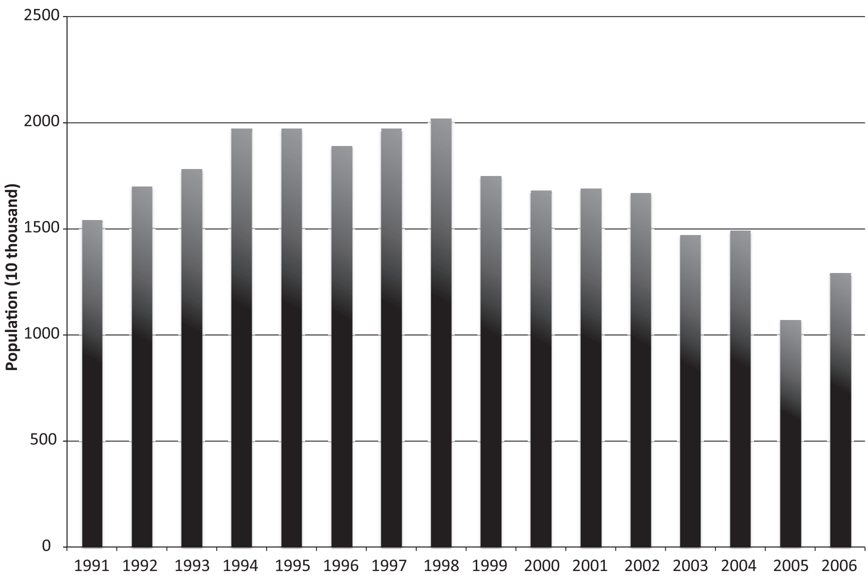


Figure 3.37 Total fishing population
Source: Japanese Productivity Center (2009).

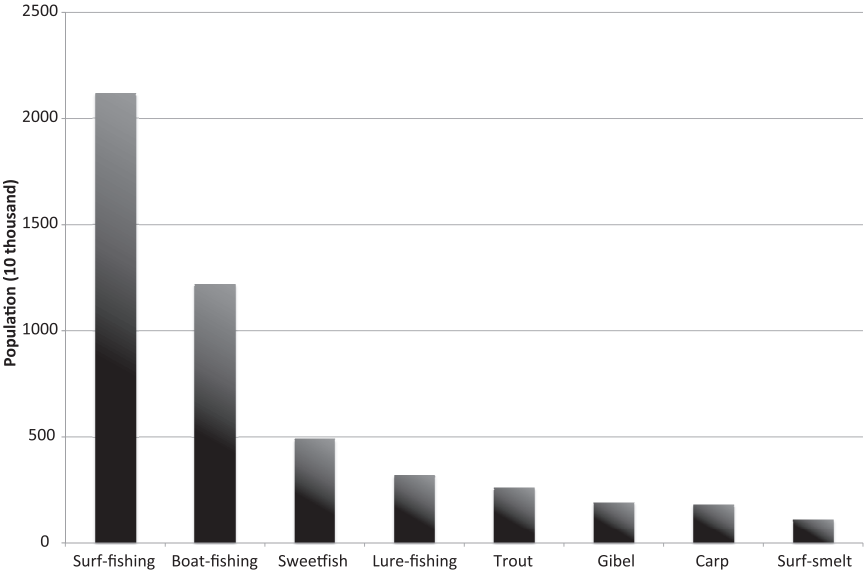


Figure 3.38 Fishing population by fishing type
Source: Statistics Department, Minister's Secretariat, Ministry of Agriculture, Forestry and Fisheries, Japan (2009).

(bigmouth bass), *M. dolomieu* (smallmouth bass) and *Lepomis macrochirus* (bluegill) were designated as invasive species.

The industrial fishing market turnover declined to 438.7 billion Japanese yen (JPY) in 2005 from its peak of 950.6 billion JPY in 1997. According to data published by the Ministry of Agriculture, Forestry and Fisheries, Japan (see http://www.e-stat.go.jp/SG1/estat/List.do?lid=000001055630), the total population of fishers in 2007 was equal to 45 million, among which there were 33 million sea fishers (the numbers of seashore fishers and boat fishers were 20.5 million and 12.5 million respectively), with *P. a. altivelis* (sweetfish) fishers, lure and trout fishers respectively at 5 million, 3 million and 2.5 million. These can be regarded as cultural services provided by *satoyama* (inland water) and *satoumi*.

(3) Gathering shellfish and sea bathing

The number of people who gather shellfish and sea-bathe has also seen a decline. A report in 1918 mentioned that "nearly one thousand female pupils came to gather shellfish in the last month" (Sakai, 1995: 214) besides 200 to 300 people who came with bicycle-drawn carts. However, after 1980, many mud flats were land-filled, with the number of people

Figure 3.39 Change in number of people gathering shellfish in Chiba Prefecture
Source: Honda (2010).
Note: Prepared by Honda (2010) based on *Statistical Yearbook of Chiba Prefecture* (1975–2003).

who came to gather shellfish significantly reduced, for instance in Chiba Prefecture (Figure 3.39).

Sea bathing first originated as a kind of medical treatment, but later became a leisure activity. Beaches in Chiba Prefecture were once inundated by people who enjoyed sea bathing because of the development of railroad systems and car transportation. But this number has decreased since 1970 due to changes in beach environments and the popularization of swimming pools (Figure 3.40).

(4) Children's activities in nature

For children, playing in *satoyama* and *satoumi* is closely associated with activities related to identifying plants and animals (Ohgoshi et al., 2003, 2004). However, playing outside is becoming less popular with children beginning to spend less time outside than inside around 1965 according to the 1996 Environmental White Paper (Environment Agency, Japan, 1996). According the results of the survey in Nosaka Town, Chiba Prefecture (Nakamura, 1982), the number of children's outdoor activities in the decade between 1955 and 1964 was 29, including fishing, and *menko* (pasteboard cards), but this fell to only 18 in the decade between 1975

Figure 3.40 Change in number of people sea bathing in Chiba Prefecture
Source: Honda (2010).
Note: Prepared by Honda (2010) based on *Statistical Yearbook of Chiba Prefecture* (1980–2000), and Materials by Tourism Division of Chiba Prefecture (1971, 2005, 2008).

and 1984, including baseball. Recently, children spend more time inside watching TV or playing electronic games. This trend is common, both in urban and rural areas, although children still like to catch insects and fish in the forests, sea or ponds (Umesato and Nakamura, 1997).

(5) Preservation of traditional festivals, culture and performance arts

About 111,000 rural communities throughout Japan were surveyed in the Agricultural and Forestry Census in 2005. Of this number, 86,000 communities observed traditional festivals (77.9 per cent), while 32,000 preserved both traditional culture and the performance arts (29.0 per cent). This shows only a slight downward trend as compared with 88,000 communities (79.8 per cent) and 34,000 communities (30.6 per cent) respectively surveyed 10 years ago. The number of communities in mid-mountainous agricultural areas and inter-mountainous agricultural areas which observe traditional festivals is equal to ca. 45,500 around 78.3 per cent of the total 58,000 communities), while those preserving both traditional culture and performing arts numbered 17,000 (29.5 per cent). These figures have slightly decreased over the past 10 years (ca. 46,300 communities [79.7 per cent] 10 years ago compared with ca. 18,000 communities [31.3 per cent]).

Conversely, the number of communities which implemented landscape conservation and reforming activities equals 64,000 (comparable to a share of 58.1 per cent overall), while the number of communities implementing the preservation of natural animals and plants is 7,000 (comparable to a share of 6.7 per cent overall). These figures have shown an increase compared to the 60,000 (54.2 per cent) and 6,000 communities (5.8 per cent) 10 years ago. Among communities in mid-mountainous agricultural areas and inter-mountainous agricultural areas, the number of communities implementing landscape reform activities is roughly 36,000 (comparable to a share of 61.5 per cent of all those communities), while the number of communities addressing the conservation of natural animals and plants is 4,370 (comparable to a share of 7.5 per cent). This appears to have increased when compared to the figure 10 years ago: 33,000 (56.6 per cent) versus 3,800 (6.5 per cent). Furthermore, over 30 per cent of communities perform various events and welfare activities for the aged, which suggests that agricultural communities retain many diverse functions in respect to cultural and livelihood aspects.

3.5.4 Education: Satoyama *and* satoumi *education*

In recent years, maintenance activities with citizen participation that focus on *satoyama* woodland coppices are being encouraged and developed throughout the nation. These activities, however, are not only limited to maintaining coppice woodland, but have extended to include multiple usages of *satoyama* such as nature observation, recreation and environmental education (Ishii et al., 1993; Nakagawa, 1996; Kuramoto and Uchishiro, 1997; Shigematsu, 1999; Satoyama Committee, 1996; Enari, 2000; Shinji, 2000; Inui, 2002; The Nature Conservation Society of Japan, 2002).

Among them, responses from 1031 groups of *satoyama* citizen activities collected in a series of questionnaire surveys in 1999 and 2000 revealed that 76 per cent had some form of educational programme in their activities. Also, 161 groups applied for the conservation activity competition, which was organized by the *Yomiuri Shimbun* (newspaper company) in 2004 to select the best 30 *satochi–satoyama* landscapes in Japan, and 4474 groups applied for the selection of the best 100 Japanese *sato* that was organized by the *Asahi Shimbun* Company (newspaper company) in 2008, although the overall picture of all *satoyama* citizen activities is unknown. In addition, the specific activities of these citizen groups could not be identified. On the other hand, *satoyama* educational courses in universities have become quite prominent recently. Examples include the Kakuma *Satoyama* Natural School and the Noto *Satoyama* Meister Nurturing Program both at Kanazawa University; the Creator of *Mori no Megumi* (ecosystem services from forest) Training Course at Nagano

University; and the *Satoyama* Wildlife Management Program at the *Satoyama* Science Research Center at Utsunomiya University.

3.6 Trends of changes in the supporting services of *satoyama* and *satoumi*

Changes in supporting services will be discussed here. We consider forests, grasslands, tidelands, seaweed beds and coral reef as the main ecological systems in *satoyama* and *satoumi* landscapes. Natural forests decreased slightly, while plantation forests increased slightly. There were no significant changes in area, and approximately 66 per cent of Japan's land is still forested. As mentioned previously, the quantity of timber is steadily rising. The primary factor for this is underutilization. However, there is no evidence that suggests improved watershed protection or disaster prevention functions.

Grazing grounds were on the rise until about 1990, but are currently saturated (Figure 3.41). Grasslands, excluding grazing grounds, are in succession due to underutilization, and their area is decreasing. Much of Japan's grasslands are semi-natural grasslands which have received continuous treatments such as prescribed burning where horses and other farming animals used to be raised.

Loss of tideland area is mainly caused by earth-filling. Sea-grass beds are comprised of general sea-grass beds, and more specific seaweed beds. In each case, the area has been diminishing due to earth-filling and environmental pollution (Figures 3.42 and 3.43). As for coral reef, the degree to which coral covers the seabed is diminishing, more so than the clear reduction in the overall area. Key drivers for the above loss are red-soil runoff from land, rising water temperature due to climate change and immense infestation of coral-eating *Acanthaster planic* (crown-of-thorns starfish).

Generally, Japan's biodiversity is still seeing a declining trend, but the rate of reduction is declining compared to the era of massive land development seen during the economic development bubble up until 1990. However, a new driver is emerging, as many species are lost rapidly due to underutilization.

The largest driver for decreases in the past has been land use change. However, secondary drivers differ depending on taxonomic groups. The fact that succession due to underutilization is listed as the third most common driver for the decrease in plants in Japan; however, this driver is rare worldwide. Japan hardly has any indigenous nature left on its land, but various distinguishing wildlife live in places like paddy fields in *satoyama*, where marsh lands or land in the process of succession still

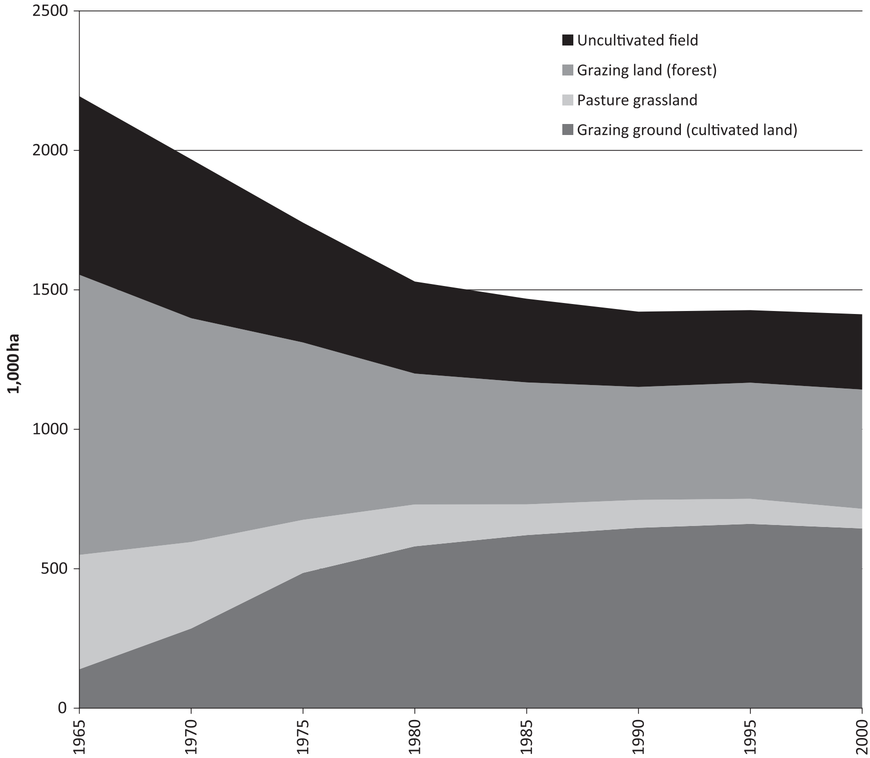


Figure 3.41 Change in Japanese grassland acreage
Sources: Pasture grassland and uncultivated field data from Statistics Bureau, Ministry of Internal Affairs and Communications, Japan website http://www.stat.go.jp/data/chouki/index.htm. Grazing ground (cultivated land) data from Statistics Department, Minister's Secretariat, Ministry of Agriculture, Forestry and Fisheries, Japan, (2008). Grazing land (forest) data from Statistics Department, Ministry of Agriculture, Forestry and Fisheries, Japan (2008).

exist. This has contributed to a decent maintenance of biodiversity for a developed nation. *Satoyama* landscapes have been disappearing in recent years because of land transformation, contamination from intensified agriculture, forestry and fishery industries, and underutilization caused by excessive rural migration.

Climate change is not thought to be an important driver for changing biodiversity in Japan. Biodiversity in Europe was lost during the glacial period, but Japan, with its rainy climate and land that stretches both south and north, possessing a variety of elevations, showed resistance to climatic changes, and this has contributed to the rich biodiversity of its relatively small land surface area.

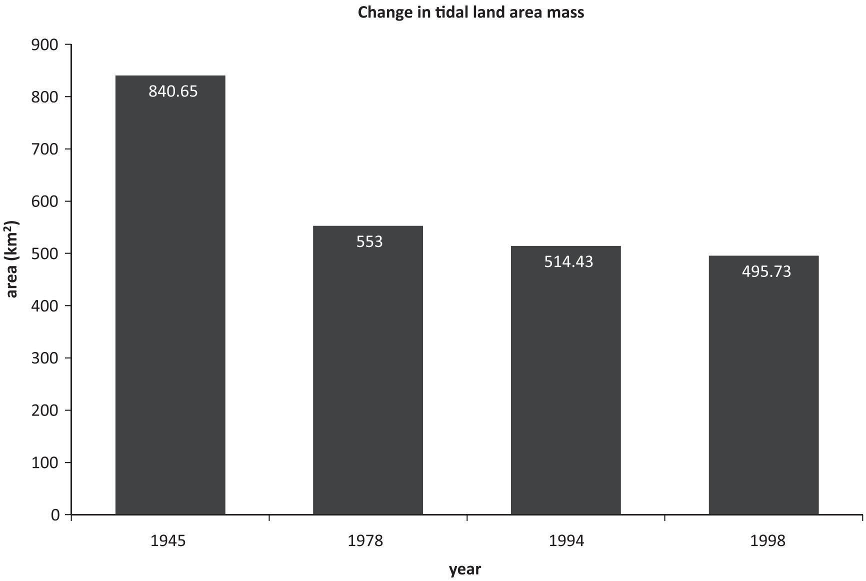


Figure 3.42 Reduction in tideland in Japan
Source: Ministry of the Environment, Japan, Japan Biodiversity Outlook Science Committee (2010).

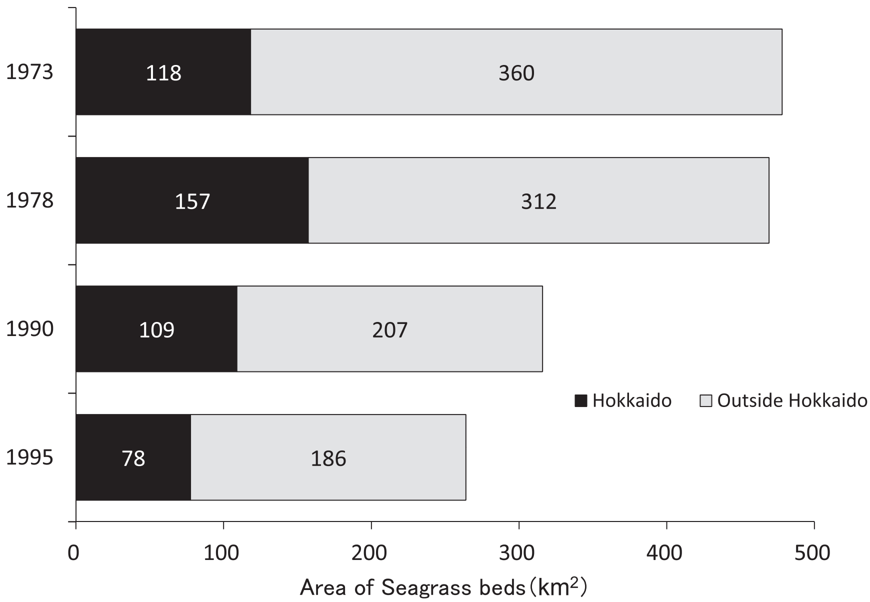


Figure 3.43 Reduction in sea-grass beds in Japan
Source: Ministry of the Environment, Japan, Japan Biodiversity Outlook Science Committee (2010).

Last but not least, the mosaic characteristic of *satoyama* landscapes is rapidly declining causing negative impacts on plant diversity.

Note

1. The self-sufficient rate of completely domestic-made feed was 55 per cent in 1965 but decreased to 25 per cent in 2006 (Ministry of Agriculture, Forestry and Fisheries, Japan, 2009).

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4

Why is change to *satoyama* and *satoumi* a concern?

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4.1 Introduction

In Chapter 3, the direct and indirect drivers and current status of *satoyama* and *satoumi* were discussed. In this chapter, we will describe how the changes in *satoyama* and *satoumi* ecosystem services have affected biodiversity and human well-being. Based on these changes, we will review why change in *satoyama* and *satoumi* is a concern.

4.2 The interlinkages of ecosystem services

4.2.1 Interlinkages between ecosystem services: Provisioning services as an indispensable lifeline

Rather than being individually and independently formed, each ecosystem service interacts with each other and functions in relation to the environmental and social context in the area. As an illustrative example, if increasing timber supply was the main goal, a region's forest should be totally converted to coniferous tree plantation, however, this change would no doubt affect other ecosystem services, such as regulating, cultural and supporting services.

Within *satoyama* and *satoumi* landscapes, the provisioning service of foodstuff and fuel is an indispensable lifeline for humans. Furthermore, the wisdom, skills and culture needed to maximize and sustain such

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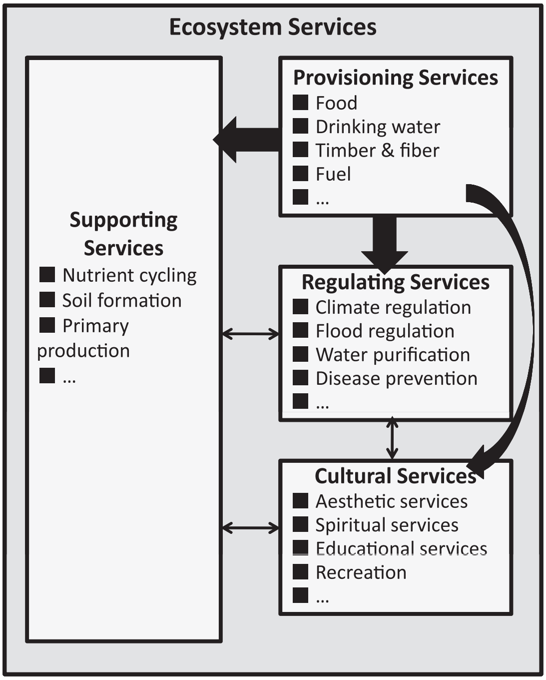

Figure 4.1 Interlinkages between ecosystem services

provisioning services have been nurtured in many regions. Accordingly, when considering the interlinkages between the ecosystem services of *satoyama* and *satoumi*, it is necessary to look at how provisioning services affect other ecosystem services. In short, we use provisioning services as the point of departure in our analysis (Figure 4.1).

(1) Degradation of other ecosystem services due to the overuse of provisioning services within satoyama *and* satoumi *landscapes*

Within *satoyama* landscapes, firewood and charcoal played the most crucial role as an energy source from before World War II until the post-war, high-growth era. In particular, the energy consuming areas surrounding major cities depended heavily on the firewood and charcoal produced by the surrounding *satoyama*. During the high demand periods, particularly from the 1930s to the 1950s, the mountains in the Kanto, Tokai, Kinki and Chugoku regions were stripped bare as a result of the excess stripping of forest resources to produce firewood and charcoal. In some regions, this led to a decline in the ecosystem services of water runoff and flood regulation.

Similarly, in order to cope with increasing demand for timber during the post-World War II period, the uniform expansion of *Cryptomeria japonica* (Japanese cedar) and *Chamaecyparis obtusa* (Japanese cypress) plantation forests progressed as a national policy. Vacant deforested sites of broadleaved *satoyama* forest sites (which had lost their value as sources of firewood and charcoal) were replaced with coniferous plantations. However, the water regulation ecosystem service provided by shallow-rooted coniferous forests preventing soil runoff was inferior to that of comparatively deep-rooted broadleaved forests. The shrub and herb vegetation on forest floors in the coniferous forests were also poorer and the latter were often inferior to the broadleaved forests in terms of soil-formation function and wildlife habitats. This transformation in the *satoyama* landscape saw a drop in the diversity of wild plants and animals.

Within *satoyama* landscapes, the primary focus on raising agricultural productivity has resulted in an improvement in the productivity of fields (e.g. land consolidation, irrigation channels and agricultural dams), as well as the usage of agrichemicals (pesticides, herbicides and chemical fertilizers). As a result, increasing the provisioning service of rice has resulted in a neglect of biodiversity and other ecosystem services within agricultural ecosystems. Even though since the 1990s, the consideration of biodiversity has been increasingly included within the national agricultural policy framework, improving productivity has still been the primary focus.

In the case of *satoumi*, aquaculture depending on artificial feeding has caused an excess of waste on the sea floor (sludge), which has been a driver for the increasing frequency of red tides. Similarly, the release of fries and young shells that were produced as breeders has caused large-scale introductions of alien populations from other regions to local *satoumi*, and has caused a problem of genetic disturbance, which has been ignored entirely. For example, in Tokyo Bay from 1997 to 2001, breeders of *Meretrix petechialis* (hard clam) from North Korea or China were released and have threatened to cause cross-fertilization with native *Meretrix lusoria* (common orient clam). Further, it has been reported that hitherto unseen, harmful organisms have appeared with the introduction of these breeders from outside Japan. For example, the widespread and rapidly expanding distribution of *Euspina fortunei* (invasive moon snail, an aggressive predator which was introduced along with *Ruditapes philippinarum* (Japanese littleneck) imported from China in the late 1990s), is now causing serious damage to the local fishing industry (Okoshi, 2004).

(2) Deterioration of other ecosystem services due to underuse of satoyama *and* satoumi *provisioning services*

Changes in the structure of energy supplies and industry, as well as lifestyles, are linked to the increasing underuse of some key provisioning services of *satoyama* and *satoumi* which, in turn, influence the underlying mosaic structure of *satoyama* and biodiversity. For example, the rapid expansion of bamboo groves in *satoyama* in Western Japan, coupled with an abandonment of *satoyama* (such as a food lifestyle wherein bamboo shoots are consumed less than before and are now imported) are having a major negative effect on biodiversity and other provisioning and regulating services, including the prevention of rainwater runoff and soil erosion (Torii and Isagi, 1997; Torii, 2003; Yamamoto et al., 2004; Ohno et al., 2004).

Similarly, deciduous broadleaved forests of *Quercus serrata* (*konara* oak) and *Quercus acutissima* (sawtooth oak) have been managed to supply firewood, charcoal and *shiitake* sources in the past. However, these ecosystem services from such forests are not being utilized as they once were. In the Northern Kanto region where *shiitake* mushrooms are still produced, usage of charcoal and firewood has dropped from a peak of 70 per cent in the 1950s to the 1960s to the present day rate of 7–22 per cent (Saito, 2004). Therefore, the supply of the provisioning service has not declined but the use of these services for human consumption and well-being has decreased. The continued underuse of these ecosystem services leads to a changing vegetation whereby the sprouting capacity of *Q. serrata* and *Q. acutissima* forests wither with age and are succeeded by the evergreen (*Quercus glauca* [ring-cupped oak] and *Quercus myrsinaefolia* [bamboo-leaf oak]) in warm-temperate zones. Therefore, the assessment of their potential supply capacity when they are abandoned needs to be considered alongside regional characteristics. In any case, the provisioning services of *satoyama* and *satoumi* are not simply evaluated in terms of utilization volume (flow), but need to be considered together with an assessment of the potential supply capacity (stock) (see Table 2.4 in Chapter 2).

4.2.2 Temporal and spatial interlinkages

(1) Present deterioration of ecosystem services due to past exploitative usage of satoyama *and* satoumi *provisioning services*

The temporal scale of socio-economic activities differs from that of ecosystems. The lifespans of mammals are close to those of humans; however, lifecycles of forest ecosystems stretch from several decades to several hundred years. In many instances, there exists a time-lag between the causes and effects on ecosystems. For this reason, the effects of past human usage may take a certain amount of time to become obvious. The forests of *satoyama* landscapes were formerly utilized often in excess of the sustainable supply of their resources, i.e. firewood, charcoal and timber for construction (Totman, 1998). Regarding construction timber, in order to cope with rapid post-World War II construction demands, tree plantations of Japanese cedar and cypress were established to increase the domestic timber supply. Even bald mountains caused by excess use can recover in 20–30 years in many areas of Japan due to its moderate temperature and humid climate. However, while the abandoned coniferous tree plantations over the archipelago as a whole may make it appear that forests are still being maintained, their provisioning (supplying timber) and regulating (mitigating floods) services are declining, and in the process, contrary to expectations, biodiversity is becoming impoverished.

(2) Deterioration of ecosystem services with an interlinkage between downstream satoumi *and* satoyama *headwaters*

In catchment areas where agriculture and livestock husbandry thrive, it is known that the use of nitrogen fertilizers and manure from livestock have a major effect on the quality of water in watercourses. Notably, an increasing volume of forage crops from abroad is fed to livestock in Japan, and consequently an increasing volume of excrement as organic refuse is disposed (Hakamada, 1992). Nitrogen from excrement of livestock accounted for 159 kg N/ha/y in 1999 (Nishio, 2002), and 33 per cent was discarded (Mishima, 2001). Nitrogen in fertilizer applied to agricultural land and that within livestock excrement dissolves in water and is transferred to both soil and groundwater. Nitrogen not consumed by crops pollutes groundwater, drains into watercourses and becomes a cause of eutrophication in lakes and closed coastal areas. For this reason, in order to reduce water pollution in downstream areas and to enrich the ecosystem services of *satoumi*, it is important for integrated approaches to be taken in the basin as a whole (Yachi et al., 2009).

After World War II, a significant number of artificial constructions (dams in particular) were built in Japan's watercourses; however, these hindered the traditional breeding grounds of salmonids, *Anguilla japonica* (Japanese eel) and *Plecoglossus altivelis altivelis* (sweetfish; "*ayu*") (Murota, 2003). In many rivers, a decrease in the number of anadromous fish has been recorded and the provisioning service of fish has deteriorated in spite of the release of a large number of fish juveniles.

In this way, *satoyama* and *satoumi* form a unit in the basin linking to each other through the water and nutrient cycle, as well as through the movement of anadromous fish. Similarly, timber lumbered in *satoyama* is transported down the watercourses, brought ashore at downstream estuarine areas and used as fuel for the salt industry. The refined salt is then returned from the coast to *satoyama* inhabitants and a relationship based on salt occurs between the headwaters and the downstream areas as a result (see Box 4.1).

Box 4.1 The salt road

Story from the mountains of Niigata Prefecture

During winter, people would enter the mountains, fell a tree and put it on the banks of the river. When the volume of water rose during the thawing of the snow, this timber would flow into and down the river. At this time, the people in the mountainous village would put their household mark on each piece of timber. Later, nets would be stretched out across the mouth of the river so as to catch the flowing timber. Each household would then collect the timber with their household mark and boil the seawater using the collected timber as firewood to extract the salt there on the seashore. Once the salt was prepared, it would be taken and returned to the mountainous village.

Before long, because of the inconvenience of doing this, the trees in the mountains came to be felled and sent down the river by the people in the mountainous villages to be burnt for their salt by the people on the coast. At this time, the quantity of firewood that was felled and sent downriver was about twice what was needed to produce enough salt for one's own house. It seems that around Niigata, this was called "flowing *shokki* ("salt trees") downstream". The local people on the coast would receive the *shokki* to be used as firewood for boiling seawater and burn them for the people on the mountain. They also began burning the remaining firewood for themselves.

However, during the Edo period, salt from the Seto Inland Sea was transported to Niigata by ships, which the people from the mountains would buy. The boiling of seawater to extract salt on the coast became economically inefficient. In response to this dwindling market, and in order to obtain money to buy salt, firewood was collected just as in the past, loaded onto boats at the shore and taken to Niigata. The firewood would then be sold to the Niigata tradesmen as fuel and the money earned would be used to buy salt, which would then be returned to the mountains.

The development of coastal salt evaporation ponds in the Seto Inland Sea made the acquisition of salt in the coastal regions easier and people from the mountains of Hiroshima and Yamaguchi Prefectures came to purchase salt in those coastal villages. At this time, the trees in the forest would be felled and even wet woods would be burnt to ashes, often together with dead branches to facilitate the burning. The ashes would be sold for money to buy salt and would be used to bleach hemp. It is said that the lye of the ash could be used to bleach and whiten the hemp.

Box 4.1 (cont.)

Salt fish

Salt was a very valuable commodity to people in mountainous areas in the past. People in these areas would only lick a salted sardine on the first day it was grilled. On the second day, they would eat the head, on the third, the body, and on the fourth, the tail. In this way, it took four days to eat a single sardine.

Source: Miyamoto (1985)

(3) Deterioration in the supporting services of satoyama *and* satoumi *in depopulated areas due to a concentration of the population in urban areas*

The population in the four prefectures of the Southern Kanto region (Saitama, Chiba, Tokyo and Kanagawa Prefectures) rapidly increased from 17.86 million in 1960 to 30 million in 1985. Over this time, there was no major increase to the nearly-saturated Tokyo population, the increase of over 10 million people occurred mostly in the three peripheral prefectures (JSSA – Kanto–Chubu Cluster, 2010). Due to this historically unprecedented drastic concentration of the population in the Kanto area, the farming areas in the suburbs became major receptacles for the population. As a result, the *satoyama* forest areas bordering the city limits, such as the forests of *Q. serrata* (*konara* oak) and *Pinus densiflora* (Japanese red pine), that had lost their economic value for charcoal, firewood and materials for agriculture, became subject to development and were subsequently lost (Saito, 2004). Similar trends were seen in the Chukyo region, especially in Nagoya city, and also in the Kansai region, with a particular focus on the cities of Osaka, Kobe and Kyoto (JSSA – West Japan Cluster, 2010).

Japan's population has continued to slide since 2005. This trend is particularly prominent in mountainous areas far from major cities, in which in 2035, only 8.1 per cent of communes will have populations greater than in 2005 (National Institute of Population and Social Security Research, 2009). The productive population (those aged 15–64 years) is also projected to decrease during this time period, whereas the elderly population is projected to significantly increase (National Institute of Population and Social Security Research, 2009). Among these locations are regional cities, such as Aomori city, where population consolidation policies are proceeding to concentrate various functions into the city centre to maintain vitality, reduce environmental loads, and reduce suburban sprawl. Concurrently, small towns and villages in the *satoyama* landscapes of mountainous areas face declines in their traditions, customs and functions of mutual cooperation due to depopulation and ageing (Ohno, 2005). Within such regions, agriculture and forestry are also retreating to produce crops only for household consumption. *Satoyama* landscape land mosaics of the are further being lost due to the abandonment of agricultural land and encroachment of coniferous tree plantations. Although these abandoned agricultural areas and forests provide suitable habitats for *Sus scrofa* (wild boar), *Cervus nippon* (sika deer) and *Macaca fuscata* (Japanese macaque), these animals damage the crops in the remaining agricultural land. Therefore, a vicious circle occurs in which crop damage by wildlife discourages the cultivation of land and ultimately prompts depopulation, which in turn causes further increases in wildlife populations (JSSA – West Japan Cluster, 2010).

4.3 Do *satoyama* and *satoumi* increase biodiversity?

4.3.1 Changes in Japanese biodiversity

Japan is one of the few developed countries that has maintained its biodiversity (Table 4.1). Some of the factors that have allowed this include: (i) tendency for island nations to have a higher ratio of endemic species compared to continents; (ii) long North-South stretched land, which enabled easier weathering during the glacial and inter-glacial periods; (iii) large amounts of undeveloped mountainous regions; (iv) prioritization of exporting manufactured goods and importing food products

Table 4.1 Biodiversity of Asia and major European nations

Country	Area (10,000 km^2) (Forest ratio)	Mammal	Avian	Amphibian	Tracheophyta
Japan	37 (68%)	188 (22%)	250 (8%)	61 (74%)	5565 (36%)
Philippines	30 (23%)	158 (65%)	196 (95%)	92 (79%)	8931 (39%)
United Kingdom	24 (8%)	50 (0%)	230 (0%)	7 (0%)	1623 (1%)
France	55 (27%)	93 (0%)	269 (0%)	32 (9%)	4630 (3%)
Germany	35 (31%)	76 (0%)	239 (0%)	20 (0%)	2632 (0%)
Italy	29 (22%)	90 (3%)	234 (0%)	41 (29%)	5599 (13%)
Spain	50 (16%)	82 (5%)	278 (2%)	28 (14%)	5050 (19%)
Vietnam	33 (27%)	213 (4%)	535 (2%)	80 (34%)	10500 (12%)

Source: United Nations Environment Programme (2000)
Note: Figures indicate the number of domestic species; percentages indicate the rate of endemic species.

meant that land development required for food self-sufficiency did not occur; (v) freshwater fish and aquatic invertebrates in lentic conditions that lost their wetland habitats but were able to survive in and around paddy fields, and (vi) sacred places and sanctuaries, which have been intentionally conserved (Yumoto, 2010).

Drivers for the loss of biodiversity include: (i) habitat modification; (ii) climate change; (iii) invasive species; (iv) overhunting; (v) pollution; and (vi) underuse. As shown in Figure 4.2, the most common driver in all species groups is habitat modification. For plants, spontaneous succession due to underutilization is the third most common factor while pollution is the second most common for amphibians and freshwater fish, and invasive species is the second common for mammals and reptiles.

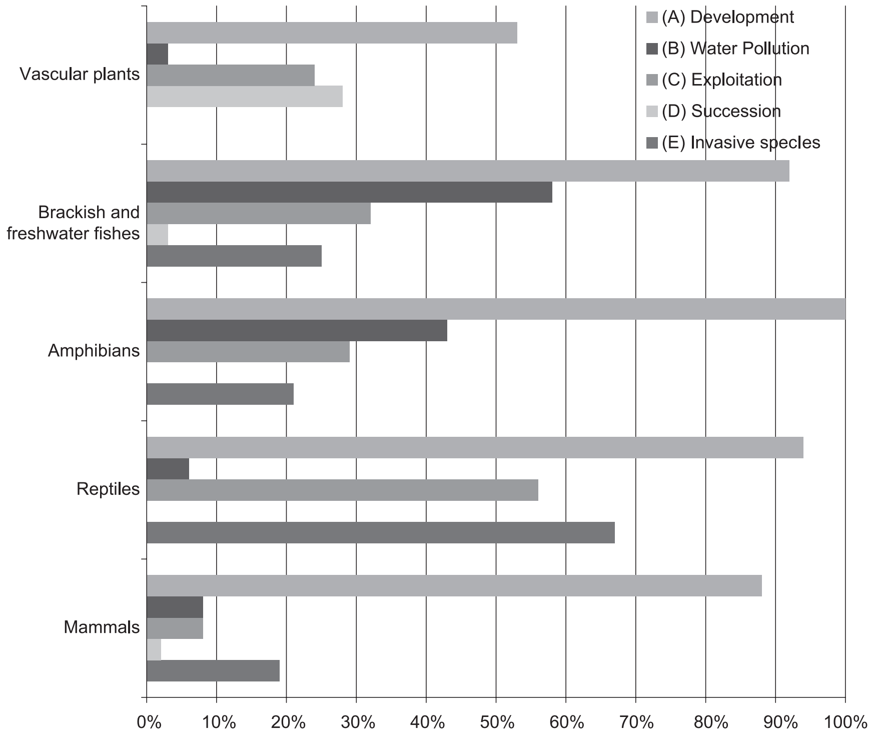

Figure 4.2 Drivers of decline in endangered species
Source: Ministry of the Environment, Japan, Japan Biodiversity Outlook Science Committee (2010).
Note: The drivers of reduction of the species listed in the *Red Data Book* (RDB) are generally categorized into (A) development, (B) water pollution (including pesticides), (C) exploitation, (D) succession, and (E) invasive species. Climate change is not categorized as a driver for any species.

Climate change also affects biodiversity. Several insects including *Papilio memmon* (great Mormon) that were previously distributed only in the southern part of Japan are gradually expanding their distribution to the north of the Kanto region (Kitahara et al., 2001) but serious ecosystem changes have not been reported yet. Climate change affects phenology; some examples of which include the blooming dates of cherry blossoms, which shifted from early April to mid-March (Masuda, 2003) and *Sturnus philippensis* (chestnut-cheeked starling) laying eggs earlier (Koike et al., 2006). These phenological changes can affect reproductive success via interactions between organisms, e.g. the mismatching of flowering and pollinator, although empirical evidence has not been documented.

By contrast, climate change effects have already been reported in *satoumi* landscapes. Based on observations by Hiroshima Prefectural Fisheries and Marine Technology Center, during the period 1970–2006 the Seto Inland Sea annual average temperature rose by 1.1°C and the annual minimum temperature rose by 1.7°C during the same period (JSSA – Seto Inland Sea Group of Western Japan Cluster, 2010). These higher temperatures in winter have resulted in more frequent sightings of various tropical and subtropical fish species such as *Siganus fuscescens* (mottled spinefoot), *Scarus ovifrons* (knobsnout parrotfish), *Plotosus japonicas* (eeltail catfish), *Alterus scriptus* (scribbled leatherjacket filefish), *Aetobatus flagellum* (longheaded eagle ray) and *Pterois lunulata* (luna lionfish), that were previously unable to endure the winter in the Seto Inland Sea. Some of these fish have caused considerable ecosystem changes through predation of mollusks and sea algae. In Hiroshima Bay, as *Portunus pelagicus* (blue crab) in the southern sea have flourished, the catch of this species sometimes exceeded that of the indigenous species *Portunus trituberculatus* (Japanese blue crab) (JSSA – Seto Inland Sea Group of Western Japan Cluster, 2010).

Furthermore, chemical pollutants have had a significant impact on freshwater organisms and birds. Substances that were thought to be endocrine disruptors, specifically polychlorobiphenyl (PCB) and dichlorodiphenyl-trichloro-ethane (DDT), were banned in 1972 and 1971, respectively. The manufacturing of tributyl (TBT), which was used in paint applied to the bottom of ships, has been regulated since 1989. Adaptation of these regulations decreased the detected amount of these substances, yet they are still found in significant quantities in fish because these substances do not break down easily once they are in the environment (Ministry of the Environment, Japan, Japan Biodiversity Outlook Science Committee, 2010).

There are two types of evaluations; those based on endangered species and those based on both endangered species and common species such as the Living Planet Index (LPI), but there is little information available for Japanese species in the LPI evaluation. There are, however, distribution

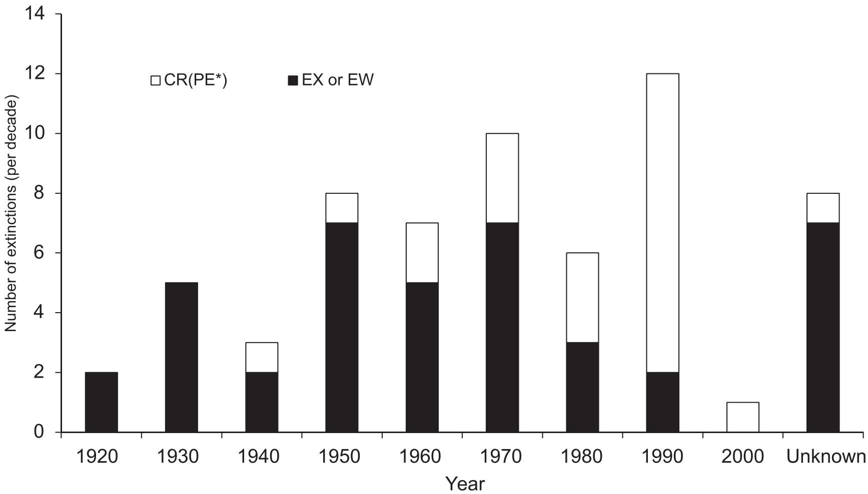

Figure 4.3 Species extinction rates of vascular plants
Source: Fujita et al. (unpublished).
Note: Black bars indicate known extinctions of species (EX: extinct; EW: extinct in the wild) and white bars indicate species whose survival cannot be verified (CR: critically endangered; PE: possibly extinct).

data available on many plants and animals in gridiron areas (10 square kilometres). Forest birds are decreasing in species diversity in more than 70 per cent of all areas, compared to the 1980s and 2000s (Ministry of the Environment, Japan, Japan Biodiversity Outlook Science Committee, 2010). However, these birds are migratory in nature and as such, habitat deterioration may be occurring in their overseas habitats. Overall, in Japan the biodiversity of birds can be considered as status quo, due to the fact that no species have become extinct since the extinction of the *Nipponia nippon* (Japanese crested ibis) and *Ciconia boyciana* (oriental stork).

The extinction risk of vascular plants, based on both past decreasing trends and current population counts, has been estimated. We can estimate the number of species that will face extinction, by assuming that these past decreasing trends will continue (Figure 4.3). If we include those species whose survival cannot be verified, we can say that in the past, 8.6 species became extinct every 10 years. In the next 100 years, 553 species out of 7000 existing species and subspecies will become extinct (Fujita et al. unpublished).

4.3.2 Biodiversity change in satoyama *and* satoumi

The mosaic within a *satoyama* landscape, made up of various ecosystems including forests, agricultural land and waterways, are habitats for a wide variety of wildlife and further maintain a rich biota and biodiversity. A defining characteristic of *satoyama* landscapes is that they provide particularly important base for provisioning, regulating and cultural services. The primary production, nutrient cycle, soil formation and constitution of habitats that are supported by the mosaic of different ecosystem types create diverse ecosystem services through various processes and mechanisms.

In the *Comprehensive list of organisms associated with paddy ecosystems in Japan* published by the Research Centre for Agriculture and Nature and the Nature and Biodiversity Agriculture Support Center, Japan in February 2009, a total of 6,138 species were listed (3,173 species of animals, 2,136 species of plants and 829 species of protozoa) (Kiritani, 2009). In particular, freshwater fish living in static water such as *Carassius* spp. (crucian carp) and *Oryzias latipes* (ricefish, "*medaka*"), and aquatic insects such as the Dytiscidae family (predaceous water beetle) have survived in paddy fields and their surrounding ecotones, which are alternatives of their original habitats (i.e. lakes and ponds). Similarly, in Japan, approximately 50 per cent of living organisms listed in the *Red Data Book* (RDB) have their habitat within *satoyama* landscapes. This reveals that while *satoyama* landscapes, in their present condition, are sites for agriculture and forestry, they also play a crucial role as sites for biodiversity cultivation – the foundation for ecosystem services.

Research carried out between 2000 and 2001 on a coppiced *Q. serrata* (*konara* oak) forest in the Kanto region, as a follow-up to a survey on vegetation there conducted from 1974 to 1980, indicated that there had been an increase in the average number of emerging species within plots that had been managed through weeding or the removal of undergrowth, and conversely, in unmanaged plots, a decreasing trend was seen (Saito, 2003). It was reported that anemochorous species groups showed a marked decrease, while zoochorous species groups showed a remarkable increase (Saito, 2003). Particularly in the *satoyama* landscapes within the zone between northern Kyushu and the Kanto region, many ephemeral plants, which bloom in early spring, and several associate insects can survive on the forest floor under deciduous trees which are maintained by regular harvesting for firewood and charcoal making. If the regular harvesting was not carried out, evergreen trees would replace the deciduous trees due to succession (Nakashizuka and Iida, 1996; Tabata, 1997).

In the village of Ogawa (Kitaibaraki City), located in the Abukuma mountain range (Tohoku region) in Ibaraki Prefecture, and in Iwaki City and Tanagura City in Fukushima Prefecture, the relationship between biodiversity and the morphology of forests is being investigated in detail (JSSA – Tohoku Cluster, 2010). The many species living in the forests in this region that have developed as old growth forests, are mixed with the many species that are found in grasslands as well as young forests in recently lumbered areas (collectively known as "*satoyama* living organisms"). Furthermore, not only do the biota of artificial *C. japonica* (Japanese cedar) and *C. obtuse* (Japanese cypress) coniferous forests differ from that of deciduous broadleaved forests, but their diversity is also low, and groups of organisms exist that do not correspond with the age of the forest. At the same time, variations in the ecosystem mosaic over the past several decades have seen a decline in old growth forests, resulting not only in a decrease of organism diversity, but also a drop in *satoyama* living organisms due to the reduction of semi-natural grasslands and ageing of secondary and coniferous tree plantations.

In recent years, the disappearance of semi-natural grasslands across the nation has created much concern over the extinction of many grassland plants and animals. Of the seven autumn flowers counted in Yamanoue no Okura's poem that appears in the *Manyo-shu* (*Anthology of Ten Thousand Leaves*), the *Eupatorium japonicum* (thoroughwort) and *Platycodon grandiflorus* (Japanese bellflower) attracted attention when they were listed in the national RDB as vulnerable (VU). The reasons for the decline in plant life, as given by the results of the RDB survey, are "horticultural picking" (24 per cent of the national mesh number) followed by "natural succession" (15 per cent), with "grassland development" at 5 per cent. A total of 63 species of butterfly were listed in the national RDB as critically endangered and endangered (CR+EN), vulnerable (VU) or threatened (NT). Of these, 39 were grassland species and 10 were from habitat environments including the grasslands of open forests and forest peripheries. Butterflies which primarily inhabit environments such as grasslands, pastures and wetlands close to human habitation have seen the most remarkable decline (Suka, 2008). The human management of semi-natural grasslands through the intentional burning of grazing land and pastures, had created habitats for many animals and plants. However, recent reduction of such management has led to the inadequacy of those habitats.

There is less evidence to show whether human activities increase the level of diversity in *satoumi* ecosystems. However, the creation of micro environments, such as "*payao*" (artificial floating fish reefs) and tidal stone weirs, may increase local biodiversity levels through diversifying the local environment (Yanagi, 2007).

4.4 Do *satoyama* and *satoumi* ecosystem services contribute to human well-being?

4.4.1 The interlinkage between ecosystem services and human well-being

(1) The deterioration of ecosystem services resulting from improved human well-being through the fuel and fertilizer revolution

Following the fuel and fertilizer revolution, the comparative economic value of *satoyama* provisioning services declined. Global economic patterns of liberalized trade and markets made import of agricultural produce and timber much cheaper. Consequently livelihoods within *satoyama* landscapes and the relationship with ecosystem services therein became weaker (JSSA – Tohoku Cluster, 2010; JSSA – Kanto–Chubu Cluster, 2010; JSSA – Western Japan Cluster, 2010). During this revolution, the usage of fossil fuels and chemical fertilizers increased, while weeds and fallen leaves from *satoyama* ecosystems ceased to be used as fuel and fertilizer (Takeuchi el al., 2003). As a result, the structure and biota of the *satoyama* ecosystem changed and various ecosystem functions and services deteriorated.

Many "basic materials for a good life" and "health" (the human well-being components established by the MA) were substituted with mechanisms external to the ecosystem services of *satoyama* and *satoumi* (i.e. imported goods, technology, social infrastructure and distribution/information systems, etc.) causing a change in lifestyles from ecosystem oriented lifestyles towards a lifestyle of convenience and simple amenity. Moreover, rapid urbanization, ageing population and low-birth rates have caused a detachment of a large majority of the population from nature and the services it provides. *Satoyama* landscapes are not utilized as positively as in the past or, put another way, lives free from dependence on *satoyama* ecosystem services are still increasing. On the other hand, it is becoming increasingly recognized that a lifestyle removed from ecosystem services, combined with population decline and the increasing age of regional communities, is more vulnerable to natural disasters, such as earthquakes, floods and landslides (Ministry of Land, Infrastructure, Transport and Tourism, Japan, 2007). In other words, the resilience of social communities is breaking down as the cultural and material links with ecosystem services provided by *satoyama* is decreasing.

The situation is worse in villages in mountainous areas which are suffering more acutely from depopulation, ageing and the abandonment of farmland. In such villages, disruption to roads and thus lack of produce from outside occurs frequently when disasters strike. Subsequently, communities could possibly face difficulty getting hold of foodstuffs and basic lifestyle products. Similarly, commercial livestock operations, which are often located in rural areas, depend on cheap imported feed; access to which is affected when disasters occur. Economic activities depending on ecosystem services from outside the area are increasingly becoming vulnerable to climatic changes and changes in international economic conditions. The recent increase in international food prices is a case in point where the entitlement of rural communities to access food go down thereby increasing their vulnerability to poverty and food insecurity.

(2) Deterioration in the supporting services of satoumi *due to improved human well-being resulting from coastal region development*

Post-World War II high economic growth spurred development within the Keihin (Tokyo–Yokohama area), Chukyo (Nagoya area), Hanshin (Osaka-Kobe area) and northern Kyushu regions of the coastal industrial zones known as the "Pacific Belt". Within these zones, improved transport and facilities (i.e. railways, roads, ports and harbours) greatly contributed to creating employment and increasing incomes. The landfill of these coasts transformed the coastal areas into industrial zones, which became the foundation for high economic growth, and ultimately brought about both direct and indirect improvements in human well-being. However, insufficient attention was paid to *satoumi* ecosystem services. This led to the problem of water pollution within the semi-closed coastal areas in the bays of Tokyo, Ise, Dokai (Kitakyushu City) and the Seto Inland Sea. In addition to polluted water, hypoxia occurred due to the accumulation of sludge at the bottom of the rivers and oceans. The environmental habitats of wildlife deteriorated, and the variety and population of fish and algae species decreased. Furthermore, due to the population increasing in large coastal cities, the burden of domestic wastewater increased and eutrophication became a problem for inland water and semi-closed coastal areas. These problems are being resolved with the introduction of legislation, upgrades to sewage processing infrastructure, and low-load type products and techniques. At present, reports are emerging suggesting a recovery in the numbers of sea creatures in Tokyo bay.

4.4.2 The changes in cultural services and human well-being in satoyama *and* satoumi

(1) Aesthetic, educational and recreational services provided by satoyama *and* satoumi

Satoyama and *satoumi* landscapes not only generate forest and marine products, they also act historically as sites for recreational activities such as nature rambles, picnics, camping, the gathering of wild plants and mushrooms, shellfish gathering and surf fishing (Tadaki, 1982). Similarly, because *satoyama* and *satoumi* landscapes are becoming sites for environmental education for both children and adults, they are also used for school education and lifelong-learning (Kominami, 1996; Nakagawa, 1996), and the shape of their usage is continuing to diversify (Yorimitsu, 1996).

JSSA – Kanto–Chubu Cluster (2010) mentions sacred forests. Sacred forests in Japan come under two categories – *satoyama* landscapes and urban landscapes. Sacred forests in *satoyama* landscapes are surrounded by farmlands or coppice forests, while those in urban landscapes are surrounded by buildings and houses. Within urban landscapes, sacred forests act as "green islands" and have multiple functions for accommodating urban biodiversity, reducing the heat island effect, providing landmarks and so on. However, the turnover of inhabitants and alternation of generations would make the maintenance of sacred forests difficult. Darkness at night, odour and the economic cost of eliminating alien species and trimming trees could be regarded as "ecosystem disservices" (Lyytimäki et al., 2008). It must be recognized that in many instances, the perceptions of these ecosystem services can vary across individuals with some citizens believing that forests in urban areas are a nuisance.

Besides this, however, maintenance activities on *satoyama* woodland coppices with citizen participation are becoming active throughout the nation. These activities are not only limited to maintaining coppice woodland, but have further expanded into multiple usages including nature observation, recreation and environmental education (Ishii et al., 1993; Nakagawa, 1996; Satoyama Committee, 1996; Kuramoto and Uchijo, 1997; Shigematsu, 1999; Inui, 2002; The Nature Conservation Society of Japan, 2002).

Furthermore, the combination of primary, secondary and tertiary industries have grown in recent years, leading to the emergence of "natural industries" (Amita Institute for Sustainable Economies, 2006), "*satoyama* business" (Tamamura, 2008) and "agri-community business" (Owada, 2008), which make full use of the characteristics of regions through restaurants, cafes, wineries, stock farms and internet sales that have utilized the various natural benefits of *satoyama*. Such industries are not only involved in the production of agricultural products but are characteristic of the fusion of food processing; ecotourism and experience of agricultural and forestry industries; exchange between urban and rural residents; and the securing of sales avenues through the utilization of Information Technology (IT). The scale of these may yet be small but these approaches are being tested in every region. The mountain climbing boom among the middle-aged and elderly, increasing trends oriented towards outdoor pursuits and the expansion of green tourism are important to the region as new tourist resources are expected to further increase in the future. On the other hand, there are fears over new problems, such as the increase of waste due to the excessive concentration of people in popular spots, the gathering of valuable plants and animals and the inadvertent import of foreign plants and animals (JSSA – Tohoku Cluster, 2010).

Concerning the aesthetic function provided by *satoyama*, a comparative analysis was used to study the difference between Japanese and European cases (Kitamura, 1995). For example, pictures of pristine nature without human existence often appears in European photo contests, while old people (who live and work in rural landscapes) and their production activities are one of the most common Japanese motifs (Kohsaka and Flitner, 2004). It has been suggested that the perception of nature and its artefacts among Japanese and European people is different, e.g. the perception of natural dead trees and processed wood (Kohsaka and Handoh, 2006).

(2) Spiritual values provided by satoyama *and* satoumi

Cultural services are associated with the spiritual aspects of human well-being. After World War II, Japan pursued material prosperity and became a "big economic power". However, issues concerning health and safety have arisen due to increased urbanization and a decrease in the use of nature's services. Tanaka (2005), studying the relationship between the natural environment and health (both physical and mental), found a significant negative correlation between the amount of nature and health, especially mental health. He suggested that too much of an artificial environment could negatively influence the physical and mental health of people who live in it (Figures 4.4 and 4.5).

Nowadays, more and more people are pursuing the fulfilment of spirituality, as opposed to that of materialism. An opinion poll conducted in 2008 by the Cabinet Office (Government of Japan), showed that 60.5

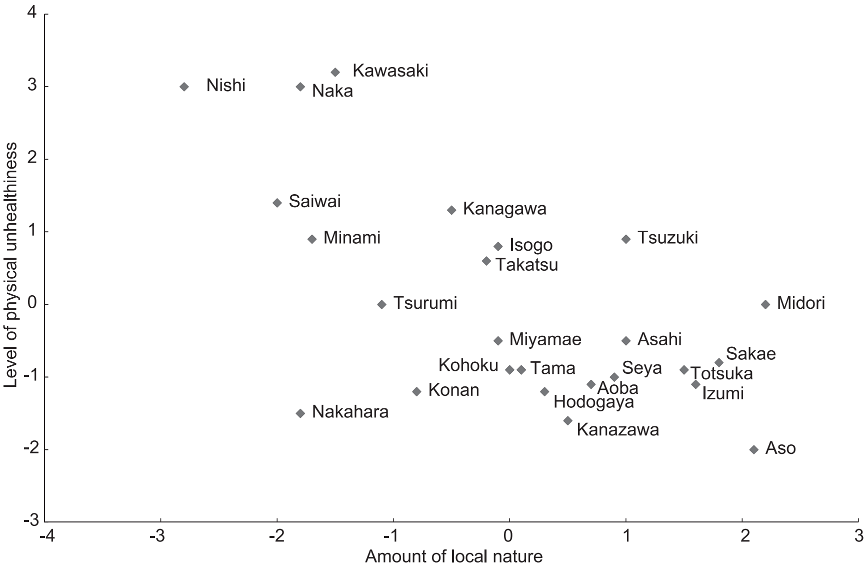

Figure 4.4 Relationship between the natural environment and physical health (in Yokohama and Kawasaki cities)
Source: Tanaka (2005)

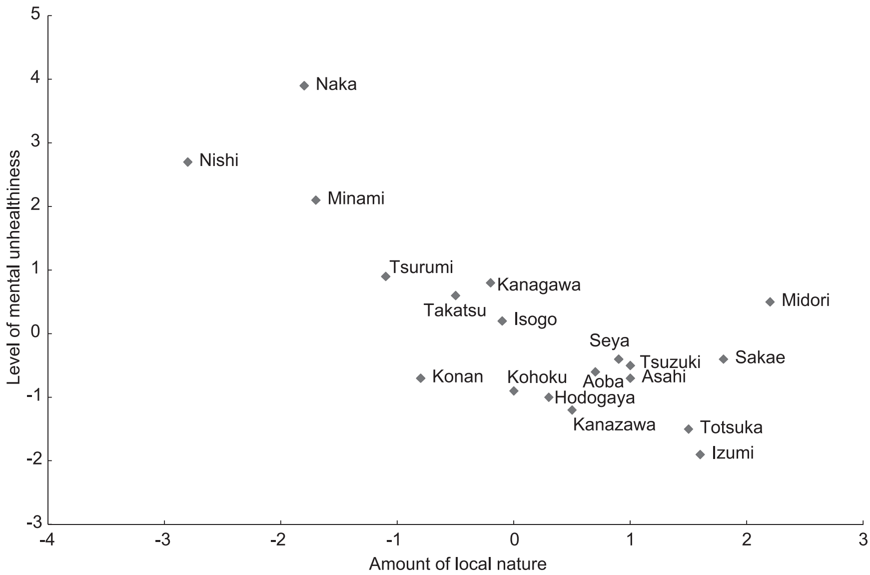

Figure 4.5 Relationship between the natural environment and mental health (in Yokohama city)
Source: Tanaka (2005)

per cent of those questioned indicated that they were pursuing spiritual richness. In contrast, 30.2 per cent answered that they were still pursuing materialism. In a similar opinion poll conducted in 1972, people who desired material riches were more than those who wanted to pursue spirituality. After 1980, the number of people pursuing spirituality began to be greater than those pursuing material riches (Figure 4.5).

The social background of these phenomena is basically that most people are satisfied with their level of materialism. However, the increasing number of suicide cases and mental illnesses is regarded as one of the severest social problems. The social priority of material gain is now in doubt. As for suicide cases, these were very high around 1955 as a result of the poverty and disorder following World War II. Yet a change in values occurred and this gradually decreased to a stable level. However, the recent number of suicides, especially in males, has rapidly increased (Figure 4.6). These trends show that mental health improved once due to the post-war reconstruction, but from 1990 started to decline.

(3) Weakening of social capital maintained by customs within satoyama *and* satoumi *and the loss of the hometown*

Satoyama and *satoumi* are closely connected to the land and so affect the culture, practices and customs of the region. It can be said that they have

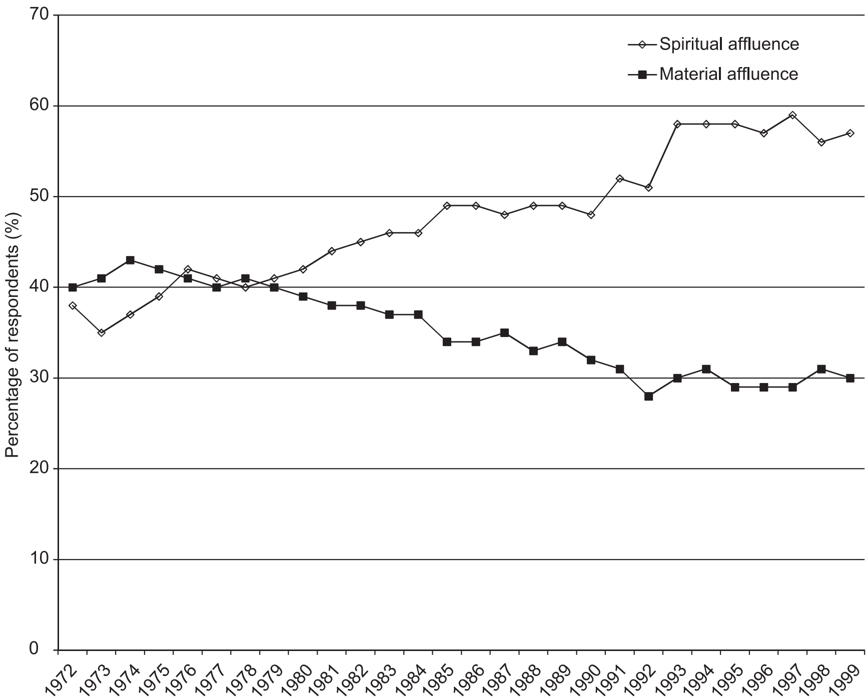

Figure 4.6 Aspiration of spiritual affluence vs. material affluence (1972–1999)
Source: Based on Cabinet Office, Government of Japan (2008)
Notes: 1. Spiritual affluence is defined as a willingness to focus on life with spiritual affluence as the material affluence has already been achieved to some extent. 2. Material affluence is defined as a willingness to focus on making life materially rich.

worked in combination with the latter in forming the undercurrents of wider Japanese culture (Tadaki, 2008). Within Japanese *satoyama* landscapes, a system known as "*iriai*" (Japanese version of the commons) has long been in existence, whereby the inhabitants of collectives communally utilize and manage the mountains, rivers and land in order to obtain life resources. Until the Edo period, Japan depended heavily on these resources and using *iriai* authority, the members of collectives safeguarded sustainable lifestyles (Murota and Mitsumata, 2004). However, from the Meiji era onwards, the *iriai* system was dissolved and the forests, buildings and lands of the *iriai* were reformed into the estates of municipalities. For the farmers, however, *iriai* land was no doubt an indispensable lifeline. Subsequently, the Meiji government met strong resistance in attempting to dissolve *iriai* land and, as a result, established complementary rules of estate zones as a system in which the settlement held the

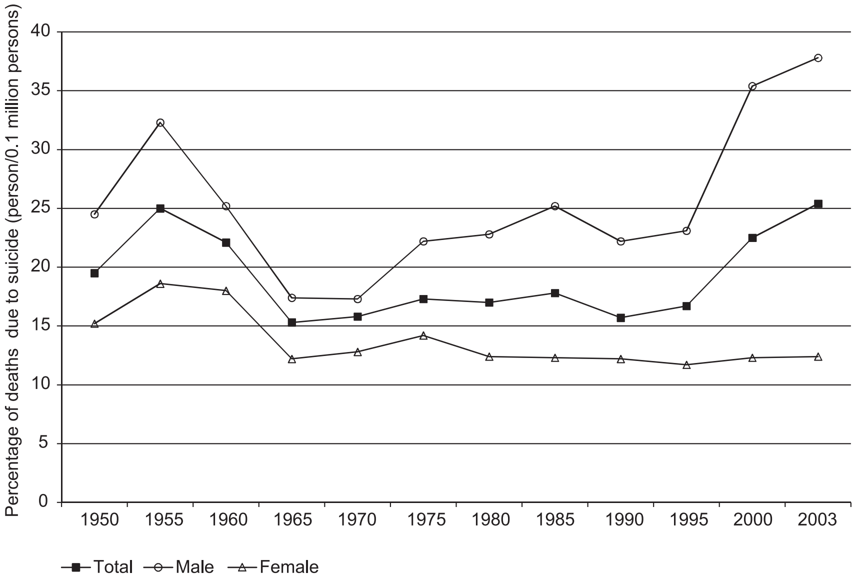

Figure 4.7 Trends in suicides in Japan
Source: Based on Ministry of Health, Labour and Welfare (2005)

authority to use, manage and dispose of their properties (i.e. former *iriai* lands) in a similar way to the rules practised in former *iriai* lands. *Iriai* customs were accepted within public-owned forests and "regulations of the usage rights of former customs" were established within the regulations of towns and villages.

Under the usage and management of *satoyama* based on *iriai* customs, predatory practices were constrained and mutually beneficial innovations in ecosystem usage were adopted. In line with the diversity of the region, wisdom and skills were accumulated in order to continue to strike a sustainable balance between the environment and its resources, and this in turn functioned as a mechanism for development (Fukamachi, 2008).

Similarly, many of the beaches all over Japan have been land-filled for the construction of private corporations, large-scale plants and thermal power stations (among other reasons). However, not only have these beaches, that formerly provided places where people gathered shellfish and small fish, now disappeared, but accessing the seashore itself has become difficult. The people of Takasago city in Hyogo Prefecture insisted that there should be a universal right to enter beach areas and enjoy the blessings of nature – otherwise known as "coastal access rights" (Takasaki and Takakuwa, 1976).

These *satoyama* and *satoumi* customs were practiced not only to avoid the overuse of resources, but also to ensure all members of the collective could obtain resources equally, further facilitating the sustainable enjoyment of the services provided. At present, the natures of the collectives that depend on *satoyama* and *satoumi* have changed significantly. Additionally, the loss of incentives to allocate resources equally has weakened collective management within these ecosystems. The social capital built by communities which had maintained *satoyama* and *satoumi* have become lost and in this process governance power over *satoyama* and *satoumi* was also lost. New governance needs to be constructed for the sustainable use of *satoyama* and *satoumi* ecosystem services by rebuilding social capital. However, unlike the past where participation was primarily local rural communities, new governance structures should encourage the participation of urban citizens and use a combination of legal and economic incentives.

4.5 Economic evaluation of *satoyama* and *satoumi*

4.5.1 Limited economic evaluation of satoyama *and* satoumi

There are three major objectives for the economic assessment of *satoyama* and *satoumi* ecosystems and their ecosystem services: (1) understanding current conditions; (2) derivation of potential values; and (3) viability of policy implementation. The complex nature of the interdependency of ecosystem services generated by mosaic *satoyama* and *satoumi* landscapes makes it a non-trivial task to derive the complete economic value of *satoyama* and *satoumi*.

4.5.2 Multi-functionality of agriculture and rural areas and its estimated value

The importance of the multilateral functions (multi-functionality) of agriculture and agricultural villages has been increasingly pointed out in particular in relation to World Trade Organization (WTO) negotiations, and has further been evaluated in both ecological and economic terms in Japan where agriculture, forestry and fishery industries are considered important for the preservation and management of *satoyama* and *satoumi* landscapes. With the objective of reviewing the value created by *satoyama* and *satoumi*, we have summarized the results of an assessment conducted by the Science Council of Japan in Table 4.2.

Multi-functionality itself is a function which cannot usually be sustained without the existence of agriculture, forestry or fisheries. In economics

Table 4.2 Estimated values of agriculture and forestry

	Estimated value
Flood prevention	3,498.8 billion yen
Watershed protection	1,517.0 billion yen
Climate mitigation	8.7 billion yen
Health, relaxation and well-being	2,375.8 billion yen
Absorption of carbon dioxide	1,239.1 billion yen
Surface erosion prevention	28,256.5 billion yen
Water purification	14,636.1 billion yen
Biodiversity preservation	3,779.2 billion yen
Health and recreation	2,254.6 billion yen

Source: Ministry of Agriculture, Forestry and Fisheries, Japan (2010)

terms, this function belongs to external economies. That is to say, if those activities were to be deteriorated by socio-economic means, then these external functions might decrease together.

As shown in Table 4.2, the total estimated value of all external functions given by agriculture and forest would be as much as 8.2 trillion yen, which is almost equivalent to the total value of Japan's agricultural production in 2007 (which was 8.4 trillion yen). Significant external effects of forestry activities are also provided to society; the estimated value for these is at least 74.0 trillion yen. With regard to biodiversity conservation, this assessment only estimated the value of the wildlife preservation function of forest, which accounted for 3.8 trillion yen.

Similar, such economic evaluations have been conducted by the respective Cluster studies. JSSA – Hokushinetsu Cluster (2010), for example, identified the regulating services by forest in monetary terms. Maruyama et al. (2009) estimated the annual value of watershed protection in Ishikawa Prefecture to be around 680 billion yen; its mountain disaster protection function reaches as much as 418 billion yen. It is estimated that the aggregated values of external functions, including human health, cultural and recreational functions, might reach as much as 1.135 trillion yen in the prefecture.

4.5.3 External economies and joint production

There are two significant points related to multi-functionality. One is that this socially beneficial function will not only be received by local residents but also to a large extent by the general public. The other point is that such functions are mostly coupled with either agricultural, forestry, or fishery activities. In other words, without agricultural activities, especially paddy farming, a variety of environmental functions such as flood prevention, water retention, soil conservation, etc., would not be sufficiently or efficiently provided (Kada et al., 1995). In economic terms, this relationship is known as “joint production”.

The ecological functions provided by forests are not totally linked with forestry activities, although socio-economic deterioration in forestry would eventually result in the loss of many positive external functions in rural, mountainous regions. In other words, the social and public benefits of multi-functionality cannot be obtained separately from agricultural, forestry and fisheries activities. Therefore, *satoyama* and *satoumi* are not only nostalgic entities for Japanese people, but they are also substantial common pooled resources, providing significant ecosystem services.

4.5.4 Economic valuation of biodiversity

Most of the economic values in biodiversity belong to the non-use value category. Although many plants and wild animals are widely used as medicinal and genetic resources, the non-use values of biodiversity can be considered more important in terms of bequeathing such values to the future generations (bequest values) and the existence of biodiversity itself (existence value).

Although the significance and importance of biodiversity is widely acknowledged among the general public, research on the economic valuation of biodiversity has been limited. This is simply because there are few or no markets for biodiversity. It is therefore extremely difficult to evaluate the value of biodiversity in monetary terms.

In recent years, however, by utilizing the Contingent Valuation Method (CVM) and conjoint methods which enable the valuation of non-use values, economic evaluation of biodiversity has been increasing in Japan, covering such examples as extinct species, wild birds, and other plants and animals (Kuriyama, 1998). In CVM, the monetary value of biodiversity is evaluated by asking respondents how much money they would be willing to pay (WTP) for its protection, or willing to accept (WTA) for its usage.

A typical example of economic valuation using the CVM method is conducted by Kuriyama et al. (2000), who evaluated the biodiversity of Yakushima Island, a world heritage site. In order to examine the future of conservation of and use of Yakushima Island, this valuation developed two types of scenarios: 1) a “strong scenario” aiming to maintain biodiversity on the island, and 2) a “weak scenario” aiming to promote tourism on the island. Based on the estimated values of WTP, they compared these two scenarios and estimated that increased monetary value which has been obtained by conservation efforts would reach as much as 97.2 billion yen.

Examples for evaluating the economic value of *satoumi* are limited in number, but a recent assessment of the sea in Kochi Prefecture should be noted, including the coral reef (Shinbo, 2007). Other recent studies, such as one by Ohno et al. (2009) focusing on the biodiversity conservation function of tidelands and beech forests are among differing examples which show the significance of ecosystem services provided by the various types of biodiversity related to *satoyama and satoumi*.

On the other hand, the conjoint analysis was applied to the value of biodiversity within forests in Kanagawa Prefecture (Kuriyama et al., 2006). Forestry plays multiple functions such as watershed conservation, recreational value and biodiversity protection in addition to lumber production. These varied functions are not necessarily compatible with each other; in fact, a trade-off relationship can often be observed as illustrated in the example of the use for recreation vs. ecological conservation. The above mentioned study indicates that the value of forestry is enhanced by choosing a mixed forestry conservation in the watershed with its recreation use, rather than opting for only one or the other. By applying this method, a comparison of alternative policies can be made to possibly indicate which conservation policy should be selected.

4.5.5 Economic assessment of satoyama *and* satoumi *and future perspectives*

These results indicate the significance of economic evaluations of *satoyama* and *satoumi*, while ecological conservation and biodiversity are considered more and more important to Japanese society. However, many issues still remain. For example, the problem of discounting future benefits to present values poses a moral dilemma as demonstrated by many economic studies including the recent Stern report on climate change.

Another issue to be solved concerns which ecological services must be evaluated. There may be other ecological services which are not recognized or well perceived, so the benefits that can be evaluated might only be a part of the total ecological services provided. Monetary valuation has also been very limited in scope and other quantitative and physical indicators should be included. It is suggested that the economic evaluation of ecosystem services should further include the non-use and existence values approach (Ohdoko, 2009). In any event, based upon value changes towards the greater harmony of human activities and environmental quality, the multi-functionality (especially public functions) of *satoyama* and *satoumi* should be better enhanced and revitalized in the future.

4.6 Key findings

4.6.1 Do satoyama *and* satoumi *increase biodiversity?*

Satoyama and *satoumi* landscapes have maintained a high level of biodiversity through human management activities for the sustainable use of ecosystem services derived from those landscapes. Typical examples of rich biodiversity in *satoyama* and *satoumi* landscapes include forest floor plants and their associated insects in coppice woodlands within warm-temperate zones, grassland species of plants and insects specific to managed semi-natural grasslands, lentic freshwater fish and aquatic insects that survive in the ecotones in and around paddy fields. In *satoumi*, the creation of small-scale environments, such as "*payao*" (artificial floating fish reefs) and tidal weirs, may increase the local biodiversity level through diversifying the local environment.

4.6.2 Do satoyama *and* satoumi *increase human well-being*

(1) Declined provisioning services and increased vulnerability in satoyama *ecosystems*

The fuel and fertilizer revolution together with the expansion of global economy (i.e. trade and market liberalizations) have led to a decline in the value of *satoyama* provisioning services and changed the structure and biota of *satoyama* ecosystems, and various ecosystem functions and services have deteriorated. Lifestyles removed from bountiful natural ecosystem services, combined with population decline and increases in age in regional communities, are becoming more and more vulnerable to natural disasters such as earthquakes, floods and landslides under the current declining trends of *satoyama* ecosystem services. Economic activities which depend on ecosystem services abroad heighten the vulnerability of lifelines against climatic changes and changes in international affairs.

(2) Changes in satoumi *ecosystems and ecosystem services*

High economic growth following World War II, spurred the development of coastal industrial zones known as the "Pacific Belt". Insufficient attention was paid to *satoumi* ecosystem services, which led to the problem of water pollution particularly within closed coastal areas. In addition, polluted water degraded the environmental habitats of organisms. However, these problems are improving with the introduction of legislation, upgrades to the sewage processing infrastructure, and low-load type products and techniques. At present, reports are emerging concerning the recovery of sea organisms in coastal areas.

(3) Declining cultural services and weakened social capital in satoyama *and* satoumi

Satoyama and *satoumi* have long been used as sites for recreational activities such as rambling, camping, the gathering of wild plants/mushrooms, shellfish gathering, surf fishing and so on. After World War II, Japan pursued material prosperity and became a “big economic power”. However, there were potential negative impacts on health and safety due to increased urbanization and a corresponding reduction of human interaction with nature.

Satoyama and *satoumi* are closely connected to the land and affect the culture, practices and customs of the region. Further, they have worked in combination with the latter in forming the undercurrents of wider Japanese culture. The loss of *satoyama* and *satoumi* landscapes is closely linked to the disappearance of the communal collectives which used to manage them, in other words, the “loss of the hometown”. The reality being that the former social capital supported by these communities has lost its governing power.

4.6.3 Economic analysis

The number of economic evaluations specifically concerning *satoyama* and *satoumi* landscapes has been limited. However, many relevant case studies have been conducted to evaluate the multi-functionality of agriculture and rural areas, implicitly indicating the values and significance of *satoyama* and *satoumi*. Similarly, the potential values of biodiversity (mainly evaluated by the CVM), suggest that *satoyama* and *satoumi* are increasingly important to society. Based upon a change of values toward the harmony of human activities and the environment, multi-functionality (especially public functions) of *satoyama* and *satoumi* should be enhanced and revitalized in the future.

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5

What and how effective have the main responses to address changes in *satoyama* and *satoumi* been?

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5.1 Introduction: A framework for response assessment

5.1.1 Objectives of the chapter

In this chapter, we will discuss measures, or responses, that can be taken to prevent the deterioration of *satoyama* and *satoumi* ecosystem services, and to regenerate and realize the sustainable management of their ecosystem services. Because *satoyama* and *satoumi* also support living areas in Japan and people derive many ecosystem services from them, there have been various responses in order to sustainably manage these ecosystems.

This chapter provides a general overview of the responses that have been implemented regarding *satoyama* and *satoumi* in Japan in recent years. The chapter provides an evaluation of the influences and effects of these responses. In this chapter, we also discuss the actions that should be taken in the future to achieve sustainable management of *satoyama* and *satoumi*.

5.1.2 Types of responses

Types of responses evaluated in this chapter include: legal responses based on laws (including ordinances) that are formed through parliamentary decisions as social imperatives; economic responses that are seen within the entire process from material production to consumption/

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accumulation; social and behavioural responses; technological responses that include newly developed scientific technologies; and cognitive responses through environmental education and personal contact networks, etc. Also, the extent of the impact of responses varies from the international, national, prefectural, and municipal levels, to the level of individuals in a society. Main decision-making response-related stakeholders are assumed to be international organizations, nations, prefectures, municipalities, business bodies, universities, NGOs/NPOs and others.

Table 5.1 shows the response types used in the Millennium Ecosystem Assessment (MA). In this chapter, we discuss major responses related to

Table 5.1 Response typologies of the Millennium Ecosystem Assessment

(1) Legal Responses
- L1 International treaties
- L2 International agreements
- L3 International customary law
- L4 International agreements made outside of environmental sector (World Trade Organization (WTO), North American Free Trade Agreement (NAFTA), etc.)
- L5 International compulsory system (international adjudication, etc.)
- L6 Domestic environmental regulations (administrative law by environmental sector and constitution)
- L7 Domestic environmental regulations (administrative law not by environmental sector)
- L8 Domestic compulsory system (ombudsman system)
- L9 Command-and-control interventions (zoning, etc.)

(2) Economic Responses
- E1 Incentive based interventions (tax, usage fee, emissions trading, etc.)
- E2 Voluntarism-based responses (eco-labelling, forest preservation agreement, etc.)
- E3 Financial/monetary measures (relocation payment, fund) and international trade policies

(3) Social and Behavioural Responses
- S1 Population policies (including family planning)
- S2 Public education and awareness
- S3 Empowerment of local communities, women and youths (NGOs, NPOs)
- S4 Civil society protest and disobedience

(4) Technological Responses
- T1 Increasing crop yields
- T2 Recovery of ecosystem services
- T3 Energy efficiency improvement

(5) Cognitive Responses
- K1 Utilization of traditional knowledge
- K2 Knowledge acquisition and acceptance (scientific research)

Source: adapted from MA (2005).

satoyama and *satoumi* in Japan (see Table B1), applying the MA response typologies.

The MA evaluated the effectiveness and availability of extensive response options for revitalization, conservation, and sustainable use of ecosystems and the ecosystem services that they provide. In terms of effectiveness, varied responses can be evaluated and compared by measuring the effectiveness of responses in influencing the indirect and/or direct drivers of ecosystem changes: to what extent can the given response be expected to modify the driver. The responses can be also evaluated in terms of their availability to various actors who influence the ecosystems management activities of other actors. It is expected that the evaluation of the effectiveness and availability of response options may help incorporate the value of ecosystems and ecosystem services into the decision-making process when choosing a response option related to various human activities.

5.2 Past and present responses

5.2.1 Responses and international laws

Satoyama and *satoumi*, in a geographical sense, are located within the territory of a single nation; therefore, their preservation and conservation are fundamentally left to national laws and international laws have little direct influence. However, the trends and movement of international society have had a certain level of impact on the establishment of national legal systems. From such a perspective, this chapter will give an overview of international regulations and instruments that are relevant to the conservation of *satoyama* and *satoumi* in Japan (hereinafter, response types of the MA listed in Table 5.1 are mentioned after the names of the laws [including abbreviated names]).

Unified international consensus has been difficult to reach in international legal systems for terrestrial *satoyama* management, due to the national sovereignty of each territory. On the other hand, international maritime regulations have been recognized at relatively early stages as much of the water body remained outside of national jurisdictions, and because of the physical integrity of ocean. In particular, the United Nations Convention of the Law of the Sea (UNCLOS) (L1) of the orders on protection and conservation of marine environment (Kuribayashi, 1994), which was adopted in 1982 after 10 years of negotiations, includes many pioneering regulations even though UNCLOS was adopted more than 10 years before the 1992 Rio Declaration on Environment and Development (L2). The adoption process of UNCLOS greatly impacted on the adoption process of various other treaties related to environmental conservation adopted in the 1990s.

The Ramsar Convention (L1), Convention Concerning the Protection of the World Cultural and Natural Heritage (especially the sections on natural heritage) (L1), and the Convention on Biological Diversity (L1) are examples of international treaties that are closely related to the protection and conservation of the environment that includes terrestrial and marine areas, which are treated as one unified environment. Recently, the importance of a new commons concept, such as the relationships between people and nature and the roles of local communities based on traditional knowledge and a reorganization of management methods, are being suggested for these treaties (Isozaki, 2000). More recently, there have been a few cases in which the conservation of *satoyama* and *satoumi* were attempted by domestic measures and policies in compliance with these treaties.

5.2.2 Responses by national law

1) Legal responses concerning satoyama

Although there are some local ordinances (see the section entitled “Legal responses at the regional level” below) on *satoyama* conservation, there are no integrated legislations or *satoyama* conservation laws that are focused directly on the conservation and management of *satoyama*. Therefore, responses for the conservation and sustainable usage of *satoyama* have relied on the various laws detailed below.

Up until the 1980s, the Urban Park Law (L7) and Urban Green Space Conservation Law (L7) were used to protect and conserve *satoyama* in urban areas. Other laws and regulations from that time were more related to enhancing development and the protection of industries, and had limited impact on the conservation and sustainability of ecosystems and biodiversity although they contributed to activating local economies to some extent. There were a series of laws on land use (e.g. Comprehensive National Land Development Law [L7] and Comprehensive Resort Areas Development Law (Resort Law) [L7]) that focused on promoting the development of *satoyama* landscapes. Also, laws relating to urban area development and the use of agricultural land and forest (e.g. City Planning Act [L9], Forest Law [L7], Agricultural Land Act [L7] and Act on Establishment of Agricultural Promotion Regions [L7]) were focused on constructions and land use changes, rather than regulating the abandonment of forest management and agricultural land resulting from urban-rural migration and the ageing of rural societies, and thus, could not effectively tackle issues specific to *satoyama*.

Ever since the Earth Summit in 1992, interest in conservation of biodiversity and ecosystems and the value of *satoyama* ecosystems has increased and new laws and strategies have emerged such as the Basic Environment Law [L6], the Act on the Promotion of Development of Infrastructure for Leisure Stays in Rural Areas [L7], and the National Biodiversity Strategy was established for the first time in 1995. In addition, provisions concerning the environment were added to existing laws which related to development acceleration and industrial protection (called environmental legalization of sectoral laws [Oikawa, 2010]) as shown in Table 5.2, with the Environmental Impact Assessment Law (L6) established in 1997. However, it is also worth noting that these sectoral laws did not contain the term *satoyama* and the Environmental Impact Assessment Law was limited to major development projects such as airports and highways, making it unsuitable for applications related to unique *satoyama* issues.

The establishment of new laws continued through the 2000s with the passing of the Law for the Promotion of Nature Restoration [L6], Landscape Act [L6] and Act on Promotion of Ecotourism [L7] in addition to the environmental legalization of sectoral laws (see Table 5.2). Consequently, new land use regulations and management considering new perspectives were becoming possible through a zoning with an understanding of *satoyama* as a landscape including different ecosystem types such as rice terraces, villages, adjacent forests, etc., and through management with various stakeholders' participation. Also, a new system of investigating the locations of abandoned cultivated land so as to provide recommendations if necessary even for the relocation of agricultural land was added to the Act on Promotion of Improvement of Agricultural Management Foundation (L7) in 2005, which led to the addressing of the issues specific to *satoyama*. Further, the central government established the 3rd National Biodiversity Strategy in 2007 (following the 2nd National Biodiversity Strategy in 2002), with line agencies establishing their own strategies as well (e.g. the Ministry of Agriculture, Forestry and Fisheries of Japan Biodiversity Strategy [L7]). The Comprehensive National Land Development Plan has come to incorporate environmental perspectives, and the National Spatial Strategy that followed (established in 2008) addresses the issues of citizen management of national land and ecological networks. These strategies are not limited to the integration of policy implementation and systems related to *satoyama*, but have led to the emergence of new initiatives, such as the *Satoyama* Initiative (K1) (Box 5.1).

The Basic Act on Biodiversity (L6) was established in 2008 and defines the conservation of applicable *satoyama* areas as "to implement measures needed for its sustainable conservation through the construction of systems and other methods". In the future, the development of an inter-

Box 5.1 The *Satoyama* Initiative

The *Satoyama* Initiative is an effort to recognize the value of "socio-ecological production landscapes" at the international level, and to maintain, revitalize and rebuild such landscapes. The Paris Declaration on the "*Satoyama* Initiative", developed in 2010, refers to "socio-ecological production landscapes" as "dynamic mosaics of habitats and land uses that have been shaped over the years by the interactions between people and nature in ways that maintain biodiversity and provide humans with goods and services needed for their well-being". This definition is based on the definition developed in the Japan *Satoyama Satoumi* Assessment which is the basis for this book. As these landscapes have existed over centuries, they could be a living example of cultural heritage. Socio-ecological production landscapes can be found in many places around the world, with such landscapes being called *satoyama* in Japan.

It is expected that the effective management of socio-ecological production landscapes will ensure the provision of a wide range of ecosystem services (provisioning, regulating, cultural, supporting). The *Satoyama* Initiative proposes a variety of activities to promote understanding and raise awareness of the importance of socio-ecological production landscapes which contribute to human well-being, and the three objectives of the Convention on Biological Diversity (i.e. the conservation of biological diversity, the sustainable use of the components of biological diversity, and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources), and to support and expand such landscapes. With the aim to implement these activities, the International Partnership for the *Satoyama* Initiative was launched at the Tenth Meeting of the Conference of the Parties to the Convention on Biological Diversity that was held in October, 2010 in Nagoya, Aichi, Japan. The initiative has been facilitated by the Japanese Government and the United Nations University Institute of Advanced Studies.

Note: For further details, see the *Satoyama* Initiative website (http://satoyama-initiative.org/en/).

sectional and inter-regional implementation of management policy and numerous non-regulation initiatives are expected under this act. Further, the establishment of this act has clarified the interrelationships between different administration plans related to the conservation and use of *satoyama* and *satoumi* (The Basic Environmental Plan, National Biodiversity Strategy and other national plans by the government). In other words, the act specifies that (1) the National Biodiversity Strategy is to be defined upon the basis of the Basic Environmental Plan, and that (2) the Basic Plan for Forest and Forestry and other national plans, related to conservation and sustainable use of biodiversity, should also be based on the National Biodiversity Strategy (Basic Act on Biodiversity, Article 12).

One of the legal responses implemented after the Basic Act of Biodiversity is the Basic Law on Promotion of Biomass Use (L7) that was enacted in 2009. This can serve as a base for discussing effective and appropriate responses for *satoyama* from the perspective of energy security.

The need for "constructing a system" for initiatives with cross-sectoral wide perspectives has been a key point in the Basic Environment Plan (revised in 2006). In some countries, there are specialized agencies that take charge of the integrated enforcement of regulations and policies in higher government, such as the Council on Environmental Quality (CEQ) within the Executive Office of the President of the United States of America. In Japan, however, there are no such agencies in the administrative level above the ministries that are specialized in environmental conservation. In addition, the cabinet office, which is superior to ministries under the legal structure, is given the jurisdiction to conduct integrated regulation, although environmental conservation is not defined within its capacity (Act for Establishment of the Cabinet Office, Article 4 [1] & [2]). Moving forward, establishment of a "control tower" that has perspectives beyond regions and fields to exercise cross-sectional wide leadership is required.

2) Legal responses concerning satoumi

Due to a high population concentration in coastal areas and river basins which became prevalent during the economic boom of the post-war era, many coastal environments of *satoumi* became polluted and subsequently deteriorated. Around the same time, coastal areas (particularly enclosed or semi-enclosed coastal seas) began to suffer seriously from the impact of land-based pollution which resulted in decreased tidal flats and seaweed beds, and red and blue tides becoming regular phenomena. Under the traditional system, coastal areas of *satoumi* were divided into four sections (harbour and port, fishing ports, agricultural coast and other coastal areas) and each came under under the jurisdiction of different ministries and departments. After 2001, the Ministry of Land, Infrastructure, Transport and Tourism, Japan came to be in charge of 70 per cent of Japan's coast lines. However, in the traditional system, related legal systems were a collection of sectoral or patchwork management, each established with different objectives, as the main management system of coastal areas was divided into various different jurisdictions. It should be acknowledged that each section of related administration has conducted

Table 5.2 Examples of incorporating environmental law into various laws

1997	River Act (L7) Revised	In addition to water management and usage, the objectives of river environment conservation was clearly mentioned (Article 1). Forest belt was specified as the management facility of river management (Article 3 [2]).
1999	Coast Act (L7) Revised	In addition to national land conservation and disaster prevention, "management and conservation of coastal environment" and "adequate use of public coastal areas" were stated in the objectives (Article 1).
1999	Basic Law on Food, Agriculture and Rural Areas (L7) Enacted	This act revised Basic Law of Agriculture, and listed the enhancement of multi-functionality of agricultural land, including environmental conservation as its policy agenda (Article 3).
2001	Basic Law for Forest and Forestry (L7) Revised	This revised law states conservation of environment and prevention of global warming as part of forests' multi-functions (Article 2).
2001	Fisheries Basic Act (L7) Enacted	First law among the fisheries related laws to state "marine resources as part of ecosystem constituent" (Article 2 [2]).
2001	Land Improvement Act (L7) Revised	"Consideration for environmental harmony" was added to the text in relation to its objectives and principles (Article 1 [2]). The implementation also stated in the basic requirement that a project should be conducted on the bases of "consideration to the harmony with natural environment" (Article 2 [6]).
2004	Forest Law (L7) Revised	This law introduced enforced management of thinning of woods, with focus on environment conservation function of forests. (Article 10 [10] & [11]).
2004	Law for Protection of Cultural Properties (L7) Revision	Cultural landscape, including *satoyama*, was stated as the subject of conservation and protection (Article 134 and below).

Source: Oikawa, 2010.

detailed management to the best of its capacity, yet an integrated approach was lacking (Ocean Policy Research Foundation, 2009).

Since the adoption of the United Nations Convention on the Law of the Sea (1982) (L1) and the United Nations Conference on Environment and Development in Rio de Janeiro and Agenda 21 (1992), the basic idea of coastal management has spread quickly in the international community. In this idea, the management system was to transfer itself from sectoral management to Integrated Coastal Zone Management (ICZM) focusing on the physical unity of the marine system (Kusuma-Atmadja, Mensah and Oxman 1997; Cicin-Sain and Knecht, 1998). ICZM is a key objective under Agenda 21 (Chapter 17), the UNEP Global Programme of Action for the Protection of the Marine Environment from Land-based Activities Action Plan, the Ramsar Convention and the Convention on Biological Diversity. For example, the "Principles and guidelines for incorporating wetland issues into Integrated Coastal Zone Management (ICZM)" in resolution VIII.4 of the meeting of conference of contracting parties to the Ramsar Convention has detailed descriptions of definitions of integrated management, items and processes required, and issues for actualization. It is a useful guiding principle for not only coastal areas, but also for integrated management of resources (Field Science Education and Research Center of Kyoto University, 2007). As a result of this international influence, after the 1990s, Japan began to discuss the need to introduce such a management system and the need to transfer to an integrated structure for the conservation of coastal areas. Responses to such demands were realized experimentally as part of the Act on Special Measures concerning Conservation of the Environment of the Seto Inland Sea (L6) (1973). However, the time taken for these actions to transform into part of the national legal system took a relatively long time.

Japan responded to this international trend with the 5th Comprehensive National Development Plan "Grand Design for the 21st Century" (March 1998) as part of the National Spatial Planning Act, which set up the integrated management of coastal areas. It recognized that "coastal areas constitute a unified ecosystem and thus comprehensive management plans for coastal areas should be developed in which local public entities take the lead in drawing up and implementing a range of projects and measures according to a schedule and in a comprehensive manner". The Grand Design values regional development under the responsibility and choices of each region. It calls for public participation in order to develop national land through collaboration with various stakeholders (Field Science Education and Research Center of Kyoto University, 2007). In February 2000, basic guidelines for regional public agencies and private bodies were formulated to help implement plans for integrated management of coastal areas based on the aforementioned Grand Design. The above mentioned guidelines are the most comprehensive fundamental document that discusses integrated management in Japan.

As Table 5.2 shows, the Coast Act (L7) of 1999, in its fully-fledged revision, reacted first and foremost to the trend. In the amendment, it was proposed that an integrated management system should balance environment and utilization of the coast with protection of the coast, which had been the original goal. Following these trends, the Fisheries Basic Act (L7) was established in 2001. This law gives the central government the responsibility to implement policies not just on water quality conservation and protection and improvement of habitat for aquatic animals and plants, but also on the conservation and improvement of forests and other necessary. Also, the Act on Special Measures concerning Rejuvenation of Ariake Sea and Yatsushiro Sea (L6) enacted in 2002 emphasizes improving forest functions, in addition to water quality conservation, the purification function of tidal flats and other landscapes, and improvement of water, coasts, ports, and harbours.

In 2007, with the establishment of the Basic Act on Ocean Policy (L7), ICZM at the national level was implemented in full force (Kisugi, 2008; Okuwaki, 2008). Activities towards the construction of *satoumi* went into full swing with such initiatives as the Strategy for an Environmental Nation in the 21st Century in 2007, Environmental Conservation Measures of the Seto Inland Sea in 2007, 3rd National Biodiversity Strategy in 2007 and the Basic Plan on Ocean Policy in 2008. In the Basic Plan on Ocean Policy, the term *satoumi* was used in two parts. It recognizes the importance of realizing the concept of *satoumi* (Yanagi, 2006), which is to create rich and beautiful coastal areas by securing biodiversity and bio-productivity of coastal areas through human interference that is harmonious with natural ecosystems in order to maintain the sustainability of water resources. The Ministry of the Environment, Japan has sited 33 examples of *satoumi* creation activities in enclosed coastal areas from across the country (see JSSA – Cluster Reports).

Governance systems such as fishing/fishery union rights or fishery rights in the coastal fishery industry are some of the examples that were used to maintain and preserve the functional conservation management of *satoumi*. These are systems specific to Japanese coastal areas, and they are regulated by the Fisheries Act (L7), among other acts, that allow for the independent management of coastal areas by fishermen. Within this system, the responsible parties are clearly identified through the division of ocean and property rights, which are assigned only to people in the fishing industry. The exclusivity of the rights provided by these governance systems is often questioned but they have been effective in regulating fish catch by enabling orderly fishing operations.

In addition to the Fisheries Act, the Fisheries Resource Protection Law (L7) has also facilitated the conservation of coastal areas for fishery purposes by establishing a “Protected Water Surface”. Other examples of environmental regulations that aim to conserve the natural environment in coastal areas include Marine Park Zones within National Parks and Quasi-national Parks in Japan based on the Natural Parks Law (L6), and Marine Special Zones within Nature Conservation Areas based on the Nature Conservation Law (L6).

3) Legal responses at the regional level

At the national level, most laws are sectoral in nature leading to *satoyama* and agricultural lands being dealt with in a separate manner, resulting in a non-integrated approach despite an integrated one being needed for sustainable management of these systems (Kotera, 2008). Furthermore, national regulations and acts are not designed to apply to regional natural, social and economic conditions. In order to overcome this lack of an integrated approach at the national level, the active establishment and use of local ordinances (L9) and local biodiversity strategies (L9), which are regional rules, are being promoted (Kanto Federation of Bar Associations, 2005; Sanpei and Takeuchi, 2006; Kotera, 2008; Oikawa, 2010).

Local ordinances are established by the initiatives of the municipal council to carry out public administration (missions and jurisdictions). Up until the 1980s, quantitative procurement of green urban space was being promoted through local ordinances related to the promotion of green space and tree planting for the conservation and management of *satoyama*. However, from the 1990s onwards, hilly areas and forests in hilly areas were added to the conservation list, thus leading to the increased protection of secondary nature. With the establishment of the Act on Promotion of Decentralization Reform (L7), authority previously exercized at the national level was given to regional governments, further expanding the leeway of establishing local ordinances. For example, with revisions to the Wildlife Protection and Hunting Law, the authority to give permission to capture wildlife was given to prefectural governments (with final authority given to municipal governments in cases where prefectural governments establish the ordinances).

Starting in the 2000s, various local ordinances with a goal to conserve and manage *satoyama* were established and include *satoyama* conservation local ordinances (City of Kochi), local ordinances related to the promotion of conservation, maintenance, and use of *satoyama* (Chiba Prefecture), and local ordinances related to the promotion of conservation, regeneration, and use of *satochi* and *satoyama* (Kanagawa Prefecture). These local ordinances outline the rules of implementation of governance with participation from citizens and non-profit organizations (NPOs) in each specified region, or unification of regions to be conserved and managed. Note that some of these rules are contained within local ordinances do not have *satoyama* and *satoumi* in their titles, such as Ishikawa Prefecture's Local Ordinances to Protect the Environment and Osaka Prefecture's Local Ordinances Related to the Conservation and Use of Agricultural Space and Promotion of Urban Agriculture (Awaji et al., 2006).

In the case of *satoumi*, prefectural governments have set up fishery coordination regulations to ensure the implementation of the Fisheries Act (L7) and the Fisheries Resource Protection Law (L7) in which non-fishing zones and other fishery resource protection means are established. Many of these regulations have a long history and some of them have existed since the nineteenth century.

Regarding biodiversity strategies established at the local level, the pioneering strategy was Chiba Prefecture's Chiba Strategy for Biodiversity (established in 2008) that specifically addresses the issues of ecosystem services. For this strategy, citizens and NPOs played significant roles in writing proposals, with many specific enforcement policies established. From there on, similar strategies were established in Aichi Prefecture, Hyogo Prefecture, Nagasaki Prefecture, Saitama Prefecture, Shiga Prefecture, the City of Nagareyama (Chiba Prefecture) and the City of Nagoya (Aichi Prefecture). The status of Japan's local biodiversity strategies is updated in the Biodiversity Asian Strategy (http://www.bas.ynu.ac.jp/index.html) on a regular basis.

The local biodiversity strategies of Japan are "established on the basis of the national strategy (Basic Act on Biodiversity, Article 13)", but its meaning is not clear. Even in the "Road Map for the Establishment of Local Biodiversity Strategy (Draft)", which the national government made public in 2009, regional governments producing local biodiversity strategies only receive "technological guidance" from central government. Because there is no precise or common definition of *satoyama* and *satoumi* yet throughout Japan, the local biodiversity strategies are left to place emphasis on the contexts of each region.

5.2.3 Economic responses

The economic value of products from *satoyama* and *satoumi* has decreased due to a decline in agricultural, forestry and fishery activities. The use of economic incentives to mitigate or reverse the decline in *satoyama* and *satoumi* has been limited due to this decreasing value of these systems. However, responses dependent on the voluntary motivation of citizens' activities and local residents have been increasingly used due to the economic conditions of financial deficit coupled with the increase in national concerns for *satoyama* and *satoumi* improvement.

1) Responses based on economic incentives (E1)

• Taxation of economic activities with external costs

There is an ongoing discussion concerning the introduction of a carbon tax in Japan to reduce greenhouse gas (GHG) emissions. It is further thought that this tax will generate income needed to finance research and technology development in related areas. In the meantime, at the regional level, the industrial waste tax regulated by local authorities has been initiated to be used for the surveillance and treatment of illegal dumping, while the municipal ordinance of such a tax is expected to function effectively to preserve the ecosystems of *satoyama* (Ministry of the Environment, 2004).

In Japan, the "Act on Special Measures concerning New Energy Usage by Electric Utilities (Renewables Portfolio Standard Law: RPS Law)" was enacted in 2003 in order to reduce GHGs. This law enforces the responsibilities of electrical companies to utilize renewable energies, such as biomass energy. Under this system, electrical companies purchase energy at a high cost from the producers of biomass energy using the thinning woods of *satoyama*, with the money being used for *satoyama* management. Thus, tree thinning secures the appropriate amount of human intervention needed in the secondary forest to contribute to its conservation (Chapters 2 and 3).

2) Reponses based on voluntary motives (E2)

- Payment for ecosystem services

In Japan, examples of payments for ecosystem services include the rice terrace owner system that manages rice terraces using financial support from urban dwellers; the forest environment tax, which is collected from the citizens of municipalities that are located downstream of water source forests for their maintenance (see Box 5.2); and the offset credit system (Japanese Verified Emission Reduction: J-VER).

The offset credit system offsets GHG emissions from areas having difficulties reducing them by purchasing emission reduction and absorption quantities in addition to voluntary efforts of reducing GHG emissions by members of society, including citizens, businesses, NPOs, NGOs, municipalities, and governments. An example related to *satoyama* includes a forest management project that receives offset credit approval by the Certification Center on Climate Change, part of the Ministry of the Environment, for absorbing CO_2 via forest maintenance, tree thinning and tree planting.

In terms of the rice terrace owner system, money and labour rendered by urban people to become an owner of rice terraces can be used for the maintenance and preservation of secondary nature and cultural services of *satoyama* (Yamaji, 2006; JSSA – Kanto–Chubu Cluster, 2010). Also, several training projects have been introduced in many areas to promote the rice terrace owner system (JSSA – Hokushinetsu Cluster, 2010).

- Active use of mechanisms that reflect consumer preferences

Sometimes, it is necessary to encourage manufacturers to adopt sustainable production methods through consumer buying behaviour when

Box 5.2 Forest Environment Tax (FET)

Forests not only supply forestry products, but also have public functions such as conservation of land, recharging of water supply, conservation of the natural environment, preservation of public health and prevention of global warming. On the other hand, deterioration of forest environments that include *satoyama* progressed with the deterioration of the forestry industry, much like other primary industries, which resulted in the inadequate maintenance of forests. With that, many prefectural governments are adopting FETs (although the names and purposes of the tax may vary) in order to secure the sustainability of public good function supplied by forests. FET is a taxation system to share the burden of promoting forest conservation projects with all the citizens in a prefecture who benefit from the public good function of forests.

The adoption of such a tax by Kochi Prefecture in 2003 spearheaded the trend. To date, 30 prefectures out of 47 prefectures in Japan have adopted the FET. The concept itself has been in existence for a while, but the reason for rapid adaptation of the system in recent years is the fact that it became easier to create special taxes for specific purposes due to the revised Local Tax Act which permitted the decentralization of authority.

The most common taxation regime for the FET is the topping up of the Prefecture Tax. This amounts to about 500 to 1000 yen annually for individuals, and about 5 to 10 per cent of the total annual tax for businesses. For many governments, tax collected amounts to 100 to 500 million yen, but there are prefectures that collect much more, including Fukushima (1 billion yen), Ibaraki (1.6 billion yen), Fukuoka (1.3 billion yen), Hyogo (2.1 billion yen), and Kanagawa (3.8 billion yen). Examples of projects undertaken include the Yamagata Green Environment Tax Utilization Project 2008, which carried out measures for environmental conservation (regeneration of *satoyama* forests that deteriorated with diseases and pests, etc.), and formulation of relationships between citizens and forests suitable for the twenty-first century (promotion of the making of forests by citizens in the prefecture).

Although there are some positive evaluations of the FET from the perspective of forest conservation that includes *satoyama*, many challenges have been pointed out. These include the need to: revisit the tax regimes (e.g. taxation on new developments, taxation on use of non-recyclable materials); revisit the use of the collected tax (e.g. adaptation of evaluation and inspection of effectiveness of environmental conservation efforts of the projects); and secure environmental conservation efforts (e.g. adaptation of a system to make it obligatory for the owners of forests that receive maintenance to manage forests).

Note: The numbers used here are from the FET database on the Blue Revolution and Governance of Water website. (http://www.uf.a.u-tokyo.ac.jp/~kuraji/BR/)

effective regulatory methods by governments are not available. A key to the success of the above would be to provide consumers with information and certification of the measures taken by manufacturers with regard to the use of ecosystem services offered by *satoyama* and *satoumi*.

For Japanese *satoyama*, there is a system to certify timbers and other products that are produced from the forests that are managed appropriately, under the Forest Certification System. This is a strategy to enhance the practice of highly sustainable production methods by the producers through consumers' choices. Today, the Forest Stewardship Council (FSC) is one of the best-known international organizations for implementing the certification system. In Japan, since 2003, the Sustainable Green Ecosystem Council (SGEC) has been managing the forest certification system for Japanese forests.

The same certification system has been organized for *satoumi* under the Marine Stewardship Council (MSC) as a world organization and Marine Eco-Label (MEL) Japan as a domestic organization.

With heightened interest in food safety, local production for local consumption, development of locally specialized food, promotion of organic farming and sales promotion of regional agricultural brands have been increasing.

However, as the branding of products that are tied to improved ecosystem services increases, measures that have additional financial burdens stemming from production methods considering environmental concerns (e.g. reduced pesticide use) might become possible. This might require a review of the subsidy system in place and if such measures need to be designed to encourage the use of *satoyama* and *satoumi* management methods.

3) Financial responses and responses by international trading policies (E3)

In *satoyama*, subsidizing policies for price support and production aid for agriculture and forestry have been implemented as major economic responses. Given the budget cuts on agriculture and forestry since the 1990s, policies for price support and production aid are being revisited, with changes in policy being made concerning direct payments to farmers.

From 2000, direct payments to hilly and mountainous areas are being made to prevent the abandonment of cultivation of agricultural lands and to ensure multifunctional sustainability of watershed protection, primarily in *satoyama*. In addition, the action plan for the improvement of farmland, water and environmental preservation has been carried out since 2007. Under this scheme, support money is paid to the regional organization which preserves farmland and irrigation water as one of the most important elements of *satoyama*, as well as farmers groups, which conduct environmentally friendly agriculture by reducing chemical fertilizer and pesticide usage.

This direct payment policy and action plan does not enforce the excessive use of ecosystem services because they are decoupled from farmers' production incentives and have small influence on the overproduction of agricultural products. It is also a highly sustainable measure classified as the green box policy, which has less of a distortion effect on trade, under the WTO agreement on agriculture.

On the other hand, the Japanese direct payment policy scheme has an interesting feature as follows: the government provides money not only to farmers but also farmers' groups, organizations and councils established for cooperative actions (such as weed control and group meetings) under the agreement in the area. In most cases, farmers as farmland owners, non-farm residents and NPOs participate in such cooperative action.

5.2.4 Social and behavioural response

Citizens, NPOs and NGOs contribute significantly to *satoyama* and *satoumi* management and conservation. In particular, contributions of NPOs and/or NGOs are absolutely necessary for the sustainable management of *satoyama* landscapes that are near urban areas. With this, the Ministry of the Environment and Municipalities has established a subsidy system for NPOs and NGOs having activities related to *satoyama* and *satoumi*.

• Assistance for activities by citizens, NPOs and NGOs

Ishikawa and Chiba Prefectures support citizens, NPOs and NGOs by establishing ordinances, and through governors approving the establishment of arrangements between land owners and groups that carry out activities in *satoyama*. It should be noted that the National Biodiversity Strategy has been established at the national level, but in Japan, municipal governments are actively establishing strategies at the regional level as well. There are examples like the Chiba Prefecture Biodiversity Strategy, for which citizens and NPOs go through multiple town hall meetings to come up with recommendations. In such cases, citizens and NPOs play important roles in establishing strategies.

Eelgrass bed regeneration activities are being carried out by citizens to re-establish nature that was lost during the past earth-filling in *satoumi*. Seeding and transplanting of *Zostera marina* (common eelgrass) are being carried out by citizens, governments, businesses and schools in the Seto Inland Sea, Tokyo Bay and Osaka Bay, and the state of nature from the time when earth-filling began is slowly being restored. In addition, the measure in which coastal fishermen themselves protect the fishing environment is also becoming popular, although there is an economic incentive for doing so. This is because an increase in fish resources produced in the coastal area that they help to conserve can be shared out between themselves in the future as their fishing area is limited by fishing rights under the Fisheries Act and outsiders are prohibited, i.e., a system where a person who pays the price also receives the benefit. Furthermore, these fishermen's efforts not only have a private, economic effect (i.e. increase in fish catch) but also a public effect concerning the conservation of public good ecosystem services such as flood regulation and water purification. Some public financial assistance to such efforts has been made available.

• Activities by businesses

Corporate social responsibility (CSR) is a generalized term that encompasses societal contributions for achieving good relationships between businesses and various stakeholders of the businesses. An important aspect of the societal contribution is the sustainable use and management of natural resources. More and more businesses mention biodiversity in their environmental reports. Some businesses actively perform *satoyama* and *satoumi* conservation activities such as the regeneration of forests and coral. Nevertheless, only a limited number of businesses carry out such activities, and thus there is a need to raise awareness and increase the involvement of the general public, which could underlay CSR.

• Ecotourism

Ecotourism has been very active since the 1990s as desires to be in touch with nature and interests towards environmental issues rose. With this increasing popularity of ecotourism, the Act on Promotion of Ecotourism was established. Many groups participate in activities that have a direct relationship with *satoyama*, such as conservation efforts for rice terraces, nature observation and canoeing.

Green tourism has been proposed in rural areas as a leisure activity to enjoy nature, culture and friendship, with 50 areas having been selected in Japan as model regions. The Act for the Promotion of Infrastructure Development for Leisure Activities in Rural Areas was established in 1994 and is the base law for promoting green tourism. Similarly, the Ministry of Land, Infrastructure, Transport and Tourism and the Fisheries Agency have promoted blue tourism, which involves citizens staying at fishing villages that act as places of leisure, while simultaneously rejuvenating the coastal and island municipalities. Nonetheless, although the model projects supported by governments and municipalities can be referred to for developing similar activities, these tourism activities have not yet been developed much.

5.2.5 Technological responses

1) Development of technologies to increase agricultural crops without environmental deterioration

In Japan, the development of environment-friendly technologies in the fields of agriculture and forestry is taking place at research institutes affiliated with the government, universities and other organizations. Relating to *satoyama*, several technological responses have been developed in the field, such as technology for monitoring forests and maintenance by using land observation and satellite imagery; technical guides for the maintenance of *satoyama*; and technology for the selection of seedlings of *Pinus thunbergii* (Japanese black pine) and *Pinus densiflora* (Japanese red pine) with high resistance against pine wilt disease (JSSA – Hokushinetsu Cluster, 2010; JSSA – Western Japan Cluster, 2010). Also, technological responses for *satoumi* include the seedling-production technology of *Clupea pallasii* (Pacific herring); management technique of intermediate breeding for *Anadara broughtoni* (bloody clam) by using marine facilities; and aquaculture technology of *Anadara broughtoni* (bloody clam) in the fallow field (JSSA – Hokkaido Cluster, 2010; JSSA – Hokushinetsu Cluster, 2010).

2) Fostering technologies to reduce the emission of greenhouse gases

Technology developments, such as the production of hylo-pellets and bioethanol, as well as pyrolysis-gasification and liquefaction, are occurring via the use of woody biomass produced by *satoyama* (see Box 5.3). These technologies contribute to reducing GHG emissions by using biomass instead of fossil fuels which have a higher greenhouse potential. In addition, environmentally-friendly technologies have also been developed in *satoumi,* e.g. fishing methods using LEDs on fishing boats (JSSA – Hokkaido Cluster, 2010).

3) Recovery of ecosystem services

This type of response is carried out through the development of regeneration technologies and demonstration experiments, such as improving the coastal sediment and regeneration technology of seaweed beds and tidelands (JSSA – Kanto–Chubu Cluster, 2010; JSSA – Western Japan Cluster, 2010), as well as projects that apply these technologies in the field in order to recover the natural environment lost in the past (e.g. wetlands, forests, grasslands, estuaries, coral reefs, mangroves, etc.).

In Japan, regeneration projects are implemented as public projects based on the Law for the Promotion of Nature Restoration. Besides public projects, regeneration and improvement of ecosystems in *satoyama* are being worked on as an independent activity of local NPOs and residents (such as the afforestation activities of the bare or deforested mountain [JSSA – Western Japan Cluster, 2010]) (Federation of NGOs for Nature Rehabilitation, 2005; Awaji et al., 2006).

Also, environmentally-friendly construction methods, such as the neo-natural river reconstruction method and the paddy field consolidation method that includes ecosystem conservation measures, have been actively adopted in forest maintenance projects, land improvement projects, Box 5.3 Organics recycling facility "Midori Museum"

The organics recycling facility called "Midori Museum", where domestic animal waste, rice hulls derived from farm households, kitchen garbage from urban households, wood thinned from plantations and fallen leaves from the secondary forests with deciduous broad-leaved trees are composted, opened in 2003 in Motegi Town, Tochigi Prefecture. The compost created in this museum is marketed, of which approximately 60 per cent is used in local farm households. The agricultural products resulting from the use of more than 500 g of such compost for paddy fields, and more than 1 ton for vegetable fields, have been certified and branded as "Midori Compost Agricultural Products" by the town. Most of those products have been sold at farm stands in roadside stations and other places, while some have been consumed by children as part of school catering. As such, "local production for local consumption" has been promoted.

The establishment of the Midori Museum also facilitated the sound disposal of rice hulls and animal waste. The town estimates that the forest thinning operation, through which wood disposed from the plantations is composed at the Midori Museum, results in maintaining 20 ha of plantations annually. Also, the composting of kitchen garbage from urban households has successfully led to a decrease in incineration costs and energy at disposal sites. Furthermore, the forest floor in secondary forests composed of deciduous broadleaved trees (which used to be coppice forests for firewood or agricultural use but have recently been mostly abandoned) is being maintained, following the utilization of fallen leaves from such forests for organics recycling. The town buys the fallen leaves for 400 Japanese yen per 20 kg bag and 100 farmers from approximately 50 farmer households have contributed to this. The town also sees this initiative as a system for increasing local employment and enhancing the heath of the town people. The town estimates that this type of gathering and disposal of fallen leaves contributes to maintaining 80 ha of secondary forests composed of deciduous broadleaved trees annually.

The organics recycling facility in Motegi Town is worthy of attention as a facility to contribute to the sustainable management of *satoyama* and to address complex issues including the sound disposal of agricultural waste, the cultivation and management of plantations, the conservation of deciduous broadleaved trees, the promotion of local production for local consumption, the decrease in incineration waste, and the enhancement of local employment and health. In 2010, it proposed a new plan to build a Bio Diesel Fuel (BDF) facility within the premises of the museum and to use the fuel extracted from edible waste for the carts operated in the museum.

river maintenance projects and others (JSSA – Hokushinetsu Cluster, 2010). Similarly for *satoumi* ecosystems, technologies for land creation such as artificial seashore as well as construction methods for seashore restoration are being improved (JSSA – Kanto–Chubu Cluster, 2010).

5.2.6 Cognitive responses

The traditional knowledge acquired through using and managing ecosystems and ecosystem services in *satoyama* and *satoumi*, as well as the knowledge generated through scientific research are expected to be effectively used and applied in decision-making. What is important in utilizing such knowledge is not to return to the lifestyle of the past, but to create new relationships and bonds between people and nature under modern understandings.

1) Dissemination of relevant knowledge and information

Various kinds of information are being made available in order to improve the recognition of *satoyama* and *satoumi* landscapes. For example, the Ministry of the Environment, Japan started an informational website "Sato Navi" in 2008, which supports volunteering conservation activities in *satoyama*. Other examples of cognitive response include the "100 Rice Terraces of Japan", which approved 134 sites featuring rice terraces in hilly and mountainous regions in Japan to acknowledge their multi-functionality, beautiful scenery and succession of traditional cultures; the "100 *Sosui* (water channels)" intended for agricultural water nationwide; and the "Japanese Sato 100", which is a selection conducted by The *Asahi Shimbun* Company and the Forest Culture Association.

For the therapeutic promotion of "forest bathing" 100 forests were selected and listed in the "100 Forests for Forest Bathing in Japan". In 2004, the Forest Therapy Society was formed by medical schools, businesses, the Forestry and Forest Product Research Institute, and some other organizations, with the goal of scientifically understanding the therapeutic aspects of forest bathing. Currently, general forest therapy projects are being conducted and their activities include the accreditation of forests and promotional activities.

2) Rebuilding communities through a commons (K2)

The idea of a commons is once again gaining attention. The term "commons" refers to a system of co-management of natural resources, or the natural resources themselves. It may be possible to form a commons at various levels from local to global. The traditional Japanese methods of management like *iriai* (traditional management of local common forest resources in Japan) in *satoyama*, rights to water and fishery rights in *satoumi*, are examples of maintenance and management through a commons on a local scale (see Box 5.4). The commons was conceived in a tragic way by Hardin in the 1960s, while Ostrom, who was awarded the Nobel Memorial Prize in Economic Sciences in 2009, has seen the commons positively as a form of effective governance. Japanese traditional management methods could be considered a case of the latter. The idea of a commons, which is neither public nor private, gained attention after "The Tragedy of the Commons" by ecologist Hardin in 1969. In Japan, the idea of a commons is positioned as a "*new public*" within the National Spatial Strategies endorsed by the Cabinet in 2008. The *new public* mentioned here refers to the idea to provide societal services that best suit local needs through cooperation with local governments and various private and voluntary sector organizations such as NPOs. The idea of the "New Commons" is presently being discussed as a social system to maintain public functions related to the provision of ecosystem services by *satoyama* and *satoumi* on a sustainable basis.

3) Scientific research by local universities and governments (K2)

Scientific knowledge relevant to *satoyama* and *satoumi* has remained limited because the target is extensive and local dependency is high. In recent years with social concerns over *satoyama* and *satoumi* increasing, local universities and governments have started to form a research and educational centre for disseminating scientific knowledge obtained from local *satoyama/satoumi* and data on biodiversity.

Kanazawa University is developing a "*Satoyama* Project" in the Hokuriku region and is conducting a wide range of activities, such as *satoyama* research and education, interacting with people working on conservation and local revitalization, research institutions, local governments and corporations mainly in Ishikawa Prefecture. Utsunomiya University established the *Satoyama* Science Research Center in the Faculty of Agriculture and trains professional engineers to deal with harmful wildlife management in agriculture and forestry, monitor *satoyama* ecosystems in the river basin and establish rural revitalization methods through community business creation in the northern part of the Kanto region. In 2008, Chiba Prefecture first developed local biological diversity strategies in the prefecture and established the Center for Biological Diversity to promote biological diversity monitoring via citizens' participation, exotic species protection, school biotope installation support and further subsidies of regional activities.

These activities among local universities and governments have common characteristics in that they address local challenges found in *satoyama* and *satoumi*, and that their scientific findings may contribute to the sustainable management of these local ecosystems directly.

Box 5.4 Tree planting that supports "*Uotsuki*" forests

"*Uotsuki*" is an old Japanese phrase that was born from the belief that fish gather to trees reflected on water surface. Fishermen called forests near coastal areas "*uotsuki rin*" (fish gathering forests), and traditionally preserved them. In fact, old shrine gates and small shrines are often seen around forests near coastal areas.

The Forest Act of 1951 mentioned "*uotsuki*" in Enactment 25, Section 1, Article 8, with the purpose of designating conservation forests. Conservation forests refers to forests that are designated by the Minister of Agriculture, Forestry and Fisheries or prefectural governors for the purpose of achieving public goals that may include recharging water sources, prevention of natural disasters such as landslides, and the preservation and generation of living environments. In conservation forests, logging of the trees and making phenotypical changes to the land are regulated in order to protect the specific functions of the forests. The *uotsuki* conservation forests consist of about 0.5 per cent or 58,000 ha of the total 12,606,000 ha of conservation forests in Japan (as of March 2008). Although this is not a significant number, it has been an increasing trend in the past few years.

In recent years, planting efforts by the fishing industry that consider the symbiotic relationship between forest ecosystems and coastal ecosystems are gaining attention. For example, Miyagi Prefecture suffered from red tides from the mid 1960s to mid 1970s due to environmental deterioration, and was forced to conduct a mass disposal of oysters. Recognizing that it is necessary to have and preserve broadleaved deciduous forest in the upstream of rivers that flow into Kesennuma Bay, plantation activities by *Kaki No Mori wo Shitau Kai* (Society to Protect Forests for Oysters) began in 1989 using the slogan "the forest longs for the sea". Similarly, in Hyogo Prefecture, plantation activities began with the cooperation of fishery cooperatives and underbrush clearing, and planting activities have been conducted in six locations in the prefecture between 1999 and 2008.

The traditional "*uotsuki rin*" custom of Japan was re-recognized in the context of protection and preservation of forest and ocean ecosystems. As a result, forest functions such as the prevention of sediment discharge and contamination of rivers, provision of clean fresh water, and supply of nutrients to rivers and organisms in the ocean are being noted to have favourable effects on oceanic ecosystems.

5.3 Evaluation of responses

5.3.1 Potential effects of responses from the perspective of influence and proximity

Potential impacts of effects of responses against drivers that change ecosystem services were evaluated using the method developed by the Millennium Ecosystem Assessment (2005) for evaluating responses for the MA. We refer to this method here.

This evaluation method is organized from two different perspectives (i.e. influence and proximity). The first indicator expresses the degree of expectation that a response corrects a driver at five levels – to what extent can the given response be expected to modify the driver (perspective of influence). Higher values suggest a higher degree of expectation that a response influences a driver. The second indicator expresses proximity of the response to the targeted driver – how long is the chain of the cause-effect relationships from the response to the driver – again at five levels (perspective of proximity). Higher values suggest lower levels of propagating steps between a response and a driver.

Therefore, in the MA method, if the score is 5/5, the potential impact is considered to be the highest, and a score of 1/1 would mean the lowest for potential impact. This flexibility to adapt to various influencing parameters of ecosystem services is a characteristic of this method. Table 5.3 lists the values that are used in the MA method for major direct and indirect drivers discussed in this book.

5.3.2 Evaluation of efficiency

There is a cost associated with executing a response. For example, nature regeneration projects require construction and maintenance costs. Even for applying a legal response, such as regulations of land use, there is a transaction cost burden to developers. Efficiency of a response is a measure of the effectiveness of a response relative to the cost – it measures effect beyond the cost.

A cost-benefit indicator is often used as a quantitative index for evaluating efficiency. This index expresses efficiency of a response (B/C) by comparing total cost associated with a response (C) and total benefit that can be obtained (B). Responses for *satoyama* and *satoumi* are often for ecosystem services that would not be valued in the marketplace in addition to the market value from agriculture, forestry and fishery products. Therefore, full evaluation requires extended social and environmental cost benefit analysis. In this sense, in order to measure benefit, stated preference methods such as the contingent valuation method (CVM),

Table 5.3 Potential effects against influencing factors of major response types (MA method)

Influencing Factors / Main Reponses		Direct drivers					Indirect drivers		
		Urbanization and development / Loss of mosaic	Global/regional warming	Overexploitation / Underuse	Invasive Species	Pollution	Population	Regional economy	Lifestyle and culture
L1	International treaty	2/1	5/4	1/1	3/1	2/1		1/4	
L2	International treaty agreement	1/1	3/4	1/1	1/1	1/1	1/3	1/4	2/4
L3	International customary law	1/1	3/4	1/1	1/1	1/1	1/1	5/5	2/4
L6	National regulations (environmental department)	4/4	3/3	3/3	3/3	3/3	3/3	2/3	2/3
L7	National regulations (non-environmental department)	3/4	3/4	3/4	3/4	3/4	5/5	5/5	5/5
L9	Order and control	5/5	5/5	5/5	5/5	5/5	5/5	5/5	5/5
E1	Incentives	4/5	4/3	5/5	3/4	5/5	3/5	5/5	3/4
E2	Unforced initiatives	3/5	2/3	4/3	2/3	2/4	2/4	2/4	4/5
E3	Financial response	4/5	3/3	3/3	3/4	5/5	3/5	5/5	3/4
S2	Public education and awareness	3/5	3/5	3/5	3/5	3/5	4/5	4/5	4/5
S3	Empowerment	4/5	3/4	4/5	4/5	4/5	3/4	4/4	4/5
T2	Regeneration of ecosystem services	3/3	5/3	4/5	2/2	3/5		4/4	
K1	Utilization of traditional knowledge	3/5	1/5	3/5	3/5	1/5	2/5	2/5	3/5
K2	Procurement and utilization of knowledge	3/5	3/5	3/5	3/5	3/5	2/5	2/5	2/5

Source: adapted from MA (2005).

Box 5.5 Cost benefit analysis

The B/C ratio, which is calculated from dividing the total benefit by the total cost, is used to evaluate the efficiency of the responses. In order for the government to carry out a public project as a response, the B/C ratio has to be over one.

The total cost needs to include two types of benefits, such as the benefit evaluated by the market value, like revenue from the sales of agricultural and forestry/fishery products, and the benefit calculated from non-market values existing in landscape conservation and cultural protection. Generally, the benefit consists of the sequential annual benefit values produced in the future. For calculation of the total benefit, the future annual benefit needs to be discounted to the present value. However, discounting the ecosystem service value raises an ethical question because benefits to the next generation could be as important as the present generation's benefit (European Commision, 2008).

Mitani et al. (2008) evaluated the recovery of *Nymphoides peltata* in Kasumigaura lake using CVM. The researchers distributed and collected questionnaires to people in the Kanto region through the internet, and calculated the willingness to pay (WTP) value. Using a similar method, the Ministry of Land, Infrastructure, Transport and Tourism published the cost-benefit ratio (B/C) of a recovery project in Tamura and Okishuku areas in Kasumigaura showing that the B/C was 2.14 (= 4.3 million yen (approx. US$43 million) / 2.01 million yen (approx. US$20.1 million). The total annual benefit was calculated as the production of the value of per household annual benefit that was measured by the WTP value and the number of beneficial households.

Yoshida (2004) evaluated the environmental tax for forest conservation and water source tax in Kanagawa Prefecture by applying the CVM. The total benefit (12.8 billion yen [approx. US$128 million]) stated by the residents for maintenance of upstream forest was larger than the total maintenance costs (5.67–7.55 billion yen [approx. US$56.7–75.5 million]), showing the feasibility of such an environmental tax in Kanagawa Prefecture.

Tanaka (2000), Watanabe (2004), and Kodama and Takeshita (2004) evaluated green tourism to *satoyama* using the TCM method. The non-market value of green tourism shown by Tanaka, for example, was 5.7–11 billion yen (approx. US$57–110 million) in the case of the green tourism to Miyama town in Kyoto Prefecture.

Box 5.5 (cont.)

The blue tourism activities to *satoumi* were also evaluated by the TCM. Tamaki (2003), for example, showed that the total benefit of visiting the traditional Hobiki-Ami fishing (traditional fishing style using a wind-towed fishing-net and boat) in Kasumigaura and Kitaura lakes was 3.5 million yen (approx. US$35,000), and this was about 44 per cent of the total cost of boat operation in the towns (8 million yen [approx. US$80,000]).

and environmental financial evaluation methods using a revealed preference method (such as the travel cost method – TCM) are often used (see Box 5.5).

In many cases, several responses address the same target (benefit). For instance, if several technological methods are available to achieve the target water standard, one may select the most affordable option. When calculating cost, life cycle cost (LCC analysis), which considers the long-term cost of a response rather than just the initial cost, may be required.

In some cases, the effects of a response cannot be valued financially, but they may be evaluated as a change in the quantitative index. Examples of such methods include rate of improvement of biochemical oxygen demand (BOD) or chemical oxygen demand (COD) by water regulation, and changes in the number of participants for local production for local consumption. The most effective response from multiple responses may be determined by calculating the cost effectiveness by subtracting the improved amount, such as the water index for example.

Among the above mentioned analyses, cost-benefit analysis (CBA) can not only compare multiple ideas, but can also help determine the amount of acceptable cost range for each response and compare the efficiency of each response (unlike LCC analysis and cost effectiveness analysis). On the other hand, LCC analysis and cost-effectiveness analysis can compare the effectiveness of alternative options for a response, but cannot be used to compare different types of responses or check for an acceptable range of costs (unlike the CBA).

5.3.3 Evaluation of effectiveness

Responses that enhance the standards of ecosystem services can be largely divided into three categories. The first type of response has the purpose of directly influencing the drivers that affect ecosystem enhancement and ecosystem services by having actual methods like the execution of subsidiary projects and legal penalties. For example, water quality regulations have penalties for those who do not follow the regulations.

Box 5.6 Evaluation methods for efficiency and effectiveness other than cost benefit analysis

- Cost effectiveness analysis

The cost effectiveness ratio can show the efficiency and effectiveness of the responses. This ratio is calculated by dividing the effectiveness indicator, which is quantified but not measured by the monetary term, by the costs of responses. The effectiveness can be measured by, for instance, the number of rare animals and plants, reduction amounts of CO_2 emissions, and water quality indexes, such as the chemical oxygen demand (COD) index.

Nomura Research Institute (2007) compared the cost effectiveness ratio of biomass resource use as bio-fuel with consideration of well-to-wheels CO_2 reduction amounts (Life Cycle Assessment) and total production costs. As a result, bio-ethanol production from sugar cane in Brazil (EU50€/CO2 eq. ton) was more effective than that from wheat in the European Union (EU340–700€/CO2 eq. ton).

- Life cycle cost analysis

Life cycle cost analysis evaluates the cost of building and maintaining, and obsolesces costs of institutions or facilities built to enhance ecosystem services. All costs, from cradle to grave, are considered. The most efficient method of substitution will have been conducted from available scenarios if the method with the smallest life cycle cost is chosen. In cases such as a nuclear power plant, where the cost of decommissioning the facility is enormous, it is crucial to evaluate the cost of building, as well as its decommissioning. In such a case, life cycle analysis is an effective method for evaluating the value.

The LCC analysis is applied to renovation projects for road improvement and irrigation facility consolidation in order to prolong the lifespan of improved or consolidated facilities and to keep them in good condition. In terms of irrigation facilities for example, the LCC value of construction methods using the main body with partial replacement before a complete break of facilities (Total cost/expected lifetime (years) = US$622 million per year) was more effective than that of complete reconstruction of facilities after completing their lifespan (US$634 million per year) (Kunimitsu, 2010).

The second type of response only sets direction and philosophy, and does not have actual concrete schemes for improving ecosystem services. Treaties, basic laws and plans publicized by governments fall in this category. Because ratification of treaties, the establishment of basic laws and the formulation of plans drive the creation of enforceable laws and business institutions, this response can effectively improve ecosystem services.

The third type of response gets applied for specific purposes. Such responses, however, have built-in systems to improve ecosystem services and sustainability. Consider land improvement projects based on the Land Improvement Act. Such projects are meant to improve agricultural productivity, but these projects heighten the interests of citizens toward conservation and the protection of animals and plants that live in farmland and agricultural water, thus enhancing education and cultural aspects of ecosystem services.

From the above mentioned responses, the first response, which is direct and substantial, is viewed to be most effective. Compared to the first response, the second and third responses, though effective, do not have the same direct and practical measures of the first response. Therefore, the last two responses are not as effective as the first response for improving ecosystem services.

On the other hand, certain responses with the purpose of improving specific aspects of the function of ecosystem services can noticeably deteriorate other functions. In other words, trade-offs exist in the case of some responses. Therefore, when applying such a response, one must comprehensively evaluate the response with consideration of trade-off effects.

5.3.4 Development trend of responses for satoyama *and* satoumi

Potential impacts of effects of responses evaluated with the MA method from the perspective of the influence and proximity are high for L6 (domestic environmental regulations: in environmental sector), L7 (domestic environmental regulations: not in environmental sector), L9 (intervention through order and control), E1 (intervention though incentives), E3 (financial responses), S3 (regional communities, etc.), T2 (recovering of ecosystem services) and K2 (obtainment and application of knowledge). On the other hand, efficiency and effectiveness of the responses are relatively high for direct payment systems in hilly and mountainous areas; action plans for improvement of farmland, water and environmental preservation; forest environment taxes; forest certification systems; water pollution control systems; and nature restoration projects.

Table 5.4 shows some of the responses that may play central roles to *satoyama* and *satoumi* in Japan, if the responses are evaluated comprehensively considering potential effect, efficiency, and effectiveness.

The number of responses that are relatively effective is highest for legal responses including regulations (L). In Japan, local governments tend to formulate ordinances aimed directly at *satoyama* and *satoumi* conservation and management in the context of increasing awareness

Table 5.4 Chosen responses that are relatively effective in *satoyama* and *satoumi*

1) *Sato* (agricultural communities and lifestyles / agricultural land and rivers) • Land use plans (L9) • Biomass utilization (E1) • System of direct payment to hilly and mountainous areas (E3) • Action plan for improvement of farmland, water, and environmental preservation (E3) 2) Mountains • Ordinance for *satoyama* conservation (L9) • Forest environmental taxes (E1) • Forest certification systems (E2) 3) Oceans • Act on Special Measures concerning Conservation of the Environment of the Seto Inland Sea (L6) • Ordinance for *satoumi* conservation (L9) • Ocean pollution prevention (L6) • Water quality regulations L6, (T2)	4) Biodiversity • National Biodiversity Strategy (L6) • Local Biodiversity Strategy (L9) 5) All areas • Environmental Impact Assessment Law (L6) • The NPO Law (S3) • Nature restoration projects (T2) • Scientific research by local University and government (K1) • *Satoyama* Initiative (K1) • Re-building of regional cooperative bodies (New Commons) (K2)

about the importance of these landscapes and biodiversity in general since the Earth Summit (Takeuchi et al., 2001). Also, many of prefectures have developed Local Biodiversity Strategies for promoting the National Biodiversity Strategy at the local revel. In recent years, municipality governments began developing the Local Biodiversity Strategy. Although ordinances have been established at the local level with the aim to promote the conservation and sustainable use of *satoyama* and *satoumi*, no comprehensive legislation for this has been developed so far. Legal responses for the conservation and sustainable use of *satoyama* and *satoumi* have long been dealt with by various different individual resource management laws (e.g. River Act, Forest Act, Agricultural Land Act and City Planning Act). But since the Earth Summit in 1992, with higher concerns among the public towards biodiversity and ecosystem conservation, many of those laws were "environmentalized". That is, new words for conservation and sustainable use of natural resources were incorporated into those laws. Those "environmentalized" laws have been emerging as a new legal basis for policy design and dialogues concerning *satoyama* and *satoumi*. Within this context, at the time of revising relevant laws, new laws are expected to increasingly address *satoyama* and *satoumi* management.

Citizen participation is critical for the success of many of the responses targeted towards *satoyama* and *satoumi* conservation and management.

Local governments have been increasingly publishing Land Use Plans that are planned in cooperation with residents (Ministry of Land, Infrastructure, Transport and Tourism, Japan, 2005). Many biomass town concepts mention cooperation with NPOs and people within urban areas, and the participation of residents that are not landowners. Another example is direct payment systems in hilly and mountainous areas (as already explained in this chapter), in which payments for the joint activities of the village organization and farmer groups are included. The participation of residents has been prescribed as a requirement in many ordinances enacted after 2000 to conserve *satoyama* and *satoumi* (Sanpei and Takeuchi, 2006). The ordinance for the assessment of environmental impacts was amended to reflect the opinion of residents by submitting their opinions to the developer at the early stage of the assessment process in Nagasaki Prefecture, where many people pay attention to the conservation of *satoumi* in Isahaya Bay. The Act on Promotion of Specified Nonprofit Activities also promotes NPO activities where many stakeholders, such as residents, enterprises and the government, are involved. Nature restoration projects are another example of this cooperation (Kusakari, 2003). One of the basic policies of nature restoration projects was established letting various stakeholders participate and cooperate in project implementation in the area. Local universities and governments contribute to conserving and managing *satoyama* and *satoumi* by using them as research and educational fields. The participation of the various stakeholders is a critical element for the management of the "New Commons" which connects a mosaic of different ecosystem types to produce a bundle of ecosystem services for individual and social well-being. These participatory responses will require the accumulation of scientific findings concerning *satoyama* and *satoumi* ecosystem services, education providing comprehensive explanation to the people and building human resources involved in this training.

The application cases of economic responses are few compared to the legal responses. This is because national concern about the economic function of *satoyama* and *satoumi* tended to decrease under declines in agriculture, forestry and fishery production. However, in addition to the production benefits, there are several values, such as conservation of landscapes, provision of cultural services and preservation of biodiversity, which are not fully evaluated in the market. For the maintenance and sustainable use of ecosystem services in *satoyama* and *satoumi*, economic responses enhanced by non-market values need to be applied in the future. For example, the forest environmental tax and activities using biomass resources in *satoyama* and *satoumi* have begun to be enforced in Japan. On the other hand, the system of direct payment in hilly and mountainous areas helps to conserve multifunctional characteristics of agriculture in *satoyama* and *satoumi* and prevents farmlands from being abandoned. It is expected that the scope of these recent economic responses will be broadened in the future.

5.4 Conclusion

Satoyama and *satoumi* are places that have been built up by interaction between humans and nature over time. Today, there is a wide variety of interaction between humans and *satoyama-satoumi* ecosystems, such as agriculture, forestry and fisheries, experiences in a natural environment, biodiversity conservation, biomass utilization and scientific research. Consequently, there are also a wide variety of responses in *satoyama* and *satoumi*.

However, there is no integrated legislation for *satoyama* and *satoumi* at the national level; many related laws have been "environmentalized". Those laws have been applied to the conservation and management of *satoyama* and *satoumi*. Additionally, local governments have begun to develop local ordinances and biodiversity strategies, in which they address *satoyama* and *satoumi* conservation and management.

Most of the responses that were evaluated to be relatively effective in *satoyama* and *satoumi* have citizen participation as a key element. *Satoyama* and *satoumi* require not only a government driven approach but also a finely-turned response through participation because there are multifunctional characteristics of *satoyama* and *satoumi,* as well as the fact that they are places which people inhabit. A new co-management system should be established with diverse actors, such as local citizens, companies, NGOs/NPOs, and local governments.

Although modern society in the past did not find sufficient economic value in *satoyama* and *satoumi*, there is a lot of non-economic value, such as biodiversity, ecosystem conservation and cultural nurturing. It is necessary to appreciate the non-economic value of *satoyama* and *satoumi*, as well as to expand the efforts to grant economic incentives.

There is also a need to combine new responses that involve establishing a co-management system of *satoyama* and *satoumi* with various actors' participation, creating an economic incentive to non-economic values for maintaining *satoyama* and *satoumi* that have changed over time in the ageing and declining population.

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6

What are the futures of *satoyama* and *satoumi*?

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6.1 Introduction

How will conditions surrounding Japanese *satoyama* and *satoumi* change in the future? How would reversing current levels of dependency on foreign sources (i.e. import of food, water, timber, etc.) affect Japanese resources, including its ecosystems? How would the use and management of *satoyama* and *satoumi*, as well as their ecosystem services change? The Japan *Satoyama Satoumi* Assessment (JSSA) utilizes scenario analysis to deal with such questions. It should be noted that although there is considerable variation in *satoyama* and *satoumi* (since socio-economic and geographical conditions surrounding them varies greatly across the country), in this chapter, we pay special attention to the overall trend of how the future of *satoyama* and *satoumi* may unfold.

Scenarios of JSSA are images of plausible and alternative futures. Therefore, these scenarios neither predict nor prophesy the road map of which path we must follow.

6.2 What is a scenario?

6.2.1 Scenario analysis in the Millennium Ecosystem Assessment

In the Millennium Ecosystem Assessment (MA), scenario analysis was utilized to discuss and examine the diverse and various directions and

Satoyama–satoumi *ecosystems and human well-being: Socio-ecological production landscapes of Japan, Duraiappah, Nakamura, Takeuchi, Watanabe and Nishi (eds), United Nations University Press, 2012, ISBN 978-92-808-1210-7*

possibilities of changes which ecosystems might follow in the future. It was also used to discuss responses to these changes. The scenarios represent plausible, alternative futures and indicate the feasible consequences under some specific hypotheses. Therefore, scenario analysis is often used as a systematic method to creatively examine a complicated and uncertain future. In the process of discussion, such as the selection of scenarios and drivers, it is possible to determine the option for ecosystem management in the future and select countermeasures. This makes it possible to promote specific examination and discussion regarding issues such as ecosystems that should be conserved now and measures that should be implemented immediately. The JSSA is based on the methodology and structure of the scenario analysis used in the MA, with a focus on direct and indirect drivers that can bring about change in ecosystems, as well as on people's attitudes and responses to nature and ecosystem services. The JSSA has established four scenarios for *satoyama* and *satoumi* until 2050. After defining the scenario storyline, changes in the ecosystem and ecosystem services, as well as future challenges accompanying the changes for each scenario have been projected. It should be noted that although four scenarios as future images of *satoyama* and *satoumi* have been developed, it is unlikely that only one of these will actually come to be. The real future will unfold as a combination of several or all scenarios suggested in this chapter (MA, 2005a).

This chapter will first present clear answers to questions such as "what kinds of scenarios are there?" and "how have they been used in environmental and social issues?". It is crucial to enhance the understanding of scenarios in order to understand the methods of scenario development and usage in the JSSA.

6.2.2 Target of scenario analysis

Figure 6.1 shows methodologies used to consider the future. The methodologies are categorized in relation to the level of uncertainty and complexity in the subjects to be studied. The subjects with less uncertainties and complexities are more suited to scientific analysis. As the levels of uncertainties and complexities increase, the methodologies shift from future prediction and forecasts, that are based on current known facts, to exploration and speculation built upon hypotheses or multiple major uncertainties, etc. Methodologies that utilize facts, prediction, and forecasting are based on firm understandings of the subjects, such as society and the environment. On the other hand, exploration and speculation are useful when dealing with subjects with more complexities and uncertainties in which scientific understanding of the phenomena faces limitations. Use of scenarios is a method that is somewhere between projections and explorations that are utilized to think for the future.

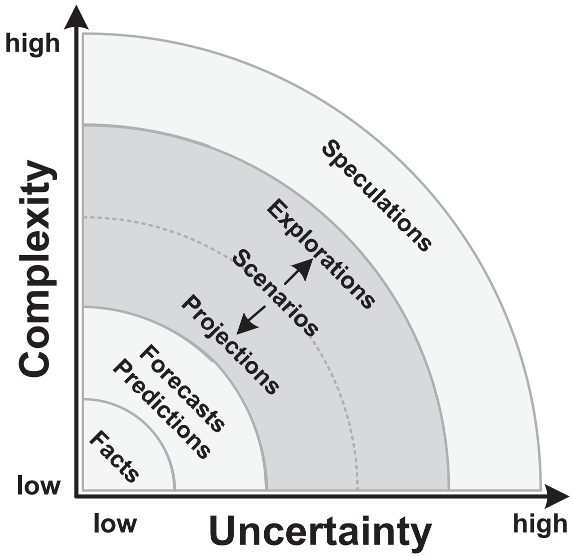

Figure 6.1 Range of tools that address future uncertainties and complexities
Source: Zurek and Henrichs (2007).

6.2.3 Scenario development initiatives on the global scale and characteristics of Japanese scenarios

Today, scenarios are developed for various environmental issues – including water, air environments and ecosystems, as well as climate change (Table 6.1). Scenarios are widely recognized by various stakeholders as the basic tool to develop strategies for an uncertain future. One of the most famous amongst these is the Special Report on Emissions Scenarios (SRES) developed by the Intergovernmental Panel on Climate Change (IPCC) in 2000. The IPCC developed four ramification scenarios that envisioned changes in population, economies, advancement of technologies and development, energy, and land use, etc. by exploring two global development paths (i.e. globalization vs. regionalization, and economy-oriented vs. environment-oriented), and presented the changes in greenhouse gas emission quantities until 2100 for each (Nakicenovic and Swart, 2000).

In Japan, scenario development by national and municipal governments, research institutes and other stakeholders is gaining popularity. The characteristic of recent Japan-based scenarios is that many are intended for policy-making (Table 6.2), commonly using a back-casting approach. While many scenarios in Table 6.1 use the forecasting approach to describe plausible futures in an explorative manner from the present to alternative futures, back-casting first defines the desirable future as an

Table 6.1 Major environmental scenarios of global and regional scales after the year 2000

Scenario title	Author	Year issued	Target period	Subject	
				Issue	Area covered
Global Biodiversity Outlook 3 (Alkemade et al., 2009; Leadley et al., 2010)	CBD[a]	2010	2050	Biodiversity	Global
Global Environmental Outlook 4 (UNEP, 2007)	UNEP[b]	2007	2050	Environment	Six regions in the world
PRELUDE: Land use scenarios for Europe (EEA, 2007)	EEA[c]	2007	2035	Scenery	Europe
The Road to 2050: Sustainable Development for the 21st Century (World Bank, 2006)	WB[d]	2006	2050	Environment	Global
Air Quality and Ancillary Benefits of Climate Change Policies (EEA, 2006)	EEA[c]	2006	2030	Air Quality	Europe
Millennium Ecosystem Assessment (MA, 2005a)	MA[e]	2005	2050	Ecosystem services and human well-being	Worldwide and 18 regions, nations, basins and other areas
African Environment Outlook (UNEP, 2002)	UNEP[b]	2002	2032	Environment	Six regions in the African continent
Global Environmental Outlook 3 (UNEP, 2002)	UNEP[b]	2002	2032	Environment	Six regions in the world
Global Water Outlook to 2025 (Rosegrant, et al., 2002)	Rosegrant, Cai and Cline for IFPRI[f]	2002	2025	Water environment/ usage	36 regions/nations
OECD Environmental Outlook to 2030 (OECD, 2001)	OECD[g]	2001	2030	Environment	10 nations (OECD members)

IPCC's Special Report on Emissions Scenarios (Nakicenovic and Swart, 2000)	IPCC[h]	2000	2100	Climate Change	Four regions in the world
World Water Vision (Cosgrove, et al., 2000)	WWC[i]	2000	2025	Water environment/ usage	18 regions in the world
Global Environmental Outlook 2000 (UNEP, 1999)	UNEP[b]	1999	2039	Environment	Six regions in the world
Global Biodiversity Scenarios for the Year 2100 (Sala et al., 2000)	GCTE[j]	2000	2100	Biodiversity	10 categories with different biological aspects

Notes: a: Convention on Biological Diversity, b: United Nations Environment Programme, c: European Environment Agency, d: World Bank, e: Millennium Ecosystem Assessment, f: International Food Policy Research Institute, g: Organisation for Economic Co-operation and Development, h: Intergovernmental Panel on Climate Change, i: World Water Council, j: Global Change and Terrestrial Ecosystems

Table 6.2 Scenario development initiatives for policy-making and implementation in Japan

				Subject		
Scenario title	Author	Year issued	Target period	Issue	Area covered	Summary
Ultra long-term vision (Ministry of the Environment, Japan, Ultra Long-term Vision Exploring Committee, 2007)	Ministry of the Environment, Japan, Ultra Long-term Vision Exploring Committee	2007	2050	Low-carbon, recycling society, nature-harmonious society, comfortable living environment	Japan nationwide	Delineate a picture of the desirable future based on the third *Basic Environment Plan*, and propose a long-term vision as a gradual pathway to achieve the desirable future.
Japan scenarios towards a low-carbon society (LCS): Feasibility study for 70% reduction in 1990 CO_2 levels by 2050 (Nishioka, 2008)	"2050 Japan Low-Carbon Society" scenario team	2007	2050	Low-carbon society	Japan nationwide	Evaluate technological capacity to reduce 1990-level CO_2 emissions by 70% while meeting levels required to provide expected 2050 services
Shiga's scenario towards the realization of a sustainable society (Shiga Prefecture Sustainable Society Research Team, 2007)	Shiga Prefecture Sustainable Society Research Team	2007	2030	Sustainable society (global warming, recycling of resources, Lake Biwa environment)	Shiga Prefecture	Set up environmental goals (relating to greenhouse gas emissions, Lake Biwa water quality, area of phragmite communities and amount of disposed waste) to ensure the sustainability of Shiga Prefecture and look at scenarios to put in place policies and measures to achieve these goals.

Technology strategy map: Ultra long-term energy technology vision (Ministry of Economy, Trade and Industry, Japan, 2005)	Ministry of Economy, Trade and Industry, Japan	2005	2100	Technology strategies in the energy field	Japan nationwide	Estimate the resources and environmental constraints for 2100 as a scenario under a hypothesis of economic development, and identify necessary technologies and their development timeline
Scenarios of the future of Japan in 2030 (Ministry of Land, Infrastructure, Transportation and Tourism, Japan website)	Ministry of Land, Infrastructure, Transportation and Tourism, Japan	2004	2030	National land formation	Japan nationwide	Formulate future images of a sustainable society of Japan in 2030 as scenarios considering external drivers

endpoint and draws alternative paths from there to the present (Robinson, 1990). Although forecasting scenarios can also consider the introduction of some specific policies and measures, Japanese scenarios tend to use backcasting, a scenario development method that was introduced to realize more desirable futures, breaking away from the trends of society and economy.

6.2.4 Scenario description methods and recent trends

(1) Scenario description methods

Scenarios can be roughly categorized into two groups: qualitative and quantitative scenarios (Table 6.3). Qualitative scenarios describe possible futures using words and illustrations. The descriptions tend to be easier to understand for non-specialist users, and therefore, qualitative scenarios can reach wider audiences compared to quantitative scenarios, which use numbers, charts and graphs to describe the future. However, qualitative scenarios are not able to supply specific numerical data relative to the environment, economy and society of the future nor can they examine the internal consistency of scenarios. A good example of qualitative scenarios is the "Scenarios of the future of Japan of 2030" (Table 6.2) published by the Ministry of Land, Infrastructure, Transport and Tourism, Japan during the formation process of the first National Spatial Plan in

Table 6.3 Comparison of qualitative and quantitative scenarios

	Qualitative scenarios	Quantitative scenarios
Characteristics	Describe plausible futures using text and illustrations.	Present necessary information in the form of tables and charts using quantitative data.
Pros	Capable of reflecting the opinions of various stakeholders. Able to convey information and more easily understood by larger audiences as compared to scenarios developed on figures and charts.	Models used for scenarios contain various hypotheses. These are indicated in the form of mathematical equations, parameters, and variables. Models can be used to check if descriptions of scenarios are consistent.
Cons	Unable to present concrete figurative information on the future society, economy and environment described by the scenario. It is also difficult to examine the consistency of alternative scenarios.	The conclusions, which the scenario development process and results present are not very clear.

Source: Alcamo (2001).

Japan (the Ministry of Land, Infrastructure, Transport and Tourism, Japan, online). The purpose of the scenarios development was to "encourage debates on a national scale among the general public about the desired Japan in 2030."

Contrastingly, quantitative scenarios provide quantitative information in the form of charts and graphs to show how the future may unfold. "Global Biodiversity Scenarios for the Year 2100" (Sala et al., 2000) is a good example of this (Table 6.2). In creating quantitative scenarios, scientific models are often used, and the background assumptions and premises are shown as formulas, variables and parameters. This makes quantitative scenarios more transparent compared to qualitative scenarios, which rarely show assumptions and premises explicitly. In addition, scientific models help examine the internal consistency of scenarios, which is difficult for qualitative scenarios to do. However, the fact that specialized knowledge is required to understand the mechanisms behind the models may be counted as a drawback, as this may prevent many stakeholders from understanding the scenarios. It has been pointed out that these complexities hinder stakeholder understanding (Alcamo, 2001).

(2) Trend of scenario development in recent years

Within recent large-scale scenario development, it has become common to adopt a Story-and-Simulation (SAS) approach which combines the characteristics of both quantitative and qualitative scenarios. The SAS approach describes in storylines how the future of the subject may unfold, while supporting the storylines with quantitative information using scientific models (Alcamo, 2001). The approach, for instance, was employed in scenario developments of IPCC's SRES, MA (Table 6.1) and Japan's long term visions (Table 6.2). However, it should be noted that the quantifiable events and phenomena are limited to those with sufficient information and based on causal relations and statistical relations (MA, 2005b). Not all the aspects of a qualitative storyline can be quantified.

In Japan, causal relations of various drivers that impact ecosystem services are not sufficiently revealed, and therefore, quantitative methods, such as the SAS approach, cannot be adopted. For this reason, scenarios in JSSA are developed on the basis of qualitative descriptions.

6.3 Scenario development method in JSSA

6.3.1 Scenario development process in the MA

In the MA, two variables were used when formulating scenarios. One variable focused on governance and economic development (regionalized versus globalized, vertical axes in Figure 6.2). The other variable looked

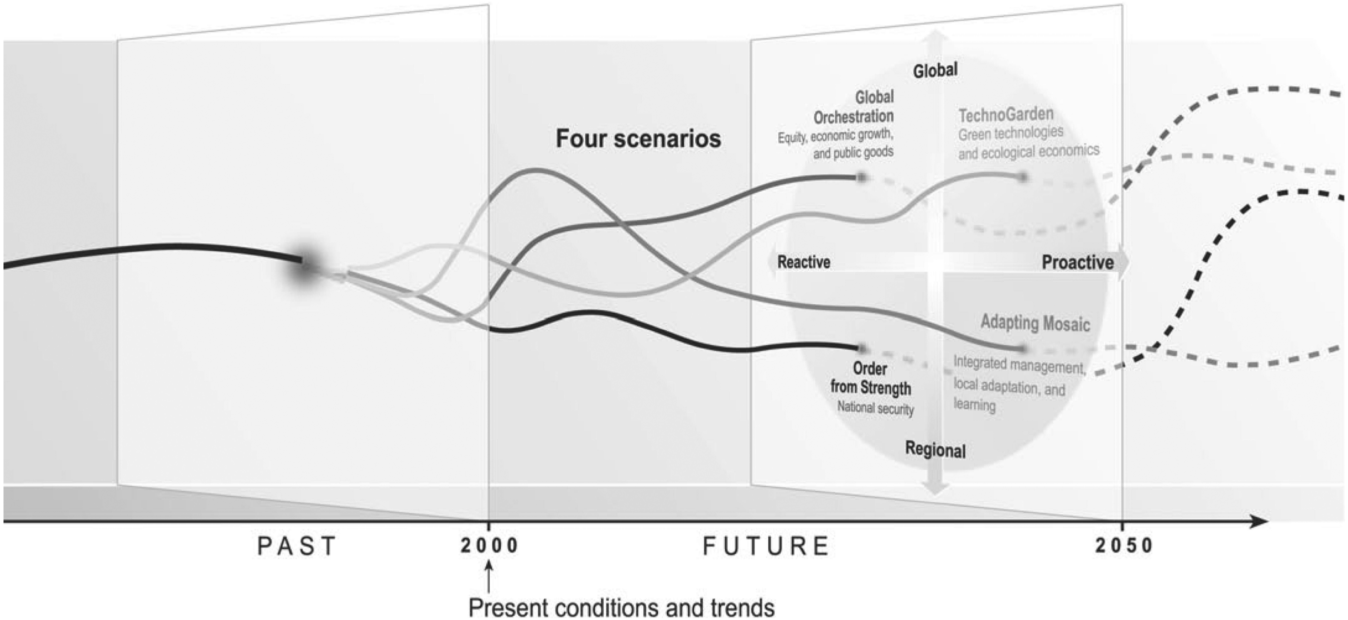

Figure 6.2 Scenario framework of the Millennium Ecosystem Assessment
Source: MA (2005b).
Note: The curved lines represent conditions and trends of ecosystem services from the past, the present and to the future, which draw different trajectories by scenarios. Cross-section diagrams of the year 2050 located on the right-hand side of the figure consist of four scenarios constructed by two axes (1) transitions of governance and economy (globalization vs. regionalization) and (2) approaches to ecosystem management (proactive vs. reactive).

at style of ecosystem management (reactive versus proactive, horizontal axis in Figure 6.2). The MA used the two axes of uncertainties to develop storylines of four scenarios in an explorative manner; Global Orchestration, Techno Garden, Order from Strength and Adapting Mosaic. After the development of qualitative storylines of the four scenarios, ecosystem services and human-well being were assessed using multiple scientific models. Each scenario had different assumptions of changes until 2050 in terms of population increase, economic activities, technological changes, energy and resource consumption, land use, etc. However, information on drivers mentioned, as storylines were not necessarily quantified in the assessment, the assessment of socio-politics, culture and religion, and introduction/elimination of species remained qualitative (MA, 2005b).

6.3.2 Role and development process of scenarios in Japan's SGA

(1) Role of scenarios

The role of scenarios in the JSSA is not to present the vision of ideal *satoyama* and *satoumi*. Instead, it is to draw alternative images of future *satoyama* and *satoumi*, considering the influence of changes in conditions, such as socio-political and economic factors, as well as people's attitudes towards ecosystem management. With alternative future images or scenarios, the JSSA aims to raise awareness and provide information for various stakeholders such as government officials, civil society organizations, NGOs, businesses and the general public to use to inform their actions and decision-making. JSSA-developed scenarios will present the prospect of plausible future changes in *satoyama* and *satoumi* by deductive combinations of future uncertainties surrounding them.

The JSSA time horizon is 2050 (Figure 6.3) and is set in consideration of the terms of administrative plans (i.e. comprehensive and master plans) formulated by national and local governments – usually five years for short plans and 10–15 years for longer plans. For example, the administrative plans implemented from 2010 are looking at 2015 as the planning period for shorter cases and to 2020–2025 in longer cases. By setting the time horizon at 2050, which is much longer than those of present administrative plans, the JSSA scenarios can provide information on changes to take place within *satoyama* and *satoumi*, raise awareness and give warning on potential issues and challenges to take place over a longer time perspective. The intended audiences for these scenarios are government officials, experts (including researchers), businesses, civil society organizations, non-profit organizations (NPOs), non-governmental organizations (NGOs) and citizens, etc. that act in cooperation with (and sometimes independent from) the government.

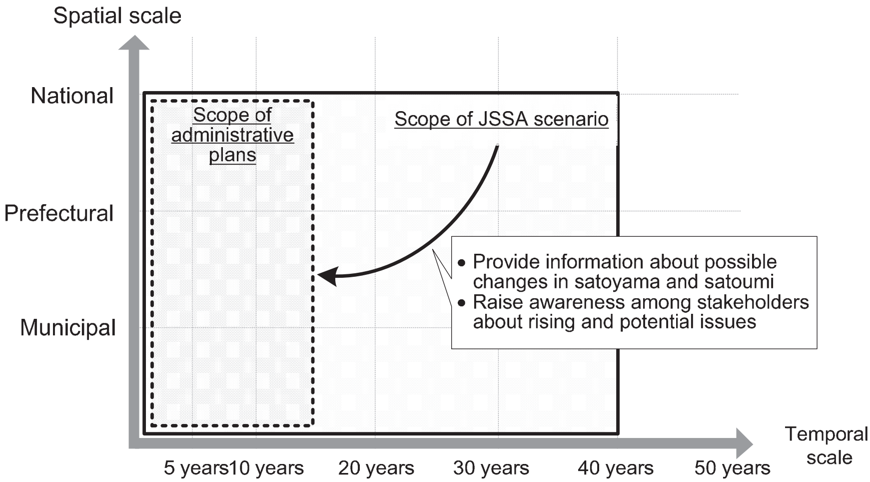

Figure 6.3 Scope of JSSA scenarios

(2) Development process

In developing scenarios for the JSSA, we followed the framework developed in the MA (Figure 2.7 in Chapter 2). While the MA employed the Story-and-Simulation (SAS) approach, which combines qualitative storylines and quantitative analyses with numerical models to build scenarios, we employed a qualitative scenario approach to analyse how the future may unfold. Expert judgment was utilized in an iterative manner to set up scenario axes, develop storylines and assess ecosystem services and human well-being for all scenarios. Table 6.4 shows the overall process of scenario building in JSSA.

The scenario working group worked interactively with other national working groups, taking charge of certain chapters of the national report, while cluster working groups took charge of cluster reports and refined the scenarios. As a first step, the scenario working group discussed the future uncertainties surrounding *satoyama* and *satoumi*, basic conditions of high certainty and the time horizon as a framework for scenario building. Upon this framework, the group described plausible futures for *satoyama* and *satoumi* as qualitative scenarios. These scenarios were then reported at a national meeting of the JSSA in which experts involved in national and cluster level assessments participated. The participants further provided input and comments on the scenarios. After the meeting, the group improved the methodologies and descriptions, incorporating the feedback received. The JSSA scenarios were developed through a number of repetitions of such processes. In addition, email inquiries to members of national and cluster working groups, the Board, the Government Advisory Committee and the Science Assessment Panel

Table 6.4 Scenario development process of JSSA

STEP 1	Discussions concerning the framework of scenario development (time horizon, basic assumptions of high certainty, future uncertainties surrounding *satoyama* and *satoumi*) by scenario working group
STEP 2	Collect ideas on discussion results (through e-mails) and revise the framework
STEP 3	Develop alternative qualitative scenarios based on the framework (first draft)
STEP 4	Report the scenarios (first draft) at the national meeting and collect feedback (first process)
STEP 5	Improve methodology and content of the scenarios (draft) based on feedback
STEP 6	Report revised scenarios (second draft) at the national meeting, and collect feedback (second process)
STEP 7	Information gathering on *satoyama* and *satoumi* by e-mail
STEP 8	Update the scenarios based on feedback and collected information (third draft)
STEP 9	Explain how to use scenarios and develop methodologies for cluster scenarios to the users in the Hokushinetsu cluster (first phase)
STEP 10	Report the updated scenarios (third draft) at the national meeting, and collect feedback (third process)
STEP 11	Incorporate collected feedback and update scenarios (fourth draft)
STEP 12	Explain how to use scenarios and develop methodologies for cluster scenarios to the users in the Hokushinetsu cluster (second phase)
STEP 13	Ad hoc meetings for the JSSA national scenarios group to discuss assessment of ecosystem services and human well-being (draft)
STEP 14	Incorporate collected feedback and develop the final draft of scenarios based on internal evaluation
STEP 15	First round review (by internal and external reviewers)
STEP 16	Report revised scenarios (final draft) at the national meeting and collect feedback (fourth process)
STEP 17	Second round review (by external reviewers)

of the JSSA were carried out three times, as well as convening special meetings with cluster users (twice in the Hokushinetsu cluster group) (Table 6.4). The expertise of participants involved in this process covers a wide range including ecology, landscape planning, environmental economics, environmental law, environmental system analysis, rural planning and urban environmental engineering.

6.3.3 Basic framework of scenario development

(1) Basic conditions for scenarios

First, basic conditions, which influence *satoyama* and *satoumi* with high certainty within 2050, were identified by expert judgement at the very early stages of scenario building (steps 1 and 2 in Table 6.4). They are 1) progress of national population decrease and ageing, and 2) responses to climate change at the national level. Both would influence future *satoyama* and *satoumi* landscapes through changing the demand for food, and the actors and modalities for use and management of ecosystems.

For the first condition, according to an estimation by the National Institute of Population and Social Security Research (NIPSSR) in 2006, Japan's population will total approximately 104 to 88 million people by 2050. This translates to a decrease from the present population by 20 to 40 million people (NIPSSR, online). On the other hand, the percentage of elder citizens (age 65 and over) will grow from 21 per cent in 2005 (Statistics Bureau, Ministry of Internal Affairs and Communications, Japan, 2005) to 36–43 per cent in 2050. However, details of demographic shifts within the country (i.e. population concentration in large cities and counter urbanization to countryside) and the increases or decreases in international migration remain uncertain.

The other basic condition is responses to climate change at the national level. In Japan, the national government has stipulated various laws and programmes to cope with climate change, such as the Act on Promotion of Global Warning Countermeasures; Renewable Portfolio Standard Law; Biomass Utilization Promotion Law; as well as the Solar Feed-in Tariff Program. However, the types of responses to be taken, for example, emphasis on renewable and biomass energies, or nuclear power, will depend largely on the values and preferences of future societies.

(2) Uncertainties that form scenarios

Uncertainties in scenarios are those which are impossible to predict and control, but are assumed to have large impacts on the use and management of *satoyama* and *satoumi*, as well as their ecosystem services. In the JSSA, Japanese politics and economy, and society's attitudes toward nature and ecosystem services, are set as two aspects of future uncertainties that might impact the future of *satoyama* and *satoumi* and their ecosystem services.

Two future directions are assumed for Japanese politics and economy: globalization versus localization. Under globalization, the national government promotes liberalization of trade and economy and global migration, while under localization, protection of agriculture, forestry and fisheries will progress, along with decentralization of government authority. On the other hand, the two directions (orientations) used for people's attitudes are technology-oriented, which prefers and emphasizes the use and development of technology to overcome the limitations of natural environments versus nature-orientation, where people prefer adaptation to natural environments instead of transformation and where efficiency and convenience are not as important as a cultural way of life embracing nature and human connection as one.

Upon the combinations of these two axes, the following four scenarios are developed: Global Technotopia; Global Environmental Citizens; Techno Introvert; and *Satoyama-Satoumi* Renaissance.

The scenarios were first drafted by the members of the scenario working group in charge of Chapter 6. Then the ideas, along with the time horizon and basic conditions mentioned above, were reported and examined at the JSSA national and cluster meetings. Together with email inquiries, this sequence was repeated three times (from Step 3 to Step 12 in Table 6.4) to enrich the storyline (6.4.1) and characteristics of scenarios (6.4.2 and 6.4.3).

6.4 Four scenarios of JSSA

6.4.1 Scenario overview

An overview (Figure 6.4) of the four JSSA scenarios appears below.

Global Environmental Citizens (globalization and nature-oriented)

In this scenario, global migration and exchange of the population and labour force expands. Here, emphasis is placed on the liberalization of

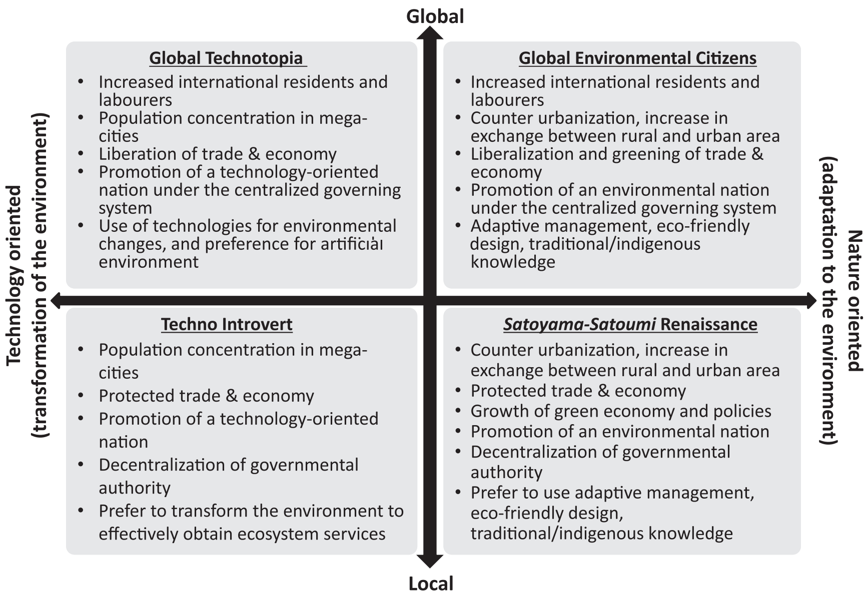

Figure 6.4 Positioning and characteristics of four scenarios in JSSA

Figure 6.5 Global Environmental Citizens

trade and economy, as well as the development of a green economy. Under a centralized governing system, investments and political interests increase toward education, social security and the natural environment. In the fields of agriculture, forestry, fisheries, public works and ecosystem management, society prefers to use eco-friendly technology for food production and management of the natural environment, such as low input agriculture, nature restoration, traditional technologies and adaptive management involving various stakeholders.

Global Technotopia (globalization and technology-oriented)

In this scenario, the global migration of people, travellers and the labour force becomes active, and the liberalization of trade and economy develops. A centralized government promotes the development of technology and amends national policies, with systems further amended to enhance international cooperation. Concurrently, political and social interests towards education, social security and the natural environment decrease. In food production, public works and ecosystem management, society prefers to transform and control the environment, using technologies to effectively utilize and extract ecosystem services, overcoming the constraints of the natural environment.

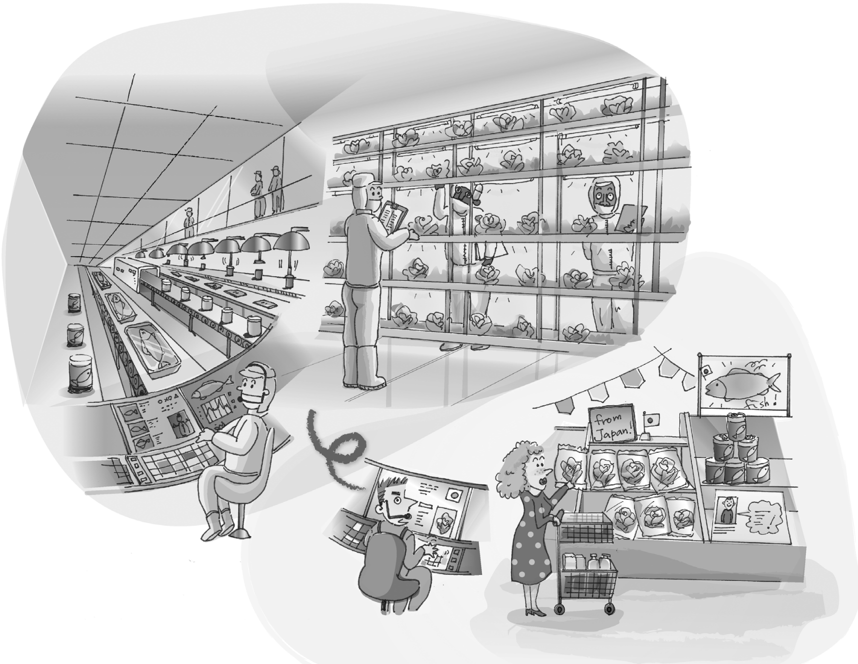

Figure 6.6 Global Technotopia

Techno Introvert (localization and technology-oriented)

In this scenario, the population decrease continues nationwide, while rural-urban migration progresses. In trade and economy, the government adopts protectionist policies, especially within primary industry, to increase the self-sufficiency of food and materials. People place higher confidence in science and technology than in traditional/indigenous knowledge. While the decentralization of administrative power and the development and use of ICT progress, social bonds in local communities weaken. Within primary industry, public works and ecosystem management, society prefers to transform and control the environment, using technology to effectively utilize and extract ecosystem services such as food and water.

Satoyama–Satoumi *Renaissance (localization and nature-oriented)*

In this scenario, an excessive population concentration in megacities comes under review, which triggers a counter-urbanization to the countryside and decentralization of government authority under a gradually declining population. The government adopts protectionist policies for trade and the economy, especially within primary industry, to improve the

Figure 6.7 Techno Introvert

self-sufficiency of food and materials, while embracing the idea of a green economy. Within primary industry, public works, and ecosystem management, society prefers to use eco-friendly technology for food production and management of the natural environment, such as low input agriculture, nature restoration, traditional technologies and adaptive management involving various stakeholders.

It should be noted that, as stated earlier, these JSSA scenarios describe how the overall trends surrounding *satoyama* and *satoumi* may unfold in the future. It should be acknowledged that in reality, the geographical and socio-economic conditions of *satoyama* and *satoumi* might vary. Thus, people could envisage that their (*satoyama/satoumi*) future in some areas could fall into one of four scenarios (e.g. Global Environmental Citizens), while in other areas, their future could be envisaged to fit into other scenarios, such as Techno Introvert. Such views would be natural, as *satoyama* and *satoumi* have regional variability in reality. The real future would unfold as a combination of several or all four of the scenarios suggested here (MA, 2005b).

6.4.2 Characteristics of responses related to the use and management of satoyama *and* satoumi *under each scenario*

"Responses" refers to (1) institutions and governance, (2) economics and incentives, (3) social and behavioural responses, (4) technological

Figure 6.8 *Satoyama–Satoumi* Renaissance

responses and (5) knowledge and cognitive options to manage ecosystem services and address promising opportunities for improving human well-being (MA, 2005b). Responses also influence direct and indirect drivers, as well as changes in ecosystem services and trends as shown in Table 6.5.

Institutions and governance responses define the frameworks of national systems and international cooperation that are taken by national and local governments. These responses also influence the directions of other responses, such as economics and incentives.

Economics and incentives responses define the state of the economy, including primary industry and policies for ecosystem management, which mainly influence the actions and behaviour of businesses and those who engage in agriculture, forestry and fisheries.

Social and behavioural responses define the activities of local communities and civil society, public participation in governmental decision-making and many other interactive areas. Thus, they define the areas of activities, social relations and actions taken by people.

Technology, knowledge and cognitive options define the preferences, state, emphasis in education and use of traditional knowledge and technologies for ecosystem management, including agriculture, forestry and fisheries. It defines the way in which people work with nature in a broad sense.

Descriptions of responses in Table 6.5 are characterized by the position of the scenario in the four quadrants of Figure 6.4. The contents of Table 6.5 along with Table 6.6 (indirect drivers) and Table 6.7 (direct drivers) – to be explained in the next section – were first drafted by the members of the scenario working group, and were presented and examined at the JSSA national and cluster meetings (Steps 11 to 16 in Table 6.4).

6.4.3 State of indirect drivers and direct drivers under scenarios

(1) Indirect drivers

Table 6.6 presents the indirect drivers that indirectly influence ecosystem services under each scenario. They are categorized into:

- Demographic (changes in national and international population movements, and interactive populations, etc.);
- Economic (globalization, trade, market, economic policy, government interventions, consumption trends, etc.);
- Socio-political (governance, institutional and legal framework, participation in decision-making, government interventions, etc.);
- Science and technology (technological innovation, technologies related to securing ecosystem services, etc.); and
- Culture and religion (value concepts, social rules, etc.)

Like the responses shown in the Table 6.5, the state of indirect drivers differs depending upon where the scenario is in the four quadrants. Categories of responses and indirect drivers often overlap, and therefore, there are similar descriptions between them. These indirect drivers not only impact ecosystem services through direct drivers (see next section), but also impact each other. For example, institutions and market formation (categorized as one of the socio-political indirect drivers), are closely linked with economic activities and the use of science and technologies, both of which are categorized as other indirect drivers. Further, people's value system, beliefs and social norms (categorized as cultural and religious indirect drivers) are in close relation with demographic shifts and visitor numbers to the countryside.

(2) Aspects of direct drivers

In the JSSA, the main direct drivers which influence changes in the ecosystem services from *satoyama* and *satoumi* are identified as land use and cover change (urbanization, sprawl and loss of mosaic), underuse, exploitation and overuse, climate change, increase in invasive species, and pollution (Chapter 3). Table 6.7 lists major examples of the direct drivers for each scenario, which is derived from the indirect drivers indicated in Table 6.6. Here, climate change occurs on a global scale. Thus, it is unlikely that differences between the direct drivers in Japan significantly

Table 6.5 Characteristics of responses related to the use and management of *satoyama* and *satoumi* under each scenario

	Global Environmental Citizens (global × nature-oriented)	Global Technotopia (global × technology-oriented)	Techno Introvert (local × technology-oriented)	*Satoyama–Satoumi* Renaissance (local × nature-oriented)
Institutions and governance	Liberalization and deregulation • Liberalization and deregulation of the economy and trade • Expansion of the role of the private sector under central governance Systems for international cooperation • International cooperation of policy and legislation • Market formation and guidance policies for ecosystem management • Systems to support international migration and domestic travellers	Liberalization and deregulation • Liberalization and deregulation in economy and trade • Expansion of the role of the private sector under central governance Systems for international cooperation • International cooperation of policy and legislation are progressed, but formation of national market and economic incentives within Japan are slow • Systems to support international migration and domestic travellers	Protection, safety, regulation, guidance • Subsidy to support agriculture and forestry for food security • Development of regulation and guidance for ecosystem management System development for decentralization and expansion of interaction • Progress in decentralization, and development of local policies and systems • Promotion of environmental management at the scale of river basins	Protection, safety, regulation, guidance • Subsidy to support agriculture and forestry for food security • Development of regulation and guidance for ecosystem management System development for decentralization and expansion of interaction • Decentralization of administrative authority, development of local policies and systems, and promotion of environmental management at the scale of river basins • Development of various systems that support counter urbanization as well as visitors to countryside

Table 6.5 (cont.)

	Global Environmental Citizens (global × nature-oriented)	Global Technotopia (global × technology-oriented)	Techno Introvert (local × technology-oriented)	*Satoyama–Satoumi* Renaissance (local × nature-oriented)
Economics and incentives	Expansion in external dependency for labour • Use of foreign labour Formation of market/use of guidance policies • Spread of payment for environment and ecosystem services, biodiversity offsets, market approach • Increase in environmental consideration Expansion of ecosystem services type businesses • Expansion and globalization of ecotourism • Evaluation of non-market value of ecosystem services	Expansion in external dependency for labour • Use of foreign labour Competitiveness enhancement by advancement and emphasis on technology • Mono-production and emphasis of agricultural, forestry and fishery products to survive international competition • Enlargement of management scale in agriculture, forestry and fishery with advanced technology	Competitiveness enhanced by advancement and emphasis on technology • Mono-production and emphasis of agricultural, forestry and fishery products to withstand international competition • Enlargement of management scale in agriculture, forestry, and fishery with advanced technology	Use of guidance plan • Introduction, expansion and spread of domestic systems of payment for environment and ecosystem services, and biodiversity offsets • Increase in environmental consideration in business management Expansion of ecosystem services type businesses • Spread of ecotourism and green tourism • Evaluation and acknowledgement of non-market values of ecosystem services

Social and behavioural responses	Increase in participation of communal society and citizens • Expansion and globalization in activities/cooperation of local communities and civil society organizations Sufficiency of social relations • Expansion of cooperation between producers and consumers Value acknowledgement of national ecosystem services • Spread of way of thinking in local and seasonal productions and consumptions of domestic products	Increase in activities by experts and engineers • Expansion and globalization in activities of civil society organizations including NPOs and NGOs with expert knowledge and technologies, while the activities of non-experts decreases Thinning of social relations • Weak social relationships • Weak relations between producers and consumers Unification of preferences • Unified preferences in consumers, and loss of seasonal characteristics in food consumption	Increase in activities by experts and engineers • Expansion and globalization in activities of civil society organizations including NPOs and NGOs with expert knowledge and technologies, while the activities of non-experts decreases Thinning of social relations • Weak social relationships • Weak relations between producers and consumers Unification of preferences • Unified preferences in consumers, and loss of seasonal characteristics in food consumption	Increase in participation of communal society and citizens • Expansion in activities/cooperation of local communities and civil society organizations Sufficiency of social relations • Expansion of cooperation between producers and consumers Value acknowledgement of national ecosystem services • Spread of way of thinking in local and seasonal productions and consumptions of domestic products

Table 6.5 (cont.)

	Global Environmental Citizens (global × nature-oriented)	Global Technotopia (global × technology-oriented)	Techno Introvert (local × technology-oriented)	*Satoyama–Satoumi* Renaissance (local × nature-oriented)
Technological responses	Artificial efficiency, adaptation to environment by high function ability • Restoration of *uotsuki rin* (fish gathering forests) and natural environment of coastal area • Shift from construction of multipurpose dams and mud-control dams to large-scale forest development and management • Expansion of environmental consideration and adaptive management in public works • Spread of ecosystem management in agriculture, forestry and fishery industries	Overcoming of environmental restraints through advancement of technology and efficiency • Artificial nature and ecosystem services • Management of supply chain and traceability using ICT • Use of machinery, technological advancement and low impact production in aqua culture and farming • Conventional project management	Overcoming of environmental restraints through advancement of technology and efficiency • Artificial nature and ecosystem services • Management of supply chain and traceability using ICT • Use of machinery, technological advancement and low impact production in aqua culture and farming • Conventional project management	Artificial efficiency, adaptation to environment by high function ability • Spread of ecosystem management in agriculture, forestry and fishery industries • Restoration of *uotsuki rin* (fish gathering forests) and natural environment of coastal area • Shift from construction of multipurpose dams and mud-control dams to large-scale forest development and management • Expansion of environmental consideration and adaptive management in public works

Knowledge responses	Use of traditional knowledge and technologies • Conservation and use of traditional technologies and knowledge Expansion in perspectives through environmental education and awareness raising • Spread and expansion of environmental education about ecosystem services for the general public	Cultural integration, loss of tradition • Integration with tradition and culture from overseas • Loss of traditional knowledge, technologies and culture Emphasis on training engineers and experts • Emphasis on engineering and specialized education	Loss of tradition • Loss of traditional knowledge, technologies and culture • Belief in technological innovation Emphasis on training engineers and experts • Emphasis on engineering and specialized education	Use of traditional knowledge and technologies • Conservation and use of traditional technologies and knowledge Expansion in perspectives through environmental education and awareness raising • Spread and expansion of environmental education about ecosystem services for the general public

Note: The headings present key characteristics of responses and the bullet points below include examples of those responses with such characteristics.

Table 6.6 Overview of indirect drivers assumed under scenarios

Indirect drivers	Global Environmental Citizens (global × nature-oriented)	Global Technotopia (global × technology-oriented)	Techno Introvert (local × technology-oriented)	*Satoyama–Satoumi* Renaissance (local × nature-oriented)
Population	Inflow of international population and labour • Strengthen international competitiveness in primary industry using cheap labour from overseas Counter urbanization and increase in visitors to countryside • Population concentration to cities slows down, and population and employment grows in suburban areas with better environments • Increased visitors from home and abroad visit countryside for ecotourism and green tourism	Inflow of international population and labour • Strengthen international competitiveness in primary industry using cheap labour from overseas Population concentration to cities • Population concentration into megacities for convenient and efficient life and economy Depopulation • Progress of depopulation and ageing in countryside becomes serious	Population concentration in cities • Population concentration into megacities for convenient and efficient life and economy Depopulation • Progress of depopulation and ageing in countryside becomes serious	Depopulation • Depopulation and ageing of community become serious issues in regional cities, as well as agricultural mountain villages and fishing villages, where no advantageous production conditions and tourism resources are found Counter urbanization and increase in visitors to countryside • Population concentration to cities slows down, and population and employment grows in suburban areas with better environment • Increased visitors from home and abroad to countryside for ecotourism and green tourism

Economy	Liberalization of trade and economy • Expansion of exports of agricultural, forestry and fishery products • Liberalization of trade and economy • Increase in overseas production • Large-scale management of agriculture, forestry and fisheries • Expansion of ecotourism, development of sixth industry which manages production, processing and distribution • Pursuit of high quality and safe products Green trade and economy • Introduction and dissemination of mitigation banking, forest carbon sink credit, environmental payments for ecosystem services, etc., based on an international framework	Liberalization of trade and economy • Expansion of export to overseas in agricultural, forestry, and fishery products • Liberalization of trade and economy • Increase of overseas production • Large-scale management of profit-oriented agriculture, forestry and fishery with advanced technologies • Pursuit of stable supply and unified quality of products through advancement of technologies Homogenous preference, loss of seasonality in food consumption • Low price products from abroad are used in food industry	Investment and support for protection • Protection of agriculture, forestry, and fisheries for self sufficiency and food security • Use of subsidies, regulation and guidance for natural resource management • Large scale management of profit oriented agriculture, forestry and fisheries with advanced technologies • Pursuit of stable supply and unified quality of products through the advancement of technologies Homogenous preference, loss of seasonality in food consumption • High preference for high quality and safe domestic products • Homogenous preferences for taste, and interest in seasonal and local products is weakened	• Investment and support for conservation • Protection of agriculture, forestry, and fishery for self sufficiency and food security • Use of subsidies, regulation and guidance for natural resource management Spread of greening in economy and payment for environment • Introduction and development of national payment for ecosystem services and biodiversity offsets, etc. Preference of domestic products • Local and seasonal production and consumption becomes common place • Organic farming and roadside markets • Development of sixth industry which manages production, processing and distribution and expansion of ecotourism

Table 6.6 (cont.)

Indirect drivers	Global Environmental Citizens (global × nature-oriented)	Global Technotopia (global × technology-oriented)	Techno Introvert (local × technology-oriented)	*Satoyama–Satoumi* Renaissance (local × nature-oriented)
Socio-political	Centralized government and promotion of international cooperation • Small-scale centralized government • International cooperation of politics and economy; enlarged role of the private sector • International cooperation to cope with global environmental issues, and expansion of related national institutions and markets • Expansion of ecotourism, green tourism and environmental consideration in policy and business	Centralized government and promotion of international cooperation • Small-scale centralized government • International cooperation of politics and economy; enlarged role of the private sector • International cooperation to cope with global environmental issues with high confidence in technological responses • Slow national market formation to manage environmental issues • Technology development and expansion encouraged for efficient use of ecosystem services and transformation of the environment	Emphasis on safety and protection • Improve self sufficiency in food and resources on the national scale in case of food crisis and other resource competition • Tighter regulation for resource management, and use of guidance policy • Decreased interest in international cooperation and market approach • Development of technology to transform natural environments in order to effectively utilize ecosystem services Decentralization and delegation of authority to municipalities • Prefer economic promotion of local industries under a decentralized government system to fill the gaps between cities and rural areas	Emphasis on safety and protection • Enhance self sufficiency in food and resources on the national scale in case of food crisis and other resource competition • Tighter regulations for resource management, and use of guidance plan • Decreased interest in international cooperation and market economy Decentralization and delegation of authority to municipalities • Decentralization of government power • Nature restoration and conservation policies considering connections between forests, rivers and the ocean • Improvement of policies related to eco-friendly business, increased visitors to countryside thorough ecosystem management and eco-tourism

Socio-political	Expansion of stakeholder participation • Increased awareness of ecosystem services through food and environmental education • Expansion and internationalization of activities by civil society organizations such as NPOs and NGOs • Globalized cooperation between consumers and producers	Weak social relationship, emphasis on experts and technology • Education of engineers and experts, rather than the general public • Increased activities by domestic and international civil society organizations such as NPOs and NGOs with expertise and technologies • Decrease in activities by non experts such as local residents • Weak relationship between producers and consumers	Weak social relationship, emphasis on experts and technology • Education of engineers and experts, rather than the general public • Increased activities by NPOs, NGOs and other groups with expertise and technology • Decrease in activities of non experts such as local citizens • Weak relationship between producers and consumers	Self governance by various stakeholders • Increased awareness of ecosystem services through food and environmental education • Expansion in activities and cooperation of local community, NGOs, NPOs and citizen groups • Expansion in cooperation between consumers, vendors and producers
Science and technology	Development and use of environmental adaptation technology • Preference for adaptation to and restoration of natural environment rather than the transformation of it	Development and use of environmental innovative technology • Preference for efficient extraction of ecosystem services through transformation of the natural environment	Development and use of environmental innovative technology • Preference for efficient extraction of ecosystem services through transformation of the natural environment	Development and use of environmental adaptation technology • Preference for adaptation to and restoration of natural environment rather than the transformation of it

Table 6.6 (cont.)

Indirect drivers	Global Environmental Citizens (global × nature-oriented)	Global Technotopia (global × technology-oriented)	Techno Introvert (local × technology-oriented)	*Satoyama–Satoumi* Renaissance (local × nature-oriented)
	• Shift toward soft systems such as fund raising and guidance policies rather than advancement of technologies • Advancement of adaptive management and environmental consideration in public works • Shift towards forest development and management such as forest management, rather than construction of multipurpose dams and mud-control dams • Combined management of forest and coastal marine resources, as well as recovery of seaweed beds, tidelands etc. • International transfer of environmental policy and systems	• Use of high technology in primary industry • Overseas food and material production • Increased use of ICT for supply chain management and traceability management through ICT • Research and technology development for ecosystem services such as plant factory • Public works with preference for conventional management strategy to adaptive management • International transfer of technology	• Use of high technology in primary industry • Increased use of ICT for supply chain management and traceability management through ICT • Research and technology development for ecosystem services such as plant factory • Public works with prefererence for conventional management strategy to adaptive management	• Shift toward soft systems such as fund raising and guidance policies rather than advancement of technologies • Advancement of adaptive management and environmental consideration in public works • Shift towards forest development and management such as thinning and planting of forests, rather than construction of multipurpose dams and mud-control dams • Combined management of forest and coastal marine resources, as well as recovery of seaweed beds, tidelands etc. • Use of traditional knowledge for agriculture, forestry and fishery

Culture and religions	Preferences of local identity, quality, and safety • Preference on high quality, local and safe products and services Diversity and reformation of society • Renewed quest for new citizens society, and sharing roles in *satoyama/satoumi* management, while international interactive populations progress • Increase in interests in Japanese food culture and nature harmonious life style, both nationally and internationally Respect to tradition and culture • Revaluation and conservation of tradition and culture while international exchanges advance	Preference of efficiency, and functionality • Priorities are on price rather than production area but still high interests in safe food products • Homogenous food preferences Weak social relations • Changes and deterioration of local communities in rural areas due to depopulation and ageing • Weak social relations in megacities due to increased population inflow Integration and transformation of tradition and culture • Inflow of international culture causes integration with and transformation of Japanese culture and tradition	Preference of efficiency, and functionality • Priorities are on price rather than local production for local consumption production areas and seasonal food but still high interests in domestic food products • Homogenous food preferences Weak social relations • Reformation of local communities with their diminished functions progress in rural areas • Management of *satoyama/satoumi* shift from local communities to external groups such as external NPOs and NGOs	References of local identity, quality, and safety • Preference on local originality, quality and safety of products and services • Local production for local consumption, as well as increased prevalence of seasonal product consumption Diversity and reformation of society • Explore a new form of sharing roles in *satoyama-satoumi* management under progress of counter urbanization Respect to tradition and culture • Re-evaluation and conservation of traditions and culture

Table 6.7 Overview of direct drivers assumed under scenarios

Direct drivers	Global Environmental Citizens (global × nature-oriented)	Global Technotopia (global × technology-oriented)	Techno Introvert (local × technology-oriented)	*Satoyama-Satoumi* Renaissance (local × nature-oriented)
Changes in land use and covering				
Urbanization and sprawl development	• Development of housing, public facilities and infrastructure in suburban areas and countryside due to counter urbanization • Increase in tourism related development in countryside due to ecotourism and green tourism	• Population concentrates in cities, re-development of urban areas and sprawl development in suburban areas progresses	• Population concentrates in cities, re-development of urban areas and sprawl development in suburban areas progresses	• Development of housing, public facilities and infrastructure in suburban areas and countryside due to counter urbanization • Increase in tourism related development in countryside due to ecotourism and green tourism
Loss of mosaic	• Loss of mosaic due to enlargement of management scale in primary industry, all in order to improve competition	• Loss of mosaic due to expansion of large-scale aquaculture, plant factories and in-facility farming • Large scale changes in mosaic due to greening of urban areas, wall and ceilings, etc.	• Loss of mosaic due to expansion of large scale aquaculture, plant factories and in-facility farming • Large-scale changes in mosaic due to greening of urban areas, walls and ceilings etc.	• Loss of mosaic in some areas due to enlargement of primary industry

Underuse	• Increase in overseas production • Decrease in food production in less-favoured areas	• Increase in overseas production • Decrease in food production in less-favoured areas	• Issue of underuse becomes a more serious issue in the countryside where depopulation and ageing progress • Such trends are more prominent in less-favoured areas	• Issue of underuse becomes a more serious issue in areas with no advantageous production conditions and tourism resources • Such trends are more prominent in less-favoured areas
Over exploitation and overuse	• Purchase of property rights by foreign capital and business sometimes leads to over exploitation and use of natural resources • Intensive management of agriculture, forestry and fisheries in order to survive international competition sometimes leads to exploitation and overuse	• Purchase of property rights by foreign capital and business sometimes leads to over exploitation and use of natural resources • Intensive management of agriculture, forestry and fisheries in order to survive international competition sometimes leads to exploitation and overuse	• Over exploitation and overuse due to profit-oriented management	• Over exploitation and overuse due to profit-oriented management in some areas

Table 6.7 (cont.)

Direct drivers	Global Environmental Citizens (global × nature-oriented)	Global Technotopia (global × technology-oriented)	Techno Introvert (local × technology-oriented)	*Satoyama-Satoumi* Renaissance (local × nature-oriented)
Climate change	• Decrease in potential yield of rice, change in cultivation land for tangerines and other products, invasion of new pests and diseases, and increase in pest damage due to climate change			
Invasive species and animal damage	• Increased number of invasive species due to globalized trade and economy	• Increased number of invasive species due to globalized trade and economy • Increase in bird and animal damage in countryside due to depopulation and abandonment	• Although seen, increase in number of invasive species is moderate compared to scenario with easing of regulations • Increase in bird and animal damage in countryside due to depopulation and abandonment	• Although seen, increase in number of invasive species is moderate compared to scenario with easing of regulations
Pollution	• Input of chemical fertilizers, pesticides, and other chemicals would be controlled at lower levels compared to tech. oriented scenarios.	• Large input of chemical fertilizers, pesticides and other chemicals in areas of intensive agriculture, forestry and fisheries industries	• Large input of chemical fertilizers, pesticides, and chemicals in areas of intensive agriculture, forestry and fisheries industries	• Input of chemical fertilizers, pesticides and other chemicals would be controlled at lower level compared to tech. oriented scenarios.

influence the direction of global climate change. For these reasons, climate changes as direct drivers are used as common factors in all JSSA scenarios (Ministry of Agriculture, Forestry and Fisheries, Japan, 2002; Agriculture, Forestry and Fisheries Research Council of Ministry of Agriculture, Forestry and Fisheries, Japan, 2007).

6.4.4 Changes in ecosystem services and human well-being under scenarios

(1) Methodology of assessment

Expert judgement was used to qualitatively assess changes in ecosystem services and human well-being for all the scenarios. At first, an initial assessment was conducted by the scenario working group. Next, the result of the assessment was presented at an ad hoc meeting for the JSSA national scenario group and of the national and cluster meetings to receive comments and suggestions from experts involved in the JSSA. Finally, the comments and suggestions were reflected in the assessment result (Steps 11 to 17 in Table 6.4). Assumptions which were set for expert judgement are described below with examples.

(2) Perspective of ecosystem services assessment

In the JSSA, ecosystem services were assessed from two perspectives, following the MA framework of "Human use" and "Enhanced/Degraded" (Table 6.8). The assessments here use the *satoyama/satoumi* ecosystem services exhibited today as a baseline. Ecosystem services from overseas are not included (e.g. imported food and timber, foreign eco-tourism). Further, supporting services that people do not use directly, such as soil

Table 6.8 Increase and decrease in human use, enhancement and degradation of ecosystem services

	Human use	Enhanced/Degraded
Provisioning services	Human use "increases" if total consumption quantity of the service increases, and "decreases" if total consumption quantity of the service decreases	The service is "enhanced" if supply area and yields per area increase, and is "degraded" if the use exceeds sustainable levels.
Regulating services Cultural services	Human use "increases" if the number of users and benefactors increases, and "decreases" if the number of users and benefactors decreases	The service is "enhanced" if greater benefits for people are provided, and is "degraded" if benefits obtained from the service are reduced.

formation, photosynthesis, water circulations, etc., are excluded from the assessment, as they are exhibited through other services (provisioning, regulating, cultural).

(3) Subject and views of ecosystem services

1) Assessment subjects
It is difficult to assess the changes in ecosystem services in every aspect for all four scenarios, given the limitations in available data and findings (Chapter 3). In the JSSA scenarios, we conducted a qualitative assessment by extracting the most critical ecosystem services, out of all ecosystem services, in order to envisage their changes (Table 6.9).
2) Views on assessment
Assessments of “increase/decrease” in human use, and “enhancement/deterioration” of services, differ in assessment method depending on whether the focus is on provisioning services or regulating/cultural services (Table 6.8).
• Human use
Human use of provisioning services is assessed by either an increase or decrease in use of energy, food and fabric, etc. Therefore, it is subject to changes in the use quantity per person of domestic products and export quantity, etc. In Japan, the population is expected to decrease in the future; therefore, if current consumption or level of use of domestic provisioning services continues, human of provisioning services within Japan will also decrease (e.g. rice and vegetable consumption in the Techno Introvert scenario, Table 6.9). However, if we increase the consumption of domestic products per person or export quantity, human use will increase (e.g. fishery products and vegetables in the Global Environmental Citizens scenario) or maintained (e.g. rice and vegetables in the *Satoyama-Satoumi* Renaissance scenario).

On the other hand, increases and decreases in regulating and cultural services are assessed by the numbers of those who benefit from these services. Therefore, their increase or decrease is influenced by the increase or decrease in population at a site, for example, river basins, where ecosystem services are generated, as well as the number of visitors to the site. As a result, it can be concluded that regulating services are affected mainly by residential populations, while cultural services are affected by the increase or decrease of interactive populations.
• Enhanced or degraded
The enhancement/degradation of provisioning services is defined by the productivity and sustainability of the land in which energy, food, fabric and other supplies are produced. If the production quantity and area increase within sustainable levels, it is considered “enhanced”, while it is “degraded” when it is no longer sustainable.

Regulating services will be "enhanced" if they provide more people with benefits, such as flood prevention by paddy fields and groundwater recharge by forests. On the other hand, they will be "degraded" should the benefit decrease due to changes in regulating services or human activities beyond environmental capacities.

In cultural services, degradation will occur when ecosystem changes decrease the cultural benefit. They will be classed as "enhanced" when changes in ecosystems increase the benefits, such as nature recreation and aesthetic scenery.

• Interlinkages between ecosystem services

Most regulating and cultural services are jointly produced through the sustainable use and management of *satoyama* and *satoumi* landscapes for obtaining provisioning services, such as food and timber (Chapters 3 and 4). Therefore, the conditions of those services, either enhanced or degraded, are closely linked to either the mode of production or how provisioning services are generated. For example, expansion of greenhouse production, plant factory and aqua-culture increases productivity within an area, which means that the provisioning service is "enhanced" (e.g. provision of vegetables in the Global Technotopia and Techno Introvert scenarios, Table 6.9). However, if these changes cause the decline in use and management of *satoyama* and *satoumi*, regulating services that have been generated through the use and management of land will be assessed "degraded" (e.g. regulating services of soil in Global Technotopia and Techno Introvert, Table 6.9). Likewise, the decline in use and management of *satoyama* and *satoumi* will lead to weakened social relationships that would ordinarily be formed and maintained through *satoyama* and *satoumi* maintaining activities, and consequently result in a degradation of cultural services (traditional art and festivals, etc.) (e.g. the cultural services in the Global Technotopia and Techno Introvert scenarios).

According to a simulation study conducted by the Ministry of Agriculture, Forestry, and Fisheries, Japan, the elimination of tariffs will cause devastating damage to domestic agricultural production as products with cheaper and/or similar quality to domestic products flow in from overseas (Ministry of Agriculture, Forestry, and Fisheries, Japan, 2007). In other words, at least in the short term, the liberalization of trade will decrease the use of domestic provisioning services, which will then result in the degradation of regulating services, such as climate regulation, flood regulation and soil erosion prevention, all of which are jointly produced from farming in *satoyama* landscapes. On the other hand, JSSA scenarios are built on the assumption that even with the trade liberalization of agricultural and fishery products, Japanese agriculture and fishery industries will shift to export strategies in the long run, taking advantage of product quality. By the strategic creation of markets, the human use of provisioning services could remain constant or increase, even under ongoing depopulation and ageing (e.g. provision of food and water in the Global Environmental Citizens scenario and the provision of rice and vegetables in the Global Technotopia scenario, Table 6.9).

(4) Changes in conditions of ecosystem services under scenarios

Table 6.9 gives a summary of changes in ecosystem services assumed under each scenario. The state of ecosystem services assumed under each scenario is described below.

• Global Environmental Citizens

In this scenario, increases in the use of provisioning services are assumed, as food exports overseas increase, based on the liberalization of trade and economy, and value added domestic products are appreciated – though domestic consumption of most provisioning services will decrease due to a declining population. In energy supply and measures against climate change, use of biomass and other forms of renewable energy will increase, which could cause decline in other provisioning services such as hydro energy. With expansion in demand for these provisioning services, sustainable use and management of *satoyama* and *satoumi* progress, and many regulating services remain at the current level. Through increases in immigrants and visitors from overseas, human use of regulating services, such as flood and climate regulation, and cultural services, such as sceneries and recreation, remain at the present level.

• Global Technotopia

In this scenario, food production, especially in agriculture, will see major changes due to the liberalization of trade and economy. In attempting to survive in the globalized market, large-scale farming and the use of plant factories will increase in some areas in order to achieve improved production efficiency. However, securing provisioning services, such as food production in this manner, would cause homogenization of land use and low level land management compared with *satoyama* and *satoumi* farming. This, in turn, will cause decreases in regulating services, such as flood regulation, and cultural services, such as aesthetic landscapes. In the energy sectors, the use of nuclear power and highly-efficient thermal power generation are prioritized, while the use of biomass and other renewable energies will decrease. Further, the concentration of the population in large cities will aggravate deterioration, and cause a loss of traditions and cultures in the countryside, thus leading to decreased human use and decline of cultural services.

• Techno Introvert

In this scenario, protection and growth of agriculture, forestry and fisheries in Japan are encouraged to improve food self-sufficiency and food security. Although exports do not increase, increases in per-capita consumption of domestic food, for instance vegetables and fishery products, contributes to maintaining the human use of provisioning services, and contributes to the enhancement of provisioning services by enlargement of production scales, greenhouse production, aquaculture, and so forth. However, the expansion of indoor production facilities for agriculture and fisheries will cause decreases in the usage and management of *satoyama* and *satoumi*, and subsequently, decreases in most regulating services. In the energy sector, the use of nuclear power and highly-efficient thermal power generation are preferred to biomass and other renewable energies. Further, the concentration of the population in urban areas will cause a decline in tradition and culture in the countryside, which will result in decreased human use and a degradation of cultural services.

• *Satoyama–Satoumi* Renaissance

In this scenario, protection and growth of agriculture, forestry and fisheries are encouraged to improve food self-sufficiency and food security. Increase in per-capita consumption of domestic food and materials based on people's preferences will contribute to improving and/or maintaining human use of most provisioning services at present levels, though exports will not increase and consequently no consumption increase due to exports is anticipated. In energy supply, use of biomass and other renewable energies will increase, which will sometimes cause degradation of the other provisioning services such as hydro energy. This will contribute to the sustainable use and management of *satoyama* and *satoumi*, which will facilitate the maintenance and enhancement of regulating services, although the human use of regulating services will decrease due to the smaller population. On the other hand, counter urbanization and an increase in visitors to countryside will maintain human use and enhancement of cultural services.

(5) Biodiversity across scenarios

Although it is difficult to assess the changes in biodiversity for each scenario (methodologies of quantitative assessments of biodiversity are yet to be developed), the following conclusions would be reasonable to make concerning the qualitative assessment of future biodiversity:

1. Globalization scenarios would facilitate the entry of alien species in exchange for improved access to foreign goods and services, which could result in a loss of biodiversity;
2. Technology-oriented scenarios which favour the transformation of land concerning *satoyama* and *satoumi* to effectively utilize ecosystem services, could trigger the loss of biodiversity through, for example, development and change of mosaic; and
3. Technology-oriented scenarios which favour concentration of the population in cities to enable a more efficient economy and lives, would

Table 6.9 Changes in ecosystem services assumed under scenarios

Type and category of Ecosystem Services			Global Environmental Citizens		Global Technotopia		Techno Introvert		*Satoyama-Satoumi* Renaissance	
			Human use	Enhanced/ Degraded	Human use	Enhanced/ Degraded	Human use	Enhanced/ Degraded	Human use	Enhanced/ Degraded
Provisioning	Energy	Fuel (biomass, charcoal)	▲	—	▼	▲	▼	▲	▲	—
		Electricity (wind, hydro)	▲	▼	▼	—	▼	—	▲	▼
	Food and water	Fishery products (including aquaculture)	▲	▲	▼	▲	—	▼	▲	▲
		Rice	—	—	—	—	▼	▼	—	▼
		Vegetables	▲	▲	—	▲	—	▲	—	▲
	Fabric	Plants (timber)	▲	—	▼	▲	▼	▲	▲	—
Regulating	Atmosphere (climate regulations, air purification, etc.)		—	—	▼	—	▼	—	▼	—
	Water (flood regulation, water storage, etc.)		—	▼	▼	▼	▼	▼	▼	▼
	Soil (landslide and soil erosion prevention, etc.)		—	▲	▼	▼	▼	▼	▼	▲

Cultural	Spiritual (shrines and temples, traditional knowledge, etc.)	▼	▼	▼	▼	▼	▼	—	▲
	Aesthetic value (scenery)	▲	—	▼	▼	▼	▼	—	▲
	Recreation (festivals, eco-tourism, farming experience, etc.)	▲	—	▼	▼	▼	▼	—	—
	Art (traditional art, etc.)	▼	▼	▼	▼	▼	▼	—	▲

Notes:
1. ▲: Increasing (for human use) or enhanced (for enhanced/degraded), —: Consistent (for human use and enhanced/degraded), ▼: Decreasing (for human use) or degraded (for enhanced/degraded)
2. The Global Environmental Citizens and *Satoyama-Satoumi* Renaissance scenarios will see an increased use of biomass and other natural energy, while the Global Technotopia and Techno Introvert scenarios prefer to use nuclear energy and highly-efficient power generation, which will result in declines in the use of provisioning services of energy.
3. All scenarios (except Techno Introvert) could maintain current levels of rice consumption either by export (rice in Global Environmental Citizens and Global Technotopia) or by increased per-capita consumption of domestic products (provision of rice in *Satoyama-Satoumi* Renaissance). This will contribute to maintaining regulating services of atmosphere(enhanced/degraded) consistent in the three scenarios, although regulating services of water will be degraded in Global Environmental Citizens and *Satoyama-Satoumi* Renaissance due to an increase in vegetable production.
4. While Global Environmental Citizens will bring increased visitors from home and abroad for certain cultural services, such as festivals and aesthetic landscapes of *satoyama* and *satoumi*, those cultural services with low profiles, such as indigenous knowledge and nameless traditional art, will not be appreciated (cultural services of Global Environmental Citizens).
5. Human use of regulating services will decrease due to depopulation and rural-urban migration in the Global Technotopia and Techno Introvert scenarios, while increased population exchange and counter urbanization will contribute to keeping the human use of regulating and cultural services at current levels in the Global Environmental Citizens and *Satoyama-Satoumi* Renaissance scenarios.

enhance depopulation in the countryside and would result in the underuse or abandonment of *satoyama* and *satoumi*, thereby causing biodiversity loss.

4. Localization scenarios which favour domestic production will enhance the use of *satoyama* and *satoumi* to provide provisioning services to meet domestic food and energy demands. The mosaic of *satoyama* and *satoumi* landscapes enhances biodiversity levels.

As such, the level of biodiversity across scenarios would be *Satoyama-Satoumi* Renaissance → Global Environmental Citizens → Techno Introvert → Global Technotopia in descending order. While one of the critical factors causing the loss of biodiversity up until the 1990s was land development (Chapter 4), the JSSA scenarios clarified that globalization and technology orientation could be potential threats to the loss of biodiversity in future *satoyama* and *satoumi*.

(6) Impacts on human well-being

In the MA, human well-being is described as being made up of five aspects: "basic materials for good life"; "security"; "health"; "good social relations"; and "freedom of choice and action" (Table 6.10), which are closely linked to ecosystem services (see figure 2.8 in Chapter 2). The JSSA followed the framework of the MA to assess human well-being. However, it is difficult to assess how human well-being may change for each scenario in an unambiguous manner. For this reason, the JSSA streamlined the impacts of human well-being under each scenario from two aspects – positive and negative (Table 6.11).

- Global Environmental Citizens

In this scenario, globalization of economy and trade contributes to cost reduction and the efficient supply of various provisioning services. This enables people to access wider and cheaper products and services from overseas, improving their basic material wealth. In the regions which

Table 6.10 Constituents of human well-being

Constituents	Methods of understanding
Security	Secure access to resources, physical security, safety and security of properties, clear visions for future, etc.
Basic materials for good life	Sufficiency of food, water, house, fabric, clothes, medical supplies, etc. Adequate level of livelihood and access to goods.
Health	To be in desirable conditions both physically and mentally.
Social relations	Level of influence, respect, cooperation, and conflicts between individuals and organizations.
Freedom of choice and action	Security and choice of material and non-material needs, such as ecosystem services, freedom of action and participation.

benefit from international exports of agricultural/forestry/fishery products and an increase in international visitors, the use and management of *satoyama* and *satoumi* will continue in a sustainable manner, which will help to maintain regulating and cultural services at current levels. However, in some places, overuse of farmland and conversion of paddy fields for other uses could trigger water pollution and degradation of flood control. On the other hand, the regions left out of such benefits will see the underuse of *satoyama* and *satoumi* in international competition. As a result, regulating and cultural services in those areas will decrease, which could reduce human well-being. Globalization, which improves freedom of choice/action and basic material wealth, increases dependency on ecosystem services imported from abroad. This may cause erosion of trust in the safety of provisioning services and bring about food security risks due to international competition, disasters, etc. In other words, it decreases human well-being in terms of security. Additionally, an increase in immigrants and overdependence on international labour could cause job losses, conflict in communities and the working place, and changes in traditions and culture. These might lead to the degradation of good social relations.

• Global Technotopia

In this scenario, the globalization of economy and trade contributes to cost reduction and efficient supply of various provisioning services as in the Global Environmental Citizens scenario.

Advanced production technology will contribute to a stable supply of provisioning services. These will improve and/or maintain human well-being in terms of basic materials and health. However, expansion of plant factories and greenhouse production, as well as aquaculture, will trigger the underuse of land and its management, which will result in the degradation of regulating and cultural services in exchange for efficient food production. As population and capital flows out of the countryside to large cities, gaps in public services and deterioration of local communities becomes prominent, which accelerates rural-urban migration, causing a loss in tradition and culture. These will aggravate the well-being of people in those areas in terms of health and good social relations. In addition, the advancement of mechanization and an increase in foreign labour may lead to job losses and a deterioration of existing social relations and security. Globalization could cause an erosion of trust in the safety of provisioning services and bring about food security risks due to international competition, disasters, etc., as well as the deterioration of public security due to conflicts in communities and social disorder along with increasing foreign labour.

• Techno Introvert

In this scenario, the government aims to increase domestic food production through the advancement of production technologies and facilities under a protected economy and trade. This will stabilize the food supply, while overcoming seasonal and geographical restraints. Increased supply of domestic food will provide a feeling of security and safety to people contributing to human well-being in terms of basic material wealth and security. However, expanded use of plant factories and greenhouse production, as well as aquaculture, will trigger the underuse of land and coastal areas compared to current levels, which will result in the deterioration of regulating and cultural services. In addition, it would also increase unemployment in primary industry, causing a deterioration of human well-being in terms of basic materials for those engaged in primary industry. The concentration of the population in cities will establish the efficient provision of public services, while in the countryside it will result in the deterioration of communities, culture and traditions, reducing human well-being in terms of social relations and health. The protection of economy and trade will cause a decrease in economic efficiency – subsequently increasing the price of food and materials. Combined with the inequality in income between cities and the countryside, this will result in a decline in human well-being for people in the countryside in terms of basic material wealth and health.

- *Satoyama–Satoumi* Renaissance

In this scenario, the government aims to increase domestic food production under a protected economy and trade. Unlike in the Techno Introvert scenario, people prefer conventional production, which utilizes land and coastal areas, rather than technology-oriented production, such as plant factories, greenhouse production and aquaculture. This trend will expand the job market in primary industry and maintain or enhance provisioning services, along with associated regulating and cultural services. People have a high interest in the cultural services provided by *satoyama* and *satoumi*, and this trend encourages their use and management through various formats, such as eco-tourism. Further, increases in the number of visitors to the countryside and the emergence of a new management body for *satoyama* and *satoumi* will improve or restructure social relationships in those areas. Protection of primary industry could expand the supply of domestic food and materials, offering a feeling of security and safety to the people, while increasing the price of agricultural, forestry and fishery products, resulting in an increased burden for the general public. This may cause a decrease in human well-being in terms of basic material wealth, health and security in some areas. Additionally, issues of human well-being in terms of social relations and health would become a critical concern due to population decrease and ageing for those regions that do not benefit from counter urbanization and an increase in visitors.

Table 6.11 Impacts on human well-being assumed under scenarios

Pros and cons	Global Environmental Citizens (global × nature-oriented)	Global Technotopia (global × technology-oriented)	Techno Introvert (local × technology-oriented)	*Satoyama–Satoumi* Renaissance (local × nature-oriented)
Positive				
Basic material for good life	• Increased supply of foreign products • Globalization of supply and demand on products and services	• Increased supply of foreign products • Stabilized food supply overcoming seasonal/natural restraints due to advancement in technology • Advancement of production technologies and facilities	• Advancement of production technologies and facilities • Stabilized food supply overcoming seasonal/natural restraints due to advancement in technology	• Increased supply of domestic products • Increase in employment in primary industry
Health	• Maintenance of climate regulation, flood control, etc. • Improvement of aesthetic scenery and natural resources	• Development and advancement of medical technology and medicines, etc.	• Development and advancement of medical technology and medicines, etc. • Enhancement of safety and security by expansion of domestic food production	• Improvement of aesthetic scenery and natural resources • Enhancement of safety and security by expansion of domestic food production
Security	• Maintenance of regulating services through climate regulations and water controls, etc. • Conservation of tradition and culture in some areas in a new form	• Energy saving and low environmental impacts with advanced production technology and facilities • Improvement of supply chain management and traceability using ICT	• Energy saving and low environmental impacts with advanced production technology and facilities • Improvement of supply chain management and traceability using ICT	• Maintenance of regulating services such as climate regulations and water controls, etc. • Improved access to natural and cultural resources and conservation of tradition and culture

Table 6.11 (cont.)

Pros and cons	Global Environmental Citizens (global × nature-oriented)	Global Technotopia (global × technology-oriented)	Techno Introvert (local × technology-oriented)	*Satoyama–Satoumi* Renaissance (local × nature-oriented)
Good social relations	• Diversified and internationalized local communities and civil society	• Development and expansion of virtual community using ICT • Introduction and emergence of foreign culture and tradition	• Development and expansion of virtual community using ICT	• Strong social capital in local community • Expansion of civil society organizations
Freedom of choice and action	• Increased access to foreign products and services	• Increased access to foreign products and services	• Increased access to domestic food products	• Increased access to domestic and local products and seasonal food
Negative				
Basic material for good life	• Increased dependency on foreign food and resources • Increased unemployment due to introduction of foreign labour	• Increased dependency on foreign food and resources • Deterioration and homogenization of ecosystem services • Increased unemployment due to introduction of foreign labour and mechanization	• Increased unemployment due to mechanization • Increase in price of agricultural, forestry and fishery products due to protected economy	• Increase in price of agricultural, forestry and fishery products due to enhancement of national supply

Health	• Slow technology innovation and development of technical innovation, medical technology and medicine, etc. • Decrease in safety and security due to expansion in foreign products and materials • Enclosure of ecosystem services by foreign capital	• Increase in regional inequality of public services • Decrease in safety and security due to expansion in foreign products and materials • Deterioration of landscapes due to underuse and homo-genization of land use • Enclosure of ecosystem services by foreign capital	• Increase in regional inequality of public services • Deterioration of national landscapes due to decrease and unification of land use	• Slow technology innovation and development of technical innovation, medical technology and medicine, etc.
Security	• Increased influence of international competition and overseas disasters on national economy • Decrease in security, surfacing of human rights issues in work places etc.	• Increased influence of international competition and overseas disasters on national economy • Increase in high-tech crimes	• Increase in price of food and materials due to decreased efficiency through protected economy • Increase in risks of disease and disaster due to enlargement of management scale in business and industry, and monoculture • Decrease in supply stability of food and resources from inter-national cooperation • Increase in high-tech crimes	• Increase in price of food and materials due to decreased efficiency through protected economy • Instability of national supply due to unpre-dictable diseases and climate • Decrease in supply stability of food and resources from inter-national cooperation

Table 6.11 (cont.)

Pros and cons	Global Environmental Citizens (global × nature-oriented)	Global Technotopia (global × technology-oriented)	Techno Introvert (local × technology-oriented)	*Satoyama–Satoumi* Renaissance (local × nature-oriented)
Good social relations	• Increase in unemployment and loss of related culture/tradition due to increased dependence on foreign capital and labour • Conflicts in communities and work places due to differences in language and culture	• Conflicts in communities and work places due to differences in language and culture • Loss of traditional knowledge and culture • Deterioration of local communities • Weak social relations	• Loss of traditional knowledge and culture • Deterioration of local communities • Weak social relations	• Loss of local communities, traditional knowledge, technology and culture in less favoured areas • Strong social relationships sometimes cause social exclusion of newcomers
Freedom of choice and action	• Expansion of regulation in system/responses for international cooperation	• Expansion of regulation in system/responses for international cooperation	• Low access and decreased choices to diverse foreign products and services	• Low access and decreased choices to diversify foreign products and services

6.5 How to utilize national level scenarios: A proposal for scenario users

6.5.1 Scenario usages in policy-making, implementation and planning at the national level

The four JSSA scenarios at the national level have been described in a narrative manner: 2050 as the time horizon, changes in the social/political/economic framework, changes in people's attitudes towards nature, and value standards that surrounds Japanese *satoyama* and *satoumi*. National scenarios are not developed to choose or realize any of these future images as the "desirable future". Instead, the objective of scenario building in the JSSA was to discover plausible futures and to prepare for future uncertainties surrounding *satoyama* and *satoumi*. Thus, scenarios were described in an explorative manner considering the major uncertainties surrounding *satoyama* and *satoumi*.

How then should stakeholders in charge of policy-making deal with the scenarios that are presented by the JSSA? The most important thing is to think about the responses such as policies and legislation that can achieve stakeholders' (policymakers') initial goals, regardless of which scenarios, or even to investigate the limitations of existing policies and legislation. For example, land use planning and agricultural policies would play a major and direct role in sustaining the level of ecosystem services provided by *satoyama*. Under such circumstances, policymakers can discuss and streamline the details of land use planning and agricultural policies that could function effectively and comprehensively deal with the various circumstances and changes arising from each scenario. It is possible that the stakeholders may reach the conclusion that "no policies exist that can comprehensively respond to every scenario." However, the understanding of such future prospects can be useful in order to prepare for future uncertainties. If such a conclusion is the case, stakeholders should then examine what policies effectively function under each scenario (a desirable outcome in this process is to come up with a policy that functions under more than one scenario). Scenarios can further act as tools for finding more robust policies and plans that can effectively function beyond scenario categories.

6.5.2 How can national scenarios contribute to municipality policy-making, implementation and planning?

(1) Implications of national scenarios

National scenarios describe the overall trends and changes surrounding *satoyama* and *satoumi* in Japan. It should be noted that the impacts of future changes on *satoyama* and *satoumi* can depend on population scale, access to cities, and the geographical conditions of *satoyama* and *satoumi*, which vary across the country.

For example, the world-wide integration of markets due to globalization will have a significant impact on domestic agriculture. However, in the case of rice farming, impacts will be largely different between lowland areas, where large scale management is possible, and mountainous areas, where such management systems are difficult to implement due to geographical conditions. Even among cases of agriculture in mountainous areas, the regions located near the market place may be able to survive by growing vegetables that deteriorate within short time periods after harvesting, such as spinach and potherb mustard. In highland areas, diversification through forcing culture to differentiate itself from other regions may help agriculture to survive. Further, rural tourism and eco-tourism in *satoyama* and *satoumi* can be established as an industry in areas that are closely located to large-scale cities, which can be the potential market. Of course, exceptions can be found where tourism flourishes and supports the local economy because of their unique natural environments and ecosystems, even in areas that are distant from cities (e.g. Yakushima island, Hachijo island). As such, although the scenario is for the national scale, its changing factors will impact each region in different manners and degrees. Therefore, the responses for these changes should take different forms in each region.

(2) Scaling down of national scenarios

Therefore, in order to consider policies and their implementation for local governments, it is necessary to understand the diverse implications of national scenarios. Based on these understandings, people could craft robust policies and planning initiatives with the ideas presented in Section 6.5.1.

In the case that direct discussion from national level scenarios is difficult, it is possible to develop local scenarios based on conditions of local *satoyama* and *satoumi* considering the uncertainties presented for national scenarios. This is often known as a "scaling down" of scenarios and is the same process presented in the MA, in which sub-global assessments at local, national and regional scales were conducted simultaneously with global assessments. This can further be called the multi-scaling of scenarios.

The scaling down of scenarios follows basically the same process as that of national scenario development, which is discussed in Section 6.3.2. In this scale down process, stakeholders should discuss how direct and indirect drivers surrounding *satoyama* and *satoumi* would change, and how this, in turn, would change ecosystem services and human well-being. The results of discussions then can be organized into scenarios. Further, these can then be organized as municipal level scenarios, which can be used in policy-making at the local government level. Under these circumstances, it is useful to consider the following items:

- What kinds of changes and in which areas will occur under each scenario?
- Would that condition be favourable to the citizens or not?
- Would existing policy implementation effectively function to prevent that condition from happening?
- Would existing policy implementation effectively function to improve that condition?
- What new responses would be needed?

It should be noted that the approach suggested here is for qualitative scenario development. Qualitative scenarios enable us to embrace the various views and opinions of stakeholders within the scenario building process. However, this approach by itself is unable to provide us with any numerical information concerning how the future may unfold (Table 6.3). If such information is necessary for decision-making and/or planning, scenarios would need to be translated into quantitative information using simulation or other methodologies.

6.5.3 Scenario development at cluster levels

In the JSSA, some clusters made efforts to scale down national scenarios using the framework set up by the scenario working group. For example, the Kanto–Chubu cluster group developed the following scenarios (JSSA – Kanto–Chubu Cluster, 2010).

Megacity Society

A megacity society is the resulting society should the current urbanization trend continue. Continuation of globalization and integration will create enormous megacities in various regions. In such cities, to compensate for expensive energy costs, high-tech manufacturing would be utilized. There would be provisions to obtain resources from other regions and, therefore, large amounts of resources would be consumed by a megacity. Environments from which resources were obtained would be destroyed if large scale commercialized approaches are continued and the waste from these megacities would be a source of pollution that may even burden global ecosystems.

Biotope Restoration Society

A "Biotope Restoration Society" that has production activities based on the reproduction of the natural or semi-natural ecosystems as its core would be formed with the movement toward more natural communities. This is in contrast to urbanization. In this society, ecosystems are managed with respect toward the natural rhythm to further heighten their functions. Nature would be conserved and revitalized thoroughly. Note that globalization is the prerequisite for the formation of this society, and thus, the method of managing these ecosystems would not be unique for each region but would be globally uniform. Therefore, indigenous ecosystems may not necessarily be utilized and function adequately, and great increases in the number of alien species are expected.

Compact Recycle-Based Society

In contrast to urbanization, the "Compact Recycle-Based Society", which utilizes available local resources to its utmost, would be formed through the advancement of localization and scientific technologies. A compact society would strive for the self-sufficiency of resources and energy as much as possible. Thus, it would not rely on large amounts of imported resources from other regions. Therefore, reductions in the use of resources and recycling would be strongly promoted. Modern scientific technologies would be used in various areas of life and production activities, while respecting traditional techniques and indigenous products specific to each region. However, there would be limitations to the living conditions and resources provided by the ecosystems under limited areas, even with scientific technologies.

Satoyama–Satoumi *Renaissance Society*

Contrasted to urbanization up until now, "*Satoyama-Satoumi* Renaissance Society" with its roots in the local natural environment, would be achieved by conserving and restoring natural environments and advancing localization. In this society, resource and energy independence would be improved and the original functionalities of local ecosystems recovered through the restoration of natural and semi-natural ecosystems within the local environment and history. Therefore, life and production activities do not burden the environment and are well-suited to local environmental characteristics and capacity. This would require in essence a complete paradigm shift of values and lifestyles.

In the Kanto–Chubu cluster, it is expected that the properties of these four scenarios would unfold while formulating the mosaic structure of space and time. Further, both "Biotope Restoration Society" and "Compact Recycle-Based Society" are considered to be the transition period to "*Satoyama-Satoumi* Renaissance Society" in the long-term.

6.6 Conclusion

Scenarios are an effective tool for us to prepare for the uncertainties of the future and have been used for the policy-making related to global environmental issues, as well as in Japan. Scenarios were utilized in the

JSSA to assess the changes in economic and socio-political conditions surrounding *satoyama* and *satoumi*, their impacts on the use and management of *satoyama* and *satoumi* and on ecosystem services that exist within these landscapes and on changes in human well-being. The four JSSA scenarios, with an approximate time horizon of 2050, have been derived qualitatively and deductively with changes in socio-political/economic conditions (globalization – localization), people's attitudes and the preferred responses towards the natural environment (technology-oriented and transformation – nature-oriented and adaptation), as aspects of future uncertainties. In reality, it is unlikely that only one of these four scenarios actually comes to be. The real future would unfold as a combination of several or all four scenarios suggested here.

The primary roles of the national level scenarios developed in the JSSA were to present future images of *satoyama* and *satoumi* from long-term perspectives (considering the uncertainties surrounding them); raise awareness about potential issues and challenges; and at times, play a warning role. The audiences of these scenarios are government officials involved in policy-making and enforcement at national and local levels; the experts and researchers involved; the general public; and NPOs and NGOs that work together with or independently from the government. However, this is by no means the limitation of the role of Scenarios. At the national level, scenarios are beneficial for us to experience future changes surrounding *satoyama* and *satoumi*, their impacts, and help us prepare for future uncertainties in order to formulate robust policies and planning initiatives. National level scenarios are useful tools for discussing responses with national and local governments, as well as civil society, and become valuable when utilized. As a first step, the scaling down exercise of national scenarios would be effective in order to consider the regional variety of consequences that would take place at local settings.

Finally, future challenges include developing spatially explicit and quantitative methodologies to simulate the scenarios of changing *satoyama* and *satoumi* landscapes, considering alternative public policies and the views of different stakeholders. Such methodologies would provide us with detailed information concerning the possible future changes in *satoyama* and *satoumi* with a more explicit spatial component.

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7

Conclusion

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7.1 Introduction

This chapter takes stock of what has been achieved so far and what has not been accomplished adequately enough, in order to provide stakeholders with useful data and suggest actions for future consideration. The overarching goal of this assessment was to provide scientific credibility and policy-relevant information on the significance of the ecosystem services provided by *satoyama* and *satoumi*, as well as their contributions to economic and human development for use by policymakers. Therefore, this chapter draws on previous chapters in order to present the most important assessment findings, analyse whether or not user needs and questions have been addressed, and identify what progress has been made in providing answers to the questions asked in this assessment. To better synthesize these findings, they are organized around key questions and issues which might be of interest to readers.

Given that the JSSA exercise intended to enhance the capacity of stakeholders to undertake assessments and to act on their findings through the "learning by doing" approach, the chapter revisits the assessment process employed by the JSSA to reflect on the experiences and lessons learned through the course of the assessment work. The chapter further examines the gaps observed between the initial intentions and the results of the assessment, in order to identify the need (if any) for continued research, and data generation and collection. In addition, as one of the main objectives of the assessment was to feed into the policy processes of

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Japan and beyond, the chapter also explores the national and international processes related to the environment and development. Finally, the chapter outlines some implications and recommendations for enhancing the impact of the assessment on the actions of a variety of stakeholders.

7.2 Synthesis of the findings

7.2.1 Revisiting the concepts of satoyama *and* satoumi *landscapes*

Satoyama and *satoumi* have recently garnered increased attention due to raised awareness in Japan concerning the environment and its need for conservation and sustainable use, particularly the potential roles of their interactive mechanisms in biodiversity conservation, and cultural and community activities. However, numerous groups and individuals have attempted to define *satoyama* and *satoumi* for their own background and interests, and there is not a general consensus on the definitions and concepts of these terms among many Japanese scientists, stakeholders, groups and institutes.

This assessment attempts to provide a scientific definition of *satoyama* and *satoumi*, building on the past three years of discussions and resulting consensus among the participants of the JSSA, which includes more than 200 scientists, researchers, experts and stakeholders. Taking the ecosystem services approach developed by the Millennium Ecosystem Assessment (MA), the JSSA intended to define *satoyama* and *satoumi* landscapes by using international scientific language in a simple and comprehensive manner. At the same time, through extensive literature reviews, the JSSA attempted to include as many elements and components as possible. This not only allows the different spatial and temporal scales to be examined, but also enables an inclusive accounting of the specificity and diversity of *satoyama* and *satoumi* landscapes to take place. Given that diversity (e.g. diversity of ecosystem types, a variety of ecosystem services, different place-based management systems, biodiversity, etc.) is one of the most prominent features of *satoyama* and *satoumi* landscapes, this inclusive approach to the definition is important to avoid overgeneralization of the concept of *satoyama* and *satoumi* landscapes.

As presented in Chapter 2, the JSSA agreed on and defined *satoyama* and *satoumi* landscapes as a dynamic mosaic of managed socio-ecological systems, which produce a bundle of ecosystem services for human well-being. Although both include a mosaic of terrestrial and aquatic ecosystems, the group distinguished *satoyama* landscapes from *satoumi* landscapes by stating the former as being focused on forestry and agricultural ecosystems that constitute a planar mosaic of different land uses, while describing the latter as constituting a stereoscopic mosaic of different coastal ecosystems including fisheries. However, both landscapes are meant to be natural resource management systems that incorporate traditional knowledge through which biodiversity is maintained as a key to the resilience and functioning of these landscapes. It is also suggested that an integrated view of these two types of landscapes can contribute to their sustainable management, given the consecutiveness and interactive relationships between them within certain local settings.

Despite the agreed conceptualization of *satoyama* and *satoumi*, the JSSA highlighted the difficulties in specifying their distribution. However, regardless of the challenges in estimating the land area of *satoyama* (due to the different definitions adopted by past studies, the unclear borders of landscapes and the lack of suitable information), several studies show that in general, *satoyama* landscapes comprise approximately 40 per cent of Japan's total landmass, although approximately 20 per cent of land in Japan is classified as secondary forest. However, there have been no attempts to estimate the land area of *satoumi* landscapes. This is mainly attributed to the absence of an established definition with regard to spatial elements and/or ranges of such landscapes. Therefore, a quantitatively scalable definition and more refined typology of *satoumi* are needed to allow future assessments, monitoring, and longitudinal studies to ensure their conservation and sustainable management.

Applying the MA conceptual framework with a focus on the features of *satoyama* and *satoumi* landscapes, the JSSA developed a slightly modified conceptual framework for its own assessment on these landscapes. Given that different types of ecosystems are pooled in a mosaic manner to produce a bundle of ecosystem services, it captures both *satoyama* and *satoumi* as entities playing a key role as a source for ecosystem services. Further, the JSSA highlights the interlinkages related to these landscapes, as the ultimate impacts on human well-being depend on the process of the interlinkages among different elements and components within *satoyama* and *satoumi*. The four types of interlinkages are explicitly built into the conceptual framework, and include those between different ecosystem services, those between ecosystem services and human well-being components, those between different time and spatial scales, and those between different policy options.

One of the examples for the uptake of this conceptual development is the development of the concept known as the "*Satoyama* Initiative". This initiative is an international effort facilitated by the Ministry of the Environment, Japan and the United Nations University Institute of Advanced Studies to promote the maintenance and revitalization of socio-ecological production landscapes – a part of which are *satoyama* and *satoumi* landscapes in Japan – to achieve societies in harmony with nature, building on positive human–nature relationships. Through this initiative, an international partnership was established in October, 2010 at the Tenth Meeting of the Conference of Parties (COP) to the Convention on Biological Diversity, among different institutes and groups, who are engaged in the conservation, management, and sustainable use of such landscapes. This international partnership is to carry out various activities identified by the Initiative and to enhance and ensure the synergies and cooperation among their activities through their knowledge, information sharing, and interactions. As an international effort, the Initiative deals with various types of socio-ecological production landscapes around the world and the JSSA has provided a scientific definition of *satoyama* and *satoumi* landscapes to be used as a base for doing so. Nevertheless, given that the current concept has been developed on the basis of Japanese landscapes and has not been contested by a wide range of scientists, experts and stakeholders worldwide, it is hoped that the definitions and concept of Japanese *satoyama* and *satoumi* landscapes can be further elaborated and developed throughout the course of international processes and cooperation, such as the *Satoyama* Initiative.

7.2.2 How have changes in satoyama *and* satoumi *landscapes affected human well-being?*

Over the past 50 years, the quality and quantity of the ecosystem services derived from *satoyama* and *satoumi* landscapes for human well-being have changed dramatically. The changes described in Chapter 4 indicate some negative and direct impacts, particularly on the human well-being of local communities where *satoyama* and *satoumi* landscapes exist. These include, for example, a decline in health (by pollution etc.) and in good social relations within local communities, while the general population in Japan has benefited from ecosystem services from other parts of the world through global trade. In addition to a gap in human well-being between rural and urban dwellers, there are some suggestions that impacts of current changes in *satoyama* and *satoumi* will affect future generations' well-being.

The woodlands in *satoyama* landscapes played a role in providing energy for people in Japan through the provision of charcoal and firewood until the 1960s. As energy is a base for many human activities and livelihoods, *satoyama* landscapes used to contribute to the basic materials for human well-being. During the period between the 1930s and the 1950s, however, the overexploitation of firewood from *satoyama* resulted in a decline in some regulating services, such as flood control and soil erosion control. Particularly in the areas adjacent to cities in the Kanto region and the Tokai, Kinki and Chugoku regions (which were expected to provide a massive amount of energy for large cities nearby), several deforested mountains emerged in some areas and consequently such areas further saw declines in flood control and runoff regulating services (Chapter 4).

The agro-ecosystems of *satoyama* landscapes provide food such as rice and vegetables, etc. for the people of Japan, and their productivity has increased due to agricultural infrastructure improvements, and the use of chemical fertilizers and pesticides. This has enhanced human well-being in general, including that of urban populations. However, at the same time, there have been negative impacts on biodiversity and regulating and supporting services. For instance, the fertilizer injected into agricultural land and the nitrogen mixed within livestock excrement dissolves in water and transfers to both soil and groundwater. This degrades the local environment and further extends to impact on downstream environments. These trends have continued until very recently, as agriculture in the past had a substantial focus on productivity for economic markets. Nowadays, the quality and added value of the products obtained through environmentally friendly agriculture are appreciated and have further been promoted since the 1990s.

Since the 1960s, the demand for provisioning services from *satoyama* in Japan has decreased due to the energy and fertilizer revolution (as well as global trade) and as such, ecosystem services have been replaced by oil, chemical fertilizers and cheaper imports from abroad. The security of resource access, basic materials and health of human well-being have been maintained by the ecosystem services derived from other parts of the world, as well as improved technologies and artificial systems. However, the decrease in the human use of some ecosystem services (e.g. underbrush and fallen leaves for fertilizers, firewood for energy, etc.) has led to changes in ecosystem functions and their biota. In addition, due to the shrinking and ageing of the population, local communities' management ability has decreased. In such communities, agricultural products are often damaged by wild animals that have expanded their habitats due to the disappearance of the mosaic in the landscape. Due to these changes in the ecosystems and a weakened ability to help other local communities, abandoned *satoyama* landscapes face higher risks of natural disasters, such as flood and soil erosion, which might particularly affect the local population. In addition, given the time lag between these continuous changes and the future results of such changes in these ecosystems, the human well-being of future generations might be affected more by the present generations' actions.

In *satoumi* areas, the reclamation of coastal zones provided essential space for industry, particularly during the period of rapid economic development (between the mid 1950s to early 1970s), which contributed to the improvement of human well-being. However, such industrialization in coastal zones led to water pollution and the emergence of dead zones (i.e. oxygen-deficient water, particularly in enclosed coastal seas such as the Seto Inland Sea and Tokyo Bay). This resulted in a decrease in the number of fish and algae populations and negatively impacted well-being, particularly in local communities. Further, the shift from fish exploitation to fish breeding may have maintained fish production for the country, but increased the accumulation of sludge and the emergence of red tides.

Furthermore, the above changes within *satoyama* and *satoumi* landscapes have undermined the cultural services that are derived from them, subsequently affecting local populations and causing the collapse of communities. First, the disappearance of *satoyama* and *satoumi* landscapes due to urbanization, particularly in the period of rapid economic development, has led to a decline in the physical and spiritual health of humans in those areas (Chapter 4). Also, the traditional management practices of local communities (as represented by "*Iriai*"), enabled local communities to equitably and sensibly use the natural resources needed for their livelihoods (Chapter 4). However, people who have become less dependent on their localities tend to become detached from their local environment, further losing the incentive to share and maintain resources within their communities. As a result, social relations within these communities have weakened and are declining.

However, over the past decade, an increasing proportion of the population and in particular, urban dwellers have come to enjoy and prefer high value-added products gained through labour-intensive farming, forestry and fishery from within *satoyama* and *satoumi* landscapes. They have further become actively involved in nature observation, environmental education, eco-tourism and conservation activities. Following this trend, however, are emerging problems such as the increased amount of waste, the inappropriate harvest of precious species and the introduction of invasive species which have accompanied the increased number of visitors to *satoyama* landscapes.

7.2.3 What are the main drivers of changes that affect satoyama *and* satoumi *landscapes?*

The assessment highlighted that all ecosystem types in *satoyama* and *satoumi* landscapes, with the exception of forest ecosystems, have been in a state of decline over the past 50 years. The main direct driver of ecosystem losses is land use change, which includes urbanization and abandonment, while damage in coastal ecosystems also occurs through climate change, which particularly affects coral reefs. In addition, grasslands have particularly decreased due to natural succession, which results from their underuse.

Following the MA, the JSSA in Chapter 3 examined two types of conditions and trends in ecosystem services, which included "increase or decrease in human use" and "enhanced or degraded ecosystem services". This revealed, for example, that timber as a provisioning service from *satoyama* has been "enhanced", although the human use of it (along with charcoal and firewood) has decreased. This timber enhancement is due to low exploitation rates, which are mainly attributable to cheaper imports, as well as Japan's afforestation policy. Taking the example of the enhanced ecosystem service of timber, the statistics show an increase in the volume of forestry from 1,887 million m^3 in 1966 to 4,432 million m^3 in 2007 (Chapter 3). The provision of agricultural products from *satoyama* has remained the same because of counter balancing of productivity increases due to chemical fertilizer and pesticide use with the decrease in agro-ecosystem area due to land use changes. Despite this trend, however, agricultural products as a provisioning service from *satoyama* have slightly decreased in terms of human use, mainly due to the availability of cheaper agricultural products imported from abroad.

The underuse of many of the ecosystems within *satoyama* has reduced the quality of numerous ecosystem services, including provisioning, regulating and cultural services. For instance, the distribution of the Sika deer species has saliently expanded over the past 20–30 years. This runs parallel to the lack of human intervention as typified by the decrease in the population of hunters, resulting in the destruction of vegetation and the loss of biodiversity (Chapter 3). Further, it has been identified that the abandonment of cultivation and the poor management of expansive afforestation areas can cause serious soil erosion (Chapter 3). Therefore, although the increase in timber may possibly imply an increase in climate regulation and air purification, the actual contribution of this timber increase toward regulating services is questionable.

Cultural services have declined due to many factors including urbanization, technological advancement, the collapse of local communities, land use change and underuse. For example, the decreased number of people who are engaged in traditional and cultural practices, such as traditional craft making, community waterway management and classical grassland management, has made the inheritance of traditional ecological knowledge from generation to generation difficult. However, people have recently begun to realize that the cultural services of *satoyama* and *satoumi* landscapes are unique and original to Japan, and as a result, cannot be compensated by other artificial systems or imports from abroad. In this regard, the cultural services of *satoyama* and *satoumi* landscapes have become "re-appreciated" particularly by urban dwellers who strive to seek the spirits of nature.

The level of biodiversity in Japan, in terms of species diversity has declined over the past few decades. The main drivers of this decline include land use change, the introduction of invasive species and climate change. The level of biodiversity in Japan is still higher than many other industrialized countries (mainly due to its geographical characteristics as an island) with rich endemic species found nationwide and untouched mountain ecosystems still in existence. In particular, *satoyama* and *satoumi* landscapes have maintained high levels of biodiversity through continuous management activities. The typical examples of rich biodiversity in those landscapes include: forest floor plants and their associated insects in broad-leaved fuel-wood forests within warm-temperature zones; grassland plant species and insects specifically living in managed, semi-natural grasslands; and lentic freshwater fish and aquatic insects unique to the ecotones in and around paddy fields. However, many species unique to the paddy fields, semi-natural grasslands and broadleaved forests within *satoyama* landscapes face extinction due to the disappearance of the mosaic structure and overgrowth. This suggests that biodiversity levels may also be related to management competencies, particularly concerning paddy field environments and unique species that depend on wetlands. In *satoumi* landscapes, which are more vulnerable to climate change, there have been changes in the types of species observed in those areas, although the change in the level of biodiversity is unclear.

7.2.4 Have the current responses been useful?

The Response Analysis presented in Chapter 5 shows that the recent development of responses in Japan has significantly contributed to addressing *satoyama* and *satoumi* landscape issues. It also reveals, however, that there are certain areas in which these responses have not made sufficient impacts, such as economic incentives for the management of landscapes, the governance of different stakeholders and the management of trade-offs.

Until the 1980s, many legal systems were focused on development and industrialization, which sometimes led to the urbanization of *satoyama* landscapes. Although some legal systems aimed at preserving the landscape in urban regions (such as the City Park Law and Urban Green Space Conservation Law) were enacted, they were not able to sufficiently address *satoyama* specific issues, such as rural-urban migration, abandonment of cultivation practices, and relinquishment of land ownership. However, following the Rio Earth Summit in 1992, as well as being influenced by the CBD and other international conventions, many new legal responses (such as the Environmental Impact Assessment Law, Law for the Promotion of Nature Restoration and Landscape Law) were established to promote and enhance the conservation and sustainable use of ecosystems. At the same time, the existing legal responses of the past 30 years have shifted their focus from development to the conservation and sustainable management of ecosystems and biodiversity. In particular, the Basic Act on Biodiversity (2008) clearly indicates *satoyama* landscapes as a target for long term conservation. Although individual laws were used to address issues within specific sectors and/or certain ecosystems, the establishment of this new act has contributed to enhancing the cross-sectoral management of *satoyama* landscapes encompassing various types of ecosystems. Similarly, the establishment of the Basic Act on Ocean Policy (2007) facilitates the conservation and sustainable management of *satoumi* landscapes, as it encourages integrated coastal zone management and further identifies *satoumi* as a target for biodiversity conservation and sustainable management. Nevertheless, as is critically pointed out in the Basic Environmental Plan (revised in 2006), there is no system for the design and evaluation of environment-related responses with cross-sector-wide perspectives. Neither is there a specialized agency, which broadly coordinates across the different sectors for environmental conservation at a level superior to the ministries and agencies.

Although there has been no law specifically aimed at ensuring the integrated management of *satoyama* and *satoumi* landscapes, an increasing number of local ordinances and strategies have been enacted to address these issues at the local level. The Act on Promotion of Decentralization Reform (1995) has enlarged the authority of local governments to establish their policy, strategies and ordinances in accordance with their localities. This has enabled local governments to make more effort in addressing specific issues (e.g. animal disasters) with greater care and the increased participation of local stakeholders. Particularly since 2000, several local governments (e.g. Kochi City, Chiba Prefecture, Kanagawa Prefecture, etc.) have established ordinances with a specific focus on *satoyama* landscapes, often taking an integrated approach to the different sectors and promoting participatory governance or management. Additionally, in accordance with the Basic Act on Biodiversity (2008), an increasing number of local governments have recently developed their local biodiversity strategies, for which a participatory approach has been taken to better reflect local specificities and needs.

The assessment on economic responses suggests that although many have been recently developed, they have not been as successful as legal responses. This is mainly because current society does not attach much economic interest to *satoyama* and *satoumi* landscapes, which is mostly due to declines in domestic agriculture, forestry and fishery products. However, given that *satoyama* and *satoumi* landscapes also provide non-material services, the potential to further develop economic responses which can make greater impact in addressing these issues still exists. In fact, as a response to citizen demand, incentive mechanisms regarding payment for the ecosystem services derived from *satoyama* and *satoumi* are in the process of being implemented. For instance, urban populations have contributed to the management of *satoyama* landscapes through the rice terrace owner system, which encourages urban dwellers to provide financial support for the management of rice terraces; the forest environment tax is collected from citizens located downstream from water sources for the maintenance of the water source forests; and the offset credit system, such as the Japanese Verified Emission Reduction Scheme, is used to offset GHG emissions from the areas having difficulties reducing them by purchasing emission reduction and absorption quantities in addition to voluntary efforts to reduce GHG emissions. In addition, the direct payment policy, which does not promote the excessive use of ecosystem services and has a smaller trade-distorting impact, is suitable for managing the *satoyama* landscapes in which agricultural and forestry production capacities are hindered. These economic responses are expected to be further developed and mainstreamed. In addition, the economic analysis in the JSSA suggests the importance of having both accurate information and sufficient levels of knowledge to appropriately link producers with the users of ecosystem services, for instance, through certification systems and/or other means.

Although the recent development of policy responses mentioned above encompasses differing ecosystems, relevant activities and numerous stakeholders, it is hoped that they will gain the critical mass needed for creating synergies and avoiding trade-offs among different response options. It would also be important to incorporate the participatory process in policy development, paying stronger attention to local specificities and needs. To achieve a more beneficial participatory approach, the capacity building of stakeholders is needed. This can be accomplished through the training of trainers or local leaders, as well as education and raising awareness of the issues. Further, given the current development of science and technology, it would also be useful to enhance innovations concerning the technical aspects of responses (including technological advancement, improvement of communications and development of incentive mechanisms, etc.).

7.2.5 What is the future of satoyama *and* satoumi*?*

Chapter 6 presents four scenarios developed by the JSSA to explore plausible futures for *satoyama* and *satoumi* landscapes and human well-being to 2050. Seeing that the basic conditions which influence these landscapes include the trends of the decreasing and ageing of the population, as well as the national response to climate change issues, the JSSA group identified two major uncertainties: 1) socio-economic development paths, and 2) people's approaches to *satoyama* and *satoumi* landscapes. The scenario exercise also explored two socio-economic development paths: one in which the Japanese economy, as well as society, become globalized and the other in which they become localized. It also explored two different approaches to *satoyama* and *satoumi* landscapes: one in which people's behaviour and actions are nature oriented and the other in which they are technology oriented. Although scenarios are not intended to show the predicted futures of these landscapes, it is hoped that they can be used as a tool for examining the policy options given for possible and plausible futures. Seeing the future development paths and people's approaches as key uncertainties, the four scenarios were developed in a deductive and qualitative manner.

1) Global Environment Citizens

This scenario represents the *satoyama* and *satoumi* landscapes that include enhanced sustainable use and management under a globally-connected world, which focuses on global trade, globalized labour markets, economic liberalization and a "green economy". Although domestic consumption slightly decreases following population decline, the human use of provisioning services increases due to the increased exports of food and the enlarged use of biomass and renewable energy. This leads to an improvement in the regulating and cultural services of *satoyama* and *satoumi* landscapes. In addition to larger investments in education, welfare, social relations and the environment, the participatory approach is strongly employed for ecosystem management.

2) Global Technotopia

This scenario depicts the *satoyama* and *satoumi* landscapes that depend highly on technological advancement, including the development of high-tech ecosystem management, and the creation of engineered and artificial ecosystems. Global trade and economic liberalization facilitate both an acceleration of productivity and an enlargement of agriculture, forestry and fisheries management. This results in the decline of regulating and cultural services due to increased pressure on ecosystems. The central government focuses on technological development, but pays less attention to education, welfare and social relations.

3) Techno Introvert

In this scenario, *satoyama* and *satoumi* landscapes are disconnected from urban areas in terms of the movement of people, goods and services, choosing instead to rely on science and technology (including ICT), which also provides links between urban and rural areas of the country. Artificial cultivation and engineered aqua-farming enable productivity to rise under the protection of domestic agriculture, forestry and fisheries. However, this leads to a decrease in the human use of the ecosystems in *satoyama* and *satoumi* landscapes, and further results in the decline of their regulating and cultural services.

4) Satoyama-Satoumi *Renaissance*

In this scenario, *satoyama* and *satoumi* landscapes are the focus of political, economic and social activities. The participatory process of policy-making is further encouraged, and local institutions are strengthened through the increased attention given to the environment and green economy. Under the policy to protect and promote agriculture, forestry and fisheries within the country, the provisioning services of *satoyama* and *satoumi* landscapes are enhanced in a sustainable manner due to increases in local consumption and the use of biomass and renewable energy. This leads to an improvement in regulating and cultural services that can be managed by increased local populations. This scenario however, will depend on a strategy of subsidies involving higher economic costs to society in the form of lower levels of material wealth.

It should be understood that there is difficulty analysing the condition and trends of biodiversity under each scenario. This is due to a lack of adequately developed methods of analysis. However, based on several assumptions (some of which include an increase in invasive species in accordance with globalization; and the decline in biodiversity following both changes in the landscape due to the acquisition of ecosystem services and population concentration to urban areas), the level of biodiversity will be highest in the *Satoyama-Satoumi* Renaissance scenario, and is followed by the Global Environment Citizens, Techno Introvert, and then Global Technotopia scenarios.

These scenarios are expected to raise awareness on the threats, opportunities and challenges of future *satoyama* and *satoumi* landscapes with regard to uncertainties. They are also to be used by stakeholders to examine and develop policies, plans and strategies to prepare for the future. Further, the framework established through scenario development at the national level is to be used to develop scenarios at the local and regional scales throughout the country, with the emphasis on local specificities and needs so as to develop appropriate local and regional policy options.

7.3 Lessons learned

The assessment process that followed the MA approach has produced synthesized findings for policy and decision-makers in Japan, which are basically comparable to the global findings on the conditions and trends of ecosystem services, scenarios and response options. In addition, and perhaps more importantly, it has brought in substantive reflections, as well as practical lessons for the Sub-global Assessment (SGA) type assessments, based on the dynamic assessment process in the Japanese local setting. Some of the reflections on dealing with local landscapes, which might be applicable for other SGAs, include:

- Given that key interlinkages exist within a landscape and between landscapes (also related to the trade-offs of policy options), *satoyama* and *satoumi* landscapes would need to be treated as a coupled human-environment system to deepen the understanding of a variety of different factors including social, cultural, ecological, economic and political components.
- As the cultural aspects of *satoyama* and *satoumi* landscapes are highlighted as a unique, important and scarce contribution to society, their valuation is needed so as to return and secure the benefits for local communities, further providing added value to society at large.
- As the causes and effects of the problems concerning local and regional *satoyama* and *satoumi* landscapes go beyond Japan (e.g. the dependency on cheaper imports leading to their underuse), the international movement of ecosystem services should be dealt with, and international action taken to address the issues.
- Sustainability also needs to be considered by bringing together all the social, economic, cultural and ecological dimensions of coupled socio-ecological systems to examine the interlinkages (i.e. trade-offs and synergies) among them, as such systems are dynamic, evolutionary and interlinked.
- As the SGAs were an experiment in applying the MA conceptual framework, the assessment process of the JSSA provided a rich learning experience for the stakeholders involved in the process. Given that the merits were verified in the multiscale assessments' efforts in the MA (Millennium Ecosystem Assessment, 2005), the iterative and bottom-up approach employed by the JSSA enhanced capacity during the course of the assessment in which a number of changes and modifications had to be made in accordance with users' needs and the dynamic nature of *satoyama* and *satoumi* landscapes. Indeed, some tensions arose between the desire to follow top-down and prescribed guidelines and the mission to meet various users' needs and local/regional specificities. This process, however, provided some practical lessons for future assessment work which include: 1) identifying a scale that is relevant to users/stakeholders for better impact and use of the assessment findings for decision-making and policy-making; and 2) defining an assessment scale in accordance with the natural and climatic conditions of conducting the scientific assessment. Although this assessment employs the clustering process, which follows the socio-economic component and the ecological and climate component, the scale in

some of the clusters was not very relevant to either the social or ecological scale. The gap between the social and ecological scales needs to be considered when determining assessment scales.

- The use of different knowledge systems including Western science and Japanese local and traditional knowledge can create a valuable epistemic community of scholars. Here, it is also important to communicate well with the different stakeholders, who have varying knowledge systems. In this regard, the MA conceptual framework has been a prominent platform for this type of communication. The experience of the experts who were involved in the MA exercise was also a key ingredient for designing the JSSA in a community where this MA-type assessment is the first of its kind. In fact, significant efforts have been made by many of the stakeholders/users to understand the basic concepts such as ecosystem services, assessment and human well-being, etc. used in the JSSA. As a result, the assessment process definitely deepened their understanding, which was fundamentally important to move ahead with and complete the assessment work.
- Securing an adequate budget, as well as time and human resources was essential to maintaining the momentum developed around the SGA initiative and to completing the assessment, as demonstrated in the MA SGAs (Millennium Ecosystem Assessment, 2005), while the assessment process needed further adjustment as a result of broad consultations with a wide range of stakeholders in Japan. The JSSA in its early stage was scaled up in its scope from a prefectural level assessment to a multiscale assessment, which further included national and regional levels. However, it was difficult to secure adequate funds early in the process, and this affected the availability of the time and human resources needed, which ultimately had impacts on the quality of assessments.
- The interactive process, in which a variety of stakeholders from different backgrounds, disciplines and sectors communicate and exchange their views, can provide a useful network and sometimes bring in a new actor or activity during the course of assessment. Significant efforts and time are needed to engage users and stakeholders, but it is an important and necessary step for developing new momentum and thinking around the ecosystem services approach.

7.4 Information gaps and research needs

The JSSA responded to many questions through assessing the best available knowledge on the ecosystem services derived from *satoyama* and *satoumi* landscapes, with the aims of providing a state-of-the-art scientific appraisal of the condition and trends of these landscapes and their services, and further providing a scientific basis for action to conserve and sustainably use them. Additionally, the assessment process also identified information and data gaps, as well as research needs. The knowledge and information gaps identified are listed below:

- The assessment shows the important role of human interaction with nature in maintaining and managing the ecosystems of *satoyama* and *satoumi* landscapes and in sustaining the benefits derived from them for human well-being, by proving that their underuse is one of the major drivers for the decline in their ecosystem services and biodiversity, particularly those derived from *satoyama* landscapes. However, it has remained unclear as to what extent humans should intervene in these ecosystems to maintain biodiversity and maximize the ecosystem services that can undergo natural succession. Given that the current knowledge is insufficient to respond to this question, new knowledge, information and data are expected to be brought in. Some quantitative methods would be useful in specifying the level of human interaction needed for the sustainable use and management of biodiversity in *satoyama* and *satoumi* landscapes. Also, adaptive management may be an effective tool to facilitate the learning process, where continuous monitoring and feedback enable us to manage the landscapes through reducing uncertainty and at the same time, maximizing ecosystem services from the landscapes.
- The newly developed conceptual framework includes the interlinkages between *satoyama* and *satoumi* in terms of ecosystem services, human well-being, time and scale, and policies. However, it is unclear as to what extent the ecosystem services from *satoyama* landscapes are interlinked with those from *satoumi* landscapes, and vice versa. As fewer studies on *satoumi* are given in this assessment, it is hoped that future assessments can pay more attention to *satoumi* and its connection to *satoyama* landscapes, so as to provide further scientific linkages between the two.
- Although the JSSA has been able to the conceptualize *satoyama* and *satoumi* landscapes as a coupled socio-ecological system, given the lack of a quantitatively scalable definition or typology of these landscapes, this assessment has not been able to fully specified the distribution of these landscapes. In order to allow future monitoring and longitudinal studies for the conservation and management of such coupled systems, there is a need to conduct a more spatially explicit assessment in relation to local and regional scales (i.e. substantively linking with the finer scales), as well as social and biophysical factors.
- The economic analysis, including the economic valuation of ecosystem services from *satoyama* and *satoumi* landscapes, is a very small part of this assessment. The reasons for this include the limitation of data and information on economic analysis, particularly in the areas of *satoyama* and *satoumi* landscapes, and the lack of expertise, capacity and re-

sources (including financial and human resources) to conduct economic valuations. As economic analysis is a powerful tool to convince policy- and decision-makers of the economic value of *satoyama* and *satoumi* landscapes, and to evaluate the trade-offs with conventional development strategies, and mainstream ecosystem services into development and economic decision-making, it is expected that future assessments will include more economic analysis, and in particular, the valuation of regulating and cultural services.

- There is an unbalanced proportion concerning the social and natural sciences within the assessment, as it is limited in the citations from social science studies. One of the reasons for this gap is the inclusion of a much smaller group of experts and researchers from the social sciences, with the majority of the assessment team being ecologists. However, given that social, cultural and political aspects are the key to issues within *satoyama* and *satoumi* landscapes, it is important to assess how different social groups perceive and understand these landscapes, what feedback signals have been transmitted from urban populations to rural ones (and vice versa), and how adaptation has proceeded at the local community level in accordance with the changes in ecosystems and their services.
- Although the scenario development in this assessment provides qualitative storylines, upon which stakeholders can examine policy options depending on their needs, the scenarios are not able to fully and specifically depict the possible changes in ecosystem services, biodiversity and human well-being in the future, as the purely qualitative nature of scenarios did not allow us to do so. Building on the qualitative scenarios developed in this assessment, quantitative scenarios are expected to be developed if more time and resources are allocated for data collection and modelling, so that they can offer more detail on the possible changes in ecosystem services and human well-being. Further, given that the cluster assessments have provided detailed data and information as a baseline, it would be important to develop longitudinal research studies to explore the future of *satoyama* and *satoumi* landscapes in more detail. This would then provide better policy options for stakeholders at the local, regional and national levels.
- Some observations on policy options are made basically through the typological analysis of responses. However, the findings of these response assessments need to be tested through developed scenarios, so as to provide policy options for users. Quantitative scenarios which allow the in-depth examination of the impact of each policy option under different scenarios would help recommend policy options.
- The JSSA has evolved into a multiscale assessment which includes cluster assessments, as well as a national assessment. Although the standalone report for each cluster and the national report (which includes

the cluster assessment findings) have been produced, not much comparison between the clusters and across the scales has been made due to the constraints of time, human and financial resources. In addition, the open process and bottom-up approach used in developing the JSSA led to the selection of a variety of assessment sites grouped into clusters, but did not provide comprehensive national coverage of all ecosystem types and geographical areas concerning *satoyama* and *satoumi* landscapes in Japan. Therefore, the methods and approach for a better and more comprehensive multiscale assessment should be further explored in future assessment work.

Based on some of the above information and knowledge gaps, a new research project was initiated in April 2009 with the support of the Environment Research and Technology Development Fund of the Ministry of the Environment of Japan. This three year research project (2009–2011) builds on the JSSA and aims to conduct a quantitative assessment of the ecosystem services derived from *satoyama* and *satoumi* landscapes, as well as further develop scenarios which include key quantitative data and information needed to provide specific policy options for building a sustainable society in Japan. Similar to the JSSA, it focuses on the management of ecosystem services derived from *satoyama* and *satoumi* landscapes in Japan but with an emphasis on land use, ecological conservation, biomass, and resource recycling. Applying the MA conceptual framework, it intends to assess the drivers of changes in ecosystem services and their impacts on human well-being, and to further demonstrate the extent to which human interventions are required to optimize ecosystem services without losing biodiversity in these landscapes. The study will develop scenarios to explore Japan's plausible futures by using both a qualitative typology of local societies and key quantitative data and information related to land use, population and industry. Finally, it will seek to define a role for *satoyama* and *satoumi* landscapes as a new form of commons, which can be a system or institution for natural resource utilization beyond the boundary conditions of existing property rights and use rights. As such, this is to identify policy options which will feed into the implementation of the Strategy for an Environmental Nation in the 21st Century, where the Japanese government proposes three types of societies (i.e. low-carbon society, recycling society and nature-harmonious society) to be integrated to achieve a sustainable society.

7.5 Contributions to national and international processes

The JSSA assessment is to inform decision and policymaking on the environment and development by providing scientifically credible information with a focus on the *satoyama* and *satoumi* landscapes of Japan. Therefore, the assessment's findings are expected to feed into national and international processes, impacting decision-making at all levels. Also, in order to ensure that the findings are transmitted and communicated efficiently, it is critical to identify mechanisms and/or ways of communicating with the stakeholders concerning the findings, in order to have maximum impact on their decisions and actions. This section explores how the JSSA can contribute to environment and development policy processes at both the national and international levels.

Some of the potential contributions to national processes include:

- The Japanese government promulgated in 2007 "Japan's Strategy for a Sustainable Society" to facilitate building a sustainable society through integrating the respective efforts to create a low-carbon society, a resource-circulating society and a nature-harmonious society. Japan has made great progress in achieving a resource-circulating society and has gone through much active discussion concerning the creation of a low-carbon society in the contexts of the United Nations Framework Convention on Climate Change (UNFCCC) and the 3R Initiative. However, there have been far less sufficient efforts made in creating a nature-harmonious society as most of the work is limited to specific nature conservation and revitalization programmes. Given that the JSSA has examined the coupled human-environment system by using the case of *satoyama* and *satoumi* landscapes, it can contribute to this strategy through providing scientific credibility, and facilitating discussion on a nature-harmonious society in relation to the two other societal visions.
- The latest National Biodiversity Strategy of Japan, promulgated in 2010 in accordance with the CBD, continues to highlight the degradation of *satoyama* due to the insufficient level of management – one of the major four crises of biodiversity in Japan – and also promotes maximizing ecosystem services while enriching biodiversity on a sustainable basis. The major outcome of the JSSA (i.e. improved understanding on the relationship between *satoyama* and *satoumi* landscapes concerning biodiversity, ecosystem services and human well-being; the credible baselines of key ecosystem services from those landscapes; the possible futures of ecosystem services derived from the landscapes, etc.) can provide a scientific basis for the biodiversity strategy and further contribute to promoting and enhancing the implementation of the strategy.
- The JSSA scenarios have shown possible future trends in the ecosystem services derived from *satoyama* and *satoumi* landscapes, as well as human well-being under four types of plausible futures at the national level to some extent. However, the study did not capture the trends either quantitatively or on finer scales. This can contribute to national

land planning by providing a framework for exploring the future of these landscapes.

Some of the potential contributions to international processes include:

- As mentioned above, the *Satoyama* Initiative works toward the development of societies that are in harmony with nature in the international context; its international partnership was launched at the CBD/COP10 to contribute to achieving the CBD's objectives. As the concept and definitions of *satoyama* and *satoumi* landscapes developed by the JSSA have been used in developing the concept used by the *Satoyama* Initiative, the findings of the JSSA will have a two-fold purpose: 1) to be further utilized in promoting the Initiative, and 2) to contribute towards the achievement of the CBD's goals. At the same time, the concept of *satoyama* and *satoumi* landscapes should be contested and further developed through networking and discussion among stakeholders worldwide. In terms of the implementation of the JSSA's findings at various levels, it is important to share information and knowledge on similar landscapes and to encourage cooperation and synergies among all the relevant activities and initiatives. In this sense, it is hoped that the partnership launched by the *Satoyama* Initiative will be a platform where various stakeholders unite their efforts in developing a common strategy, as well as implementing training and capacity building activities.
- Given that the JSSA follows the approach and methodologies developed by the MA sub-global assessments, it is expected that it will be compared with other local, national, and regional assessments (including global findings), to further contribute to global assessments. Since the completion of the MA in 2005, many follow-up activities have been carried out, and as a part of this global MA follow-up process, the sub-global assessment follow-up has been initiated. This SGA follow-up aims to ensure that the lessons learned through the MA experience are applied in a wider set of contexts to harmonize and synergize sub-global efforts and initiatives; to catalyze new assessment work, especially in areas not well covered by the MA; and to mobilize the resources and capacities needed to achieve them. As the SGA network has been evolving to include the original MA SGAs and newly emerging SGAs like that in Japan, it is hoped that JSSA experience and lessons learned can be shared and utilized in the assessments from other parts of the world.
- Further, following up the outcomes of the MA, the establishment of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) that is similar to the Intergovernmental Panel on Climate Change (IPCC) has been discussed by a variety of stakeholders at the international level. The final Ad Hoc Intergovernmental and Multi-stakeholder Meeting on the forming of an IPBES,

which was held in June 2010 in Busan, Republic of Korea, adopted the "Busan Outcome" wherein the delegates agreed, among others, that an IPBES should be established to strengthen the science-policy interface for biodiversity and ecosystem services and that it should be scientifically independent and provide policy-relevant information. It is hoped that the findings, capacity and expertise developed by the JSSA can contribute to both the future and possible new forms of assessments undertaken by IPBES either directly and/or indirectly.

- Since 2002, the UN Food and Agricultural Organization (FAO) has promoted an initiative for the conservation and adaptive management of Globally Important Agricultural Heritage Systems (GIAHS) with the aim of establishing a basis for the international recognition, dynamic conservation and adaptive management of GIAHS and their agricultural biodiversity, knowledge systems, food, and livelihood security and cultures around the world. As the JSSA assesses *satoyama* and *satoumi* landscapes that are recognized as facilitating dynamic human-environment relationships, in which human dependence on ecosystem services varies across different time and spatial scales, the GIAHS designation places a similar emphasis on the dynamic conservation and adaptive management of agro-ecosystems. Therefore, the state-of-the-art scientific appraisal of such systems in Japan, provided by the JSSA, can also inform the GIAHS initiative, and it is hoped that both information exchange and cooperation between the *Satoyama* Initiative and the GIAHS will ensure that the assessment findings of the JSSA can be of use for such an international effort.

In addition, the conservation and sustainable use of ecosystems and biodiversity (for which the JSSA is intended to provide a scientific basis for action through the assessment of Japanese *satoyama* and *satoumi* landscapes), is key to making sustainable development and high human well-being a general reality. Hence, the place-based findings of the JSSA can also contribute broadly to numerous multilateral processes which enshrine various elements of the conservation and sustainable use practices found in *satoyama* and *satoumi* landscapes. Therefore, all the processes on sustainable development (such as the Rio Agenda, the WSSD and the Rio+20), multilateral environmental agreements (such as the CBD, the Ramsar Convention and the Convention on Migratory Species) and initiatives on the preservation of culture (such as the UNESCO World Heritage Convention) can be informed by the JSSA.

7.6 Conclusions

The JSSA is an experimental exercise for Japanese society that includes local scientists, policymakers, practitioners and many others. By providing a platform to translate scientific knowledge into policy and relevant actions at the local and national levels, it has addressed the needs for information to some extent, and also developed the capacity of assessment practitioners. Compared to 2006, when the JSSA was in its planning phase, the understanding of the MA conceptual framework and the terms of ecosystem services and human well-being, have since been significantly deepened and shared among a wider range of stakeholders. In particular, the JSSA includes cluster assessments in which many local assessments were involved and integrated, and during the course of those assessments, many new initiatives and actors have emerged, an example being the *Satoyama* Science Centre, which was established at Utsunomiya University in 2009. Furthermore, several site assessment reports were published, among others, in Chiba and Yokohama.

We hope that the findings of the JSSA conveyed through this book can be used by many stakeholders to promote sustainable development. It is also expected that the outcome of the JSSA could act as a base for future scientific activities, contributing to improving the decisions and actions which affect ecosystems and human well-being, and further supporting the reconstructive steps needed to be taken on behalf of future generations.

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8

Hokkaido cluster

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8.1 Overview

Hokkaido is located at the highest latitude of the Japanese archipelago and is subject to temperatures comparatively lower than that of Honshu throughout the year. The remaining indigenous nature of the alpine and subalpine forest belts as well as the wetlands and forests that expand over the low altitude plains mark the characteristics of the nature and landscape of Hokkaido, which differ greatly from that of the main island of Japan, Honshu.

Until the 1800s, the main human livelihood was from hunting, fishing, farming and trading by indigenous communities of the Ainu with a few Japanese people called *Wajin* (the dominant ethnic group within Japanese archipelago). The scope and extent of these activities were conducted within the natural regenerative capacity. When the Hokkaido Development Commission was established in 1869 (Meiji 2 of the Imperial Calendar), the human population was 58,000. In the initial phase of the development programme, emigrants harvested vast quantities of construction timber, developed new agricultural land, and gathered a massive amount of firewood and charcoal in preparation for the severe winter through clearing the forests on the outskirts of their residential area. Although not considered as typical *satoyama* landscapes as witnessed in Honshu, the land management system practised in the initial development phase provided many key ecosystem services. However, from the 1880s onwards, the rapidly increasing numbers of emigrants

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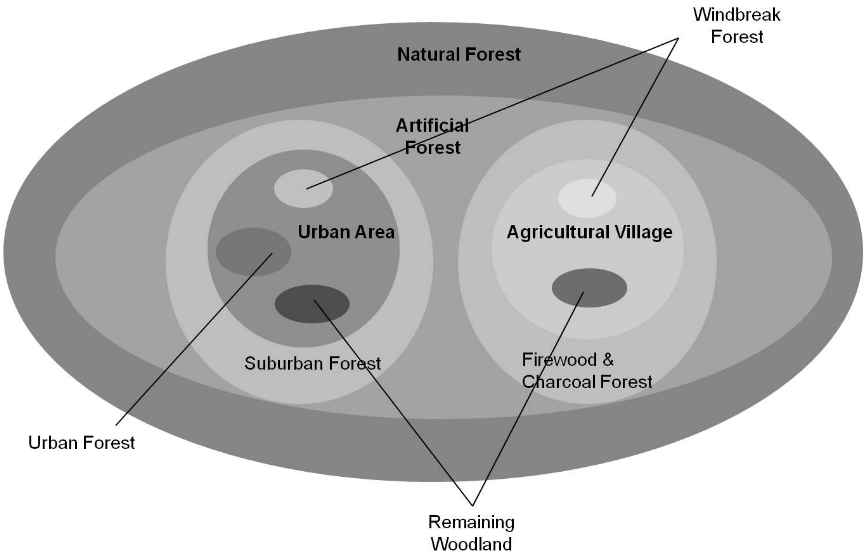

Figure 8.1 *Satoyama* of Hokkaido (conceptual diagram of urban areas, agricultural villages and various woodlands)

caused an increase in timber harvesting. But at the same time, a movement to protect Hokkaido's natural resources emerged and the natural capital of Hokkaido remains in abundance even today when compared with Honshu. In 1959 (Showa 34) as the population reached 5 million, the spread of oil, gas, electricity and chemical fertilizer as well as agricultural mechanization brought about a rapid change whereby usage of firewood and charcoal dropped.

The climate, topography, history and the rapid development in Hokkaido produced a very different landscape to the mosaic structure seen commonly in Honshu. In the Hokkaido Cluster, the term "*satoyama*" is used in the wider sense to refer to the forests which are close to living areas (i.e. firewood, charcoal, agricultural, suburban, remaining, urban and windbreak forests) in addition to natural and artificial forests (Figure 8.1).

8.2 Historical and narrative context

The equivalent period from the Jomon culture (Japanese prehistoric history from about 14,000 BC to 300 BC) to the Edo era (the division of Japanese history which was ruled by shoguns of the Tokugawa family, running from 1603 to 1868) on Honshu is divided primarily into the cultures of Continued Jomon (between third century BC and seventh century

AD), Satsumon (post-Jomon era named after the brush-patterned pottery style between seventh century and thirteenth century) and Ainu (between thirteenth century and nineteenth century) in Hokkaido. Haji pottery was introduced in the seventh century and Satsumon pottery came to be used in place of Jomon pottery. During the same period a culture originating among the Northern people known as the Okhotsk culture flourished in eastern Hokkaido, and was assimilated into Satsumon culture in the ninth century. While the Kamakura Shogunate was expanding in central Japan, trade between the Ainu and Honshu was thriving, and the culture of the Ainu flourished as iron pots spread and replaced Satsumon pottery.

At the same time as the Hokkaido Development Commission was established in 1869, the lands to the north of Japan, called Ezo, where the Ainu had lived, became Hokkaido and the Ainu were incorporated into the Japanese nation. The Hokkaido Agency was established in 1886, and the development of Hokkaido proceeded rapidly between the Meiji and Taisho periods. After the Pacific War, the Hokkaido Development Act was passed in 1950 (Showa 25), and the Hokkaido Development Agency was established.

8.3 Condition and trends

Table 8.1 shows the transformation of ecosystem services derived from key ecosystems within Hokkaido over the last fifty years. Every ecosystem service displayed a counter trend vis-à-vis human use (trends of human use of ecosystem services). The "indicators/criteria" column displays the statistical values and events used in the assessment of ecosystem services.

8.3.1 Forests

Excessive harvesting of natural forest resources and the reduction in forest coverage caused by excessive harvesting of timber and conversion of forestland for agriculture continued until the early 1980s. However, this trend has been reversed recently due to a reduction in timber harvested and the cultivation of artificial forests. The reduced use of timber was also propagated by the reduction in demand for firewood and charcoal due to the switch to more efficient energy resources after the 1950s. On the other hand, though the area of forest reserves providing regulating ecosystem services is increasing, it is not clear as to how the regulating ecosystem services themselves are changing.

Table 8.1 Overview of trends in ecosystem services and their effects on well-being (Hokkaido cluster)

Ecosystem services covered by the Hokkaido cluster			Human use	Enhanced or degraded	Indicators, criteria	Direct drivers									Trends in the effect on human well-being			
						Development					Underuse				Security	Basic material for good life	Health	Good social relations
						Farmland develop-ment	Afforesta-tion	Riparian work	Overuse	Pollu-tion	Succes-sion	Regres-sive succes-sion	External input	Global/regional warming	Personal safety, secure resource access, security from disasters	Adequate livelihoods, sufficient nutritious food, shelter, access to goods	Strength, feeling well, access to clean air and water	Social cohesion, mutual respect, ability to help others
Provisioning	Energy	Fuel (charcoal and firewood)	3.1 ↘	3.1 ↗	Timber cut quantity of charcoal and firewood forest	4.1	4.1				4.1	4.1				–		
		Electric power (hydro, wind)	1.3 ↗	NA	Electricity demand													
	Foods	Terrestrial animals (brown bear, Hokkaido sika deer)	3.5, 3.6 ↘	3.5, 3.6 ↗	Number of animals hunted											–		
		Aquatic animals (fishery, aquaculture)	3.8, 3.9, 3.10 +/–	3.8, 3.9, 3.10 +/–	Fish catch quantity			4.8	4.8, 4.10	4.11				4.10		+		
		Plants (crops)	3.3, 3.4, 3.7 ↗	3.3, 3.4, 3.7 ↘	Cultivated acreage, number of agricultural household, yield per acreage	4.7, 4.4												

Provisioning	Fiber	Plants (timber)	3.1 ↘	3.1 ↗	Forest accumulation, plantation forest percentage, woodland development permits, timber cut quantity, number of forestry workers	4.1	4.1		4.1		4.1	4.1	4.1			–		
	Décor	Animal (leather)	3.5 ↘	3.5 ↗	Number of animals hunted				4.5	4.5						–		
Regulating	Soil erosion regulation		3.3, 3.9 ↗	3.3, 3.9 ↘	Sediment supply quantity, area coverage of coastal vegetation, change in quantity of coastal line, extension of windbreak forest, blow sand quantity	4.3, 4.9		4.9	4.9						–			

Table 8.1 (cont.)

Ecosystem services covered by the Hokkaido cluster			Human use	Enhanced or degraded	Indicators, criteria	Direct drivers									Trends in the effect on human well-being			
						Development					Underuse				Security	Basic material for good life	Health	Good social relations
						Farmland development	Afforestation	Riparian work	Overuse	Pollution	Succession	Regressive succession	External input	Global/regional warming	Personal safety, secure resource access, security from disasters	Adequate livelihoods, sufficient nutritious food, shelter, access to goods	Strength, feeling well, access to clean air and water	Social cohesion, mutual respect, ability to help others
Cultural	Spiritual	Scenery	3.3, 3.9 +/–	NA	Hokkaido heritage		4.9	4.9									+/–	
	Recreation	Education	3.2 ↗	NA	Number of park users												+	+
		Game-hunting/fishing, gathering clams/wild vegetables	3.2, 3.8, 3.9, 5.8 ↗	NA	Fishing population, awareness survey, number of leisure facilities												+	+
		Climbing, travel, green-tourism	3.2, 3.9 ↗	NA	Number of park users												+	+

※ Human-use/enhanced or degraded: arrow width indicates probability. Bold arrows are used for items that have supporting data, and thin arrows are used for the items without supporting data.
※ The direct drivers: chapter and section number is listed for the items with relevant descriptions within the Hokkaido cluster report. For the items without specific relevant descriptions in the cluster report, no number is listed.
※ Trends in the effect on human well-being: increased (+), decreased (–), or both (+/–: perception differs by age group and region) as a recent trend.

8.3.2 Suburban forests

In general, forests have primarily been converted into agricultural land in Hokkaido. However, near cities such as Sapporo, many of the forests have been converted to manufacturing and business sites. More recently, much of previous forested lands have come under protection. For example, Nopporo Forest Park used previously for plantations and agricultural land during the Meiji development era came under protection in 1895 as a watershed protection forest. Similarly, Mt. Moiwa and Mt. Maru, both suburban forests, have also been already protected since the development era to protect their scenic beauty and nature. A point to note is the shift in the priorities placed by the community on the services provided by these forests. In the past, suburban forests were valued primarily for regulating and provisioning services such as watershed protection forests, climate control, and the supply of timber, firewood and charcoal. However, in recent years, a rapid increase in the importance of their cultural services (scenic beauty, environmental education, recreation, and ecotourism) has been observed and is a trend that is expected to continue in the future. Similarly, while it has to be said that the conserving function of the suburban forests in maintaining biodiversity has declined when compared with those of the past, they still continue to be areas important to wildlife and *satoyama* management is being practiced in some areas to maintain and increase biodiversity.

8.3.3 Windbreak forests

In the development era, the provision of windbreak, maintenance of scenic beauty and collection of firewood and charcoal, that is to say, regulating, provisioning, and cultural services functions were expected of windbreak forests. However, in order to alleviate post-war food shortages, the supporting agricultural windbreak forests were also felled and removed, and the width of the forest belts of the mainline reserves of windbreak forest was reduced as they were converted to agricultural land, thereby increasing the rate of soil lost from winds leading subsequently to lower crop yields. Similarly, windbreak forests also play an important role as the transitory stop for many birds as well as feeding grounds of local wildlife. Even if the expanse and width of windbreak forests is decreasing, they continue to maintain their value as the subject matter and material for *tanka* (31 syllable verse in Japanese), *haiku* (17 syllable verse in Japanese) and landscape photography and/or as a resource for tourism. Therefore, on the one hand, it has been recognized that some provisioning services (such as vegetable foodstuffs) have deteriorated and others (such as charcoal and firewood) have improved, and regulating services (such as weather control and soil retention) have deteriorated; on the other hand, it is assumed that cultural services have either not changed or that the expectations on them have increased.

8.3.4 Agricultural land

Since the introduction of chemical fertilizer and chemical pesticides in the 1950s, while yields per unit of area have increased and stabilized, the destruction of the soil ecosystem and the negative effects on human bodies have become serious. Since the 1970s, there has also been an attempt to improve productivity through large-scale management and biotechnology. The results have been mixed with some provisioning services coming from agricultural land improving significantly (vegetable foodstuffs), while regulating services have declined, i.e., the control of the quality and source of water and soil retention.

8.3.5 Ecotone of forests and agricultural land (brown bear and Hokkaido sika deer)

In the ecotone between forests and agricultural land, *Ursus arctos* (brown bear) and *Cervus nippon yesoensis* (Hokkaido sika deer) have had significant impacts on ecosystem services offered by the ecosystem. In the absence of *satoyama* management (i.e. decline in hunting, increased feed available from the increased area of agricultural land in the low altitude zones, and decreased death rate in the wintertime due to the increased area of coniferous tree plantations), the population size of *U. arctos* (brown bear) and *C. n. yesoensis* (Hokkaido sika deer) has increased. Although the provisioning services offered by the *U. arctos* (brown bear) and the *C. n. yesoensis* (Hokkaido sika deer) (potential ability of providing meat, hides, medicines and antlers) have enhanced, their actual provision has declined. For example, the listing of the *U. arctos* (brown bear) in the 1992 Washington Convention prohibiting the trade of *U. arctos* (brown bear) products has forced a significant reduction in imports of these bears. The increase in these two species has made them invade to agricultural land and caused damage to agricultural crops as well causing as increased psychological stress and decreased physical security on local communities living.

8.3.6 Grasslands

Since the high economic growth period (mid-1950s–early 1970s), there has been a significant conversion of natural grasslands into artificial grasslands, and as the efficient production of highly nutritive feed has become possible, the yield and number of livestock reared per unit of area have increased.

However, on the other hand, the deterioration in water quality due to fertilization of grasslands and livestock excretions coupled with the consolidation of soil from the tread pressure of livestock is bringing about a reduction in the habitats of the rare plants that originally inhabited the grasslands. As a result, though the provisioning services from the grasslands have increased (feed, foodstuffs from animals), it is thought that the regulating services of maintaining water quality and the cultural service of enhancing the landscape with the originally inhabited plants are in decline.

8.3.7 Rivers

The creation of river works has caused basins to become fragmented and the inhabiting environments of salmonid fish are deteriorating. In particular, when compared with the *Oncorhynchus keta* (chum salmon), which has spawning grounds in the brackish waters of the mid-to-downstream basin, the effects on the *Oncorhynchus masou* (cherry salmon), which requires a freshwater environment, have been relatively major. While the fishery resource of chum salmon has increased rapidly due to the release of hatchlings from the 1970s onwards, cherry salmon resources continue to stagnate. In recent years, salmonid fish have not only constituted a provisioning service as a food resource, but also (O. keta [chum salmon] in particular) have played a role in environmental education such as through run viewings and release of fry, and in recreation and ecotourism such as through game fishing; in other words, the enhancement of cultural services is gaining attention.

8.3.8 Coastline

Human activities such as the creation of river works and land reclamation have caused the breakdown of the sediment supply balance on the coast, and rapid erosion of the coastline and alteration to sand-beach landscapes have occurred since the high economic growth period (mid-1950s–early 1970s). Similarly, though the coast has been used historically as a site of recreation since, the diversification of utilization form, which is often accompanied by cars driven onto the coast in recent years has caused the destruction of seashore vegetation. In this way, the coastline's regulating service such as soil retention, and supporting service of maintaining biodiversity are declining. On the other hand, of the cultural services, the function of landscape is in decline and it is thought that the recreational function is not changing.

8.3.9 Oceans

The changes in the ocean ecosystem such as rising ocean temperatures and variations in the periods that plankton appear have caused changes to the supply of spring *Clupea pallasii* (Pacific herring) (from Hokkaido and Sakhalin), which repeatedly recedes, disappears and recovers. Spring *C. pallasii* (Pacific herring) disappeared from the coasts of Hokkaido in 1958 and the herring industry shifted either to offshore fishing or to overseas waters. The ways of using *C. pallasii* (Pacific herring) have also changed with the era. From the Edo to the Meiji eras, herring residue was used as a fertilizer, though from the late 1940s onwards became almost entirely diverted to human consumption. Usage as gutted herring and salted herring roe continue to be important today, though in recent years frozen herring has started to be imported, and almost all domestic herring is used as fresh fish for consumption. In this way, while the provisioning service of fertilizer from the ocean in the form of herring is declining, the usage of herring as a foodstuff in the form of fresh fish, gutted herring and salted herring roe is increasing.

Eumetopias jubatus (steller sea lion) were hunted commercially for their meat, hide and gallbladder from the 1910s to 1940s. However, since 1959 they have been hunted as pests due to the damage they cause to the fishing industry. Since 1994 restrictions have been in place upon the number of sea lions that can be hunted. The damage caused to the fishing industry can be both direct (destruction of submerged sea-nets and gill-nets) and indirect (loss of catch or damage to captured fish). The landing sites and migratory routes of *E. jubatus* (steller sea lion) around Hokkaido vary from year to year. In the 1920s they were often seen on the Pacific seaboard, but in recent years they have more often frequented the coastlines along the Sea of Japan. The background to this change may be a variation in the quantity of feed, such as *C. pallasii* (Pacific herring), a long-term change in oceanic conditions, a fluctuation in the population found at breeding grounds in Russia (where the migratory origins are thought to lie) and concentrated extermination at landing reefs. The provisioning services obtained from the ocean in the form of *E. jubatus* (steller sea lion) (foodstuff from animals, hides, medicines) are experiencing major decline due to the restrictions placed upon the number that can be hunted and the continuing decline in demand.

8.4 Drivers of changes

Looking at the transitions of land-use in Hokkaido from the 1920s to 1990s reveals a remarkable shift from forests to agricultural and urban land. This trend was particularly prominent in the subprefectures of Soya, Nemuro and Hidaka. The development of agricultural land in each region proceeded primarily through national initiatives. In Soya from 1982 to 1995, the scale of dairy farm operations was expanded as one part of a strategy to develop nationally owned farmlands. This expansion included an increase in the area used for pastureland, heads of dairy cattle and the production of raw milk. In Nemuro, from 1955, under the First-Term Hokkaido Comprehensive Development Plan, the Konsen Pilot Farm Project and the large-scale agricultural land development of Konsen Plain began. From 1973, the New Dairy-Farming Village Development Project attempted to positively expand the scope of dairy and upland farming. The Shinsei district of Hidaka was adopted as a model area for the Pilot Project to Reorganize Nationally-Owned Agricultural Land from 1990 and 1996, and there was an attempt to revitalize the region through a development of agricultural land to cultivate crops for feed. Such large-scale government-initiated strategies for development and conversion of forests to agricultural land, which treated the areas as the "food store-houses" of the nation, were the primary factor in the transformation of the terrestrial ecosystems of Hokkaido.

There was also a remarkable increase in coniferous forest between the 1920s and 1990s. In the 1920s, the majority of Hokkaido's forests were broadleaf forests, while coniferous forests saw distribution mainly in northern Hokkaido, centring around Mt. Taisetsu that straddle Kamikawa, Tokachi and Abashiri. However, as a result of the post-war expansion of afforestation, the proportion of broadleaf forests decreased in almost every region of Hokkaido except in Shiribeshi while that of coniferous forest, agricultural and urban land increased.

Changes in ocean and coastal ecosystems seem to be affected not only by relatively localized human-induced disturbances, such as the construction of dams, land reclamation, and overexploitation, but also by alterations in the environment of a global magnitude.

Table 8.1 indicates the key direct drivers of changes to ecosystem services. The prominent drivers in ecosystem service changes are thought to be development (agricultural land development, afforestation, riparian work, overexploitation, over-utilization and pollution), underuse (succession, regressive succession and external input) and regional and global warming.

8.5 Responses to changes

In the face of the changes to ecosystem services as described above, policy responses through passing acts and ordinances and systematic and organizational revision are advancing alongside technical responses via the development of new methods. Some examples of these along with the future challenges are mentioned below.

8.5.1 Forests

• Policies:

Subsidy system for thinning; promotion of utilization of materials produced by thinning; promotion of the utilization of Hokkaido-made materials; formulation of policies on managing the resources of artificial plantations; and resource management utilizing a logging notification system.

• Technology:

Participation of new parties, such as the initiatives by the fishing community on forestry management and maintenance, citizens' volunteer work in *satoyama* areas, Forest Stewardship Council (FSC) and other forest certification systems, and forest therapy.

• Challenges:

The cooperation and formation of a network between the Hokkaido government, municipalities, forestry cooperatives and local residents are essential to achieving sustainable management.

8.5.2 Suburban forests

• Policies:

The designation of Mt. Maru and Mt. Moiwa as national natural treasures; regional systematic conservation and green space generation through the "Ordinance on the Conservation and Generation of Green Spaces in Sapporo"; the Urban Environment Forestation Maintenance Project under the Urban Forestation System, Special District for Green Conservation; designation of special green space conservation districts; designation of Nopporo primeval forest as a national treasure of historic importance and scenic beauty; and the designation of various types of forest and wildlife preserves.

• Technology:

Forest maintenance by citizens groups; recovery of rare plants, vegetation management, and removal of alien species in city parks and suburban forests through the cooperation of local residents, municipal agencies and experts.

• Challenges:

Various organizations in many regions are working to encourage the conservation and utilization of suburban forests. However, in the case of municipally-owned land, there are instances in which restrictions need to be imposed on such activities. Conflicts of interests among the different users of suburban forests could potentially arise as their purposes continue to diversify. While Hokkaido still has a rich natural environment, awareness-raising activities and political leadership, which will further acknowledge and conserve the ecosystem services therein, are required.

Various cities in Hokkaido, such as Sapporo, possess large scale urban and suburban forests, and are blessed by a rich natural environment when compared with the cities of Honshu. Ongoing city planning is necessary to maintain these forests as sites for the conservation of biodiversity, and to utilize them for human-environment interactions and as places to raise environmental awareness.

8.5.3 Windbreak forests

- Policies:

Establishment of the Windbreak Forest Strategy Council by Tokachi Subprefecture; the "Project to form a Sorachi Agricultural Space" by Sorachi Subprefecture; and the Windbreak Forest Maintenance Project by Konsen, Tokachi and Ishikari.

- Technology:

Construction of road crossing structures for *Pteromys momonga* (Japanese dwarf flying squirrel); installation of box culverts (confirmed to be used by bats); windbreak forest education for the public in the Tokachi Agricultural Museum; and the utilization of windbreak forests as a resource for tourism.

- Challenges:

Financial support is required to promote quantitative research into not only the role played by windbreak forests in the biodiversity of the region as a whole, but also into the manifold functions that windbreak forests possess other than in the maintenance of agricultural land.

8.5.4 Agricultural land

- Policies:

Policy on agriculture and agricultural communities in Hokkaido; the Landscape Act; the Northern Clean Agricultural Product Labelling System; acts to regulate the management and promote utilization of livestock excretions; Direct payment system in hilly and mountainous areas; Action plan for improvement of farmland, water and environmental preservation.

- Challenges:

Maintenance of the production foundations, such as the concentration of agricultural land usage, is required so as to foster and secure successors, new farm owners and farm-hands.

8.5.5 Ecotone of forest and agricultural land

1) Urus arctos *(Brown bear)*

• Policies:
Scheme of Brown Bear Capture Incentives; Spring Bear Culling System; and Oshima Peninsula Brown Bear Protection and Management Plan.

• Technology:
Installation of electric fences and temporary removal of underbrush on the periphery of agricultural lands.

• Challenges:
Securing new hunters to replace the ageing generation.

2) Cervus nippon yesoenis *(Hokkaido Sika Deer)*

• Policies:
Plan to Protect and Manage *C. n. yesoensis* (Hokkaido sika deer) in Eastern Hokkaido; ninth Wildlife Protection and Management Project Plan; tenth Wildlife Protection and Management Project Plan; and special measures to prevent damage caused by wildlife.

• Technology:
Feedback management based on the *C. n. yesoensis* (Hokkaido sika deer) protection and management plan; and net or electric fencing to prevent *C. n. yesoensis* (Hokkaido sika deer) intrusion.

• Challenges:
Securing sufficient number of hunters to respond to the excessive increase in the *C. n. yesoensis* (Hokkaido sika deer) population; developing methods of processing *C. n. yesoensis* (Hokkaido sika deer) venison, antlers and hides while devising and exploiting new channels of distribution.

8.5.6 Grasslands

• Policies:
Livestock excretions act (acts to regulate the management and promote utilization of livestock excretions).

• Technology:
Survey of the effects of re-introducing intentional burning to the Koshimizu Wildflower Garden on the conservation of vegetation (controlling alien grasses) in the coastal meadows; and survey of the effects of establishing bush-cutting and anti-grazing areas within the horse pastures of Ayamegahara of Akkeshi town in eastern Hokkaido (growth of *Iris setose* (blue flag iris) and abundance of species per unit of area).

• Challenges:
Approaches to maintain water quality are required within the entire basin such as establishing buffer zones for grasslands, and conserving and regenerating riparian forests. An attempt to revert back to agriculture with low-input and extensive farming using semi-natural grasslands in place of highly concentrated stockbreeding using artificial grasslands (where fertilizers and high grazing density are employed) is required. There is also the issue of how to compensate for the lowered productivity incurred through reverting back in the manner just described.

8.5.7 Rivers

• Policies:
Nature regeneration project that considers the entire basin's ecosystem; and Fishery Resources Protection Act (in effect as of 1951).

• Technology:
Study of the effective utilization of the salmon and trout of Chuurui River of Shibetsu Town.

• Challenges:
Establishment of restrictions on recreational fishing of the kind generally seen on Honshu; and further integration of improved user awareness with ecosystem conservation and regeneration activities.

8.5.8 Coastline

• Policies:
Revised Coastal Act.

• Challenges:
Immediate action is necessary on coasts where various patterns of usage co-exist such as the Ishikari coast, which is accessible from almost every point of the surrounding areas. Action is required to address the impact on coastal vegetation and to ensure the safety of people using the coast. A usage indicated by the coastal protection policy and the appropriate management of environmental conservation efforts are desirable.

8.5.9 Ocean

1) Clupea pallasii *(Pacific Herring)*

• Policies:
Release project with Akkeshi Fisheries Cooperative Association as the central body.

• Technology:
Production and release of artificial seedlings; construction technique of seaweed beds which are the spawning site for *C. pallasii* (Pacific herring); and resource management strategies.

• Challenges:
Adaptive management, resource assessment.

2) Eumetopias jubatus *(Steller Sea Lion)*

• Policies:
Capture of *E. jubatus* (steller sea lion) for pest control, introduction of reinforcement fibre to fishing equipment, ecological investigation of *E. jubatus* (steller sea lion), improvement of the research system for the purpose of resource management of *E. jubatus* (steller sea lion) with the scientific base, analysis of the status of *E. jubatus* (steller sea lion) coming over to Hokkaido and their feeding habit, and investigation of effects on fishery resources.

• Technology:
Estimation of the number of migrating population; restrictions on the capture number; and development of damage prevention technologies.

• Challenges:
Establishing a monitoring system to understand long-term migratory behaviour; maintaining traceability; understanding both the feeding behaviour of the *E. jubatus* (steller sea lion) and how damage occurs; and publicizing information on *E. jubatus* (steller sea lion) and sharing the responsibility for issues related to same.

8.6 Conclusion

Even though human use of ecosystem services over the last 50 years could be assessed, in some instances, the enhancement or deterioration of the supply of some ecosystem services was non-trivial. This was because no appropriate indicator was found whereby the supply of ecosystem services could be assessed (particularly with cultural services). Table 8.1 therefore only displays events detailed in the Hokkaido Cluster report, but if not detailed in the report, does not provide any information on the trends of ecosystem service changes and the direct drivers of them that are even generally conceived obvious. Similarly, if an appropriate direct driver was not established as an item, it would not be assessed. Under these limitations, it was found that the regulating service of soil erosion control had clearly deteriorated. It is thought that the breakdown of the sediment supply balance due to rapid conversion of forests into agricultural land, removal of windbreak forests and installation of river structures, was the primary driver for the decline in the soil erosion regulation service. In the case of provisioning services, in particular agricultural production, increases in supply driven by introduction of chemical fertilizers and agrichemicals were negated to a large extent by the increasing damage caused by an increasing population of *U. arctos* (brown bear) and *C. n. yesoensis* (Hokkaido sika deer).

In the Hokkaido Cluster report even though the issues have been described individually by ecosystem, those ecosystems are not independent of each other and are in fact very closely intertwined. For example, agricultural land, forests, grasslands and watercourses are mutually related within terrestrial landscapes through the intermediary movements of water and nutritive salts, and furthermore, the layout of each individual ecosystem has a close relationship with the development and habitats of wild animals. In addition, there is also interaction between the land and oceans as can be seen from the relationship between basin sediment production and coastal conservation. These relationships differ according to the region, however. What can be said from the above is that conservation efforts must be discussed region by region, considering the overall ecosystem in a comprehensive manner. The Hokkaido Cluster report assessed the functions and presents the changes and responses by ecosystem or ecosystem service. Assessing ecosystems and ecosystem services individually may be useful in clarifying the root causes of the problems. However, ecosystems have complex relationships with the local communities and the economies therein, and therefore conservation and sustainable use efforts must necessarily be comprehensive in nature.

The Hokkaido Cluster study is the first step in considering the relationships between the ecosystem and regional society through a comprehensive assessment of the former with the cooperation of local communities. The assessment results of this report should not be taken out of context.

9

Tohoku cluster

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9.1 Overview

The Tohoku region has a long history of utilizing the natural environment at the peripheries of residential areas – called *satoyama* – as ecosystem services. In forested regions, forests that lie on the outskirts of residential areas have been utilized as *satoyama* through the provisioning of timber. The lumbered timber was used as a valuable source of fuel in the form of firewood and charcoal for about 400 years before being replaced by fossil fuels. Similarly, the fallen leaves from woodlands have been used as compost and fertilizer for paddy fields and dry fields. In upstream rivers and areas that line the wetland valleys, cisterns have been created that have supported the expansion of paddy field agriculture. In hilly and highland areas, much woodland has been used as pastures, and areas of livestock husbandry such as horse production have spread. On the slopes of the hilly terrain in the southern Tohoku, mulberry plantations were cultivated to support the sericulture which was the main industrial activity in the region until World War II. The forest regions of Tohoku were utilized as sources of fuel, forestry and agriculture (products from agriculture and livestock), fertilizer and water under the comprehensive management of the natural environment, called *satoyama*. Similarly, on the flatlands, through the process of developing wetlands and floodplains into new rice paddies, artificial forests were created which were used as a source of windbreak for residential areas, water conservation, fuel and materials required for living, and the method of managing the natural

Satoyama–satoumi *ecosystems and human well-being: Socio-ecological production landscapes of Japan, Duraiappah, Nakamura, Takeuchi, Watanabe and Nishi (eds), United Nations University Press, 2012, ISBN 978-92-808-1210-7*

environment known as "*igune*" or "*egune*" was created. This method of enjoying the ecosystem services from *satoyama* while managing the natural environment was carried out in all parts of Tohoku until World War II. However, post-war industrialization and the declining status of forestry and agriculture together with the further decline in population within these areas caused a decline in *satoyama* areas. Much of the land under the *satoyama* management was converted to residential areas and golf-courses. Moreover, agricultural methods changed with an increased focus on the use of chemical fertilizers, creation of irrigation channels and introduction of agricultural machinery at the expense of *satoyama* landscape management techniques. The result of these transitions were the abandonment of arable land, decline in ecosystem services and deterioration of water quality.

In the Tohoku Cluster report, we shall analyse the key drivers responsible for the decline in *satoyama* areas and the ensuing decline in the many ecosystem services provided by *satoyama* landscapes. We shall also provide an analysis of ways of reintroducing the concept of *satoyama* landscapes and the ecosystem services they provide and propose specific strategies for adapting them to modern society.

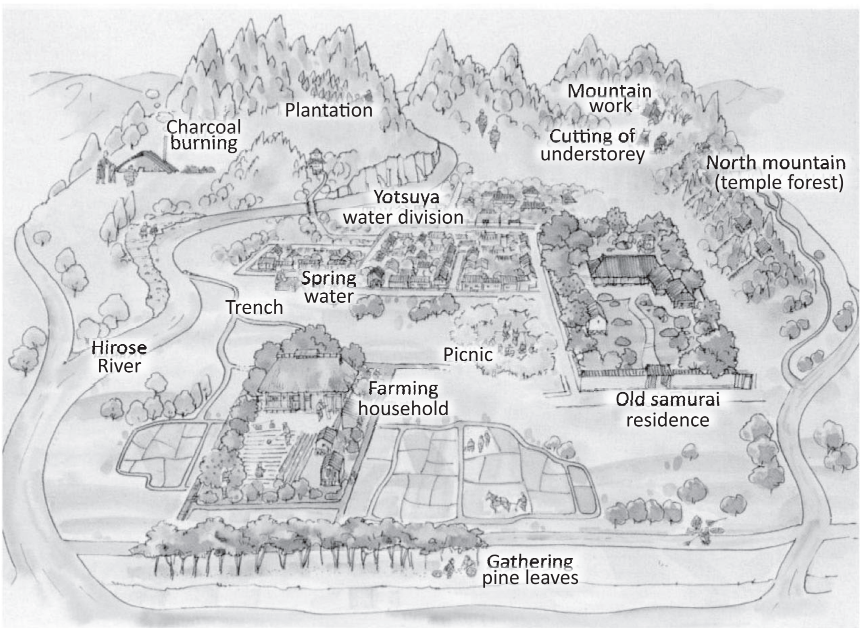

Figure 9.1 Model diagram of *satoyama* landuse within Tohoku
Source: Sendai City

9.2 Historical and narrative context

Tohoku's mountainous areas witnessed the mining development during the Edo period, while the fully-formed *satoyama* method of utilizing ecosystem services had begun 400 years earlier. Similarly, large-scale water projects such as river improvement led to the development of new flatland paddy fields which were accompanied by the beginnings of the "*satochi*" style of utilizing ecosystem services. At the same time, pastureland development (areas of horse husbandry), were created in all parts of Tohoku and the production of horses thrived. Among the clans of Tohoku, the local ruling family of Nanbu migrating from Kai province (today's Yamanashi Prefecture) brought with them the techniques of livestock husbandry to a part of Iwate Prefecture where horse production started thriving as it did on the pastures of the Abukuma highlands in Fukushima Prefecture. The demand for timber resources increased, and periods of logging for timber, firewood and charcoal began to alternate with afforestation efforts. In particular, *Thujopsis dolabrata* var. *hondae* (Aomori cypress; "*Hiba*") of Aomori and *Cryptomeria japonica* (Japanese cedar) of Akita over time became popular as special local products. These forests were also utilized for fuel, whereby charcoal stoves were constructed in Tohoku's mountainous regions and charcoal production began. As a way of using the woodlands, settlement units of forest were created under shared ownership and a communal method of managing the utilization of ecosystem services became established. Similarly, as the development of paddy fields progressed to the borders of hilly regions, cisterns were created as water sources which also came to be communally managed. In contrast to the *satoyama* management, mining developments were ongoing in Innai (Akita Prefecture), Obanazawa (Yamagata Prefecture), and Hosokura (Miyagi Prefecture).

Since the Meiji era, pasture development (horse husbandry areas) became increasingly important as demand for horses as chargers and draft animals increased leading to a thriving horse production sector in the Kitakami and Abukuma mountains. With regards to timber demand, almost every mountainous region witnessed the progression of lumbering and development projects within national forests and the renewal of the latter as artificial forests. Similarly, charcoal making expanded in every part of Tohoku as a fuel resource that was a valuable source of income to the local rural communities. As the primary crop of *satoyama* regions, the silk industry expanded throughout southern Tohoku as woodlands were converted to mulberry plantations. This expansion had a major effect on the land use of the southern Tohoku *satoyama* peripheries. As for the developments in mining, with the deployment of mining techniques came the large-scale management of mines. Government operated mines in

Ani, Innai and Kamaishi were sold off to the private sector and thereafter witnessed large-scale expansion. Similarly, mining developments proceeded in Kosaka, Hanaoka, Matsuo and Hosokura, and forests were deforested for timber on a mass scale.

One characteristic of the population in Tohoku from World War II onwards was the post-war reclamation of mountain forests and moors and the rapid development of unused land. However, on entering the high economic growth period, an outflux of migrant workers and the young to the Tokyo metropolitan area propelled the population decline in the area. Nevertheless, until the 1970s, the population engaged in forestry and agriculture within regions of rural communities had been widely dispersed due to the era of increased food production. However, since the 1970s, the rapid shift towards subsidiary industries caused a shift away from agriculture and forestry.

Characteristics of the usage of the ecosystem services resources within Tohoku were:

(1) Cedar afforestation had progressed for timber against the background of timber demands. However, with the import of timber resources, forest utilization fell into decline from the high economic growth period onwards which in turn created a situation where many cedar forests were left abandoned due to insufficient management;

(2) The firewood and charcoal industry that had supported the economies of the rural communities within Tohoku receded rapidly after the full-scale energy revolution of the 1950s. At the same time, the large-scale conversion of urban fringe *satoyama* into residential areas progressed, leaving those firewood and charcoal forests that were not subject to development unmanaged; and

(3) Mulberry plantations, which had been the primary land use of southern Tohoku's *satoyama*, disappeared with the decline of the silk industry, were first converted to fruit trees and then finally abandoned. Similarly, the widely distributed production of leaf tobacco as upland cropping within *satoyama* landscapes receded from the 1980s and the cultivation of dry fields became increasingly abandoned.

(4) One large-scale usage of the *satoyama* ecosystems in Tohoku from the 1950s was the generation of electricity and creation of water resources for agriculture through the development of dams. Similarly, tourism and leisure development increased from the 1970s with large-scale ski sites constructed in the snow covered districts of the Ou mountain range and golf-courses developed on the Pacific Ocean board. However, such developments also experienced decline subsequently with the economic recession and the decline of the ski-boom of the 2000s onwards.

9.3 Condition and trends

The land in Tohoku comprises of 71 per cent mountainous forests, 13 per cent arable land and 16 per cent urban land. This means that the vast mountain forests provide a forest ecosystem service, which, while constituting a valuable resource, has in recent years seen insufficient utilization and conservation. Also, within mountain forest regions, *satoyama* areas are not being sufficiently managed and maintained through human utilization because of the ageing and decreasing population of residents. The ecosystems of arable lands that exist in close proximity to urban residents are being under-utilized due to increasing competition over agricultural produce, the increasing average age and decline in the number of agriculturalists, and the labour-saving strategies of a mechanized and chemically-emphasized agriculture (Figure 9.2).

The Tohoku region is supported by vast mountain forests and enjoys water retention, CO_2 reduction and a supply of nutrients to water for agricultural use. However, once managed *satoyama* close to residential areas have fallen into decline and the alternate artificial ecosystem services have taken priority such as intensive agriculture using agrichemicals and chemical fertilizers, those ecosystem services have also changed. Table 9.1 below provides an overview of the trends witnessed among some key ecosystem services in the Tohoku region.

1) Provisioning services

Since the 1970s there has been a shift to mechanized labour-saving rice production methods together with increased use of chemical fertilizers and use of pesticides against in particular the rice blast fungus. The increase in production efficiency through these modern methods increased the desire for production. Such mechanized steps in cultivation systems reduced the number of labour hours required to cultivate rice and provided the producers a temporal leeway in which to engage in a subsidiary industry. Similarly, until 1995 the existence of a government rice price system functioned to support independent rice distribution and provided the producers with one standard rice price of around 20,000 yen per 60 kg of brown rice. This production characteristic and rice distribution system supported the rice-producing regions of Tohoku and made it possible for a class of agriculturalists to emerge that took on the burden of a subsidiary industry. Since the abolition of the Food Control Act in 1995, rice distribution channels have diversified and prices have tended to drop incessantly, and at present hover at around 15,000 yen per 60 kg. The shape of rice distribution and production as described here has greatly

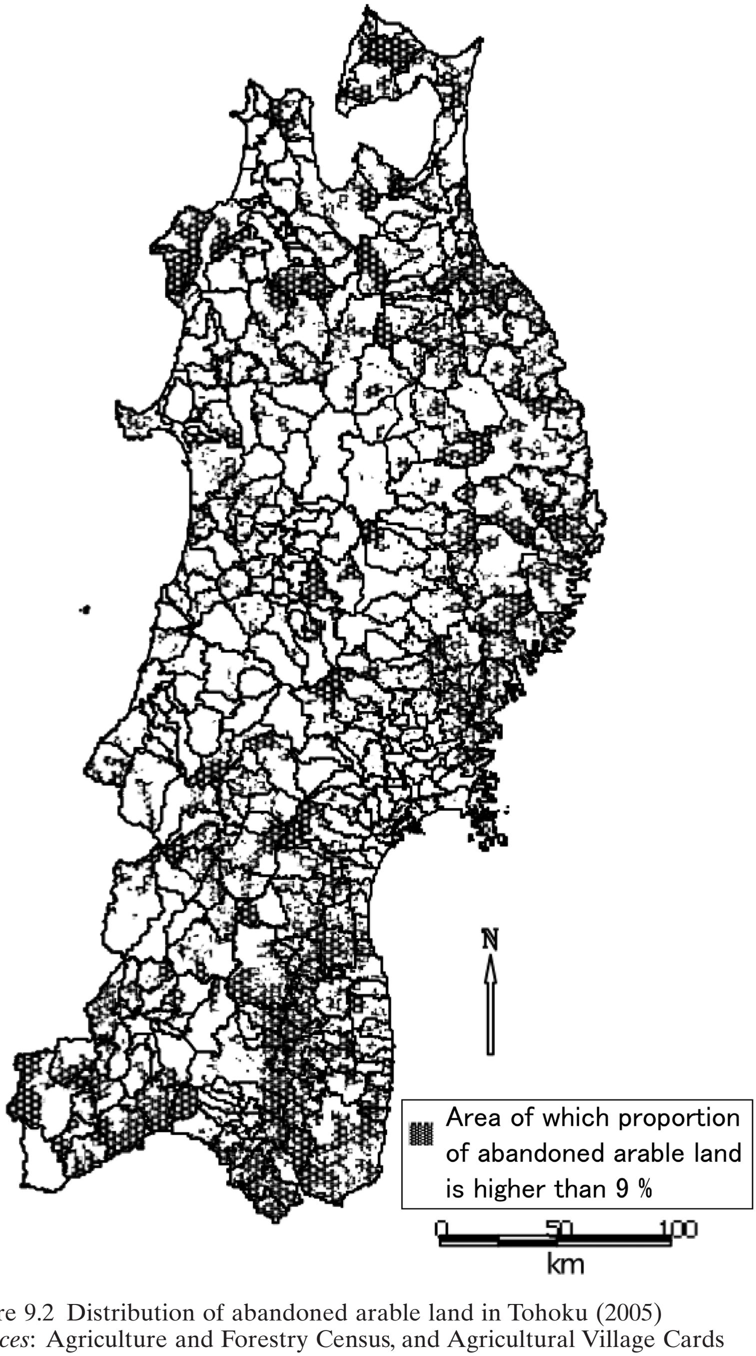

Figure 9.2 Distribution of abandoned arable land in Tohoku (2005)
Sources: Agriculture and Forestry Census, and Agricultural Village Cards

Table 9.1 Overview of trends in ecosystem services (Tohoku cluster)

Ecosystem service	Subcategory	Human use	Enhanced/ degraded	Notes
Provisioning services				
Food	Agricultural products	▼	▼	While there is a high demand for agricultural produce, imports increase as domestic supply decreases. Similarly, composite agriculture decreases while there is an increasing specialization into a single crop. Farmers are also ageing and decreasing in number. Cultivation of agricultural land in mountainous regions is becoming increasingly abandoned.
	Livestock	▲	▼	While the demand for meat has become major, imports are also increasing. Livestock are increasingly reared on imported feed while those raised through a combination of grazing pastures and grasslands are in decline.
	Fish catch	N/A	N/A	
	Aquaculture	N/A	N/A	
	Wild animal and plant products	+/–	▼	While there is major demand for mushrooms and wild plants, imports and those cultivated artificially increase and utilization of mountain forests decreases.
Energy	Timber	+/–	▼	Low-priced imports of timber increase, and the cycles of lumbering and afforestation stagnate due to the fall in price of domestic timber. While the development of mountain forest areas into resorts has progressed, demand has receded and management has become insufficient.
	Firewood and charcoal	▼	▼	With the energy revolution, the demand for charcoal falls, broadleaf germination is not renewed and forests management recedes.
Regulating services				
Atmospheric control		▲	▼	While there are major conservation demands on woodlands and agricultural land to absorb CO_2 and prevent a rise in temperatures, management of forests and agricultural land recedes due to changes in the social structure.

Climate control	Global scale	▲	▼	There is a major demand on this service to prevent global warming. However, forests and agricultural lands are insufficiently managed.
	Local/regional level	▲	▼	Areas of forest and agricultural land are indispensable in preventing regional temperatures from rising, however management is insufficient.
Disaster control and prevention	Water	▲	▼	While adequate management of forests is necessary for groundwater recharge and to prevent debris flow, forest stewards and their organizations decline while disasters increase.
	Soil	▲	▼	Chemical substances are being used for soil creation due to a lack of organic substances, causing a deterioration in soil quality. Soil runoff is also increasing due to flood damage.
Cultural services				
Cultural diversity	Culture	▲	▲	The respect and demand for the cultural values provided by *satoyama* are major and activities to contact and commune with nature are increasing. However, the willingness to manage *satoyama* voluntarily is weak, and an ideology of leaving such responsibilities to others prevails.
Religious and spiritual values	Faith	▼	▼	There is still some demand for religious values despite a general trend to decline.
Intellectual systems	Education	▲	▲	Educational demands on nature and the environment have grown majorly. The issue is how to properly convey an education that details the reciprocal relationship between the environment and humans.
Aesthetic values	Landscape	▲	▼	While there are demands on the landscape including major commercial demands from photography and film, the recognition of the necessity of management is weak.

Table 9.1 (cont.)

Ecosystem service	Subcategory	Human use	Enhanced/ degraded	Notes
Supporting services				
Soil creation		†	†	
Photosynthesis		†	†	

Notes: ▲ = Increasing (for human use column) or enhanced (for enhanced or degraded column)
▼ = Decreasing (for human use column) or degraded (for enhanced or degraded column)
+/− = Mixed (trend increases and decreases over past 50 years or some components/regions increase while others decrease)
NA = Not assessed within the cluster assessment. In some cases, the service was not addressed at all in the assessment, while in other cases the service was included but the information and data available did not allow an assessment of the pattern of human use of the service or the status of the service.
† = The categories of "human use" and "enhanced or degraded" do not apply for supporting services since, by definition, these services are not directly used by people (their costs or benefits would be double-counted if the indirect effects were included). Changes in supporting services influence the supply of provisioning, cultural, or regulating services that are then used by people and may be enhanced or degraded.

changed the face of rice producing areas that were an integral part of *satoyama* landscapes.

The livestock of Tohoku have been raised through forage crop fields and pasture establishment, and so changes to livestock husbandry have been intertwined with those to *satoyama* landscapes. However, the livestock of Tohoku have continually increased in size and become specialized while the number of livestock farmers' households in Tohoku has declined. Even now, while regions that specialize in livestock still exist, the dispersed composite livestock management introduced in the 1960s onwards is declining, and the domains of crop cultivation and that of livestock husbandry continue to grow apart. The management of livestock husbandry within Tohoku has followed the similar path of declining local recourse circulation type agricultural management with the turning point being the liberalization of beef imports in 1991.

Charcoal production was once widely distributed within Tohoku but has seen dramatic decline since the energy revolution. The demand for a recyclable and sustainable energy resource that uses the germination renewal of broadleaf trees, still decreased, leading to a decline in the daily management of mountain forests. However, in place of charcoal production, *shiitake* mushroom production using these forests increased. However, maintenance of *shiitake* mushrooms through raw wood cultivation is highly labour intensive compared to the recent prevailing sawdust based cultivation and with the large rural-urban migration witnessed during the industrialization process, the ageing problem made it difficult to maintain these *shiitake* mushrooms forests for *hodagi*, or decayed bed logs.

The declining demand for many of the *satoyama* ecosystem services has driven the abandonment of arable land usage expanding from the mountainous areas to the semi-mountainous regions and to the plains of agricultural communities. The increasing abandonment of cultivation accurately reflects changes to the Tohoku region's upland cropping. Even in 1980 there was little evidence of widespread abandonment of cultivation. However, by 1990 the picture began to change with observable changes in northern Iwate Prefecture, eastern Yamagata Prefecture and the Abukuma mountain range of Fukushima Prefecture. This increase was particularly seen in mountainous areas wherein paddy fields were situated alongside mountain streams. These areas were not suitable for the introduction of agricultural machinery and so cultivation therein was the first to be abandoned especially with the introduction of rice acreage reduction policy in the 1970s onward. The same trend was also witnessed with the forage crop fields which were progressively abandoned due to the increasing trend in purchasing feed-dependant livestock.

From 2000, arable land was becoming increasingly rapidly abandoned in mountainous areas, in particular in the Shimokita Peninsula and the mountains of the Tsugaru region. Due to the labour shortage brought on by the ageing population, the abandonment of paddy fields and dry fields progressed. The area of abandoned arable land was particularly remarkable in the Abukuma Mountains, where indigenous leaf tobacco had conventionally been the primary crop, but saw a rapidly decrease in cultivation while animal husbandry also declined.

2) Regulating services

In the Tohoku region, the vast areas of mountainous forests are essential for clean air regulation, absorbing CO_2, providing clean water and water regulation among others. National forests make up 46 per cent of the mountain forests in the region and broadleaf trees account for 65 per cent of the trees in Tohoku's forests. The ratio of national forest coverage is high compared to the national average of 30 per cent and this makes forest conservation efforts easier. However, the effects of yellow dust and acid rain along with pests such as pine and oak wilt are increasing as burdens on the forest ecosystem due to natural factors. Similarly, privately owned forest management within mountainous regions has become insufficient due to a decrease in those engaged in agriculture and forestry and hence the opportunities to utilize the forests. The forests of the region have been instrumental in providing the watershed functions in terms of water regulating and water purification. The rivers and lakes in turn are dependent on the watershed functions of the forest ecosystems. Weirs, irrigation channels and cisterns have been constructed to use and regulate water effectively and have fulfilled a regulatory function. After World War II, dams for drinking water and agriculture were created as water usage became increasingly efficient. As the dams were constructed, irrigation channels for agriculture were improved to increase efficiency, paddy field productivity was raised and the situation of battling for water, so to speak, decreased. However, the efficient water supply system increased the number of U-shaped gutter and three-face block type structures which imposed a burden on the ecosystems of canals and paddy fields and brought about a decline in the biodiversity of the ecosystems of agricultural land.

3) Cultural services

The scenery of Tohoku was formed by mountain landscapes such as the Ou mountain range and isolated peak volcanoes such as Mt. Chokai and Mt. Iwaki, and the forest vegetation that cover them. Historically, mountain faiths represented by that of the three mountains of Dewa (Dewa *Sanzan*) thrived, and a way of life became established that incorporated landscape, faith and also cultural events such as festivals. Similarly, the Shirakami mountain range on the border of Aomori and Akita Prefectures was designated a national heritage site within which a natural beech forest has been preserved. Against this background of a forest landscape, the agricultural landscape of terraced paddy fields, grazing pastures and mulberry plantations developed within *satoyama,* and the homestead woodland and windbreak forests known as "*igune*" and "*egune*" were created within a plentiful natural landscape. However, the agricultural landscape of *satoyama* had been converted first into mechanized agricultural fields followed later by these farms being abandoned. The change to the homestead woodland way of life is also responsible for causing a continual decrease in *satoyama* landscapes. Similarly, the decline of the regional community is bringing an end to events which embodied the unity of landscape maintenance (pond dredging, grass-mowing, water-channel cleaning) and recreation (feeding the carp in reservoirs). At present, such cultural functions of ecosystem services are being re-evaluated, with pond dredging and fire fly appreciation societies seeing a revival. Local resident tour guides and green ecotourism using abandoned elementary schools are gradually on the increase and the seeds of exchange between regional and urban residents have been nurtured. Environment and food education in elementary and junior-high schools is spreading which has become an important opportunity to increase awareness of the cultural functions of ecosystem services and biodiversity.

4) Supporting services and biodiversity

Forest roads and national roads to transport the timber to demand centres have been constructed in mountainous areas. Though the construction of such roads provides convenient transportation, they also threaten to weaken the supporting services of the natural ecosystem. Slurries of mud and rock and landslides due to natural disasters have begun to occur more frequently as the area of human activity has progressively expanded into mountainous regions. In order to supplement the regulating service of disaster prevention that is aided by supporting services provided by the natural ecosystem, sediment control dams have been constructed in mountainous regions and upriver. In some areas, sediment control dams and bunds have also been made out of wood so as to coexist with the natural ecosystem. In the Tohoku region, mountain forest area, which accounts for 70 per cent of all area maintains the watershed protection function. Such issues as conserving the forests of headwater regions and preventing the illegal dumping of industrial waste upstream are coming to the fore.

The forests of the Tohoku region's *satoyama* are inhabited by many *Capricornis crispus* (Japanese serow), *Macaca fuscata* (Japanese macaque), *Ursus thibetanus* (Asiatic black bear) and *Sus scrofa* (wild boar). In recent years the migratory domains of the *U. thibetamus* (Asiatic black bear), *M. fuscata* (Japanese macaque) and *S. scrofa* (wild boar) have extended as far as residential areas and damage to crops as well as harm to humans is increasing. Tohoku is also a major transitory home to many migratory birds. Swans and geese come flying to the Ramsar Convention designated wetlands of Izunuma, Naganuma, Uchinuma, Kabukurinuma and Kejyonuma in Miyagi Prefecture. As a case of adventives in *satoyama* regions, there has been remarkable increase in *Micropterus* spp. (black bass). *Micropteris* spp. (black bass) have been released into the reservoirs and lakes of *satoyama*, destroying the ecosystem of the pre-existing *Cyprinus carpio* (common carp), *Carassius* spp. (crucian carp) and Atyidae (family of freshwater shrimp). In the forests, damage from disease and pests such as *Bursaphelenchus xylophilus* (pine wilt nematode) and *Platypus quercivorus* (oak ambrosia beetle) is becoming wide-spread. Mortality caused by a fungus (*Raffaelea quercivora*) that is vectored by *P. quercivorus* (oak ambrosia beetle) is spreading to the *Quercus crispula* of Tohoku's Sea of Japan board, and has at present passed the Ou mountain range and is spreading to the Pacific Ocean board.

9.4 Drivers of changes

As indicated above (9.3 "Condition and trends"), the present situation is one where on one hand the ecosystem services of the Tohoku region are insufficiently utilized, while on the other hand, man-made substitutes for ecosystem services coupled with artificial approaches drawing excessively on ecosystem services have been causing the deterioration of ecosystem services in general. The correlation between direct and indirect drivers is as shown in the Table 9.2. The primary indirect driver of change has been the shift in focus towards achieving economic efficiency since the end of World War II and the change in the social fabric of society towards a modern lifestyle of universal convenience.

1) Changes in the social structure

The population of Tohoku started to fall in 1995 and was approximately 9.82 million in 2005. Future projections estimate a decline to 8.69 million in 2025. It is predicted that the ratio of elderly persons, which was 21 per cent in 2005, will rise to 32 per cent by 2025. The number of agricultural

Table 9.2 Correlation between indirect and direct drivers

	Direct drivers	
Indirect drivers	Agro ecosystem	Forest ecosystem
Changes in the social structure	Population change Ageing society (increase in the number of marginal village) Decline of local community function	Population change (population decrease of mountain villages) Energy revolution Increase in disease and pests Increase in animal damage
Changes in lifestyle	Change in dietary habit Increase in subsidiary business of agriculture and birthday drop in agricultural communities City dwellers' greater interest in nature	Change in housing demand Increase in outdoor recreation
Globalization	Increase in import of agricultural products Price decline of agricultural products Decrease in income of farm household Decrease in the number of agriculture workers and their successors	Increase in import of timber Price decline of domestic timber
Advancement of science and technology	Farm land consolidation Mechanization Increase in use of chemical fertilizer and pesticides Breed improvement Re-organization of environmentally-friendly agricultural technology	
Public policy	Removal of rice price support system Implementation of production adjustment	
Climate change	Increase in temperature Decrease in amount of snowfall	

households in *satoyama* saw a decline of 200,000 households falling from 660,000 in 1985 to 460,000 in 2005. The population of the agricultural community also fell over the same period by approximately 1.2 million from 3.2 million to 2.01 million. Similarly, the proportion of people over 65 years old among the agricultural population, which was 16 per cent in 1985, had risen to 31 per cent by 2005. Looking at the general population distribution and that of the ageing population reveals that population concentration is restricted to flatland agricultural communities and cities, and that the population distribution in hilly and mountainous regions is declining rapidly. However, looking by settlement unit rather than municipal unit shows that the ratio of elderly, and in particular, that of farmers who are over 65, is high not only in the hilly and mountainous regions but also in the flatland rural communities and that the ratio of elderly within those engaged in agriculture is becoming a serious problem. For example, in Miyagi Prefecture the population of farmers aged 65 or over exceeds 50 per cent for both men and women and is increasing.

A survey of the agricultural settlements in the Tohoku region revealed that about 75 per cent of all settlements were holding festivals in 2005; this percentage has decreased a little over the last 10 years – the figure was about 78 per cent in 1995. Around a third (33 per cent) of settlements engage in the conservation of traditional culture and art; this has not decreased much significantly over the last 10 years – the figure was about 35 per cent in 1995. In terms of community function, those settlements engaging in activities for landscape conservation and formation have increased slightly to 73 per cent (in 2005, compared to approx. 70 per cent in 1995), and though a relatively low percentage was observed for engagement in elderly welfare at 35 per cent in 2005, this has also seen an increase over the last 10 years (approx. 29 per cent in 1995). Even though the means for regional communities to function and cope with the advancing age of the population are available, it is anticipated that these coping mechanisms will decline in future generations.

2) Changes in lifestyle

The Japanese people's food diet and consumption is changing while the import of agricultural and ocean products and foodstuffs increases. It cannot be said that the insufficiency of domestic production is the main cause for the increased demand for lower priced imported agricultural and ocean products and foodstuffs. In fact, mass quantities of foodstuffs supplied are not being sufficiently consumed and the food product loss ratio per household unit (uneaten edible food products and waste, etc.) stands at a national total of 3.7 per cent, which is the same ratio as Tohoku's. This ratio increases significantly if we add the loss ratio from the food industry and retail trade. Both the behaviour of the consumers who seek the easy acquisition of a variety of lower-priced foodstuffs and that of the food producers and retailers who prompt such behaviour on the part of the consumer drags down the domestic food self-sufficiency ratio on a calorie basis to 39 per cent at the national level. The food self-sufficiency ratio of Tohoku which is a base for food production in Japan, indicates 107 per cent on a calorie basis, but is 32 per cent when rice is excluded from the food categories to calculate the self-sufficiency ratio, which cannot be called high when compared with the national average of 22 per cent. This means that even though the rice self-sufficiency in the Tohoku region is high, self-sufficiency in other agricultural products – with the exception of fruit and vegetables – is almost as low as the national average. For this reason it is only the production of rice in addition to the production of fruit and vegetables in a few areas that supports agricultural production in Tohoku which indicates an uneven structure. The composite agricultural management that made regional agriculture plentiful is declining, and the current situation is one where foodstuffs are supplied through the subsidiary industry of rice production and the specialized crops of fruit and vegetables.

From the 1970s, the relocation of factories to the provinces including the Tohoku region provided employment opportunities to a wide-ranging labour force from men to women, young graduates fresh from high-school to the middle-to-old age groups. In the 1960s, Tohoku's agricultural labour force turned to the cities for seasonal work. While the shift to subsidiary businesses for agricultural workers began through such migratory seasonal work, employment avenues other than agriculture were created as factories began to move into the provinces. The increase in such employment opportunities made it possible for female agricultural workers to become independent in terms of income and helped push up the household income. Higher family disposable incomes brought major changes to lifestyles. The ratio of distribution of agricultural workers within Tohoku who have a second subsidiary business (households where the income from sources other than agriculture exceeds that of the latter), reveals that regions where more than 70 per cent of agricultural workers engage in a second subsidiary business have continued to expand since 1980 throughout the entire Tohoku region. This expansion has not been confined to the urban fringes and flatland agricultural communities but has also reached the mountainous regions. As the shift to subsidiary business developed and even with no major change to the three-generation households within agricultural communities, these communities were beginning to behave similar to the urban populations where they had to purchase their food supplies; the era of self-supply and self-sufficient in food, clothing and houses had ceased to exist. The low birth-rate among agricultural communities, with increasing educational opportunities and increasing proportion advancing to university is becoming increasingly prevalent. For this reason, the supply of agricultural workers is declining and even though the succession of agriculture to the eldest son continues, the number of those taking up employment in agriculture is decreasing.

Due to increased demand for houses that use materials from overseas, the demand for domestically produced timber has rapidly contracted. Japan's overall timber self-sufficiency ratio stood at 80 per cent in 1960, falling to 40 per cent in 1970 and has stagnated since 1990 at the 20 per cent mark. Similarly, changes to the way of life in the form of collective housing and condominiums have brought about a decrease in the demand for timber. While there was once demand for conventional timber not only for construction but also for railroad cross-ties, this demand has slackened due to substitution towards concrete cross-ties. Similarly, the demand for material from forest thinning to be used as bed logs in mushroom cultivation has declined as the use of shiitake cultivated through mushroom beds increased. While forest ecosystem services are being looked at anew in light of walking in the woods for therapeutic purposes and the "outdoor boom", these activities have contributed to the deterioration of the ecosystems through increased pollution from waste dumping and the picking or capture of wild plants and animals.

3) Globalization

The Tohoku region food base has decreased its primary crops with the import of agricultural products. The price war with imported agricultural produce has driven the diverse production of crops into recession. The expansion in the regional labour market has also had a major effect in reducing the number of people engaged in agriculture, and a decline in crop alternatives that could increase income has been a driver in agriculture's loss of appeal to those who would have otherwise been successors of the industry.

Even though rice prices have fallen, rice cultivation continues over a wide area and continues to fulfil a role not only in terms of its ecosystem provisioning service function but also one of regulatory function. As for the pastures and public breeding pastures that once extended as far as the mountain villages, pastures for cows have decreased and the land use within mountain villages has declined with the increase in imports of livestock and dairy products. Similarly, silk and leaf tobacco production, which had continuously been the primary source of cash income in mountainous districts declined with the increase in imports and change in consumer preferences. While crops have been diversified from paddy fields to fruit trees from mountainous regions to flatlands, fierce competition between producing regions has meant that fruit tree production only remains in those areas where it constitutes the primary crop. With vegetables also, increased imports and domestic competition between producing areas has resulted in a restriction of production to those areas that can respond to market distribution. The increase in imported agricultural produce and decrease in the price of agricultural produce overall prompted a decline in the number of people engaged in agriculture and a shift to subsidiary businesses. As a result, the number of people that maintain the ecosystem services in areas of agricultural communities has been decreasing. Additionally, the problem of the ageing population of those engaged in agriculture has been another major driver for the declining number of people maintaining the *satoyama* landscapes. Looking at the distribution of agricultural workers over the age of 65 in Miyagi shows a ratio of 70 per cent in almost every village. In particular, by 2005 the population ageing rate of women was increasing. Such a decline in the number of people engaged in agriculture is having a major effect on the usage ratio of arable lands. The area recorded as planted within the total area of arable land in Tohoku's upland cropping started to fall below 100 per cent in the 1990s and had decreased to 89 per cent by 2005 with total paddy and other cropped fields falling to 87 per cent. At present, available arable land is not being fully utilized.

Although domestic timber is priced higher than imported timber, the cost of production has become problematic causing a decline in the use of timber. There have been approaches to using domestically produced timber in the construction of "*local production for local consumption*" housing; however, this has not increased the level of use of domestic timber due to the high costs.

4) Developments in science and technology

Large scale improvements to the Tohoku region's paddy fields proceeded in some areas during the 1960s. As of 2006, 61 per cent of all Tohoku's paddy fields had been improved and 10 per cent of those were improvements to large-size fields. The order of those improvements by region was Yamagata (71.7 per cent), Fukushima (66.6 per cent), Akita (61.5 per cent), Aomori (61.4 per cent), Miyagi (58 per cent) and Iwate (48 per cent) Prefectures. While such field improvements had the major effect of consolidating agricultural land for farmers, they also became an obstacle in the training of diverse agricultural workers and hence require regional soft-projects, which can promote the vitality and image of the region, to be implemented. Similarly, another issue is coping with unimproved paddy fields and agricultural land because these have the potential to become abandoned arable land. The mechanization of agriculture is progressing with the introduction of tractors, rice planters, combine-harvesters and drying machines. The flip side of such remarkable streamlining of agricultural practices is the dramatic decline in communal work. Though agricultural machinery is occasionally used communally, with the progressing shift to subsidiary businesses the number of farmers hoping to partially or completely delegate their agricultural work is increasing, and there is a growing situation of segregation into those agriculturalists who undertake agricultural work and those who do not. Even though the introduction of agricultural machinery has raised productivity, it has also brought about selection of agricultural helpers. Specialist agriculturalists who have become agricultural helpers have received large areas of agricultural land which they subsequently manage. Similarly, the introduction of agricultural machinery has also promoted agriculture under production corporations, and has also led to the decline in region-wide agricultural production systems although it has been promoted by new policy responses (e.g. action plan for improvement of farmland, water, and environmental preservation; and settlement agriculture). While increasing quantities of chemical fertilizer and agrichemicals are being used, their excessive usage imposes a burden on environmental conservation and ecosystems which is an issue of growing concern to both producers and consumers.

In Miyagi Prefecture, a local newspaper company – the *Kahoku Shimpo* – started the "Think about agrichemicals" campaign in 1991, which brought about a decrease in daily aerial agrichemical spraying by helicopter. After this an awareness of the necessity to reduce agrichemicals and chemical fertilizer became established among producers and agricultural cooperatives during the "Environmentally Friendly Rice Experiment Campaign". As of 2009, 40 per cent of the total area of Miyagi Prefecture's paddies was being specially cultivated for "Miyagi Environmentally Friendly Rice" which sees a low usage of agrichemicals and chemical fertilizers. Rice production in Tohoku saw some concentrated cultivation of brands as represented by *Sasanishkii* from Miyagi and *Akita Komachi* from Akita. However, systems of cultivation and removal became standardized, and there was a growing trend for cultivation of brands even on inappropriate land; a trend that only grew stronger amidst falling rice prices. In particular, with a standardized system of removal came widespread introduction of the same chemical components, weeds emerged that were resistant to weed-killer, and the appropriate cropping of breeds on suitable lands has become an issue in the maintenance of ecosystem services.

5) *Social policy*

One agricultural policy that has had a major influence on the rice dependent Tohoku agriculture was the 1995 abolition of the Food Management Act and subsequent enactment of the New Food Act. Under this policy, the price of rice was left to be determined by market principles and now continues to fall. The fall in rice price had a major effect on the agricultural management style of rice production (including subsidiary manufacturing and service businesses) that was practiced by the majority in the Tohoku region in the late 1970s. The early 1990s standard of 20,000 yen per bag of rice had fallen to 15,000 yen by 2005. The policy of trimming rice production from 1969 to the present has brought about an adjustment of rice production and 30 per cent of the area of paddy fields has been subject to crop diversification. While there has been much diversification to vegetables and fruit trees, many paddy fields in hilly and mountainous regions began with diversification, then left uncultivated and finally abandoned. In recent years there have been attempts to maintain the function of paddy fields through diversifying their usage to grazing pastures and biotope, and policies for enhancing ecosystem services are being developed and implemented continuously.

6) Climate change

Elevated temperatures in the Tohoku region have been accompanied with reports of inferior rice quality due to increased pest damage and high-temperatures. While still largely unnoticeable, there are concerns that elevated temperatures will increase pest damage. Similarly, high temperatures during grain filling periods are starting to lower the class of rice through the occurrence of white-turbid rice of inferior quality. Decreased snowfall due to a raise in temperatures can also be indicated as a factor in obstructing the function of ecosystem services such as watershed protection.

One of the changes to the climate of recent years has been the frequent occurrence of concentrated downpours in mountainous regions which cause mudslides and slope failure. The insufficient management of forests is exacerbating such problems while it is predicted that elevated temperatures will bring about increased damage to forests from disease and pests.

9.5 Responses

1) Economic responses

More economic opportunities within *satoyama* regions are needed to address the conservation of ecosystem services within *satoyama* landscapes. However, whether it is forestry or agriculture, such hopes are failing as the imports of forestry and agricultural products increase under World Trade Organization (WTO) rules. Under such circumstances, one effective strategy that can be cited is an economic response through administration-led regional policy and community development at the private level. Examples of such public administration-led regional policy are the direct payment system at the level of agriculture in hilly and mountainous regions and strategies to improve agricultural land, water and the environment. Though not implemented in all regions, a direct guarantee of income and payments offered to environmental conservation type cultivation for strategies to improve agricultural land, water and the environment have demonstrated a definite efficacy in preventing the abandonment of cultivation within *satoyama* regions. From the viewpoint of forestry, while there are systems in place to promote the logging of artificial forests, such aid is insufficient to provide incentives for afforestation.

Although rice price declines caused a shift to subsidiary business, it can be said that business models that promote value-added agriculture using the guidelines of the "Organic Japanese Agricultural Standard (JAS) Certification System and Specially Cultivated Agricultural Produce Labelling" have increased under the community development using the private sector. Similarly, administrative support to stands selling agricultural and forestry produce and the deployment of roadside stations are producing major results. Through utilizing the ideology of "local production; local consumption" and food-processing techniques, opportunities are increasing even for small-scale produce to become a source of definite monetary income.

2) *Legal responses*

The Tohoku region has been devising environmental ordinances, as legal measures at the prefectural level based on the national Basic Environment Law to maintain the ecosystem services of *satoyama* landscapes. Similarly, environmental ordinances have also been drawn-up at the local authority level. The latter plan was devised through an assessment of regional environments and surveys of the residents of local communities (administrative wards), and such efforts made it clear that while every region is seeing some level of environmental conservation, there is some regional discrepancy throughout the local authorities. However, basic environmental plans being drawn up are subsequently being confronted with insufficient budgets to respond to each of the issues, and there is the risk that such plans will only be dealt with by existing project agencies. There is therefore a need to secure an independent source of financing regional environmental conservation. The environmental tax introduced by Miyagi Prefecture is one such financial guarantee through which the plan for the environment has been made concrete and effective.

3) *Social and behavioural responses*

Environmental education, food education and the promotion of open-air activities, ecotourism and green tourism have been developed under the Basic Environmental Education Act and the Food Education Act and implemented in most areas. Under environmental education, an implementation of local environment conservation through school education and an environmental education that utilizes local resources is being pursued. Many diverse practices such as surveys of the region's wetland and paddy field life and also of water quality are being created, and schools are becoming sites that effectively increase environmental concern. Recently United Nations Educational, Scientific and Cultural Organization (UNESCO) schooling is spreading which is a practice that promotes an "Education for Sustainable Development" approach to environmental education within schools. Nearly 50 of the Tohoku region's schools have registered with this programme. At the citizen level, learning activities are being organized which aim at achieving a recycling society. To use the example of Sendai City, the City of Trees[1] Citizen's Environmental Education and Learning Promotion Council was formed and environmental conservation led by citizen groups have been developed and implemented. Since the establishment of the Food Education Act, food education has spread to every school and on the level of health and nutritional education, practices are being created which direct attention to the fact that food is linked to agriculture, forestry and fisheries which are in turn linked to the local environment. A specific example of the latter is field trips to winter flooded rice paddies, called *fuyumizu-tambo*, in the wetlands of Kabukurinuma in Tajiri district of Osaki City within which migratory bird observation studies are conducted. In addition "*igune* schools" which utilize the homestead woodlands (called "*igune*") of the Sendai plains, and water source and forest conservation experience programs within Shichikashuku town in Miyagi Prefecture have been initiated.

4) *Technical responses*

Recent developments in agricultural technology have been indispensable to the development of organic and environmentally friendly agriculture. There is a broad array of techniques that reduce agrichemicals, chemical fertilizer and environmental load. Specific examples are the incorporation of unhulled rice sterilization using hot-water sterilization, the utilization of cross-bred ducks or machinery to efficiently eradicate weeds, deep water management and selecting rice planting periods to adapt to the regional environment and improve rice quality. Such technological developments within the Tohoku region are being created through practical cases under the Organic Agriculture Promotion Act and Environmentally Friendly Rice Network.

Within forestry, the sprout regeneration of broadleaved forests is being encouraged and systematic logging practices are being implemented. The logging of broadleaf trees in Kawasaki town of Miyagi Prefecture is one technique that is spreading which is crucial to the regeneration of broadleaf trees. Similarly, usage of timber chip biomass and heating energy developments are being advanced by the Tohoku University Graduate School of Environmental Science. Biomass is being practiced as an effective technique of utilizing agricultural and forestry resources; in particular in the entire town of Kuzumaki in Iwate Prefecture. Though such technological developments in *satoyama* conservation are being sporadically produced in every part of Tohoku, there are challenges such as common ownership of a data bank of techniques and also that of the financial basis to implement them.

5) Knowledge and cognitive responses

"The Forest longs for the Sea" movement in Kesennuma city of Miyagi Prefecture and the Environmentally Friendly Rice movement that is expanding in all parts of Miyagi are examples of approaches to conserving ecosystem services at the regional level, which are socially cognitive. The former example was an approach where the oyster cultivating fishermen of Kesennuma city (former Karakuwa town) planted trees upstream of the bay wherein oysters were being cultivated and supplied the plentiful "fruits" of the forest to the ocean. The movement was well named and the name supported the original idea that environmental conservation links the forests and oceans, and the movement's ethos spread across the whole nation, even being mentioned in the social studies textbooks of the elementary school curriculum. The latter example of the Environmentally Friendly Rice movement centred on the local *Kahoku Shimpo* news company which was responsible for starting this environmental conservation campaign. The movement has continued for over 10 years and has seen expansion to approximately 40 per cent of all Miyagi's current area of paddy fields. Methods of information transmission that utilized IT, knowledge and recognized responses were indispensable to these two cases.

9.6 Conclusion

In Miyagi Prefecture and the wider Tohoku region, ecosystem services have been conserved by the *satoumi* of the coast, *satoyama* of the cities and suburbs, and the forestry and charcoal making of the mountain villages, *okuyama* mountain recesses and *satoyama* of vast agricultural lands. In Sendai, the ideology of recyclable afforestation with utilization of timbers through forest logging has been handed down since the time of Date Masamune (warlord of the sixteenth and seventeenth centuries who ruled the Tohoku region). On the peripheries, "*igune*" were made as part of new paddy field developments and man-made *satoyama* were created. In the hilly areas, *satoyama* that utilized charcoal making were widely maintained, and in the *okuyama* mountain recesses, horse husbandry through grazing and the utilization of firewood and charcoal forests has been maintained. However, though provisioning services are being secured to an extent through the conservation of agricultural lands, regulating services are declining due to the expanding area of abandoned arable land, as are cultural services through the continual decline of the agricultural community. Supporting services are also at risk due to the decline in forest management capabilities. Increased damage from wild animals and the advance of adventives are also seen. As ecosystem services continue to decline in this way, approaches to conserve the regional environment are being created in Tohoku in prefectures such as Miyagi through administrative efforts and local activities. Here we shall introduce some specific case examples of approaches to maintain and manage *satoyama* as well as regenerate ecosystem services.

One such approach is the Environmentally Friendly Rice movement. This movement reduces agrichemicals and chemical fertilizer in the manufacture of safe rice, secures regional biodiversity, reduces CO_2 emissions through low energy agriculture and approaches regional environmental conservation in terms of the circle of water and soil. The challenge is how to maintain a mechanism of producing rice that conserves the environment through which the value of environmental conservation is both satisfactory to and supported by the consumer while producers engage in a form of sustainable environmentally conservational agriculture. This is a proposal for a business model that conserves the regional environment. At present, a system that sees a collaboration of Miyagi Prefecture, all the agricultural cooperatives therein and institutions that carry out third party certification has expanded within the prefecture to cover 40 per cent of all paddy field area. While following the environmental conservation production standards, regional production expands on every front and surveys of living creatures indicate that diverse life is increasing. This is an approach wherein surveys of living creatures have been conducted within the whole prefecture, environmental conservation has become visible and Miyagi Prefecture as a whole is tackling environmentally-friendly rice manufacture.

A second approach is the sustainable community development and link-up with school activities that is being taken up in Tohoku and within every region of Miyagi to cultivate major public consensus. This proposes a network model that links activities to conserve and create the regional environment, and is an approach of Education for Sustainable Development (ESD) advocated by the United Nations. ESD is an approach at training personnel who will create the future through regional and school development. By establishing the regeneration of ecosystem services as the primary issue of this approach, conservation of *satoyama* and *satoumi* is becoming possible. As per the analysis in the Tohoku cluster report, the reality is that there are major challenges to the provisioning of ecosystem services by *satoyama* and *satoumi*. In order to overcome this reality, the approaches of individual people and a network power to link them are required. Each individual working together to approach the creation of the regional environment will create a major consensus through coalitions and networks. Linking the specific issues to such a course and continuing to act on them is tied to the regeneration of ecosystem services.

Note

1. Sendai is affectionately known as the “City of Trees”.

10

Hokushinetsu cluster

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10.1 Overview

10.1.1 Characteristics of the Hokushinetsu cluster

The Hokushinetsu cluster covers the region on the Sea of Japan side (Fukui, Ishikawa, Toyama and Niigata Prefectures) commonly known as Hokuriku and the inland area of Central Japan (Nagano Prefecture) known as Shinshu. The total area mass is 3,880,000 ha. The Tsushima Warm Current flows northward along the coasts of Sea of Japan and the seasonal winds from the Asian Continent run into approximately 3,000 metre high mountains behind the coast. This condition brings frequent and heavy rain and snow. The cluster houses various climatic divisions from warm temperature zones (low land) to cold zones (alpine), and acts as a transition zone from a warm temperature zone to a cold zone. The climate of Hokuriku is mild with abundant annual precipitation with heavy snow in winters. Regional differences between Hokushinetsu and metropolitan areas widened when the capital and people moved to metropolitan cities on the Pacific Ocean side during and after the rapid economic growth of the 1960s. Depopulation and the ageing of the population are serious problems in this cluster. The national population ageing rate is at 22.7 per cent,

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whereas Hokushinetsu is at 25.3 per cent (7,605,000 people), Ishikawa Prefecture is at 23.4 per cent and Noto region is at 33.5 per cent (2009).

The agricultural ecosystem of *satoyama* of this cluster is composed of large-scale paddy fields in alluvial fans, terraced fields and terraced paddy fields in hilly areas, and "*yachida*", paddy fields in valleys in hilly and mountainous areas. Slash-and-burn agriculture used to be practiced in the mountainous regions. The forest ecosystem of *satoyama* in the cluster is comprised of coastal forests with specific functions like windbreak forests and *uotsuki* forest (fish breeding forest), homestead woodland, coppice woodland with oak (primarily *Quercus serrata* [*konara* oak]) as the main tree, bamboo forests, and plantation forests made up of coniferous trees like *Cryptomeria japonica* (Japanese cedar) and *Thujoposis dolabrata* ("*ate*"). The inland water ecosystem is comprised of rivers, springs, and irrigation ponds seen in mountainous and hilly areas.

Main components of *satoumi* include lagoons that were created in a bay where it would be divided by sand reef or sand dune, rocky shore, sandy coast and seaweed bed in shallow areas.

10.1.2 Objectives

This chapter intends to summarize changes that occurred in *satoyama* and *satoumi* in the Hokushinetsu region over the past 50 years, while shedding light on direct and indirect drivers that contributed to the current conditions. We will also examine the trends of these changes and develop scenarios for conservation and use of *satoyama* and *satoumi* for the twenty-first century, attempting to provide policy guidance accordingly. Stakeholders from universities, research institutes, and local and regional governments participated in the assessment of *satoumi* and *satoyama* in this cluster. The discussions were based on information gathered and their analysis. Participation of local governments from prefectures, cities, and towns was a characteristic unique to this cluster.

10.2 Historical and narrative context

In Hokuriku, the lives of people expanded from hilly areas to edges of alluvial fan or flat areas in the mid-Jomon period (14,000 BCE–300 BCE). In Kahokugata Lake and surrounding area, paddy was cultivated about 2600 years ago (from late Jomon period into mid Yayoi period).

Under the feudal system during the Edo period (1603 to 1868), in Hokuriku there were many small and medium-sized domains in addition to large domains including Fukui *Han* (domain), Kaga *Han* and Nagaoka *Han*. There were a total of 19 small and large domains in Shinano Province (Nagano Prefecture) including Matsushiro *Han*. During the Edo period, Kaga *Han* (1,190,000 *koku*; 1 *koku* = 150 kg of rice) developed approximately 330,000 *koku* worth of paddy fields. In the second half of the seventeenth century, *kaisakuhou,* a large-scale reform of agriculture, was put into place for the domains to directly control farmers. *Kaisakuhou* helped to develop a monetary economy, which encouraged farmers to increase production. Leading farmers in each region would publish technical farming guides in response to desires for more advanced farming technologies. Mountain forests were deforested during the Edo period when timber was demanded as fuel for salt production (*shiogi*) and construction. As part of mountain forest protection measures, Kaga *Han* established feudal forests called "*ohayashiyama*" and "*ohayashi*" and established "the system of seven kinds of trees" which limited the logging of certain species, including pine and chestnut trees. Villages that were only able to make tax payments in a form of marine products were given the right to fish. There were many restrictions on fishing equipment and methods for each region during the Edo period, and consequences of non-compliance were severe. Because each fishing village was given an exclusive area for fishing, policies were followed well. Fishing methods matched well to types of fish caught in each region, such as set fish nets seen in Toyama Bay, and *boramachi yagura*, a platform where fishermen would wait for *Mugil cephalus* (flathead mullet) and catch it in a net, was common in Nanao Bay.

Industrialization came in the second half of the nineteenth century. Taking advantage of ample precipitation, places like Toyama Prefecture use hydroelectricity. Many modern factories that use electrical power were constructed and created the Hokuriku industrial region. Rapid industrialization accelerated in the twentieth century and brought industrial pollution and environmental contamination to Hokushinetsu (e.g. *itai-itai* disease [cadmium poisoning disease] in the Jinzu River and *Niigata Minamata* disease [mercury poisoning disease] in the Agano River). The effects of environmental contamination in the Asian continent became apparent in Japan in the late twentieth century with acid rain, yellow sand and harmful aerosol. Issues related to the ocean are becoming more serious each year, with an oil spill near the coast of the Sea of Japan by a Russian tanker named Nakhodka in 1997, poor fish catches due to an outbreak of *Nemopilema nomurai* (Nomura's jellyfish) seemingly drifting from the mouth of the Yantze River from about 2002, and garbage washing ashore from foreign borders being recent examples. As can be seen from the above, Hokuriku is located such that it is highly affected by cross-border pollution from the Asian continent. Such pollution is a source of concern for *satoyama* and *satoumi*. In addition, the energy revolution and rapid economic expansion that occurred in the 1960s made conditions surrounding rural areas much worse. Depopulation and an ageing population have further caused rural areas to decline in economic and social importance.

10.3 Current condition and trends

10.3.1 Provisioning services

1) Farmland ecosystem

Hokuriku is known as “rice country” because its warm climate with a lot of rain is ideal for rice production, while snow accumulation in winter makes the region unfit for other crops. In Hokuriku, in the 30 years from 1978 to 2008, the area of paddy fields decreased from 352,400 ha to 287,100 ha, and the area of other agricultural fields reduced from 43,200 ha to 33,100 ha. In Ishikawa Prefecture, the area of paddy fields reduced from 57,400 ha to 37,100 ha (35.4 per cent reduction), and the area of other agricultural fields reduced from 13,600 ha to 7,180 ha (47.2 per cent reduction). The amount of abandoned farmland in Ishikawa Prefecture was 2,321 ha (5.4 per cent) in 1995, but increased to 3,131 ha (8.7 per cent) in 2005. That is a 34.9 per cent increase in 10 years. Rice yield of Ishikawa Prefecture increased from 230,000 t in 1960 to its peak in 1968 at 264,700 t. After the production quantity hit its peak in 1968, yield per given area increased because of technological advances, but the overall yield kept decreasing due to reduction in the paddy field area. The yield in 2005 was 142,000 t. The yield reduced to 139,100 t in 2008 (47.4 per cent reduction from 1968), showing the continued reducing trend.

2) Forest ecosystem

The use of timber, wood based energy sources and forest products has been decreasing over the past 50 years. This decrease in use was primarily driven by the low price of timber, cheaper imported materials, lack of labour from depopulation and the ageing of the population in the area. On the other hand, the stock of timber and other forest products has increased. The forest area in Ishikawa Prefecture was 294,000 ha in 1970, then dropping by 7,544 ha to 286,456 ha in 2006. In particular, in the first five years of the 1970s, the forest area reduced by 4,400 ha due to conversion into land for residential, agricultural and leisure uses. The ratio of forests to the overall land area of the prefecture was 69.1 per cent in 1975, and this dropped to 68.4 per cent in 2006. This is a reduction of 0.7 per cent.

The main provisioning ecosystem service from forests is timber. Other major provisioning services included charcoal that was used until the 1950s, and thereafter cultivation of raw-wood *shiitake* mushrooms that utilized broadleaved trees. The timber production in Ishikawa Prefecture dropped from 495,000 m^3 in 1961 to 94,000 m^3 in 2003, and started increasing thereafter. This increase is primarily due to the increased production of plywood material for domestic timber.

3) Marine ecosystem

Hokuriku possesses waters rich with aquatic resources. These waters provide fishery products and seaweed. A unique characteristic of Hokuriku fishery products is the high ratio of squid in the catch as compared to the rest of the country. The fish catches however, have been decreasing since 2002.

Fish catches from Ishikawa Prefecture by deep-sea fishing recorded the highest catch in 1970 (approximately 36,000 t in total), but has been decreasing ever since. The impact of deep-sea fishing to the fish catch quantity has been decreasing since the establishment of 200-nautical mile system. Offshore fishery was showing an increasing trend from 1968 to 1990, when it reached its peak of 166,000 t. However, it too has been decreasing. The key factors responsible for the increasing trend up until 1990 were enhanced equipment onboard fishing boats, increasing sizes of deep-sea and offshore fishing boats, and significant increase of *Sardinops melanostictus* (Japanese sardine) catches between 1983 and 1990. The amount of catches from coastal fishing had been steady at about 20 to 30 per cent for a period of time, but increased after 2005 to 40 per cent. The importance of coastal fishing has been increasing.

Main shellfish caught in Ishikawa Prefecture include *Haliotis* spp. (abalone), *Turbo cornutus* (horned turban), and *Crassostrea nippona* (Japanese oyster). Sea cucumber (primarily *Stichopus japonicas* [Japanese common sea cucumber]) and oyster farming are being carried out in Nanao Bay, which is an enclosed water body. The production quantity of farmed oysters and sea cucumbers has been decreasing in recent years.

10.3.2 Regulating services

1) Water

It snows a lot in Hokuriku. Part of the snow replenishes the ground water reservoirs. It flows as subsoil water under alluvial fan, and then springs out at the edge of alluvial fan to be used for human activities and needs. The underground water has been used for industrial and drinking water purposes, and it has contributed to a high level of biodiversity within the downstream basin. However, overuse of this underground water reduces the quantity of water in natural springs and is also causing subsidence. River water has been used for power generation, agriculture and drinking water through the construction of dams and improvement in water facilities. Agricultural use, in particular, increased significantly with enhancements to fundamental agricultural facilities as well as improved water management. On the other hand, the natural water networks, essential for much of the biodiversity in these areas, were segmented because of the use of concrete channels or pipes for water channels. But more recently, many water reservoirs are being abandoned because of the decreasing trend in agricultural activities caused by depopulation and an ageing population. Moreover, enhancements to irrigation facilities are another reason why the long-used traditional water reservoirs are being abandoned. The number of water reservoirs in Ishikawa Prefecture reduced from 3,220 in 1985 to 2,286 in 2007 (about a 30 per cent reduction).

2) Soil

Conifer plantations (*C. japonica* (Japanese cedar), *Chamaecyparis obtusa* (Japanese cypress) and *T. dolabrata* ("*ate*") in Ishikawa Prefecture, which had low undergrowth vegetation cover due to lack of maintenance, had about three to 65 times more soil runoff compared to those plantations that are maintained well and have plenty of undergrowth vegetations. As this case shows, deterioration of regulating ecosystem services such as watershed protection and prevention of soil runoff is a growing concern.

Along the coast, sandy beaches have been receding as well. For example, the beaches that lay between Shirao in Kahoku City and Chirihama in Hakui City in Ishikawa Prefecture have been receding. One contributing factor for this highlighted by the study is the reduced quantity of sediment provided by rivers because of the dams that have been constructed upstream.

10.3.3 Cultural services

The Tsushima Warm Current flows northward along the coast of Hokuriku. This current has provided ideal conditions for broadleaved evergreen forests, which are the original vegetation of the area. Many of these forests are protected as shrine forests, and are symbols of faith and culture with some of these designated as "forbidden forests". These forests also have high academic value because they exhibit original vegetation and provide a valuable source of information for academic studies. Many shrines, temples, and personal residences in Ishikawa Prefecture have *Cerasus lannesiana* (Chrysanthemum Cherry trees) and *Rhododendron obtusum* (Noto-Kirishima azalea) growing; these plants have high local cultural significance.

Local traditional festivals that stem from prayers for good harvest and bountiful fish catches as part of *satoyama* and *satoumi* agriculture, forestry and fishing industries have been an integral part of the local culture. Kiriko Festival is a traditional festival in the Okunoto region and it is the biggest spiritual and religious activity for the locals. Traditional cuisine "*yobare*" is served at the festival. However, with the ongoing labour shortage and ageing of the population, many villages are no longer able to host this long-standing traditional *Kiriko* festival. Mushroom gathering from *satoyama* landscapes is one of the traditional recreations in Ishikawa Prefecture. Large varieties of mushrooms like the Tricholomataceae family, which also have local names, are gathered. Green tourism, where tourists participate in regional activities such as festivals and mushroom gathering, while staying at farming, mountain and fishing villages are becoming increasingly popular in Ishikawa Prefecture. Success of ecotourism and green tourism that utilizes resources available in *satoyama* and *satoumi* for regional redevelopment can transition provisional services from the agricultural, forestry and fishing industries into cultural services. Environmental education for the next generation using *satoyama* and *satoumi* is also becoming more prevalent.

10.3.4 Biodiversity

Biodiversity has decreased in Ishikawa mainly due to both the mismanagement of forests, as well as unlogged forests. This has resulted in the increasing size of the habitats of large mammals such as *Capricornis crispus* (Japanese serow), *Macaca fuscata* (Japanese macaque), *Ursus thibetanus* (Asian black bear), *Cervus nippon* (Japanese sika dear) and *Sus scrofa* (wild boar). The subsequent increasing population of these mammals has led to increasing economic damage caused by these animals to the already declining farming and forestry industry. In addition to the increasing population size of the native animal species, alien species such as *Procyon lotor* (common raccoon) and *Paguma larvata* (masked palm civet) have also been increasing and contributing to the damage to forests and farms. *Paguma larvata* (masked palm civet), originally living in hilly and mountainous areas of Kanazawa and Kaga in Ishikawa Prefecture, have now expanded their habitat and encroached into the Noto Peninsula and are causing damages to agricultural crops. While the population of mammals has been increasing, the population size of *Passer montanus* (Eurasian tree sparrow) and *Hirundo rustica* (barn swallow), who make their habitats in a human settlements with an abundance of rice paddy presence, has been on the decline due to the declining number of households, rice fields and other agricultural activities. Such changes to the bird population affects ecosystems in the surrounding environment.

The close proximity of inland water systems (i.e. ecosystems with surface water and underground water, including rivers, lagoon, paddy fields and irrigation ponds) to people's living areas, makes the biodiversity in these systems vulnerable to human activities; and as such proper management is in particular required for these ecosystems. The Red Data Book of Ishikawa Prefecture lists a total of 10 types of freshwater fish under threat. The primary factor for this threat is "Crisis 1: Human Activities and Developments" as discussed in the *National Strategy for the Conservation and Sustainable Use of Biological Diversity 3rd Edition* (2008). Factors such as concrete water channels, disruption of movement due to drop structures, reduction of groundwater level, conversion of lagoon into freshwater and upgrading of water reservoirs can destroy, divide, and deteriorate animal habitats. Also, alien species have a large impact on ecosystems. In Ishikawa Prefecture, alien species such as *Micropterus salmoides* (largemouth bass), *Micropterus dolomieu* (smallmouth bass), and *Lepomis macrochirus* (bluegill) are increasing their breeding grounds. *M. salmoides* (largemouth bass) was introduced by humans into the prefecture in 1975, *M. dolomigu* (smallmouth bass) in 1999, and *L. macrochirus* (bluegill) in 1975. *Trachemys scripta elegans* (red-eared slider), *Rana catesbeiana* (American bullfrog) and *Procambarus clarkia* (red swamp crayfish) have also expanded their habitats. In particular, *R. catesbeiana* (American bullfrog) and *P. clarkia* (red swamp clayfish) are expanding into the Okunoto region, which was not previously invaded by these species.

In coastal plant communities in Ishikawa Prefecture, both northern plants (*Rosa rugosa* [rugosa rose] and *Leymus mollis* [American dunegrass] communities) and southern plants (*Vitex rotundifolia* [beach vitex]–*Melanthera prostrata* communities) naturally coexist in mosaic like fashion. In recent years, habitats of seaside plants have been in decline in some regions. For instance, communities of *Carex kobomugi* (Asiatic sand sedge), *Carex pumila* (dwarf sedge), *V. rotundifolia* (beach vitex) and *R. rugosa* (rugosa rose) were spread widely in 1966 in Uchinada Sand Dune (Uchinada Town, Ishikawa Prefecture), but the communities are presently extremely limited within small areas. Currently, rare plant species in coastal areas include *Glaux maritima* var. *obtusifolia* (sea milkwort) and *Viola grayi*. Rare animal species include *Abroscelis anchoralis* (tiger beetle) and *Lycosa ishikariana* (burrowing spider).

The seaweed bed that contains *Sargassum* spp. (gulfweed) and *Zostera* spp. (eelgrass) in Noto Peninsula is the foundation for offshore biodiversity. In the rocky zone of Sotoura Beach (west coast of Noto Peninsula), *Ecklonia stolonifera* dominates the area, and in the rocky zone of Uchiura Beach (east coast), *garamo* field (seaweed bed of *Sargassum* spp.) comprised of *Sargassum patens*, *Sargassum confusum*, *Sargassum macrocarpum* and *Sargassum fulvellum* is dominant. Although the overall areas of these seaweed beds have not decreased, reduction in growth quantity is increasingly becoming evident.

Table 10.1 Overview of trends in ecosystem services (Hokushinetsu cluster)

Ecosystem services	Subcategory	Human use	Enhancement/ degradation	Remarks
Provisioning services				
Food	Rice	▼	▲	There was a temporary increase in rice yields per "*tan*" (a [*tan*] is a unit of surface area equal to 100 square metres) as well as total rice yields due to improvement in production technology. However, due to the increase in abandoned cultivated land in recent years, total rice yields have been declining.
	Seafood	+/−	NA	The level of increase and decrease of fish catch varies depending on fish species. However, total fish production has been decreasing.
Housing	Lumber	▼	▲	Lumber production (utilization) has been decreasing while forest volume has been increasing as a result of the dependence on imported lumber.
Energy	Charcoal and firewood	▼	▼	Production has been decreasing due to the fuel revolution.
	Electricity	▲	▲	There has been an increase in hydropower generation capacity that utilizes abundant water resources in mountainous areas. The power generated is supplied to metropolitan areas on the Pacific side.
Regulating services				
Atmosphere	Climate	▲	NA	The average temperature is increasing as a trend.
	Atmosphere composition	▲	NA	Industrialization and urbanization have led to an increase in CO_2 emissions.
	Cross-border pollutants	▲	NA	There has been an increase in cross-border pollutants and yellow sand that come from the Asian Continent.

Table 10.1 (cont.)

Ecosystem services	Subcategory	Human use	Enhancement/ degradation	Remarks
Water	Agricultural water management	+/–	NA	Farmland restructuring has improved the ratio of the development of water channels. However, the utilization of irrigation ponds and the water retention capability of forest have decreased.
	Flood prevention	+/–	NA	Flood control capabilities have been enhanced as the result of dam construction and bank protection work along rivers. However, changes in land use and insufficient land management have caused deterioration in the flood prevention function provided by forest and farmland.
Soil	Forest	▲	▼	There is a concern that soil runoff and the decline in the water source protection function in uncared for plantation forest may occur.
	Seacoast (sand beach)	▲	▼	Sand beaches have been receding due to factors such as the decrease in sediment supply as a result of dam construction in upper reach areas of rivers.
Cultural services				
Artistic value	Traditional craftwork	▼	NA	There has been a decrease in the production of craftwork such as lacquer ware. It has become difficult to pass on craftwork technology to the next generation.
Spiritual and religious value	Forest around temples and shrines (sacred forest)	▼	NA	The development of forest roads and housing areas has destroyed forests around temples and shrines. In addition, a decrease in shrine parishioners has led to a lack of management.
	Traditional festivals	▼	NA	Festivals have deteriorated due to depopulation and the ageing of the society.

Recreation	Environmental education	▲	NA	Through the utilization of *satoyama* and *satoumi*, environmental education has been actively conducted for people of the next generation mainly by local governments and schools.
	Green tourism	▲	NA	There has been an increase in the number of facilities and visitors.
Supporting services				
Forest	Water source protection Protection from disasters in mountainous areas			Supporting services are essential to produce all of the other types of ecosystem services. Drivers that have brought about changes in ecosystems have direct impact on provisioning, regulating, and cultural services. On the other hand, these drivers have indirect and long-term impact on supporting services. Moreover, the impact of changes in supporting services on people is indirect. The impact emerges over an extremely long period of time.
Water cycle				
Nutrient cycle				
Primary production				

Notes: ▲: Increase ▼: Decrease (degradation), +/–: Mixed (Both increasing and decreasing trends have been observed over the past 50 years. Additionally, it may be possible that there is an increase in some items or regions while there is a decrease in other items or regions.), NA: Impossible to assess (due to a lack of data and discussion not having been conducted)

10.4 Drivers of changes

Primary indirect drivers of changes in ecosystem services in Hokushinetsu are globalization, changes to lifestyles (energy revolution with use of gas and fossil fuel, use of chemical products), industrialization and urbanization. Direct drivers include abandoning of management due to depopulation and the ageing of the population, and alteration of habitats due to construction (dam construction, farmland consolidation, lagoon reclamation, seaport construction). Depopulation and the ageing of the population were primarily caused by changes in industry and lifestyles that occurred at the national level in the 1960s. During the rapid economic expansion of the 1960s, industries shifted from primary to secondary, then from secondary to tertiary, and energy shifted from coal, charcoal and firewood to fossil fuel and natural gas. With these shifts, the population moved from rural areas to urban areas, causing urban congestion while agricultural and fishery villages were depopulated and left with an ageing population. The ageing population as of 2009 in Hokushinetsu was at 25.3 per cent, compared to 22.7 per cent at the national level.

10.4.1 Abandoning management due to depopulation and ageing

1) Farmland ecosystem

The number of agricultural workers has been declining with migration to urban areas since the rapid economic expansion of the 1960s, and more recently with the centralization of agriculture due to large-scale farming. Agricultural workers in Ishikawa Prefecture declined from 233,614 in 1960 to 94,914 in 2006 – a 59.4 per cent decrease. Among agricultural workers, the ratio of workers who are 60 years old or older has increased from 30.5 per cent in 1983 to 79.8 per cent in 2004. This shows that seniors are the pillars of the current Ishikawa Prefecture agricultural sector. The ratio of senior workers over 65 in Hokuriku as a whole (66 per cent, 2005) is on the rise, and higher than the national average of 57.4 per cent (2005) in Japan.

Hokuriku leads ageing in Japan, and has a declining farming population. In addition, many agricultural workers hold other jobs in addition to farming to supplement their income. These issues have lead to lower arable field utilization rates and the abandonment of arable fields. Therefore, the mixed housing arrangements between agricultural households and non-agricultural households and the depopulation of mountainous agricultural regions are causing difficulties in maintaining farming facility management, water channels and water reservoirs leading to a fragmentation of the mosaic structure typical of *satoyama* landscapes.

2) Forest ecosystem

The number of people involved in the forestry sector within Ishikawa Prefecture was 1,192 in 1988. This number declined to 600–700 between 1993 and 2003, dropped below 500 in 2005, and then dropped even further to 358 people in 2006. Factors for this decline include reduced amount of available work in afforestation and silvicultural management, reduced price of timber and the merging of forest unions.

3) Marine ecosystem

The number of people engaged in marine fishery in Ishikawa Prefecture declined from 9,647 in 1963 to 44 per cent of that figure (4,282 people) in 2003. The deep-sea fishing population also declined from 475 people in 1988 to 6.5 per cent of that figure (31 people) in 2003; the offshore fishing population also declined from 989 in 1988 to 45 per cent of that figure (449) in 2003. The inshore fishing population declined 70 per cent from 5,437 to 3,802 (69.9 per cent). These reductions in many ways were influenced by international regulations related to fishing.

The gender and age group that dominated the fishing population was males between 30 and 39 years old in the 1963–1968 period, shifting to 40–49 year olds in the 1973–1978 period, and then shifting further to 50 to 59 year olds in the 1983–1988 period. In 1993, approximately 40 per cent of the fishing population was aged 60 years old or older, and 30 to 32 per cent were between 60 and 69 years old in 1998 and 2003. This shows that the core members of the labour force who were in their 30s in the 1960s are still the core members of the labour force today, but much older. The ratio of people 60 years old or older was 20 per cent or lower between 1963 and 1983, but it reached 53.6 per cent in 2003. On the other hand, while about 25 per cent of the fishing population was 29 years old or younger in 1963 (2,094 people), that number has reduced to about only 5 per cent (192 people) in 2003.

10.4.2 Habitat modification

1) Farmland ecosystem

In Ishikawa Prefecture, farmland consolidation for water paddy fields, which started at the national level in 1963, began within Kaga City in 1965. Traditional water paddy fields were now required to be drained in order to mechanize farming and to be converted into dry paddy fields Under-drains were constructed, and these drains were dug deep (over 70 cm) to reduce the underground water level. In addition, pipes were used for water drainage channels or the channels were lined with concrete to reduce maintenance costs and to effectively utilize water resources. However, with these constructions, *Carassius* spp. (crucian carp) and *Silurus* *asotus* (Japanese common catfish), that bred in paddy fields, lost their breeding grounds because of a loss of pathways between water channels and paddy fields. Between 1994 and 2001, funds from Uruguay Round related to "New Policies for Food, Agriculture and Rural Areas" were spent on farmland consolidation in Noto and the surrounding regions with 1 *hitsu* (lot) 1 ha compartmentalization. Modernization areas over 30a were 22,995 ha (approximately 62 per cent of paddy fields in Ishikawa Prefecture), and the rate of modernization of paddy fields (the ratio of consolidated land area over 30a to total area of land required for farmland consolidation) in Ishikawa Prefecture in 2008 was 76.1 per cent.

Field modernization for dry fields also started in the 1960s. In Ishikawa Prefecture, seven areas totalling 2,559 ha were developed between the 1960s and the 1990s under the National Farmland Development Project. The development occurred in Okunoto and surrounding regions. The reason that the Okunoto region was chosen for the large-scale development was that the region had large hilly areas at the tip of the peninsula which travelling to and from was difficult. The project attempted to develop this region through developing necessary roads, stabilizing labour and reducing the income disparity between this rural region and urban areas.

2) Forest ecosystem

Forest areas in Ishikawa declined between the early 1970s and the 1980s because they were developed into farmland, roads, residential areas and leisure areas. In the 1960s, the National Farmland Development programme (began in 1961) and Noto Toll Highway construction (began in 1971) focused on mountainous areas of the Okunoto region where land prices were low. In the 1970s, development of land for leisure such as golf courses and resort homes, inspired by *Rettou Kaizouron* (Japan Archipelago Remodel Plan) in 1972, began in earnest. By the 1990s, there were noticeable conversions of forests near urban areas into housing.

3) Inland water ecosystem

In lagoons in Ishikawa, including the Kaga Three Lakes (three major lakes of Kaga), Ouchigata Lake and Kahokugata Lake, reclamation and paddy field development advanced after World War II to enable the mass production of food. Approximately 60 per cent (1,359 ha) of Kahokugata, which was the largest lake (2,248 ha), was reclaimed. Approximately 80 per cent (374 ha) of Ouchigata (456 ha) in Hakui City, about 60 per cent (343.2 ha) of Shibayamagata (576.2 ha) in Kaga City and all of Imaegata (238 ha) in Komatsu City were reclaimed. Remaining lagoons were transformed into freshwater lagoons. These were turned into enclosed waters with tide gates causing a deterioration in water quality.

4) Marine ecosystem

From about 1960 and into the rapid economic expansion era, coastal reclamation and seashore development were rapidly conducted. Roads were created and expanded for stabilizing livelihoods and for convenience. In sandy beaches of the Noto region, the population of *Cincindela anchoralis* and *Lycosa ishikariana* decreased because of the creation of artificial coasts with coastal development, offshore levees, and vehicles accessing the area. With the enlargement of fishing boats, local ports were expanded and coastal levees were elongated. In particular, many fishing ports were developed in the Noto region.

10.5 Responses to changes

There have been many responses to changes in ecosystems and social situations surrounding *satoyama* and *satoumi* in Hokushinetsu. The responses have been from multitude of sectors including the agricultural, fishery and forestry industries, environment, tourism and culture. In the past, various government departments used to take on these tasks, but in recent years, many other organizations such as local communities, NPOs and businesses have become increasingly involved. The project tasks are becoming more diverse as well.

10.5.1 Legal responses

In order to promote even development of the nation and underpopulated rural areas, the national government enacted five regional development laws. These were the Remote Island Development Act (1953), Mountain Villages Development Act (1965), Depopulation Act (established in 1970, succeeded by the Act on Promotion of Independence for Underpopulated Areas in 2000), Peninsula Areas Development Act (1985) and Designated Rural Areas Act (1993). However, even with these legal responses, the economic difference and imbalance have been widening between urban areas in the Pacific Ocean side and underpopulated areas such as Hokushinetsu. Ishikawa Prefecture, recognizing the importance of hilly and mountainous areas where underpopulated regions were concentrated, formally defined “hilly and mountainous areas” in 1996 before any other prefectures. The prefecture established the Hilly and Mountainous Area Response Office within its Agriculture, Forestry and Fisheries Department, and has been attempting comprehensive and pioneering activities to tackle issues in those areas.

Farmland: With the establishment of the “Food, Agriculture and Rural Areas Basic Act” in 1999, Ishikawa Prefecture recognized the multifunctional nature of the farming industry and farming villages, and has taken on projects and policies to support agricultural workers and promote the revitalization of farming villages, such as "Ishikawa School of Paddy Fields", "Guidelines for Environment-oriented Ishikawa Farmland Consolidation", "Subsidies for the System of Direct Payment in Hilly and Mountainous Areas", "Rural Space Development Project" and "Wide-Area Environmental Maintenance Project".

Forest: With the declining timber price, many plantation forests in the country became mismanaged, which led to deterioration of the public functions of forests such as watershed protection and national land conservation. Acting on these concerns, many municipal governments beginning in 2003 started establishing regional taxes for the purpose of forest maintenance and conservation. Ishikawa Prefecture followed suit in 2007 with the "Ishikawa Forest Environment Fund Ordinance" and "Ishikawa Forest Environment Tax".

Fishing Industry: Under the "Fisheries Basic Act" enacted in 2001, a new fisheries management system, the "Resources Recovery Plan", was established. In 2003, the TAE system, whereby the upper limit of fishing efforts was defined as the "Total Allowable Effort (TAE)", was adopted. In 2002, a management plan for *Hippoglossoides dubius* (flathead flounder) and *Chionoecetes opilio* (snow crab) was established for the mid-western part of the Sea of Japan (from Ishikawa Prefecture to Shimane Prefecture). Under this plan, Ishikawa Prefecture established *C. opilio* (snow crab) protected areas and adopted modified nets. In 2007, Ishikawa Prefecture independently established plans for *Paralichthys olivaceus* (olive flounder) and Pleuronectidae (righteye flounder family).

The first comprehensive environmental act by Ishikawa Prefecture is the "Ordinance to Protect the Environment of Ishikawa" established in 2004. Later provisions included the "Promotion of Conservation and Protection of *Satoyama*" and the "Establishment of Biodiversity (rare wild animals and plant species, foreign species, etc.)".

In 1968, the national government established the Noto Peninsula National Park that primarily covered the coastal area of Noto Peninsula (including parts of Ishikawa and Toyama Prefectures), and Echizen-Kaga National Park, which includes Wakasa Bay in Fukui Prefecture and the coast of Kaga City in Ishikawa Prefecture. In 1971, the Uchiura Marine Park in Noto Town in Toyama Bay, and Kinoura Marine Park on the Sotoura Coast in Suzu City were opened. In 1993, Katano Kamoike in Kaga City became a registered wetland under the Ramsar Convention. In 1997, Kahokugata Lake and Kahoku Coast were designated as "Important Stopover Sites for Migratory Shorebirds (Scolopacidae [sandpipers] and Charadriidae [plovers])" by the Environmental Agency. In addition, Ishikawa Prefecture publicized endangered wildlife species (animal version and plant version) to establish rare species and protected species. The prefecture also named eight animal species and seven plant species that are particularly in need of protection as "Ishikawa Prefecture Designated Rare Wildlife" to prohibit hunting under the "Ordinance to Protect the Environment of Ishikawa".

The *Satoyama* Project Team (*Satoyama* PT) was established in July 2008. The team consists of various departments, including the Department of Environment, Department of Agriculture, Forestry and Fisheries, Department of Civil Engineering, Department of Tourism Exchange, and Department of Planning and Promotion, responsible for conserving *satoyama and satoumi*. The team's mandate is to consider and execute new cross-sectional policies to appropriately utilize resources and conserve biodiversity in *satoyama* and *satoumi* in Ishikawa Prefecture. As a local biodiversity strategy, "Ishikawa Biodiversity Strategic Vision" was laid out in March 2011. Furthermore, in April of 2011, the *Satoyama* Innovation Office was established in Ishikawa Prefecture.

10.5.2 Economic responses

Under the Subsidies for the "System of Direct Payment in Hilly and Mountainous Areas", which was started in Ishikawa Prefecture in 2000, a total of 512,190,000 yen was paid out against 422 agreements for 3,456 ha.

As for the forests, Ishikawa Prefecture adopted Ishikawa Forest Environment Tax (started in 2007, scheduled to end in 2011) in order to improve and manage the unkempt coniferous plantations under the "Ishikawa Forest Environment Fund Ordinance". The tax supports activities like educating citizens in the prefecture and cooperative projects with NPOs, in addition to forest maintenance.

10.5.3 Societal, behavioural and cognitive responses

In order to gain more awareness of *satoyama* and *satoumi*, and to have real impact on social conscious and consumer behaviour, Ishikawa Prefecture adopted systems such as the "Sign System for Agri-Eco Products", "Eco-Farmer Certification System" and "Organic Japanese Agricultural Standard (JAS) Certification". In Ishikawa Prefecture, the Forest Stewardship Council (FSC) certified Kaga Forestry Union in 2005.

In Ishikawa Prefecture, forestry development activities were conducted in 17 locations by 15 businesses between 2000 and 2009 as part of Corporate Social Responsibility (CSR) activities. Ishikawa Forest Promotion Society (established in 1996) has been supporting the activities of businesses such as forest maintenance and public education.

The Ishikawa Nature School was established in 2001 to promote ecotourism and environmental education on *satoyama* and *satoumi*. The school connects nature experiencing programmes that are hosted by various private and government organizations as well as providings coaching and training.

As an educational institution, Kanazawa University established the "Kakuma *Satoyama* Nature School" in 1999. The school provides opportunities to learn about nature and the environment for citizens and children as well as University staff and students, utilizing the *satoyama* area within the university campus. In the Noto Peninsula, where depopulation and the ageing of the population is a serious problem, a closed elementary school building was utilized to establish the "Noto Peninsula *Satoyama Satoumi* Nature School" (Suzu City, Ishikawa) in 2006. In 2008, the Nature School's supporters developed and launched "NPO Noto Peninsula Our *Satoyama Satoumi*" and it is pursuing *satoyama* conservation through cooperation with local communities and the university. "Noto *Satoyama* Meister Nurturing Programme" started in 2007 to nurture the next generation of youths who will work towards the reactivation of *satoyama* from the perspective of environment-oriented agriculture, forestry and fisheries.

Although responses toward *satoumi* just started in recent years, Ishikawa Prefecture has been conducting "Nanao Bay *Satoyama* Creation Project" (2008 to 2009) as a part of "*Satoumi* Creation Supporting Model Project" (2008) of the Ministry of the Environment. The project was carried out by local governments and research institutions and has contributed to raising awareness among residents as well as the government.

10.5.4 Technological responses

An example of technological responses towards forest ecosystems includes the "Environmental Forest Development Project Monitoring" (started in 2007) to improve the maintenance and management of *satoyama* as part of "Ishikawa Forest Environment Fund Project". There is also the "*Satoyama* Guide to Forests" (published in 2007), which provides guidelines for *satoyama* forest maintenance activities by local citizens, NPOs and businesses.

Technological responses for marine ecosystems include marine ranching, aqua farming, and development of coastal fish farms. In Ishikawa Prefecture the experiment station has been supplying fishermen with fish seedlings for *Acanthopagrus schlegelii* (Japanese black porgy), *P. olivaceus* (olive founder), *T. cornutus* (horned turban), *Haliotis* spp. (abalone), and *Anadara broughtoni* (bloody clam) since 1968. This project has been appraised with such catches as 17 t (30,000,000 yen) of *A. broughtoni* (bloody clam) in 1994 and 1998. The development of coastal fish farms was started by a national project of "Costal Fish Farm Development" in 1976. These coastal farms are contributing to increasing resources through the construction of artificial fish reefs in various locations around Ishikawa Prefecture, building foundations for inquiline for *Stichopus japonica* (Japanese common sea cucumber) and *T. cornutus* (horned turban), and the creation of a seaweed bed as a feeding ground for *Pagrus major* (red seabream) and *A. schlegelii* (Japanese black porgy). Other examples include responses to stormy current for set fishing nets and use of LED lights on squid fishing boats (for energy efficiency).

Examples for inland ecosystems include the "Natural River Development Project" and nature regeneration of *Phragmites australis* (common reed) community.

10.6 Conclusion

The key findings from the evaluation of the current status and changes in ecosystem services of *satoyama* and *satoumi* in this cluster are:

Provisioning services

In farmland ecosystems, rice production plays an important role. Over the past 50 years, rice production increased temporarily with agricultural methods, variety improvements and field development. However, abandoned fields increased with depopulation, the ageing of the population and the lowered price of rice. Hence, both the overall rice yield and the area of rice paddy fields have decreased. In forest ecosystems the volume of timber and forest-related products produced is on a decreasing trend due to cheaper imports and a general reduction in the price of timber. On the other hand, accumulated timber resource is continuing to increase due to lack of use. In marine ecosystems, fishery production temporarily increased with development of fishing machinery and fishing grounds. With international regulations on the fishing industry, the primary mode of fishing shifted from deep-sea fishing to coastal and offshore fishing from the second half of the 1970s. The production volume is decreasing with the reduced resource.

Regulating services

Water management improvement was a primary driving factor for the consolidation of farmlands. However, with depopulation and the ageing of the population, managing water reservoirs and water channels that were used for a long time is becoming increasing difficult. The amount of pollutants and yellow sand that are blown over from the Asian Continent is on the rise in recent years. The impacts of these factors on ecosystems and societies needs to be analysed in future studies.

Cultural services

Traditional festivals held by local citizens are on the decline with depopulation and ageing of the population being factors for this. On the other hand, eco-tourism that uses *satoyama* and *satoumi* resources is being promoted as a regional redevelopment measure. With this, the provisional services from agriculture, forestry and fisheries are being expanded and transformed into cultural services. Environmental education for the next generation utilizing *satoyama* and *satoumi* is becoming more prevalent as well.

Biodiversity

The number of plantation forests, coppice woodlands and farmlands that are not properly managed are increasing as a result of a lack of labour due to depopulation and the ageing of the population. Biodiversity in *satoyama* is suffering due to lack of management. Damage caused by large mammals (*U. thibetanus* [Asian black bear], *M. fuscata* [Japanese macaque], *C. nippon* [Japanese sika deer], *S. scrofa* [wild boar]) is becoming a serious issue because these mammals invade human habitats due to an under management of forests. Moreover, changes in water irrigation systems and an introduction of pipes and concrete water channels to improve farm productivity have caused the destruction of the habitats of many species. The loss of this biodiversity has also caused a drop in the resiliency of farmland ecosystems. As for inland water ecosystems, specific foreign species such as *M. salmoides* (largemouth bass), *M. dolomieu* (smallmouth bass) and *L. macrochirus* (bluegill) are expanding their territories. On the other hand, for marine ecosystems, habitats for native animals and plants are decreasing because of coastal development and the disappearance of sandy beaches.

Drivers of changes

Direct drivers that affect ecosystems and ecosystem services are abandonment of management due to depopulation and the ageing of the population, and alteration of habitats due to construction. Indirect drivers that brought about these direct factors are globalization, lifestyle changes (energy revolution towards use of fossil fuels and use of chemical fertilizer and plastics, etc.), and industrialization and urbanization.

Construction that alters habitats includes dam construction in mountains (there is a need to consider the needs and issues related to dams after classifying them as mountain conservation, sand control, agricultural water and multi-purpose dams); consolidation of farmlands, reclamation of rivers, lagoons, lakes and ponds; port construction on coasts; and levee construction. These kinds of constructions improved some provisioning and regulating services, but have had huge negative impacts on ecosystems and biodiversity. For example, the construction of large dams reduces or stops water flows in rivers and as a consequence, decreases the supply of sand to coasts.

Responses to changes

In Hokushinetsu, national and municipal governments often led projects. In recent years, however, NPOs, businesses and universities are increasingly taking on more activities surrounding *satoyama* and *satoumi* conservation and regional redevelopment. We need to evaluate and understand the effects of these responses.

Future scenarios for satoyama *and* satoumi

Although we were unable to consider scenario development sufficiently in this chapter, we would like to proceed with the tasks by selecting appropriate factors for the Hokushinetsu cluster while referencing the scenario development process utilized by the MA and the national level of the JSSA. The tasks will be carried out at different local and regional levels (Hokushinetsu, prefectures, municipalities, villages, etc.), and the results will be used to help develop future plans. For the development of scenarios at the local level, an understanding of the relationships between global, national and regional levels of scenarios is crucial. Also, the development of scenarios for upper levels (cluster and national levels) will not be successful if they lack information from future trends of *satoyama* and *satoumi* on a local level. We plan to develop scenarios by fully utilizing scientific data and experiences of involved stakeholders gathered from activities thus far (including not only cluster and prefecture level, but cities, towns and other levels).

Future challenges

In the process of this evaluation, an enormous amount of scientific data was gathered and a network of stakeholders was formed. Going forward, we must continue to discuss amongst various stakeholders at different levels (Hokushinetsu, prefectures, cities, towns, villages, etc.), as well as supplement information gathered so far, share this information, and consider developing future scenarios, which we were unable to accomplish for this chapter. We hope to aid the crystallization of regional policies to conserve and utilize the biodiversity of *satoyama* and *satoumi*, while supporting regional redevelopment.

11

Kanto–Chubu cluster: The future of *satoyama*, *satoumi* and cities

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11.1 Overview

In conjunction with the development and expansion of urban areas, the artificial alteration of natural environments and the globalization of commerce and economies have been accelerating in each region. In the midst of this, the JSSA Kanto–Chubu cluster report regards *satoyama* and *satoumi* areas as models for sustainable ecosystems. In these *satoyama* and *satoumi* areas, local people, nature and culture are unified, harmonize with each other and coexist. The Kanto–Chubu cluster evaluated the current conditions of the ecosystems in *satoyama* and *satoumi* and urban areas, and discussed new values and an ideal society to take advantage of these *satoyama* and *satoumi* landscapes.

The Kanto and Chubu regions are located at the centre of the Japanese archipelago. The regions are located in the transitional zone of the broadleaved evergreen forest and broadleaved deciduous forest belts (Figure 11.1). These regions are influenced by the *Kuroshio* Current and the *Oyashio* Current. In addition, these regions are supported by a mild and moist climate, and an abundantly rich soil. These regions also receive benefits brought on by the ocean and constitute some of the world's leading metropolitan areas. Therefore, these urban areas have a major manifold relationship with the neighbouring or adjacent *satoyama* and *satoumi* and have affected *satoyama* and *satoumi*.

Satoyama–satoumi *ecosystems and human well-being: Socio-ecological production landscapes of Japan, Duraiappah, Nakamura, Takeuchi, Watanabe and Nishi (eds), United Nations University Press, 2012, ISBN 978-92-808-1210-7*

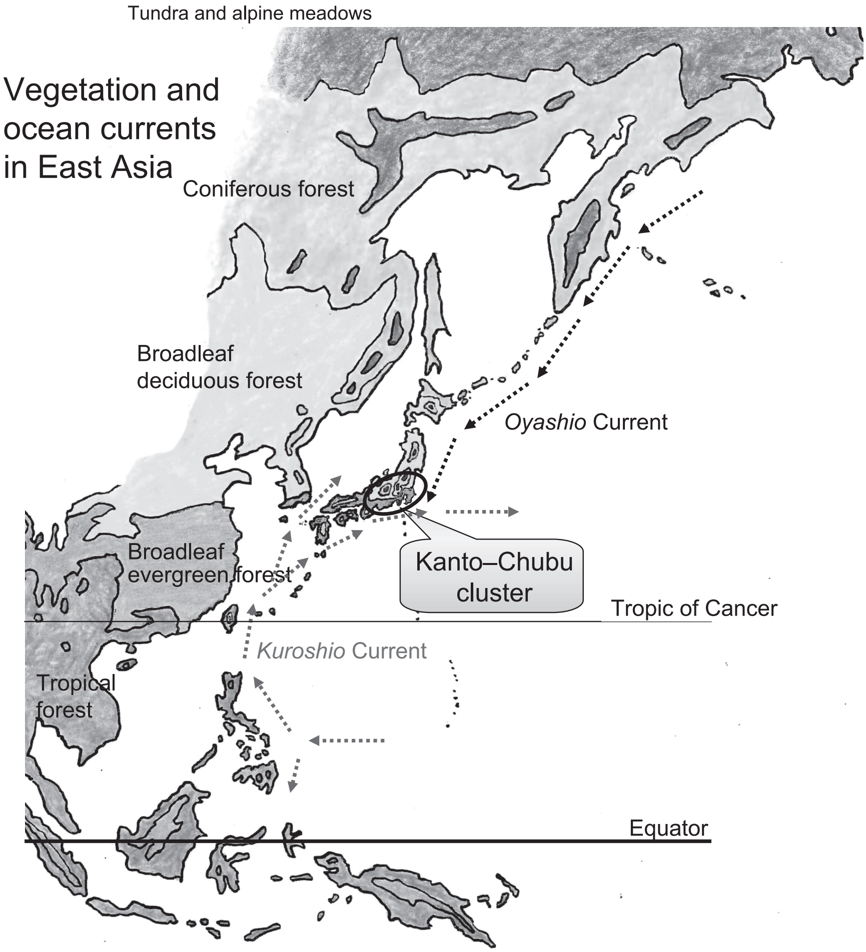


Figure 11.1 Location of the Kanto–Chubu cluster in East Asia
Note: Please see the back of this book for a colour version of this figure.

The population of the Greater Tokyo metropolitan area in the Kanto region of Japan is approximately 35.2 million people, indicating that Tokyo is the world's largest city. In addition, with a population of 2.25 million people, the city of Nagoya is a major economic and industrial leader in the Chubu region. The Kanto region includes Tokyo Bay, while the Chubu region encompasses Ise Bay and Mikawa Bay. Thus, marine resources in these regions have bolstered human activities and played important roles in the circulation system in watershed ecosystems.

11.2 Historical and narrative context

In the Kanto–Chubu cluster report, the concept of "*satoyama-satoumi*" is not used simply to compare "*satoyama*" and "*satoumi*". The origins of the term "*sato*" are found in the words "*ta*" (rice field) and "*tsuchi*" (earth). "*Sato*" also has the former meaning of an administrative unit or natural village. Returning to these origins of *sato*, this report has defined *satoyama* and *satoumi* as "a complex area where human habitations that are referred to as *sato* are integrated with neighbouring mountains and seas. Humans interact in pursuit of their livelihoods with these neighbouring mountains and seas. Various human, natural and cultural elements including rice paddies, fields, forests, rivers, ponds, seacoasts and oceans are incorporated."

One important reason to evaluate the ecosystems of *satoyama* and *satoumi* is the abundance of biodiversity. Despite the alteration of nature caused by humans who have for a long period reaped the benefits, the biodiversity of *satoyama* and *satoumi* has been maintained at a high level. The following three factors can be given as reasons for the high level of biodiversity displayed by *satoyama* and *satoumi*: (1) "the creation of a diverse and continuous aquatic environment such as rice paddies by human beings", (2) "a spatial mosaic that has been formed by plant communities and associations of diverse seral stages", (3) "moderate resource usage and a natural-world friendly culture".

The terrain conditions of the island and watershed are among natural units that human beings recognize. In addition to these natural elements, the elements of human society constitute a basic spatial area of *satoyama* and *satoumi* which corresponds to that of the previous Japanese "village". This is a basic unit of *satoyama* and *satoumi*. Furthermore, in watershed areas, social elements such as logistics and trade are added. This spatial area unit can be identified as the reflection of the concept of *satoyama* and *satoumi*. In the Kanto and Chubu regions, based on the unit of watershed areas, *satoyama* and *satoumi* as well as *satokawa* (*sato* river) and *satonuma* (*sato* pond) have been classified into nine categories according to location and structural characteristics (Figure 11.2).

The history of the relationship between humans and nature has roughly been divided into three eras: "hunting/gathering era", "*satoyama* and *satoumi* era" and "development and urbanization era". These eras have further been compartmentalized into 11 periods.

In the *satoyama* and *satoumi* era, life and livelihoods were managed in such a way that the benefits of the natural world were utilized to the maximum. In order to produce foodstuffs in rice fields and other fields, *karishiki* (branches, young leaves and shoots that were collected in mountain areas and placed in crop fields as fertilizer) and compost were pro-

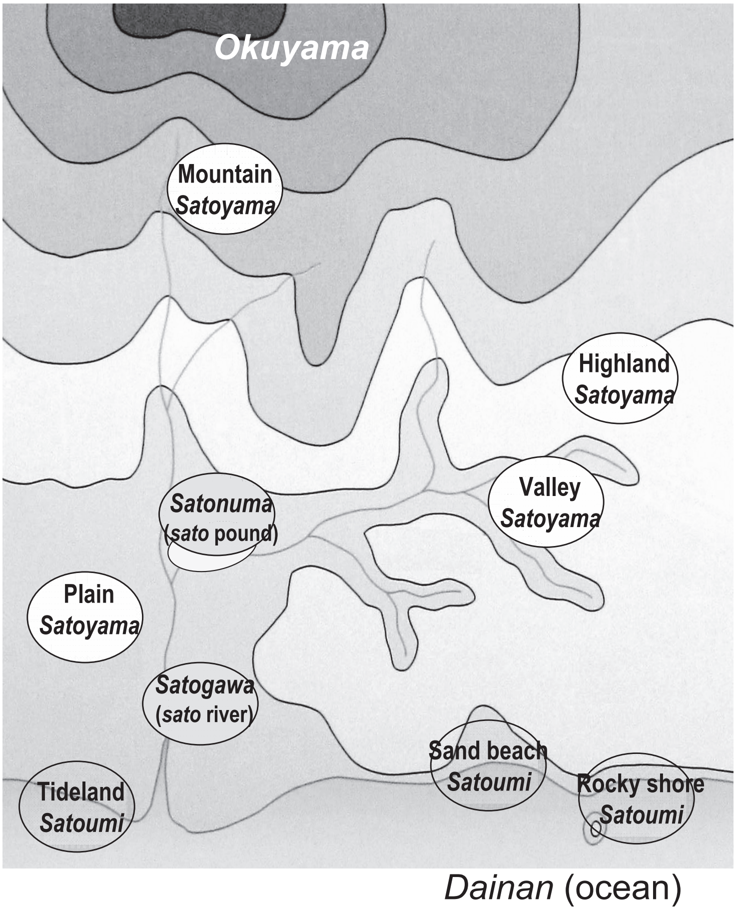


Figure 11.2 Spatial distribution of each type of *satoyama* and *satoumi*

duced in nearby forests and grasslands. There was a resource circulation system in which almost all the necessary energy of that time was supplied within the region (Figure 11.3). The outflow and inflow of goods into and from external regions took place through mechanisms called "*ichi*" (village market). In spite of this, an essentially independent cyclical semi-enclosed ecosystem was formed. However, coinciding with developments and advancements in science and technology as well as distribution economics, external resources and energy were introduced into regions and cities. These village markets began to expand and develop from "*machi*" (towns) to "cities" while absorbing the peripheral *satoyama* and *satoumi*. Through a further increase in population and an expansion of logistics, the alteration of the natural environment and globalization were promoted.

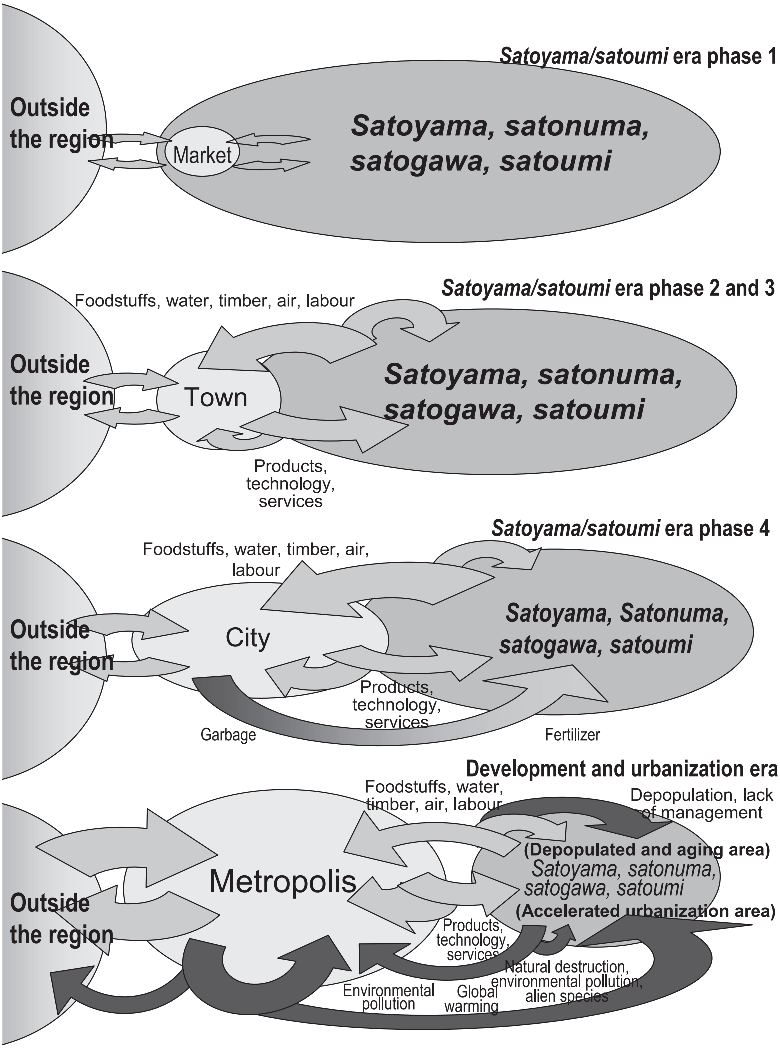


Figure 11.3 Transitions in resource circulation in cities, *satoyama* and *satoumi*

Sites outside the region such as those overseas were heavily relied upon as the source of the resources and energy supplied rather than the neighbouring *satoyama* or *satoumi*. The lifestyle of mass-production and mass-consumption has brought about an increase in garbage and waste. It has also resulted in the widespread destruction of the natural environment and environmental pollution bringing about warming temperatures and the depletion of natural resources on a global level (Figure 11.3).

Satoyama and *satoumi* areas are located between urban areas (with populations of 4,000 people/km^2 or more) and inland *okuyama* areas (with populations of 100 people/km^2 or less) or between urban areas and sea *dainan* (far offshore) areas. Issues regarding *satoyama* and *satoumi* areas are classified into "urbanizing rural areas" and "depopulated rural areas" (Figure 11.4). Urbanizing rural areas have been engulfed into urban areas and have experienced the destruction of nature and environmental pollution at an accelerating pace. Depopulated rural areas have been deserted by urban areas and have experienced an increase in abandoned cultivated land resulting from the lack of agricultural successors. The devastation of mountains and forests has also accelerated. Furthermore, there has been a rapid increase in illegal dumping of industrial waste as well as damage to agricultural and forestry industries caused by birds and animals.

11.3 Conditions and trends

11.3.1 Supporting ecosystems

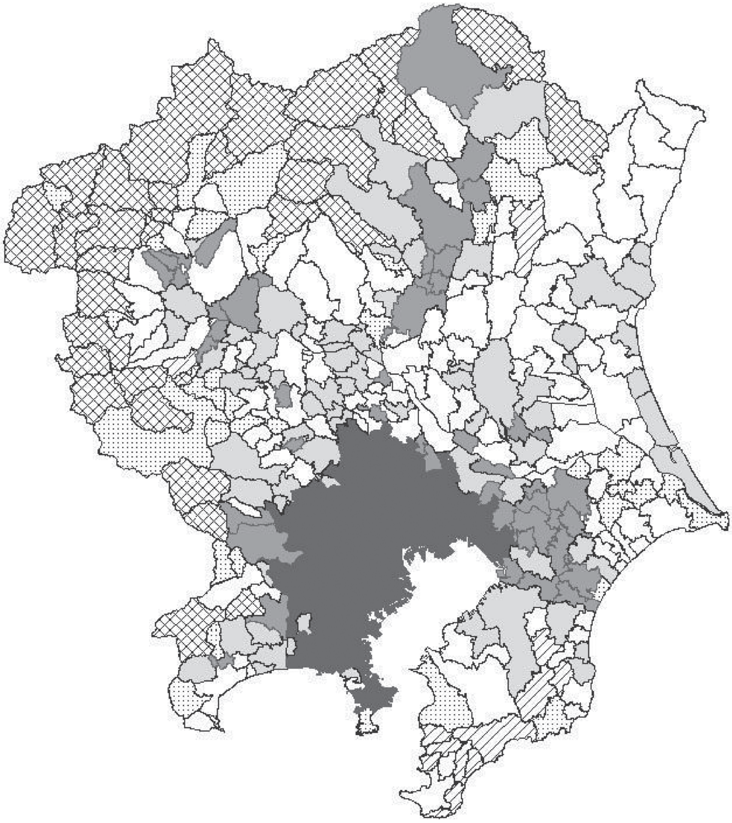
Between the post-war period and 1990, urban areas experienced significant change in land use. Farmland and forests were rapidly replaced with artificial environments such as urban areas, resulting in the drastic acceleration in the alteration of nature. The alteration of the natural environment also accelerated in sea areas. Neritic zones were reclaimed, causing a decline in tidelands and seagrass beds. In 1990, population growth reached its peak and since then, land use change has been restrained. After 1970, urbanizing rural areas experienced acceleration in the large-scale alteration of the natural environment through development of, for instance, Tama New Town and Chiba New Town. However, currently, such alteration has levelled off. In depopulated rural areas, land use has not changed significantly since the post-war period.

In regards to biota, mainly in highly urbanized areas, there has been deterioration in domestic organisms such as mammals, amphibians and ocean shellfish. On the other hand, in these areas, there has been a drastic increase in alien organisms in almost all taxonomic groups. The alteration of the natural environment and poor land management are among the primary causes of the decrease in endangered domestic organisms.

11.3.2 Ecosystem services

Table 11.1 is a summary of main ecosystem services.

Looking at provisioning services (food supply), the area of farmland increased after the post-war period, but it has decreased since 1970. On the other hand, yields per land area unit have consistently increased.



		Population density (people/km²)	Population increase-decrease ratio (%)	Ratio of elderly people (%)
	Okuyama	Less than 100		
	Depopulation and aging	100 ～ 4,000	Less than -5	30 or more
	Population decrease and aging	100 ～ 4,000	0 ～ - 5	30 or more
	Population decrease	100 ～ 4,000	0 ～ -5	
	Population increase	100 ～ 4,000	5 ～ 0	
	Accelerated urbanization	100 ～ 4,000	5 or more	Less than 20
	Cities	4,000 or more		

Figure 11.4 Social and regional classifications of municipalities in the Kanto region
Notes: 1. For population density and the ratio of elderly people 2005 data is used. The population increase-decrease ratio is calculated based on the population in 1995 and 2005.
2. Please see the back of this book for a colour version of this figure.

Production of grains and beans has decreased while production of lettuce and flowers has increased. Production of paddy rice hit its peak around 1970 and has decreased since that time. Urban areas and urbanizing rural areas have focused on vegetable production. Marine production in Tokyo Bay, particularly shellfish production, has dramatically decreased since 1960 when the area of tideland rapidly decreased. The food self-sufficiency ratio has drastically declined. External dependence on food accounts for 90 per cent or more particularly in highly-urbanized areas.

In regard to provisioning services (lumber), production of raw materials reached its peak around 1960 and has decreased since that time. Even now, the northern Kanto region produces a large amount of raw materials. In contrast, production has significantly declined in the urbanized southern Kanto region.

For provisioning services (water), water supply sources were originally well water, river water and lake water that were available within the local area. However, in conjunction with the diffusion of tap water, water supply sources have shifted from local water to dam water since 1970, accelerating external water dependency. This trend is outstanding in highly urbanized areas such as Tokyo and Chiba. On the other hand, the utilization of groundwater has drastically declined in Tokyo.

In regards to regulating services, temperatures have increased particularly in urban areas. Sea surface temperatures in Tokyo Bay have also increased. In urban areas, water quality in shallow sea areas, rivers, ponds and lakes began to deteriorate in the 1950s, reaching a low point in the 1960s and the early 1970s. After this period, water quality has been improving. In urbanizing rural areas, water quality began to deteriorate later than in urban areas and hit a low point in the 1980s. Depopulated rural areas have not seen water quality deterioration. Water quality improved after these periods. However, it is the diffusion of sewage systems that has contributed to the resolution of water quality deterioration. There has been no progress in the restoration of tideland ecosystems or aquatic plant communities that were previously responsible for water purification.

For cultural services, there has been a decrease in the number of people who use natural environments for recreation such as shellfish gathering and swimming in the sea. In addition, the recreational areas for children have shifted from outdoor environments to homes and parks. For these reasons, there have been fewer opportunities for interacting with nature, leading to a decline in the use of cultural services. Yokohama City and Kawasaki City have observed a decline in physical and mental health due to the decrease in the level of nature in the region. Thus, it is pointed out that excessive artificial alteration in urban areas adversely affects physical and mental health. In addition, urban areas have seen an increasing crime rate. Natural environments have been increasingly recognized as healing and recreational environments.

Table 11.1 Overview of trends in ecosystem services (Kanto–Chubu cluster)

Ecosystem services	Subcategory	Human use	Enhancement/ degradation	Remarks
Provisioning services				
Food	Crops	▼	+/–	Domestic food consumption quantity was on the rise until approximately 1990 when it hit the peak. Crop yield per acreage has been increasing while mass area of farmland is decreasing due to development. In recent years, increase in abandonment of farmland is observed.
	Fish catch	+/–	▼	Domestic consumption of seafood had increased until late half of 1980s, but begun to decrease afterwards. Production quantity of seawater fishing of Tokyo Bay dramatically decreased after 1960s. This is because of the major decrease in catch of shellfish (clam, etc.) due to decrease in area mass of tidal flats. Also, freshwater fishing is seeing decrease in scale, also.
	Aquaculture	+/–	+/–	Most of seawater culture in Tokyo Bay is seaweed culture. Production quantity of seaweed has remained level, though some changes are seen by years.
	Wild animal and plant products	NA	+/–	Production quantity of *shiitake* mushroom was on increase until 1980s, but then begun to decrease due to competition with imported products, etc.
Fibre	Timber	▼	▲	Usage quantity of timber increased until 1990s, and then hit the peak. Areas of secondary forest increased due to expansion of afforestation, while accumulation of *Cryptomeria japonica* (Japanese cedar) and *Chamaecyparis obtusa* (Japanese cypress) in plantation forest are increasing also. This translates to increase in ecosystem services related to timber. On the other hand, production quantity of raw material is decreasing annually.

	Firewood and charcoal	▼	▲	Usage quantity of charcoal and firewood drastically decreased as fossil fuels become commonly widespread. Looking at the case of Chiba Prefecture, accumulation of timber in coppice forests is increasing, hence the ecosystem services of charcoal and firewood. However, production quantity of wood charcoal decreased drastically from the 1950s, due to a decrease in demand caused by the energy revolution.
Fresh water		▲	▼	The number of people that consume and utilize water has been increasing, due to population increase. However, such demand is dependent on surface stream water from dams; dependency on subterranean water and living streams is decreasing.
Regulating services				
Climate regulation	Local and regional level	▲	▼	Increase in annual mean temperature and number of sweltering nights are caused by the heat-island phenomenon, which indicates the deterioration of climate regulation services due to urbanization.
Water temperature control	Seawater	▲	▼	In Tokyo Bay, bottom water temperature decrease in summer and increases in winter. The cause for this phenomenon is thought to be the increase in inflow of fresh water, and the inflow of fresh water with a high temperature accompanying population increase in the basin.
Water purification	Seawater	▲	▼	Water quality of sea water is being affected by population increase. Landfills have decreased the area mass of tidal flats and shallow sea areas, causing a decrease in the water purification function (regulating service). Improvement was observed for COD density of Tokyo Bay in the 1970s, but the figure has remained constant since then. Nitrogen and phosphorus burden in recent years is decreasing, but is increasing compared with 50 years ago, and its quantity exceeds the purification capacity of tidal flats.

Table 11.1 (cont.)

Ecosystem services	Subcategory	Human use	Enhancement/ degradation	Remarks
	Fresh water	▲	▼	River improvements such as bank protection has caused a decrease in aquiherbosa, which decreased water purification function. Water quality in rivers, lakes and ponds deteriorated between the 1960s and 1980s, but has improved since then. The improvement is due the fact that human-made facilities such as sewage systems are substituting for regulating services. However, human-made facilities as alternative since then for regulating services are quite limited, especially in the purification of lakes and ponds.
Cultural services				
Spiritual values		▲	▼	Negative correlation was seen between regional nature levels and ill-mental health. For this reason, negative effects on physical and mental health due to the loss of nature accompanying urbanization have been pointed out.
Social relations		▼	▼	Communal management of agricultural water in villages is a practice that sustainably utilizes regional resources of *satoyama*. However today, collective work in villages is decreasing, and in some cases only farming households participate in this. For reasons including the one aforementioned, collective management is disappearing. This trend is seen particularly in urban areas and urbanizing rural areas.
Recreation		+/–	▼	The number of users of tidal flats and coastal areas for recreation, such as shellfish gathering and ocean bathing, are decreasing. This may be due to more diverse forms of recreation available today, as well as the impacts of a decrease in area mass of tidal flats. However, increase in the value of *satoyama* as a new source of recreation is observed among some urban citizens, who participate in *satoyama* maintenance and farming experiences.

Notes: ▲ = Increase (human use column) or enhancement (enhancement/degradation column)

▼ = Decrease (human use column) or degradation (enhancement/degradation column)

+/− = Mixed (Both increase and decrease trends have been observed over the past 50 years. Or, there is an increase in some items or regions while there is a decrease in other items or regions.)

NA = The item was not evaluated in this assessment. In some cases, no discussion was conducted regarding the service. In other cases, discussion was carried out regarding the service, but the evaluation of the conditions and trends of human use based on available information and data was impossible.

† = The classifications of "human use" and "enhancement/degradation" have not been applied to supporting services. This is based on the definition of supporting services that the services will not be directly used by human beings (if indirect impact was included, cost and benefit would be counted redundantly). A change in supporting services has an impact on provisioning, cultural and regulating services. These services can be both enhanced and degraded through human use.

11.3.3 Changes in human well-being

We have adopted "material comfort level", "environmental comfort level" and "mental health level" as indicators of human well-being that are closely related to ecosystem services. We have recapitulated changes in these indicators.

GDP per capita that indicates material comfort consistently increased after the post-war period. Supplies for domestic consumption that also indicate material comfort hit their peak around 1970 and have gradually diminished since 1990. Focusing on the provision of food that is an essential service to human beings, Japanese people have lived contentedly since the 1970s (Figure 11.5).

We have used the number of pollution complaints to indicate environmental comfort. The number of pollution complaints related to water contamination and air pollution reached their peaks in the 1970s and the number of air pollution-related complaints experienced another peak period in the late 1990s due to the dioxin problem. In recent years, water contamination and air pollution have shown distinct patterns. However, both have reflected similar changes since the 1960s. In other words, human well-being that is represented by environmental comfort began to be rapidly aggravated in the late 1960s and experienced its worst level in the early 1970s. However, environmental comfort recovered to a certain level in the 1980s (Figure 11.5).

Looking at mental health levels, since the late 1970s a larger number of people have pursued spiritual wealth rather than material affluence. Currently, an increasing number of people are pursuing the wealth of the spirit. A high suicide rate was seen around 1955 due to confusion, pov-

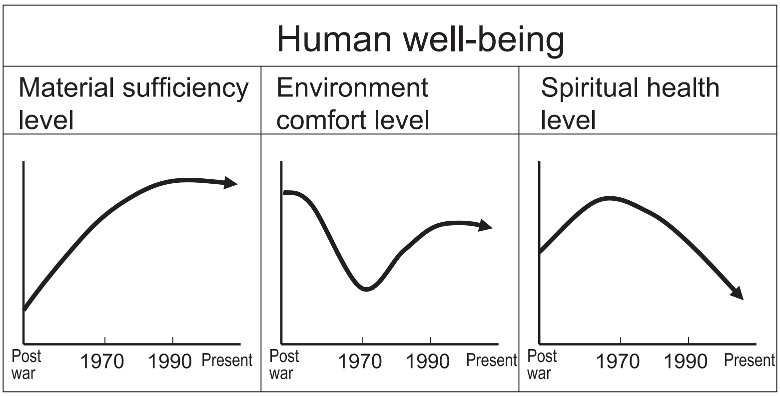


Figure 11.5 Overall trends in human well-being

erty and changes in values during the post-war period. After that period, the suicide rate became stable. However, in recent years, there has been a rise in mortality due to suicide. Particularly, suicide by males has been rapidly increasing. Judgeing from this situation, although post-war restoration temporarily contributed to the enhancement of mental health level, spiritual well-being has continuously declined since the 1970s (Figure 11.5).

11.4 Drivers of change

In the Kanto area in modern times, trends in the international city of Tokyo represent the most significant direct and indirect drivers of change. After returning to international economic society in 1955 by joining the GATT, Japan achieved high economic growth through the rapid expansion of the scale of trade and domestic demand. It was the Greater Tokyo metropolitan area that experienced the highest growth and drove economic growth across Japan. As the most significant driver of change, this rapid expansion acted on ecosystems in Kanto region, resulting in the destruction of *satoyama*.

However, in parallel with the end of the Cold War in 1990, the economic bubble collapsed. Simultaneously, there was a radical turnover in industrial structure from manufacturing industries to knowledge-intensive and service industries. There was also a change in urban structure in the Greater Tokyo metropolitan area, resulting in a return of people to urban areas. In response to a decrease in population across Japan, knowledge-intensive industries have been established in urban areas, intensifying overconcentration in Tokyo. In the midst of accelerating globalization through the integration of international finance and economy, the Greater Tokyo metropolitan area has become more and more internationalized. However, at the same time, the Tokyo area is about to shrink. In other words, primary and secondary industries will be hollowed out and reduced even in the Kanto region, starting from those areas with less transportation convenience to access urban areas. In addition, in the marginal region of the Greater Tokyo metropolitan area, population size will drastically decrease. Vacant factory lots, empty houses and land and abandoned cultivated land will be observed in various areas. It is necessary to develop the multiple aspects of ecosystem services through the regeneration and reuse of these empty spaces that will be newly created across the national landscape.

Indirect drivers of change include politics, economy and industry, population, scientific technology and technological innovation, as well as society and culture. Direct drivers of change include the destruction of the natural environment, artificial management, environmental pollution, alien species and climate change. In this section, we will focus on and review the main drivers.

11.4.1 Indirect drivers

11.4.1.1 International political and economic society

The post-war period is roughly classified into the "cold-war era" (1945–1989) and the "post-cold war era" (1990–present). From the perspective of the global economy, this period can be roughly divided into the era of a system of fixed exchange rates (1945–1970), the era of a system of flexible exchange rates (1971–1989) and the era of the global economy in which the impact of coordinated exchange rate management has emerged after the conclusion of the Plaza Accord in 1985 (1990–present). The Greater Tokyo metropolitan area has been directly influenced by and has participated in international political and economic society.

11.4.1.2 Economy and industrial structure

Kanto region can be roughly divided into the northern Kanto region and the southern Kanto region which includes the Greater Tokyo metropolitan area. During the early stages of the high economic growth period between 1955 and 1970 (the entire high economic growth period was between 1955 and 1989), the Greater Tokyo metropolitan area was formed, chiefly driven by heavy chemical industries. Due to the introduction of a system of flexible exchange rates in 1971 and the oil shock in 1973, a shift to advanced technology industries and a service economy as well as the expansion of the economic block accelerated in the Greater Tokyo metropolitan area. This triggered the overflow of secondary industries into the northern Kanto region. Since 1990, in order to respond to the global economy as an international city, Tokyo has accelerated the shift to knowledge-intensive industries and a service economy, causing a radical transition in the industrial structure (Figures 11.6 and 11.7).

11.4.1.3 Employment structure and population change

Reflecting the change in industrial structure, the southern Kanto region maintains an extremely large number of workers in tertiary industries. In the northern Kanto region, workers in secondary industries are still dominant (Figure 11.8). Since 1990, the population in the northern Kanto region has levelled off. In contrast, there has been a continuous population increase in the southern Kanto metropolitan area due to the large number of workers in knowledge-intensive service industries. Particularly, in recent years, the movement of people to urban areas has resulted in a

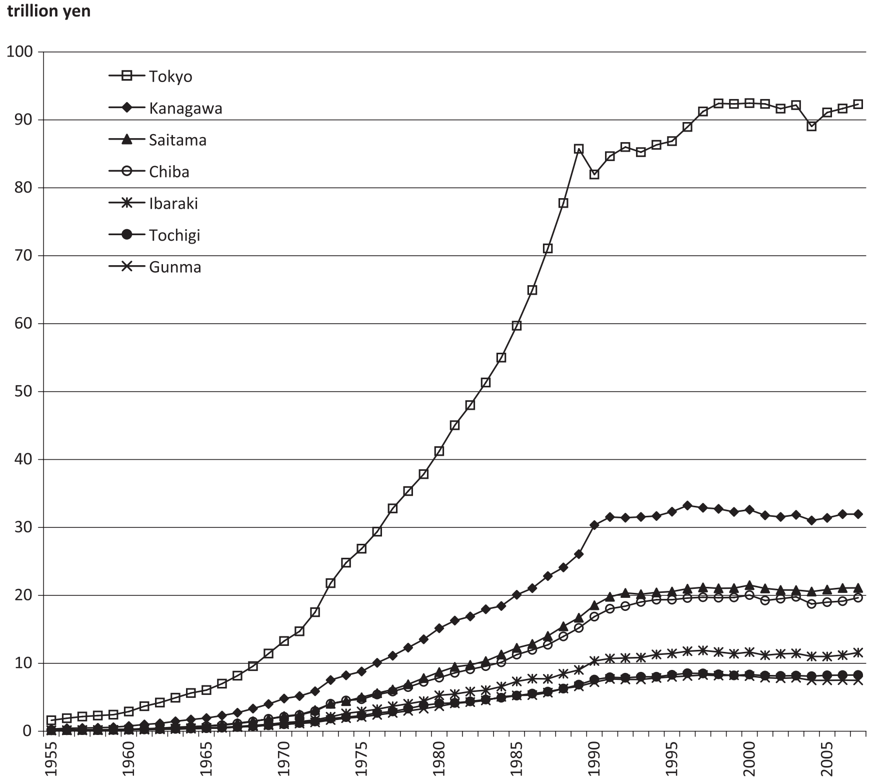


Figure 11.6 Gross production in the Kanto region by prefecture
Source: Created based on the prefectural accounts system issued by the Cabinet Office

drastic population increase in the international city of Tokyo (Figure 11.9). This phenomenon is a reflection of the overconcentration of people in Tokyo from all over Japan. This marks the beginning of the consolidation and contraction of the Greater Tokyo metropolitan area.

11.4.2 Direct drivers

11.4.2.1 Alteration of land use

Vanishing *satoyama* and *satoumi* areas have fallen victim to the expansion of industry and the economy in the Greater Tokyo metropolitan area. Development in Tokyo Bay as well as in former farmland in Tokyo and Kanagawa began prior to World War II. These areas had been completely developed by the early 1970s. In the 1970s, the amount of farmland in the northern Kanto region decreased (Figure 11.10).

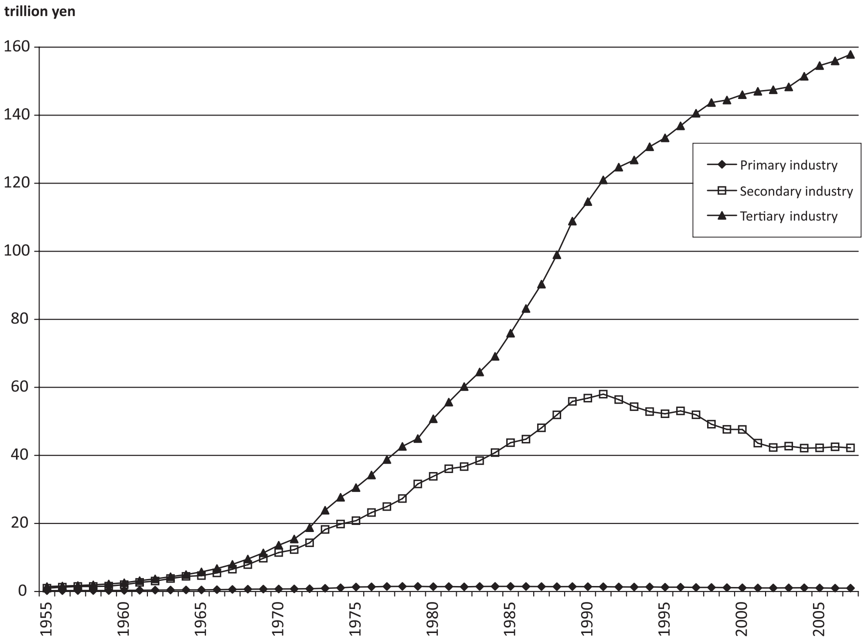


Figure 11.7 Gross production in the Kanto region by industry
Source: Created based on the prefectural accounts system issued by the Cabinet Office

11.4.2.2 Alteration of artificial management

The liberalization of the import of lumber in 1960 triggered the abandonment of the management of plantation forests in the Kanto region. This resulted in the devastation of *okuyama* areas as well as in damage caused by birds and animals. In addition, there has been a rapid increase in abandoned agricultural land due to the appreciation of the yen after the Plaza Accord in 1985 as well as due to the liberalization of the import of rice in the 1990s. In rural areas distant from urban areas, there has been a sharp increase in the number of vacant houses. *Okuyama*, *satoyama* and suburban areas in the Kanto region have also suffered from a lack of people engaging in land management, contributing to the expansion of unmanaged areas across the nation (Figure 11.11).

11.5 Responses

Here we will present actions that should be taken in the future in order to sustainably manage ecosystem services provided by *satoyama* and *satoumi* without degrading those services.

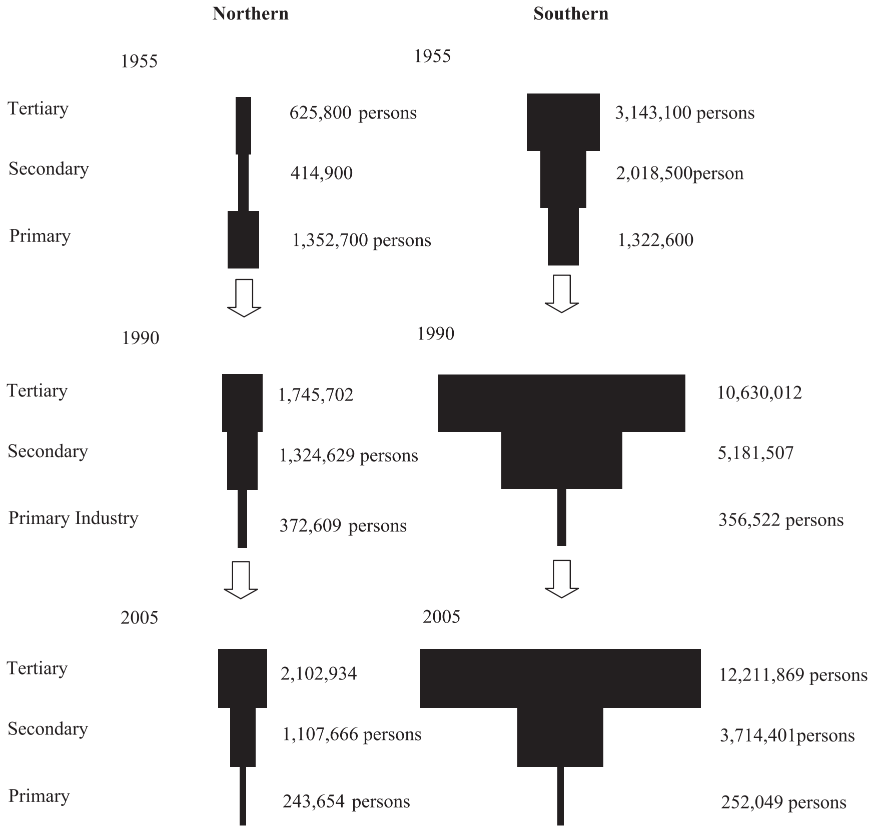


Figure 11.8 Changes in industrial structure in northern and southern Kanto
Source: Created based on the National census

11.5.1 Overview of responses and the types of responses

11.5.1.1 Institutional and governance responses

In the 1990s, the Earth Summit raised interest in environmental preservation and the maintenance of biodiversity, resulting in the enactment of new laws such as the Basic Environmental Act and the Environmental Impact Assessment Act. Moreover, laws such as the River Act and the Forest and Forestry Basic Act were continuously revised. As a result, considerations for the environment including *satoyama* have been clearly specified in each law. In the 2000s, laws such as the Act on the Promotion of Natural Restoration, the Act on Promotion of Ecotourism and the Landscape Act were enacted. The enactment of these laws has gradually made it possible to restrict land use from a new perspective. Looking at

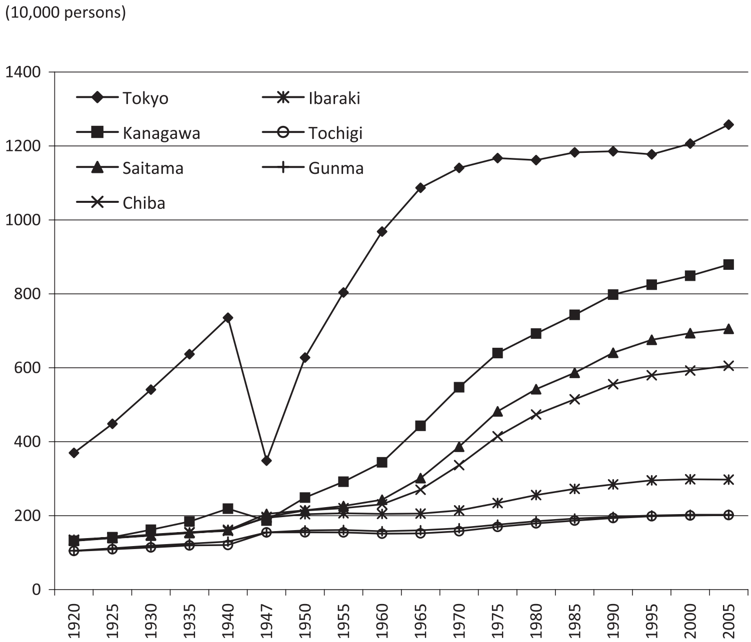


Figure 11.9 Population changes in the Kanto region by prefecture
Source: Created based on the National census

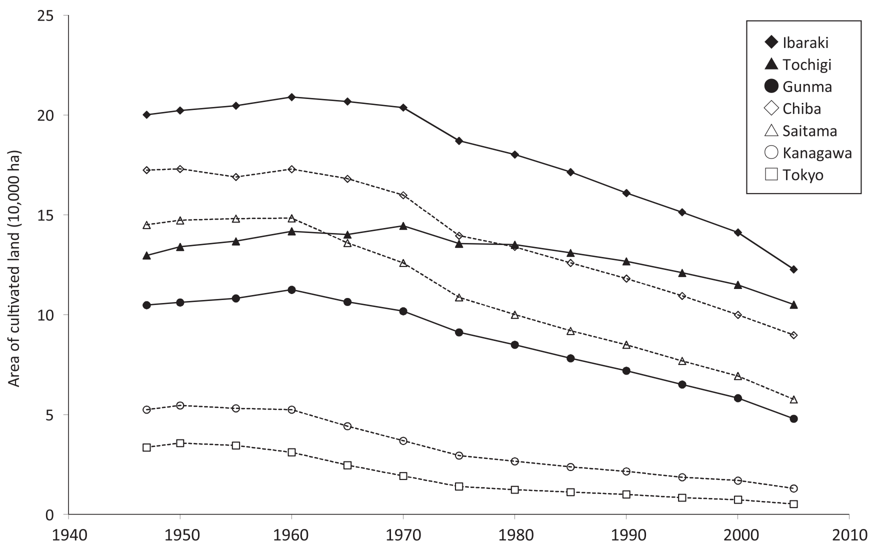


Figure 11.10 Changes in the amount of agricultural land under management in the Kanto region by prefecture
Source: Created based on the Agricultural and Forestry Census

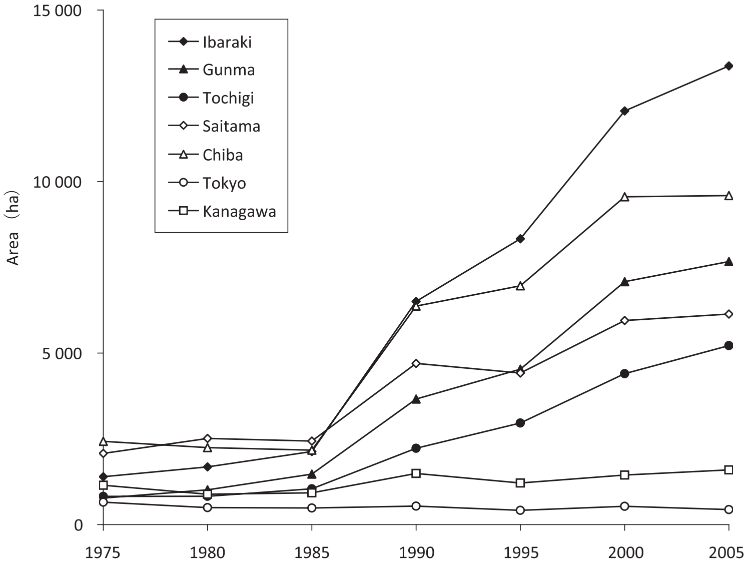


Figure 11.11 Changes in the amount of abandoned cultivated land by prefecture
Source: Created based on Agricultural and Forestry Census Annual Statistics

the latest trends, in 2009, the Basic Act on Biological Diversity was formulated as a basic law that would allow for the implementation of comprehensive measures related to the conservation of biodiversity. As one of the serious crises in biodiversity, this law has specified the degradation of *satoyama* and other issues due to reduced human activities that have resulted from changes in social and economic situations. With regard to the conservation and management of *satoyama* and *satoumi*, the future utilization of this law is anticipated.

On the other hand, in response to a revision of related laws including the Local Autonomy Act, municipalities such as Chiba Prefecture and Kanagawa Prefecture have begun to draw up ordinances with the direct objective of conserving *satoyama* and *satoumi*.

11.5.1.2 Economic and incentive responses

In order to maintain the public functions provided by forests, the introduction of various taxes such as the forest environmental tax has been promoted by local governments across Japan. The forest environmental tax is a local discretionary tax earmarked for special use. In order to secure financial resources for the preservation and restoration of water source environments, Kanagawa Prefecture revised the prefectural tax ordinance and introduced the "excess prefectural tax for the preservation and restoration of water source environments" in FY2007. The city of Yokohama formulated the "Yokohama Green Tax Ordinance" in FY2009 for the first time among cities, towns and villages in urban areas in Japan.

Since 2000, the "Program for Direct Payment to the Intermediate and Mountainous Areas" has been implemented. This programme has been effective in the maintenance and management of *satoyama* to some degree. Also, in order to ensure appropriate conservation and management of farmland and agricultural water as well as to introduce environment-conservation agriculture, the "Measures for the Conservation and Enhancement of Farmland, Water and the Environment" have been implemented since 2007.

11.5.1.3 Social and behavioural responses

The citizenry, NPOs and NGOs have made great contributions to the management and conservation of *satoyama* and *satoumi*. For example, Chiba Prefecture has formulated the "Ordinance regarding the Promotion of the Conservation, Maintenance and Utilization of *Satoyama* in Chiba Prefecture". Under this system, land owners and *satoyama* conservation groups conclude agreements and the governor approves these. In addition, Yokohama has carried out citizen-led eelgrass bed regeneration activities.

11.5.1.4 Technological responses

Examples of technological responses are as follows: nature restoration technology such as the regeneration of aquatic plants and the development of *Phragmites australis* (common reed) communities in lakes such as the Inbanuma Pond and the Kasumigaura Lake. In addition, another response has been technology for utilizing wood biomass that has been derived from materials such as wood thinned from forests and the materials remaining in forests. In *satoumi*, technological responses include nature restoration technology that is identified in the restoration of eelgrass beds such as eelgrass beds. In addition, technology has been advanced for the construction of artificial beaches such as the Kanazawa Artificial Beach (Yokohama City, Kanagawa Prefecture) and the Funabashi Seaside Park. Construction methods have also been improved and developed for other areas such as the Sanbanze tideland (Funabashi City, Chiba Prefecture) restoration project.

11.5.1.5 Knowledge and cognitive responses

Nowadays, the Internet has been widely used to disclose information related to *satoyama* and *satoumi* as well as to support citizen, NPO and NGO activities. For example, since 2005, Chiba Prefecture has implemented the online *Satoyama* Information Bank System. Thus, as a method of information disclosure, the Internet has been actively utilized. On the other hand, an increasing number of universities and other institutions have participated in the maintenance and management of *satoyama* and *satoumi*. Utsunomiya University (in Tochigi Prefecture, northern Kanto) established the "*Satoyama* Science Center". This institution has engaged in education, research and regional contribution activities focusing on *satoyama* near the university.

11.5.1.6 Comprehensive responses (cross-sectional responses)

Chiba Prefecture formulated the "Chiba Prefecture Biodiversity Strategy" as the first local strategy in Japan in 2008. Then, Chiba Prefecture established the "Chiba Biodiversity Center". In order to restore the health of ecosystems, nature restoration projects have been carried out in various localities.

In 2002, the "Biomass Nippon Strategy" was formulated. This strategy defines specific initiatives and action plans regarding the promotion of the utilization of biomass. It is expected that organic resources in *satoyama* such as wood biomass will be utilized as the biomass town initiative is being diffused.

Various parties have cooperated and collaborated in implementing measures for the conservation and restoration of water environments in rivers and neighbouring areas. They have adopted *Ciconia boyciana* (oriental stork) and *Nipponia nippon* (Japanese crested ibis) as indicators. Through these activities, the Southern Kanto Ecological Network Formation Project is being launched in order to create an attractive community that enables the future restoration of numbers of *C. boyciana* (oriental stork) and *N. nippon* (Japanese crested ibis).

11.5.2 Visions for responses for satoyama *and* satoumi

In the Kanto–Chubu cluster, the restoration of *satoyama* and *satoumi* is required in urban areas. On the other hand, the conservation, maintenance and management of *satoyama* and *satoumi* are required in suburban areas where *satoyama* and *satoumi* is vanishing as if they were being swallowed up by the expanding cities. An increasing number of local governments have tended to enact ordinances primarily for *satoyama* and *satoumi*.

Responses for *satoyama* and *satoumi* have been accumulated through the flow of international initiatives as well as the implementation of local and regional initiatives by the citizenry and administration. For example, in addition to the national government, municipalities have also promoted the formulation of the biodiversity strategies that were drawn up in conjunction with the Earth Summit. These biodiversity strategies define the direction and specific actions regarding the conservation and restoration of *satoyama* and *satoumi*. It is expected that the proactive implementation of this strategy will promote the implementation of responsive measures.

On the other hand, in response to the issue of global warming, the establishment of a low-carbon emission society is regarded as one of the goals of Japan. The import of low-cost foreign lumber and the energy revolution have impaired the value of *satoyama* forests as lumber and energy sources. However, the future utilization of *satoyama* forest resources as a renewable energy source is anticipated.

In addition, from the standpoint of a stable food supply in Japan, the promotion of the agricultural, forestry and fisheries industries in *satoyama* and *satoumi* is conceived as an important issue. It is necessary to promote the implementation of economic measures in order to prevent the expansion of abandoned cultivated land and to promote local economies through the Program for Direct Payment to the Intermediate and Mountainous Areas and other programmes. In addition to food supply, *satoyama* is expected to play a significant role as a water source area.

The Kanto–Chubu cluster has a large population and has benefited from vigorous economic activities. Thus, expectations for responses that will be implemented by this cluster for *satoyama* and *satoumi* have been heightened. In the future as well, new measures will be proactively created and implemented.

11.6 Conclusion: Future scenarios and *satoyama-satoumi* initiatives

Human beings that had lived in a primitive society immediately after the dawn of humanity developed a village society in order to live in the natural environment in the region. Then, human beings developed science and technology to transform their society into an urbanized and civilized global city society. During this development process, human society expanded population, goods, finance and information while transforming natural environments into artificial environments. As a result, the supporting services of ecosystems have drastically declined. This has ultimately caused a significant deterioration in other types of ecosystem services provided by *satoyama* and *satoumi*. These include “provisioning services” for supplying natural resources such as food, “regulating services” for controlling various environments such as atmosphere and water, and “cultural services” for supporting the human mind and spirit.

Currently, the well-being of Japanese people has been marginally supported by and dependent on external ecosystem services (Figure 11.12). Japan has depended on overseas areas for a huge amount of resources such as food and energy. On the other hand, even though a decrease in population is projected, there has been an augmentation in abandoned

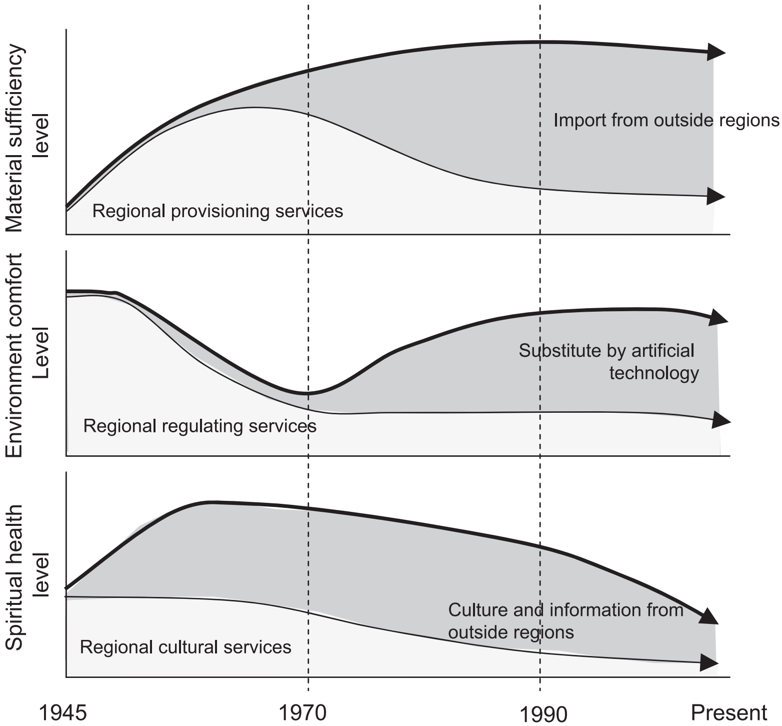


Figure 11.12 Changes in human well-being and ecosystem services

farmland and forests in Japan. From a global perspective, the current situation in Japan is abnormal. It is obvious that this situation is not sustainable.

Human society has followed a path of change from primitive society to a *satoyama* and *satoumi* society, and ultimately to the creation of cities and the metropolis. Based on the history of human society, we have proposed four possible scenarios for future society: “Megacity society”, “Biotope restoration society”, “Compact recycle society” and “*Satoyama-satoumi* renaissance” (Figure 11.13). The “Biotope restoration society” and “Compact recycle society” may also be positioned as transitional phases to the “*Satoyama-satoumi* renaissance”. Additionally, it is assumed that the areas specified in these four scenarios will be placed in a spatial and temporal mosaic as well as in zoning structures. Thus, there will be advancement in the implementation of measures for the establishment of a comprehensively sustainable society.

Even when the scenario of “*Satoyama-Satoumi* Renaissance” is selected among the four scenarios, in reality, *satoyama* and *satoumi* areas have faced many issues such as those regarding urbanizing rural areas and

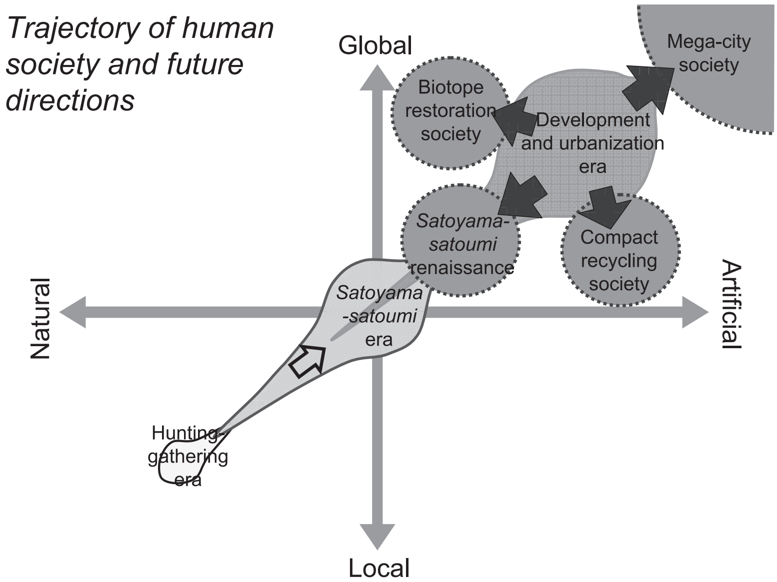


Figure 11.13 Future scenarios of urban society based on the history of human society

depopulated rural areas. In order to address various issues that have been raised in *satoyama* and *satoumi* areas by taking advantage of the potential of *satoyama* and *satoumi*, four directions have been suggested based on the selection between modern technology and natural culture as well as between globalization and localization: “Technological community *satoyama-satoumi* (modern technology and globalization)”, “Gardening village *satoyama-satoumi* (natural culture and globalization)”, “Hometown *satoyama-satoumi* (modern technology and localization)” and “Rural hometown *satoyama-satoumi* (natural culture and localization)”. At any rate, the selection of the options depends on the people involved with *satoyama* and *satoumi* areas based on the current situation (e.g. citizens, policymakers and administration).

Whichever scenario or direction may be taken, in order to build a sustainable community, we should take actions based on the following fundamental guidelines:

a. Understanding of biodiversity and ecosystems as well as the establishment of a monitoring system;
b. Conservation and restoration of locally specific biodiversity and ecosystems;
c. Conservation and utilization of regional traditional culture and locally specific technology;

d. Reduction of environmental burdens and impacts on ecosystems;
e. Reduction of external dependence for resources and energy;
f. Establishment of a system that will internalize the external economies of environmental costs;
g. Ensuring of free and fair logistics as well as information;
h. Experience and education regarding organisms and life.

Human beings are members of the natural environment. Ecosystem services provided by the closed environment of the earth are not inexhaustible. Now, a paradigm shift to new values is required. We must place value on the protection of local biodiversity and ecosystems, respect for human culture, and the ensuring of sustainability of the earth's environment, rather than on economic rationality. We would like to propose this idea as the "*Satoyama-Satoumi* Initiative".

12

Western Japan cluster

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12.1 Overview

Satoyama has experienced two changes due to the social changes that have been commonly observed over the past 50 years across Japan. One of the changes is urbanization and underuse (cessation of use). The other change is a greater geographical distance between the areas of ecosystem service provision and the areas of service consumption. Traditionally, most ecosystem services for human use were provided and utilized within human settlements. However, currently, people are benefiting from services that are provided by countries overseas. These social changes have brought about changes in ecosystems and ecosystem services. In the Western Japan cluster assessment, social responses to these changes were reviewed and the efficacy of the response measures was assessed. Ultimately, this chapter on the Western Japan cluster assessment is intended to serve as a basic document for establishing scenarios for a sustainable society that will make the best of renewable natural resources.

Satoyama–satoumi *ecosystems and human well-being: Socio-ecological production landscapes of Japan, Duraiappah, Nakamura, Takeuchi, Watanabe and Nishi (eds), United Nations University Press, 2012, ISBN 978-92-808-1210-7*

The sustainability of *satoyama* is characterized by its mosaic landscape. Therefore, the assessment focused on changes in the landscape and assessed changes in ecosystems and ecosystem services.

In western Japan, the population density greatly varies according to the prefecture. Osaka Prefecture ranks second in population density in Japan while Shimane Prefecture ranks forty-fourth. Thus, western Japan can be said to be a representation of the whole of Japan. Most parts of western Japan belong to the warm-temperate zone. Some areas are in the cool-temperate zone and a very small part of western Japan is in the subalpine zone. The geographical proximity of western Japan to the Korean Peninsula is one of the cultural characteristics of the region. In addition, western Japan was the political and economic centre of Japan since the Yayoi Era. For this reason, native natural vegetation is extremely rare in western Japan. Most vegetation has been altered by human activities. Secondary forest is such an example. The vegetation map created in 1986 (the Third National Survey on the Natural Environment by the Ministry of the Environment, Japan) shows that secondary forest accounts for 55.3 per cent of total land area, agricultural fields and plantation forest account for 28.9 per cent, and in terms of natural forest, cool-temperate deciduous broadleaf forest and evergreen broadleaf forest account for 2.1 and 6.3 per cent respectively.

12.2 Historical and narrative context

Changes over the past 50 years can be classified into the following three periods: the high economic growth period which Japan entered into in the late 1950s, the sluggish economy after the oil shock in 1974, and the period after the collapse of the economic bubble in 1992 and 1993. In the high economic growth period, post-war agricultural land reform and modernization policies expanded. In this situation, the expansion of provisioning services was aggressively promoted through expansive forest regeneration, land reclamation and farmland restructuring. Post-war economic growth was achieved in conjunction with labour concentration in urban areas. Over the five years between 1955 and 1960, larger cities, towns and villages with more than 30,000 people experienced a population increase while smaller cities, towns and villages with less than 30,000 people saw a population decrease. Agricultural land reform dissolved the relationship of landowners and peasants, allowing a large number of small farmers to own farmland. At the same time, the ownership of common forest that was used as shared areas was also transferred to individuals or the nation. In metropolitan areas, a massive amount of farmland was converted for the expansion of urban areas and the development of golf courses. On the other hand, depopulated areas suffered from the abandonment of land cultivation that resulted from a lack of available labour and this created unmanaged barren farmland. Depopulation was particularly drastic in high mountainous areas. In the low economic growth period, plantation forests and farmland were abandoned due to the decline in agricultural product prices and the rice acreage reduction policy. After that, Japan experienced a liberalization of food imports and a decline in the self-sufficiency ratio. The population started to decrease during the 2000s. As a result, abandoned cultivated land was observed not only in mountainous areas but also in lowlands and farmlands near urban areas. Moreover, the use of forests by the forestry industry also declined.

Over the past 50 years, nature conservation campaigns have greatly evolved. Until the 1980s, the purpose of nature conservation activities was to protect virgin forests. However, since the 1980s, the nature in *satoyama* landscapes has drawn attention and many citizens have participated in *satoyama* conservation activities. In addition, the government has supported the conservation and restoration of *satoyama* environments through various measures such as the Law for the Promotion of Nature Restoration and the direct payment system for hilly and mountainous areas. However, these measures for conserving and utilizing *satoyama* have been applied only to a limited number of areas. Thus, issues regarding how to utilize national land in its entirety and how to sustain each region are yet to be resolved.

12.3 Conditions and changes

12.3.1 Changes in ecosystems

Ecosystems in western Japan have experienced drastic changes over the past 50 years since 1955. These drastic changes can be identified as a decrease in grassland (wasteland), the expansion of urban areas, the restructuring of rice paddies and the extinction of wetlands.

12.3.2 Farmland

The area of cultivated land in Western Japan declined from 1,642,246 ha to 984,844 ha between 1955 and 2000. In order to improve agricultural productivity, agricultural infrastructure development was promoted. Through infrastructure development, the section of rice paddies expanded. In addition, rice paddies were completely drained and dried out during the non-cultivation season. Irrigation channels and drainage canals were separated from each other and were concreted or pipelined. Dams were constructed and irrigation channels were developed. As a result, the role of irrigation ponds as irrigation facilities was impaired and irrigation channels were left unmanaged or redeemed. These changes greatly affected the habitation of amphibians, fishes, and aquatic insects that lived in rice paddies as well as birds that fed on these animals. In Osaka Prefecture, the total area of farmland decreased by 68.2 per cent between 1960 and 2006. The area of abandoned cultivated land was 291 ha in 1975, accounting for only 1.2 per cent of the farmland in Osaka Prefecture. However, after that, abandoned cultivated land continued to increase and reached 798 ha in 2005, 2.7 times the area in 1975. This accounted for 5.4 per cent of the farmland in Osaka Prefecture.

12.3.3 Forest

The area of forest slightly increased from 8,100,071 ha to 8,175,603 ha between 1960 and 2005. Although there was no significant change in the area of forest, the constituent elements of forests drastically changed. Secondary forest such as *Pinus densiflora* (Japanese red pine) forest declined while plantation forest made up of *Cryptomeria japonica* (Japanese cedar) and *Chamaecyparis obtusa* (Japanese cypress) increased. Ground cover rate of plantation forest accounted for 37 per cent in Miyazaki Prefecture in 1962, but it exceeded 60 per cent in 1973, currently accounting for 61 per cent. Thus, the amount of natural evergreen broadleaf forest has decreased. In Takaoka Town in Miyazaki City, the ground cover ratio of broadleaf forest has decreased from 20 to 14 per cent while coniferous forest has increased from 6 to 35 per cent. It is believed that these changes have mainly been caused by conversion to plantation forest through expansive forest regeneration policies.

In the vicinity of urban areas, the development of housing areas has accelerated particularly in hilly areas. As a result, *satoyama-rin* (*satoyama* forest) has vanished. A decrease in the use of resources in *satoyama-rin* has changed the quality of these resources. Firewood-charcoal forest including pine forest experienced a drastic increase in pine wilt disease in the 1980s. Since the 1990s, there has been an increase in oak wilt (infectious disease due to fungus) in Fukui Prefecture and the northern part of Shiga Prefecture. The increase in *Phyllostachys edulis* (moso bamboo) forest has also been prominent. The area of farmland in Osaka Prefecture was 39,865 ha in 1950 and increased to 45,430 ha by 1960. However, the area has continuously decreased after 1960.

12.3.4 Grassland

The area of grassland was 243,835 ha in 1960 but decreased to one-quarter of this, 58,211 ha, by 2005. In hilly and mountainous areas, there has been a significant decrease in grassland (wasteland). For example, the area of wasteland in the watershed areas of the Sendai River in Tottori Prefecture was 25,392 ha in 1900, accounting for 21.3 per cent of the total area. Currently, the area has decreased to 1,120 ha, accounting for 0.9 per cent. In the lowland hills in Takaoka Town in Miyazaki City, Miyazaki Prefecture, although the area of grassland accounted for 20 per cent of the total area in 1952, it decreased to 8 per cent by 1999. In the Tango Peninsula, the ratio of grassland decreased by approximately one-sixth between 1900 and 1990. The area of wilderness has drastically diminished since 1955; 69 per cent of the previous wilderness has been transformed to coniferous forest in Chizu Town in the watershed areas of the Sendai River.

12.3.5 Inland water

There were also drastic changes in inland water. In Biwa Lake, lagoons and floodplain areas were reclaimed and revetments were constructed. The number and total area of lagoons in Biwa Lake were 103 and 3,515 ha, respectively, in 1900. Through reclamation, the number as well as the area decreased to 23 and 429 ha, respectively, in 2003. In addition, the Ogura Pond (800 ha) that was located near the confluence zone of three rivers which comprised the Yodo River was also reclaimed by 1941. The Yodo River was straightened and the river bed was excavated at an accelerated pace. The water level was also stabilized through the construction of dams.

12.3.6 Satoyama *landscapes*

Satoyama is characterized by its natural and social constituent elements that are distributed temporally and spatially in patches forming a mosaic pattern. Around the year 1900, in the *satoyama* landscape in the Kamiseya and Ikaga districts (Tango Peninsula) in Kyoto Prefecture, cultivated land was located and centred on human settlements. Mildly-sloping hills with access to water resources were utilized as rice paddies as much as possible. Other areas surrounding these mildly-sloping hills near the water were utilized as crop fields or meadows for pasturing. The trees on these hills were also cut down to avoid casting shadows over fields and the hills were converted to grassland and crop fields. Around these mildly-sloping areas, there was semi-common land such as sites for harvesting and storing *Imperata cylindrica* (Japanese bloodgrass) or *Miscanthus sinensis* (Chinese silver grass). Outside this semi-common land, there were firewood-charcoal forests and plantation forests that were utilized routinely. There was common forest in the most distant areas of the concentric circle. However, since the 1950s, there have been remarkable changes in traditional land use. Burnt fields totally vanished. In parallel with widespread use of chemical fertilizers, there was a drastic decline in meadows and grasslands which provided organic fertilizers. The dissemination of fossil fuel resulted in a drastic decrease in demand for firewood-charcoal forest, leading to an increase in unused *satoyama-rin*. Due to clear-cut logging on a large scale for pulp chip materials and serious pine wilt, the area of *P. densiflora* (Japanese red pine) forest has decreased. As a result, an important landscape element, the border element of the land between forest and farmland, has disappeared. Thus, a small area of cultivated land and forest are currently located in proximity to each other. In terms of composition of forests, the ratio of plantation forest has rapidly risen.

12.3.7 Biodiversity

Approximately 940 vascular plant species are endangered in the Kinki region. Looking at the breakdown according to habitat, species inhabiting secondary forest are predominant at 354 species. The number of species in grassland in *satoyama* is also high at 95 species.

On the other hand, the land areas of 75 per cent of the remaining evergreen broadleaved forests in Japan are small with each having an area of 10 ha or less. Moreover, in many cases, the preservation conditions are considered to be poor. According to an investigation conducted in the 1970s and 1980s, approximately half of the evergreen broadleaved forest in Miyazaki Prefecture has been altered through the conversion to plantation forest or development.

In *satoyama*, various ecosystems such as forest, rice paddies and grassland form a mosaic in a narrow space, supporting unique biodiversity in *satoyama*. Some amphibians and accipitrine birds such as the *Butastur indicus* (grey-faced buzzard) inhabit areas in which both forest and rice paddies exist. These animals tend to inhabit places in which both forest and rice paddies cover a large area. It has been reported that there is an increase in the number of species of butterflies, parasitic bees, flower visiting insects, and birds near the border between forest and farmland or grassland. These species have experienced a decrease in their population due to the deterioration in mosaic landscape.

With respect to mammals, according to the National Survey on the Natural Environment conducted by the Ministry of the Environment, the distribution of some mammals such as *Cervus nippon* (sika deer) and *Capricornis crispus* (Japanese serow) tended to increase between 1978 and 2003.

12.3.8 Provisioning services

Gross forestry production in the Kinki region has declined after experiencing its peak in 1980. However, in Miyazaki Prefecture, *C. japonica* (Japanese cedar) resource volume expanded through expansive forest regeneration, almost doubling the cedar production between 1980 and 2000. Regarding broadleaf forest, paper manufacturing companies have increasingly come to depend on raw materials from overseas. Thus, the demand for *Quercus acutissima* (sawtooth oak) as *shiitake* mushroom logs which was high around 1980 declined and consequently resulted in a decline in production. With regard to pine, pine timber accounted for approximately 51 per cent (671,000 m^3) of total material production (1,306,000 m^3) in Hiroshima Prefecture in 1965. However, pine timber production decreased by half to 383,000 m^3 in 1970, further falling to 74,000 m^3 in 2006.

In Miyazaki Prefecture, charcoal production increased from 25,000 tons in 1945 to 62,000 tons in 1957. However, after that, it decreased to 13,000 tons in 1962. Bamboo production has also drastically declined since 1970. Imports of bamboo shoots in spring water from China and other countries exceeded 50 per cent in the middle of the 1990s. The current bamboo shoot self-sufficiency ratio in Japan has fallen to approximately 10 per cent.

Production of rice as a staple food source has continuously decreased since 1960 in Japan. Potato production reached its peak in 1962 and then decreased to half by the early 1970s. After this period, production has hovered at approximately 4 million tons. Although vegetable production increased in the 1960s, it declined in the 1990s. Fruit production decreased in the 1980s. The production of meat continued to increase until the 1980s and slightly decreased in the 1990s.

The utilization of grassland for activities such as grazing has declined. In Sambe Pasture, although there were 1,200 grazing animals in 1950, the number decreased to 100 in 2000. Sites for harvesting *Imperata cylindrica* (Japanese bloodgrass) or *Miscanthus sinensis* (Chinese silver grass) provided materials for thatched roofs and played an essential role in human settlements. Moreover, such grasslands served for the production of compost, manure and multipurpose materials (for crop fields and tea fields) and hence were indispensable for agricultural production activities. These traditional materials have been replaced with other modern materials such as tiled roofs and plastic materials.

In Biwa Lake, the total aquatic production was 10,000 tons in the 1950s. This significantly decreased to 1,837 tons in 2006. Particularly, there was a drastic decline in fish species that lay eggs on the coast of the lake or in the waterweed areas of lagoons such as *Carassius* spp. (crusian carp) and *Gnathopogon caerulescens*. No decline has been observed for fish species which lay eggs in rivers and inhabit offshore areas such as *Plecoglossus altivelis altivelis* (sweetfish; "*ayu*") and *Oncorhynchus masou rhodurus* (Biwa trout). Under these circumstances, indigenous species which fishermen intend to catch such as *Carassius buergeri grandoculis*, *Carassius cuvieri* (Japanese crucian carp), *Gnathopogon caerulescens*, and *Gym-*

nogobius isaza are also designated as endangered species in the Red List issued by the Ministry of the Environment, Japan.

The use of water for consumption including drinking water has increased. This increase has been supported by dams. According to the Water Handbook, the annual quantity of water intake was 6,654,000,000 m^3 in 1965. It rose to 16,796,000,000 m^3 in 1994. The ratio of water which is supplied from dams increased from 11 to 36 per cent.

12.3.9 Regulating services

At a point a little upstream of the point where the Aya Minami River and Aya Kita River meet (Aya Minami Bridge), normal water discharge (185-day water level) and low water discharge (275-day water level) have declined to approximately one-third over the approximately 40 years since the 1970s. During this period, rainfall data from the Kunitomi Meteorological Observation Station of the Meteorological Agency does not show a declining trend. Therefore, it is conceived that some watershed factors led to a decrease in normal water discharge. It is known that forest logging increases the volume of water runoff from mountain areas. This is because no water is discharged into the atmosphere through forest transpiration and instead, water flows as surface water or underground water. Due to expansive forest regeneration policies in the 1950s and 1960s, natural forest was cut down and plantation forest was also planted in the Aya Minami River watershed. It is assumed that the volume of runoff into the river decreased during this period as a result of the growth of trees in plantations in the Aya Minami River watershed and the subsequent increase in the transpiration rate.

The area of coastal forest and coastal conservation forest in Japan was a total of 164,353 ha in 1990. The breakdown of this is as follows: shifting sand prevention forest (16,244 ha), windbreak forest (54,770 ha), tidal wave and salty wind prevention forest (13,113 ha), fog inflow prevention forest (51,317 ha), fish breeding forest (27,808 ha) and navigation landmark forest (1,101 ha). These types of forest have been preserved for regulating services. On the other hand, there has been a decrease in transportation of sand from rivers to the sea. The rate of coastal erosion was 72 ha per year until around 1988. However, it has increased to 160 ha per year since 1988.

Ground cover has changed at a high rate in the Osaka region in parallel with urbanization. In the central part of Osaka City, the urban heat island effect surpassed 1°C in the 1960s. The areas affected by the urban effect stretched over almost all regions in the area of the plain in the 1990s. In addition, the urban effect in the city area exceeded 2°C in the 1990s. As a result, in urban areas, if the seasonal phenomena of plants that take place in spring such as blossoming and bud flush occur earlier, the population of insects and other organisms also increases earlier. This leads to the phenomenon in which migrant birds come to metropolitan areas earlier than to surrounding areas. In addition, the actual, impact on vegetation in urban areas has been reported. For example, plants which inhabit tropical southern areas can survive in the centre of metropolitan areas.

12.3.10 Cultural services

Cultural services include activities such as the formation of local communities and the creation of culture through the utilization of *satoyama* for production. These activities are linked to human well-being.

It is reported that the common use and management of Japanese red pine forest in local communities have contributed to improvements in biodiversity, ecosystem services and human well-being. For example, activities for maintaining the mountains for *matsutake* mushroom production have been implemented as projects for the creation of fulfilling lives by elderly community organizations. Not only have these activities conserved *P. densiflora* (Japanese red pine) forest, but these activities have also increased the biodiversity of forest floor vegetation. Moreover, these activities have reinforced collaboration within the community.

Continuous human intervention has maintained an almost constant environment in the cultural landscape of semi-grassland. In other words, the utilization of grass for agriculture and livelihood has restrained vegetation succession, which otherwise would have advanced toward forest, to the halfway stage (semi-natural grassland). This history of traditional grassland management has been developed through technologies related to grassland, farming tools, the handing down of customs, and established practices to ensure sustainable grass utilization. On the other hand, grassland management has also created a life culture and landscape that are rooted in the local natural environment. For example, seven autumn flowers in grassland have been admired or written about in poems since the time of Manyo (the seventh century to the eighth century). In addition, "*Bon* flower collection" (*Bon*: Japanese Buddhist custom to honour the departed spirits of one's ancestors) has been one of the tasks at farmers' homes during the *Bon* season in August, in which people gather flowers in fields and place the flowers on graves. Moreover, in the Aso region, there was also a scene in which people built lodges (temporary grass houses) with *Miscanthus sinensis* (Chinese silver grass) to camp out near meadows in autumn. However, over the past 50 years, grassland utilization has declined, resulting in the loss of grassland and the associated culture that had been nurtured in grassland.

In *satoyama* near Kyoto, natural resources which are essential for traditional events have been harvested. For example, in regard to *okuribi* (the great bonfire event) on Mount Daimonji in Kyoto, the local preservation society has managed common forest and ensured the availability of *P. densiflora* (Japanese red pine) firewood materials that have been used on the fire bed on the mountain slope for several hundred years. However, the survey conducted by the preservation society in 2007 has indicated that almost all 80-year-old to 100-year-old pine trees have wilted in the common forest which have provided firewood materials for *okuribi* on Mount Daimonji. Thus, it has become difficult to obtain the materials that are necessary for *okuribi* on five mountains including Mount Daimonji in Kyoto. Beautiful landscapes in the town of Higashiyama have been depicted in drawings such as "*Yashoku Roudaizu* (Snow-clad Building at Night)" by Buson Yosa (1716–1783) in the Edo Era. With respect to Japanese gardens, there has been a traditional technique called *shakkei* (borrowed landscape) which incorporates the surrounding landscape into gardens. Many gardens borrowed the Higashiyama landscape. However, most *P. densiflora* (Japanese red pine) forest in Higashiyama that have provided a landscape image to people living in Kyoto for many years have experienced succession to evergreen broadleaved forest at an accelerated pace, resulting in changes in the visual quality of landscape.

Satoyama encompasses various natural elements such as forests, rivers, rice paddies and grasslands. Thus, it also provides children with important opportunities for experiencing natural environments. It has been pointed out that children's play experiences in natural environments encourage children to recognize plants and animals as well as their biotopes. These experiences also contribute to the development of children's sensitivity. Furthermore, these experiences influence the sense of nature and sense of environmental value that are established once children have grown up. There has been a rapid deterioration in children's playing environments since around 1965. According to the report on playing environments based on comparisons between around 1955 and 1975, there was a drastic decrease in time spent and spaces used for playing, degradation in playing methods, and reduction in playing groups. Comparison of children's recreational activities between around 1975 and 1995 has also indicated that there was a decrease in time spent and spaces for playing, degradation in outdoor playing, and the tendency of playing groups consisting of similar-aged children. Among these, play in natural spaces such as forests and rivers has continuously declined temporally and spatially.

Ecotourism has tended to expand, incorporating *satoyama* management and agricultural experiences. Since 1996, the number of tourists who visit Aya Town for evergreen broadleaf forest has reached five times the number in 1980. Similarly, the number of tourists to the Aso grassland region has increased.

12.3.11 Association with human well-being

Agricultural income produced in Japan started to increase from 1.1411 trillion yen in 1955, reaching its peak at 5.4206 trillion yen in 1978. After that, it decreased, falling to 3.3066 trillion yen in 2005. In recent years, depopulated prefectures and metropolitan areas have experienced a drastic decline in agricultural income. For example, agricultural income in Shimane Prefecture has declined to 35 per cent of its peak year. Although the rate of suicide was 25 people per 100,000 people in 1955, it decreased to 15 people in 1965. However, the rate has been maintained at a high level of approximately 25 people again since 1988. Looking at the rate of suicide in each prefecture, the rate is high in Shimane, Miyazaki, Kochi, Wakayama and Saga Prefectures. An ageing society and economic problems affect the rate of suicide. The decline in *satoyama* ecosystem services has had a significant impact mainly on the well-being of elderly people in depopulated areas. At the same time, the deterioration in ecosystem services has also influenced the well-being of all Japanese people through a decline in amenities, an increase in costs spent for supplementing regulating functions, and an increase in energy consumption in urban areas.

Hilly and mountainous areas have experienced acceleration in depopulation, making it impossible to maintain community functions due to depopulation and an ageing society. As a result, villages have been deserted. The number of agricultural villages with five farming households or less was 4,932 in 1980. However, it increased to 12,135 in 2000. In cities which have developed by losing *satoyama*, most ecosystem services are obtained outside the cities. For example, the food self-sufficiency ratio (on a calorie basis) was only 2 per cent in 2006 in Osaka Prefecture. Ecological footprints in Osaka Prefecture were approximately 19 million ha in 2000, reaching 100 times of its land area. These changes have impaired regional sustainability.

12.4 Drivers of changes

12.4.1 Overview

In western Japan, urbanization and depopulation have significantly divided *satoyama* ecosystems into two types: *satoyama* ecosystems which "are engulfed into urban areas" and those which "return to forest". With regard to *satoyama* which "is engulfed into urban areas", ecosystems have vanished as a result of housing land development in *satoyama* or other factors, leading to a loss of ecosystem services. On the other hand,

Table 12.1 Overview of trends in ecosystem services (Western Japan cluster)

Ecosystem services	Subcategory	Human use	Enhancement/ degradation	Remarks
Provisioning services				
Food	Grain and potatoes	▼	+/−	A decrease in the production of grain and potatoes is attributed to a decline in the production area that has resulted from a decrease in consumption. The productivity of farmland has been maintained. In many cases, productivity has been enhanced through infrastructure development.
	Vegetables and fruits	=	+/−	There is no significant difference in the production volume of vegetables and fruits as compared to that of 50 years ago. Crop variety improvement and production method improvement have enhanced production efficiency.
	Livestock products	▲	+/−	The production of meat, eggs and milk has increased. This has resulted from an increase in poultry farming, pig farming and cattle raising that are intensively conducted in a limited area. The increase in production has been brought about by an increase in imported feed. Therefore, this increase cannot be regarded as ecosystem services in *satoyama*.
	Fish yields	▼	▼	Fish yields have declined in the Biwa Lake as well as in rivers in Aya Town.
	Products from wild animals and plants	▼	+/−	Wild bird hunting for food production has declined. This is mainly due to the implementation of stricter laws. Harvests from most mushroom and wild vegetables have also decreased. For some species such as *matsutake* mushroom, yields have decreased. For other species, no decrease in yields has been observed. Instead, the species has no longer been consumed due to a change in eating habits.
	Deer and boars	NA	▲	The number of deer and boars hunted as well as their population have increased. However, because the number includes animals that have been hunted as pest animals, no quantitative data regarding resource usage is available.

Table 12.1 (cont.)

Ecosystem services	Subcategory	Human use	Enhancement/ degradation	Remarks
Fibre	Lumber	▼	+/−	Lumber production has decreased. Although the volume of forest has increased, some forests have been left unmanaged after tree planting and have indicated degradation in lumber quality. However, lumber utilization has been increasing. This increase has been met by imported lumber.
	Cotton, hemp and silk	▼	▼	There has been a decrease in the cultivation of cotton and hemp as well as silkworm farming. Nevertheless, the utilization of these types of fibres has been increasing. This increase has been met by imports from overseas countries.
	Thatches (e.g. Japanese bloodgrass, Chinese silver grass)	▼	▼	The utilization of thatches for roof production has almost vanished. Grassland in which to cut thatches has drastically decreased as well.
Non-timber forestry products	Charcoal	▼	+/−	There has been a significant decrease in the utilization of firewood and charcoal because these materials have been replaced with fossil fuel. Traditionally utilized *P. densoflora* (Japanese red pine) forest has declined due to death from diseases or ecological succession to other types of forests. Trees such as *Quercus serrata* (*konara* oak) have shown a significant growth. However, these trees are not suitable for sprout regeneration. In addition, similar to Japanese red pine, a decreasing tendency has been observed due to death from diseases and pests or ecological succession.

	Bamboo	▼	+/−	The utilization of bamboo materials has drastically decreased. Products that were made of bamboo materials have been replaced with plastic products. The production of bamboo for human consumption has also decreased. However, this is not due to a decrease in consumption. Imports of bamboo shoots have been increasing. The underuse of bamboo has raised an issue regarding the expansion of *Phyllostachys edulis* (moso bamboo) forest that has put pressure on other types of forests.
Water		▲	+/−	Water supply has increased. This is mainly due to the construction of dams. There has been a complicated impact of the growth of trees in forest on water runoffs.
Regulating services				
Atmosphere control		NA	NA	
Climate control	Global level	▲	NA	Carbon emissions have increased in western Japan. It is believed that some of the emitted carbon dioxide is absorbed by ecosystems in the region.
	Regional or local level	▼	▼	In urban areas, heat island phenomena have been widely observed. Various greening efforts have been made over the last 50 years. The increase in green areas has been far overwhelmed by the decrease in green areas resulting from urbanization.
Fixation of sloping areas		▲	▲	Greening of mountainous areas has prevented landslides.
Flood mitigation		NA	NA	Flooding has decreased. In addition, flood control has allowed for the utilization of land that could not be used due to flooding. This has been achieved through the development of dams, levees and drainage canals. Whether or not ecosystem services have brought about any changes in flood mitigation functions are unknown.
Artificial beach nourishment		▼	▼	The construction of dams has discouraged the transportation of sand from rivers, causing erosion in most beaches.
Animal damage		▲	▼	Negative services have increased. There has been an increase in damage that is caused by animals such as *C. nippon* (sika deer), *Sus scrofa* (wild boar) and *Macaca fuscata* (Japanese macaque).

Table 12.1 (cont.)

Ecosystem services	Subcategory	Human use	Enhancement/ degradation	Remarks
Cultural services				
Natural resources used for traditional culture		▼	▼	Plants such as *Bon* flowers, pine needles, bamboo leaves, pine firewood and azalea sticks have become unavailable.
Environmental education		▲	▼	Utilization through environmental education has increased. (The term environmental education did not exist 50 years ago.)
Landscape		▲	+/−	Quantitative assessment of landscape utilization is impossible. However, as is indicated by the enactment of the Landscape Act, it is believed that there has been an increase in landscape use. In some areas, natural landscape has been enhanced through various factors such as the growth of trees and nature conservation activities. In other areas, landscape has degraded due to factors such as development, the abandonment of management, and ecological succession.
Recreation		▲	+/−	The number of visitors to natural parks and other recreational sites has increased. Some areas have improved through conservation and management. Other areas have degraded due to the development of roads and resort facilities.

Notes: ▲ = Increase (the column of human use) or enhancement (the column of enhancement/degradation)
▼ = Decrease (the column of human use) or degradation (the column of enhancement/degradation)
= = Almost no change has been observed.
+/− = Mixed (Both increasing and decreasing trends have been observed over the past 50 years. Or, there is an increase in some items or regions while there is a decrease in other items or regions.)
NA = The item was not evaluated in this assessment. In some cases, no discussion was conducted regarding the service. In other cases, discussion was carried out regarding the service, but the evaluation of the conditions and trends of human use based on available information and data was impossible.
† = The classifications of "human use" and "enhancement/degradation" have not been applied to supporting services. This is based on the definition of supporting services that the services will not be directly used by human beings. (If indirect impact was included, cost and benefit would be counted redundantly.) A change in supporting services has an impact on provisioning, cultural, and regulating services. These services can be both enhanced and degraded through human use.

in *satoyama* which "returns to forest", the fuel revolution and the materials revolution have prevented the full utilization of provisioning services. This has induced the abandonment of management in secondary forest and bamboo forest. This has also resulted in substantial animal damage to crops caused by *Sus scrofa* (wild boar) and *C. nippon* (sika deer). This phenomenon has been attributed to changes in the industrial structure in Japan that were involved with post-war reconstruction. In conjunction with the shift in the ratio of employed people from the primary industry to the secondary and tertiary industries, the population has moved from agricultural mountainous villages to urban areas on a large scale. Moreover, the fuel revolution and the materials revolution took place. The fuel revolution has urged the conversion of energy from charcoal and firewood to oil and natural gas. The materials revolution has converted commodities from bamboo and wood products to plastic products. Additionally, the advancement of globalization in the form of the import of low-cost materials and bamboo products has restrained the utilization of provisioning services in *satoyama*. Currently, there have been trends for restoring *satoyama* and depending on *satoyama* for cultural services. In *satoyama* near urban areas, local governments and voluntary activities of citizens have led the initiative. In some *satoyama* areas in depopulated regions, *satoyama* has become a site for interaction between cities and agricultural mountain villages through green tourism, environmental education and farm stands.

12.4.2 Farmland ecosystems

Main indirect drivers of changes in farmland ecosystems in western Japan are as follows: (1) changes in social structure, (2) development of science and technology, (3) changes in lifestyle and (4) social systems.

12.4.2.1 Changes in social structure

The 50-year-period after 1955 can be classified into the high economic growth period, medium growth after the oil shock of 1974 and low growth after the collapse of the bubble economy in 1992 and 1993. The rate of population increase has also declined since 1975. However, changes in population greatly vary depending on the region. The Kinki region and the prefectures which include metropolitan areas experienced a rapid population increase in the first half of the period and sluggish growth in the second half. On the other hand, the other prefectures such as Shimane saw a consistent population decrease due to population movement to urban areas from the first half of the period. Behind the decrease in farmland and increase in abandoned cultivated land, there are issues regarding people who engage in managing farmland (ageing society, lack of successors and acceleration of part-time agriculture). The total number of farming households was 92,090 in 1950. It significantly decreased to one-third, 27,893 households, in 2005.

12.4.2.2 Development in science and technology

In each region, comprehensive development plans have been formulated since around 1955 to construct dams and build river banks. Thus, agricultural production has been stabilized. Simultaneously, farmland conservation and land readjustment projects have been implemented to increase the area of cleared land for agriculture. Drainage and agricultural roads have also been developed. The introduction of power machinery such as large tractors, rice planters, combines and dryers has accelerated to improve farm working efficiency. Therefore, community collaborative tasks such as traditional "*yui* (cooperative work in a community)" have been dramatically reduced.

12.4.2.3 Changes in lifestyle

In 1965, annual rice consumption per capita was 112 kg. It decreased approximately by 50 per cent to 59 kg in 2005.

12.4.2.4 Social policies

Since the implementation of the rice production reduction policy in 1969, rice production has been adjusted, forcing crop changeover in 30 per cent of rice paddies. Most rice crops have been changed over to vegetables and fruits. In hilly and mountainous areas, in many cases, rice crop changeover has discouraged farmers from cultivating and has led to the abandonment of cultivation. This has caused the increase in *satoyama* which "returns to forest".

12.4.3 Forest ecosystems

Main indirect drivers of changes in forest ecosystems are (1) changes in social structure, (2) changes in lifestyle and (3) social systems.

12.4.3.1 Changes in social structure

Mountain villages have faced seriously aggravating depopulation. Combined with an ageing society, depopulation has resulted in a lack of human resources in the forestry industry. This is partially attributed to policies which have promoted urbanization and advanced industrialization. However, this is mainly because all industries in mountain villages other than the tourism industry have been virtually devastated. This industrial devastation has been caused by several factors. For example, cheap timber materials have been imported. The fuel revolution has brought about an energy shift. The materials revolution has also taken place. Additionally, imports of overseas fibres have led to a decline in silk culture and hemp cultivation. Furthermore, in the middle of the 1990s, imports of bamboo shoots in spring water from overseas countries such as China dominated more than 50 per cent of market share. Since then, *P. edulis* (moso bamboo) forest has been extensively abandoned. The current bamboo self-sufficiency ratio has fallen to approximately 10 per cent. The main cause of the ongoing expansion of bamboo forest is the abandonment of *P. edulis* (moso bamboo) forest.

12.4.3.2 Changes in lifestyle

Japan has undergone the fuel revolution, which represents an energy shift from charcoal and firewood to oil and natural gas. The fuel revolution devastated the coal industry, one of the large industries in mountain villages. In addition, for commodities, most bamboo products, wood products and vine products have been converted to plastic products. This has led to a decline in handicrafts such as bamboo and wood processing and vine knitting. Import of overseas cotton and silk has resulted in deterioration in silk culture and hemp cultivation. The dissemination of foreign paper has diminished Japanese paper manufacturing which utilizes *Broussonetia kazinoki x B. papyrifera* (hybrid of paper mulberry) and *Edgeworthia chrysantha* (oriental paperbush).

12.4.3.3 Social policies

In the process of post-war reconstruction, there was an increase in timber demand. The price of timber started to rise sharply around 1960, seriously affecting the national economy. Hence, the "Emergency Measures for Timber Price Stabilization" was drawn up. Miyazaki Prefecture cut down trees in national forests, aiming to double yields from 600 million m^3 in around 1955 to 1.2 billion m^3 in 1963. Forest plantation also expanded to 3,810 ha in 1966. However, demand for pure Japanese style houses that are built with domestic timber has declined and consequently the use of domestic timber has rapidly decreased. Due to an increase in low-cost and standardized imported lumber, the domestic lumber self-sufficiency ratio has remarkably stagnated. The decline of the mountain village stumpage value of *C. japonica* (Japanese cedar), which is income for forest owners, is more drastic. While the price was approximately 18,000 yen per m^3 in 1980, it fell to 2,000 yen per m^3 in 2000. This price slump has made it impossible to ship timber even if trees are cut down. Currently, there has been no progress in tree thinning.

12.4.4 Grassland ecosystems

The main indirect drivers of changes in grassland ecosystems are (1) changes in social structure, (2) development of science and technology, (3) changes in lifestyle and (4) social systems.

12.4.4.1 Changes in social structure

Similar to farmland ecosystems and forest ecosystems, agricultural mountain villages experienced a decrease in population and acceleration in depopulation. In parallel, the ageing of population also accelerated. This resulted in a decrease in and the ageing of workers in the agricultural and livestock industries. The abandonment of cultivated land also caused other issues such as the abandonment of the management of neighbouring grass cutting sites. In addition, each region has faced a critical issue regarding a lack of people who engage in the scheduled work of burning due to depopulation and ageing. This has resulted in the cancellation of scheduled burning and the reduction of the scale of the scheduled burn.

12.4.4.2 Development in science and technology

Prior to the diffusion of chemical fertilizer, fertilizer that had been supplied from neighbouring areas was used in cultivated lands such as rice paddies. It was also said that grass harvested in grassland of five *tans* (approximately 4,959 m^2) was necessary per rice paddy of one *tan* (approximately 992 m^2). In conjunction with the diffusion of chemical fertilizer, the utilization of these grass resources has drastically declined. Traditionally, cattle and horses were indispensable labour forces for farming and transportation. In a human settlement at the base of Mount Sambe in Shimane Prefecture, out of approximately 840 households, 670 households had cattle and the number of cattle exceeded 1,700 around the beginning of the Showa era (1926–1989). In parallel with the diffusion of machines such as cultivators, cattle and horses have become unnecessary for labour. Once livestock animals disappeared in the human settlement, grass harvesting for producing feed has decreased and the utilization of grazing land has been discontinued. Grass harvesting was essential not only as feed and grass mats for cattle and horses but also as materials for thatched houses.

12.4.4.3 Changes in lifestyle

The diffusion of tiled roofs has eliminated the necessity for grass cutting for thatching the roof. Management activities such as grass cutting and scheduled burning have gradually decreased. Traditionally, the main feed for cattle and horses was straw in rice paddies as well as grass in furrows and meadows. Once the purpose of raising cattle and horses changed from labour to dairy, grass resources as feed have shifted from wild grass to pasture grass. In this way, grassland improvement has accelerated the conversion of grassland into sown grassland.

12.4.4.4 Social systems

Expansive forest regeneration policies have been promoted since around 1960. Many grasslands that had experienced the abandonment of management for the aforementioned reasons have been converted to regeneration areas.

12.4.5 Inland water ecosystems

Main indirect drivers of changes in the Biwa Lake are (1) development in science and technology, (2) changes in lifestyle, and (3) social systems.

12.4.5.1 Development in science and technology

It is believed that improvements in the materials for fishing net and the performance of fishing boats have naturally raised fishing efficiency, consequently causing unintentional overfishing.

12.4.5.2 Changes in lifestyle

As a commuter town of the Keihanshin (Kyoto-Osaka-Kobe) area, the Biwa Lake region experienced a population increase after World War II. Along with the population increase, a large quantity of pollution flowed into Biwa Lake from the watershed areas. As a result, eutrophication accelerated.

12.4.5.3 Social policies

There has been a remarkable decrease in the area of *Phragmites australis* (common reed) zones and lagoons. In addition, artificial lakeside bank protection has decreased natural lakeshores. Also, recently, based on the Seta River Arai Weir operation rules that were enacted in 1992, the lake water level has been controlled, resulting in the drying out of the eggs of *Cyprinus carpio* (common carp), *Carassius* spp. (crucian carps), and *Gnathopogon caerulescens*. Furthermore, *Carassius* spp. (crucian carps), *C. carpio* (common carp), and *Silurus asotus* (Japanese common catfish) can no longer enter rice paddies. This is because the gap between rice paddies and water channels has increased due to infrastructure development projects that have been carried out in the areas of the plains over several decades. This factor is also regarded as one of the causes of the decline in domestic fish. Biwa Lake has suffered from ecological conflicts and predation pressure that are imposed on domestic fish by *Micropterus salmoides* (largemouth bass) and *Lepomis macrochirus* (bluegill) from North America. Specifically, there has been a decline in or the threat of extinction to fish that spend their lives mostly in lakeside areas and fish which live offshore but inhabit coastal areas at the initial stage of life.

12.5 Responses

12.5.1 Land use plans

Osaka Prefecture designated all Osaka areas as urban planning areas in 1970. At that time, farmland in urbanization target areas reached 48.2 per cent of the total area of farmland in Osaka Prefecture. Urbanization-restricted areas also accounted for 34.2 per cent of farmland that had been converted between 1995 and 2006. Even though the Osaka government attempted to control aggressive urbanization policies by defining the scope of urbanization areas, this countermeasure was not effective in the conservation of farmland. The Productive Green Land Act (1974) and the revised Productive Green Land Act (1992) were enacted to ensure green environments in urban areas. Between 1995 and 2006, while an 8.7 per cent decrease in farmland within the productive green zone was observed in the urbanization promotion area; there was a 27.4 per cent decrease in farmland outside the productive green zone, which was converted for housing land. This indicates that this act was effective in restraining urbanization to some degree. The designation of agricultural developing areas (which consist of farmlands of 9,687 ha [29.8 per cent], lands for agricultural facilities [17 ha], forest and wooded areas of 9,527 ha [29.3 per cent], and other areas of 13,330 ha [40.9 per cent] as of 2006) has modestly restrained urbanization. With regard to the preservation of biota in the *satoyama* natural environment, responsive measures have been implemented only in a limited manner such as the designation of Mount Mikusa (14.48 ha in 1992) and Jiou Wetlands both in Nose Town, Osaka Prefecture (17.70 ha in 1998) as "green zone environmental preservation areas".

On the other hand, Kyoto Prefecture has implemented various legal regulations such as the Ordinance on Landscape District (1930), "Act on Special Measures concerning Preservation of Traditional Scenic Beauty in Ancient Capitals" (1966), green area conservation system of suburban green zone preservation areas (3,333 ha in 1969), special suburban green zone preservation areas (212 ha in 1996), special green zone preservation areas (26 ha in 1981 and 1994), and "Ordinance on Natural Landscape Conservation in Kyoto" (1995). Through these regulations, Kyoto has been successful in restraining urban sprawl and preserving landscapes.

12.5.2 Responses in the agricultural field in recent years

Osaka Prefecture has established certification programmes such as that of the "Eco Farmer" (farmers who are certified for the introduction of highly sustainable agricultural production methods) and "Osaka Eco Agricultural Products". Community farmland is also expected to exert a restraining effect on the conversion of farmland and abandonment of cultivated land. However, as of 2007, only 709 community farmlands with a total area of 78 ha existed in Osaka. In hilly and mountainous areas, aid has been provided for each community's initiatives through the utilization of the "Direct Payment System for Hilly and Mountain Areas" and "Action Plan for Improvement of Farmland, Water and Environmental Preservation". In some cases, various entities such as local non-farming inhabitants, urban inhabitants, and incorporated NPOs have participated in these activities.

In Toyooka City, Hyogo Prefecture, initiatives have been carried out to perform winter water flooding, early water flooding, deep water irrigation, and the postponing of intermittent drainage in rice paddies. In addition, in order to ensure biodiversity, "farming methods which nurture *Ciconia boyciana* (oriental stork)" have been promoted to reduce agrochemicals and chemical fertilizers as well as to install fish ladders. At the same time, through the brand certificate (Stork Dance), high added value has been created.

In the Kamiseya and Ikaga regions in the Tango Peninsula, there has been an increasing interest in *satoyama* cultural services. In the midst of this, local and suburban citizen groups launched activities in the 1990s. Various parties have participated in these activities: breweries using rice which has been produced in terraced rice paddies, the conservation society for traditional local culture *fujiori* (Japanese wisteria-weaving), schools which impart agriculture to urban people, pension owners, students and farmers. These parties aim to share information about *satoyama* culture and develop activity networks. Certain results from these activities have been observed.

Currently, direct payment to farmers is being discussed as a policy in the new administration. From the viewpoint of the conservation of ecosystems and biodiversity, it would be essential to zone farmland more clearly or to designate target areas. In other words, it is necessary to clearly distinguish farmland for food production from farmland for environmental conservation. For the farmland in the latter category, it would be necessary to extend aid for environmental conservation instead of imposing strict regulations.

12.5.3 Major measures for forest and forestry in the post-war period

Post-war measures primarily focused on the conservation of mountain areas that had been severely devastated. Due to severe flood damage caused by the concentrated heavy rain that occurred in western Japan in 1953, the "Act on Temporary Measures concerning the Protection of

Forest Consolidation" was enacted in 1954 to promote the regeneration of degraded land. After that, there were several changes such as an upfront increase in timber demand involved with post-war reconstruction and a decrease in demand for firewood-charcoal materials as the result of the fuel revolution. Under these circumstances, aggressive conversion of broadleaf forest to coniferous forest was promoted. This brought in the time of mass-development of coniferous forest plantation resources mainly consisting of *C. japonica* (Japanese cedar) and *C. obtusa* (Japanese cypress). However, around 1970, there was an increasing interest in the public functions that forests provided. In 1991, the forest planning system was reinforced to establish the "watershed area management system". In addition, national forest was classified into four categories: national land conservation forest, naturally maintained forest, forests that provide spaces for human use and timber production forest. (After that, in the basic forest resource plan, this classification was changed to three categories: water and soil protection forest, symbiotic forest between forest and human beings and cyclical resource utilization forest.) Thus, with regard to the functions of forest, there was a shift from an emphasis on timber production functions to an emphasis on public functions.

12.5.4 Grassland

In recent years, various values of grassland have been re-evaluated. These values include biomass production, tourism resources, biodiversity conservation and the tradition of local culture. For spacious grassland landscapes, 19 million tourists visit the Aso region in Kumamoto Prefecture every year. Ahead of other regions in Japan, the Aso region has established a mechanism named "Prescribed Burn Support Volunteers". This mechanism allows urban residents to participate in the management of grassland. In order to allow various parties to meet together and to provide support for various activities, the Japan Grassland Summit Symposium was launched in 1995.

12.5.5 Biwa Lake

Biwa Lake is designated as a registered wetland under the Ramsar Convention (registered in 1993; Nishinoko Lake was added in 2008). In Biwa Lake, in order to respond to the devastation of egg-laying sites and habitats for fish, there has been an attempt to revitalize lagoons, to protect and reclaim *Phragmites australis* (common reed) zones, and to develop fish passages to allow fish to enter rice paddies. With respect to the adjustment of the level of lake water, dam operation has been attempted to reduce the impact on fish egg laying. In order to prevent the invasion and propagation of alien species, measures targeting invasive alien species have been enforced. For example, the re-release of invasive alien species is banned. However, fish yields have not recovered sufficiently. In regards to the deterioration of the water environment, the "Ordinance for the Prevention of Eutrophication in Biwa Lake in Shiga Prefecture" was enacted. In addition, the sewage system has been diffused. As a result, there is a trend towards the improvement of eutrophication in Biwa Lake.

12.5.6 Protected species and natural parks

Originally, excellent natural landscape areas were designated as national parks. However, the Tango Amanohashidate Oheyama Quasi-National Park (designated in 2007) was the first national park or quasi-national park that was explicitly designated as *satoyama* landscape. This quasi-national park encompasses *satoyama* cultural landscapes such as *satoyama Fagus crenata* (Japanese beech) forest and rice terraces in Kamiseya. Prior to this, in Osaka Prefecture, 10 regions such as Nose Town in Hokusetsu (northern Osaka Prefecture) were nominated as the "Osaka Hokusetsu National Park". A plan was implemented to connect the park with natural pathways in 2001. It seems that this is the first example of a response to *satoyama* conservation based on the National Park Act. However, the designation has been limited to mountain forest areas. Therefore, this does not mean that diverse mosaic structures in agricultural mountain village landscapes have been preserved. After having been incorporated into the Daisen Oki National Park in 1963, Mount Sambe resumed prescribed burns and grazing in 1988 and 1995 respectively.

12.5.7 Other responses

The foremost and major vegetation type in *satoyama* in western Japan has been *P. densiflora* (Japanese red pine) forest. For this reason, damage from pine wilt disease has also been severe. Several actions have been taken to fight against pine wilt disease. The "Act on Special Measures concerning Pine Wilt Disease Damage" was enacted in 1977 and consolidated with the "Forest Pests and Disease Control Act" in 1997. However, this problem has not been resolved yet. In recent years, an attempt has been made to introduce disease-resistant pine trees. At the same time, through social collaboration, various responsive activities have been carried out to obtain firewood materials for *okuribi* in Mount Daimonji and the fire festival in Kurama in Kyoto Prefecture.

The "Aya Laurel Forest City Declaration" was issued in 1985 based on laurel forest that accounted for 80 per cent of Aya Town. This declaration led to the invitation of *shochu* (Japanese distilled beverage) factories that sought one of the ecosystem services in evergreen forest, the abundant water resources. The *shochu* theme park has attracted over a million tourists every year since 1996. In 2005, five parties of the Kyushu Regional Forest Office of the Forestry Agency, Miyazaki Prefecture, Aya Town, the Nature Conservation Society of Japan, and the Teruha no Mori no Kai (a citizens' organization for conservation of laurel forest in Aya) concluded an agreement regarding the project entitled "Protection and Restoration Plan for Laurel Forest in the Watershed Areas of the Aya River".

In order to give incentives for the conservation of favourable *satochi* and *satoyama*, awards programmes have been introduced such as the 100 best landscapes. In western Japan, quite a few *satoyama* areas have been selected for various awards such as "100 Best *Sato* in Japan (*Asahi Shimbun* and Forests Culture Association, 2008 and 2009)".

Urbanization has diminished the number of sites where people can conveniently interact with the natural environment. In response to this issue, the creation of school biotopes has been actively conducted in each region since the 1990s. School biotopes have been established in 58 schools out of 185 public schools in Kyoto City.

12.6 Conclusion

Due to its small watersheds and diverse geographical conditions, western Japan maintained a wide variety of *satoyama* landscape patterns and cultures. Characterized by detailed land utilization, *satoyama* systems in western Japan each depended on ecosystem services within a relatively narrow area. Over the past 50 years, firewood fuel that was produced in the mountains in the backyards of houses was replaced with imported oil and gas. *Karishiki* fertilizer (wood, young leaves and young shoots that were collected in mountains and placed in crop fields as a fertilizer) has also been replaced with chemical fertilizer that is produced from imported mineral phosphate. Furthermore, labour has moved to the industrial sector that increases cash income, bringing about depopulation in hilly and mountainous areas and overpopulation in urban areas. These changes have polarized *satoyama* into a kind of *satoyama* which is engulfed into urban areas and *satoyama* which returns to forest. This has posed two biodiversity issues. These issues are known as the first biodiversity crisis (urbanization and overuse) and the second biodiversity crisis (underuse). The first crisis was predominant prior to the economic bubble period in the 1980s while the second crisis has been commonly observed after that period. Since the end of the economic bubble period, there have been obvious increases in the volume of plantation forest, bird and animal damage, as well as oak wilt. All of these have resulted from an increase in unused ecosystem provisioning services.

These changes present trade-off relationships in ecosystem services. The main trade-offs are as follows: A decline in provisioning services in grassland has caused the transformation of grassland to forest as well as the first biodiversity crisis since the glacial period. The reclamation of wetlands and floodplains such as the lagoons of Biwa Lake and the Ogura Pond has brought increased benefits to paddy rice production. At the same time, it has destroyed biodiversity in inland water ecosystems and resulted in a loss of the benefits of biodiversity. The development of agricultural infrastructure has led to an increase in provisioning services in farmland ecosystems while losing biodiversity. In urban and suburban areas, human well-being has been enhanced through the development of housing land. However, this has led to a loss of farmland and forest, causing a decline in ecosystem services. In Biwa Lake, the construction of lakeside embankments and manipulation of the water level have allowed for mitigation of the risk of flooding damage to farmland and other areas. On the other hand, fish yields have declined and biodiversity in the ecotone between water areas and land areas has degraded.

Initially, these trade-offs were regarded as inevitable in order to increase human well-being. However, despite increases in ecosystem services in the region, globalization has deprived ecosystem services of their linkage to human well-being. The lumber import policy has led to a decrease in the consumption of domestic lumber. The rice acreage reduction policy has caused the abandonment of restructured farmland. Although hilly areas and seaside reclaimed areas were developed to provide housing land and industrial parks, these areas are now empty.

Various measures have been implemented in each region. Nonetheless, due to the lack of the overall goal, the assessment of the significance of these measures has been impossible. Discussion must be conducted to determine to what extent the abovementioned trade-offs can be tolerated. For example, not only do trade-offs between floodplain areas and farmland areas (rice paddies) affect provisioning services regarding seafood and rice, but they also have an impact on regulating, supporting and cultural services such as flood control, material cycle and recreational activities. Furthermore, biodiversity is of great importance. All of these points must be comprehensively assessed. In addition, it is also essential to discuss the innovation of trade-off mitigation design such as the reproduction of lagoon functions in rice paddies near Biwa Lake.

Even though various measures are being implemented to respond to an increase in "unused" provisioning services such as oak forest, plantation forest, and wild animals and birds, these measures will not contribute to human well-being if only harmful factors are exterminated, or the thinning of trees is conducted and the trees that have been logged are left in the forest. In order to ensure the sustainable use of ecosystem services, the development of a new method for utilizing ecosystem services is necessary. The execution of these new attempts and the verification of the results require that the current *satoyama* and agricultural mountain villages be open to these attempts. However, due to depopulation and the ageing of society, in reality, issues such as the presence of abandoned cultivated land, the absence of land owners, the rights to the disposal of standing trees, and mosaic-patterned land ownership have been bottlenecks to these attempts. The key to the implementation of realistic responses will be the review of the relationship between ecosystem service providers and service consumers as well as the sharing of costs and benefits with these parties.

13

Western Japan cluster: Seto Inland Sea as *satoumi*

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13.1 Overview

The Seto Inland Sea is the largest enclosed sea area in Japan. Approximately 30 million people live in the coastal area of the Seto Inland Sea, including the river watershed areas of the river basins that flow into the Seto Inland Sea. For this reason, the area supports active industrial activities, and therefore, is susceptible to human behaviour. The ecosystem services and landscapes provided by Seto Inland Sea as *satoumi* have been shaped by the long-standing interaction between human activities and the coastal waters. Being reflective of regional characteristics and the historical background, *satoumi* may take a variety of shapes. However, the straightforward definition of *satoumi* in Seto Inland Sea is "coastal waters where human influence has increased both biological productivity and diversity". In other words *satoumi* is a "bountiful coastal area shaped by the coexistence between humans and nature". However, the bountiful *satoumi* of the Seto Inland Sea, maintained for a long time during a time when the influence of human activity on the marine environment and resources was relatively small, changed dramatically in the high economic growth period after World War II. The result was environmental degradation due to pollution and the disappearance of neritic areas due to land reclamation. These were accompanied by the deterioration of ecosystems and decrease in marine resource levels. For this reason, the word *satoumi* is morphing in meaning from what it was initially, "the state that was", to a word indicating "a target for a lost environment to be restored" or "an ideal relationship

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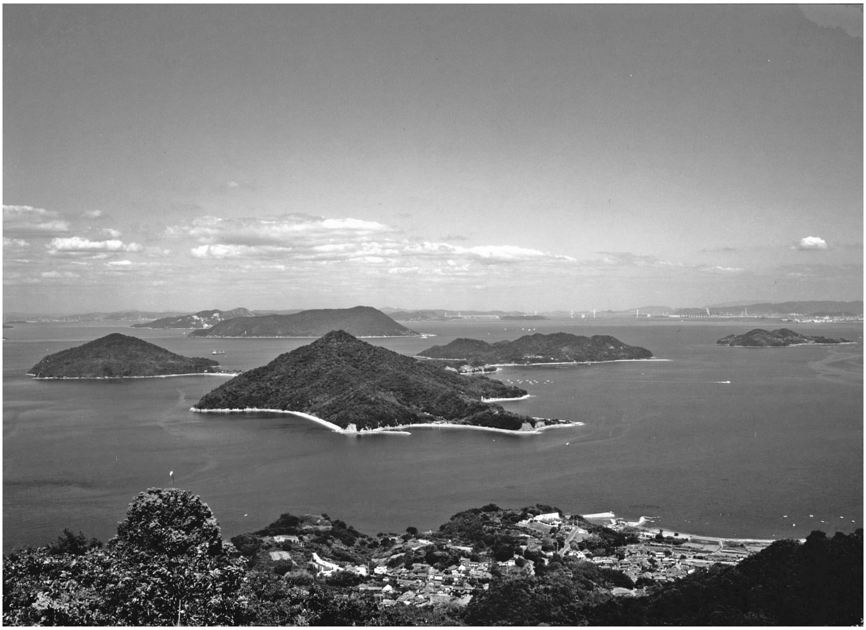

Figure 13.1 Landscape of the Seto Inland Sea archipelago
Source: Provided by the Association for the Environmental Conservation of the Seto Inland Sea.

between people and sea to be newly forged". This is the reason the term *satoumi* is used in phrases such as "the creation of new *satoumi*".

Here, we will provide a general overview of the transformation and current state of Seto Inland Sea ecosystems and their ecosystem services. Furthermore, we will clarify the causes of these transformations. In addition, we will introduce the responses which have been implemented to address these transformations.

13.2 Historical and narrative context

Since ancient times Seto Inland Sea has possessed the characteristic of *satoumi* that is closely connected to human life. By the Jomon Era, not only were its ecosystem services already being utilized in a primitive way through gathering seafood along its shores, but there is also evidence which indicates its sea routes were being used for trade and commerce. The Seto Inland Sea has provided the people on its coast with the important services of "field (food, salt)", "garden (bathing, tourism)" and "road (ocean traffic, cargo transport)" for a long time. In particular, the Seto

Inland Sea's provision of fish in its function as "field", which is a major ecosystem service, is exceptionally high even by international standards. Salt was also an important staple. In addition, the tranquil archipelago landscape of the Seto Inland Sea where the first Japanese national park was established has been internationally acclaimed.

The formation of the Seto Inland Sea as *satoumi* is also closely linked to *satoyama*. The beaches of white sand and green pines, which were once extolled as the typical landscape of the Seto Inland Sea, were formed as a result of the salt industry benefiting from the region the tranquil archipelago landscape of Seto Inland Sea where the first consumption of fuel to condense salt water. As a result, bare granite mountains appeared in the landscape, and the eroded sand from those mountains accumulated to form the white beaches. The pine trees, which do well on poor soil, flourished on the granite sand beaches. The nationally famous oyster farming in Hiroshima Bay and the *satoumi* landscape of rows of oyster rafts both benefit from *satoyama* in the Ota River basin. This is because the management of *satoyama* and the forest directly reflects on the water quality and regime of the rivers, affecting the marine environment and the production of plankton, which is food for oysters. Since the bounties of *satoumi* including seafood and salt have also been used inland, the relationship between *satoumi* and *satoyama* is basically bidirectional.

13.3 Condition and trends

13.3.1 Marine environment of Seto Inland Sea

The quality of the water in the Seto Inland Sea was generally good until the early 1960s. From the mid-1960s, a wave of land development and industrialization swept in. Waterfront areas were reclaimed and became industrial zones, and the population converged on the coastal cities (Figure 13.2). Large quantities of industrial runoff and sewage flowed into the area resulting in eutrophication. The quality of the water in the Seto Inland Sea deteriorated rapidly from the late 1960s to the early 1970s.

This change is typically noted by the change in the number of red tide occurrences (Figure 13.3). The annual occurrence of red tides increased suddenly in the 1970s, peaking in 1976 at approximately 300 occurrences. However, the number fell to under 200 in the 1980s and to around 100 occurrences post the 1990s. These red tides frequently caused damage to the fishing industry and had an enormous impact on ecosystem services.

Eutrophication is accompanied by the occurrence of hypoxic bottom water and the deterioration of sediment, which have also had a large impact on the marine environment. Hypoxic bottom water occurs when

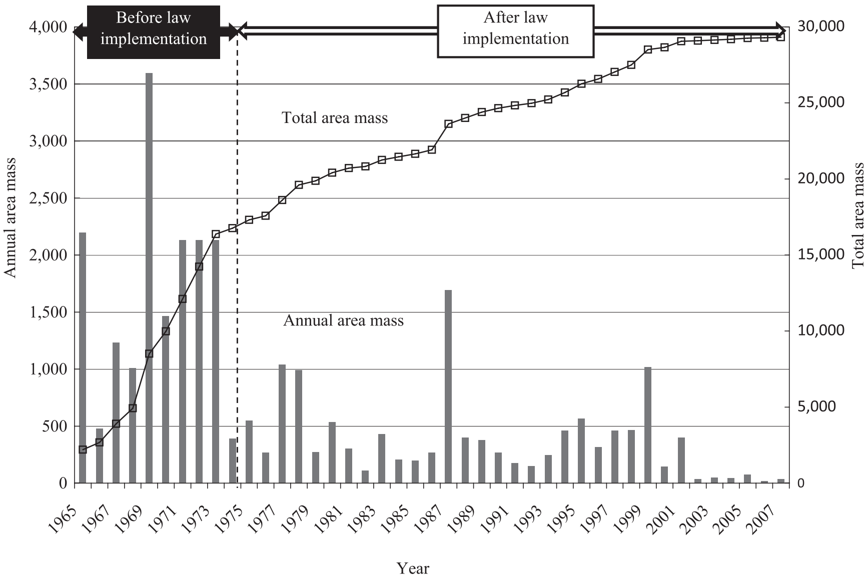

Figure 13.2 Change in the mass area of landfill in the Seto Inland Sea
Source: Setouchi Net website (in Japanese)
http://www.seto.or.jp/seto/kankyojoho/shakaikeizai/01umetate-2.htm.
Note: Created based on a survey by the Ministry of the Environment, Japan.

oxygen consumption in the bottom seawater exceeds oxygen supply and is extremely destructive to the biological habitat. Hypoxic bottom water is usually caused by sludge deposited on the seabed and the damaged sediment impedes habitation of benthic organisms (benthos). Since the sludge deposited on the seabed has accumulated over many years, the sediment cannot be improved in a short period of time even with the reduction of contamination inflow. For this reason, although somewhat dependent on oceanic conditions, the rate of transformation for sediments and hypoxic bottom water has levelled off in recent years.

13.3.2 Regulating services provided by seaweed beds and tidal flats

The neritic zone of the coast, which includes seaweed beds and tidal flats, has a variety of functions. Not only is it high in biological productivity, but it also acts in a broad sense as filter or buffer area between the land and ocean areas. For example, it is equipped with a large natural purification capacity to filter out contaminants that have flowed in from the land. The Seto Inland Sea is also known for the reproduction (spawning, rearing of fry, etc.) of a variety of fish and shellfish in its shallow areas such as seaweed beds, tidal flats and sand beaches with the notable dubbing of

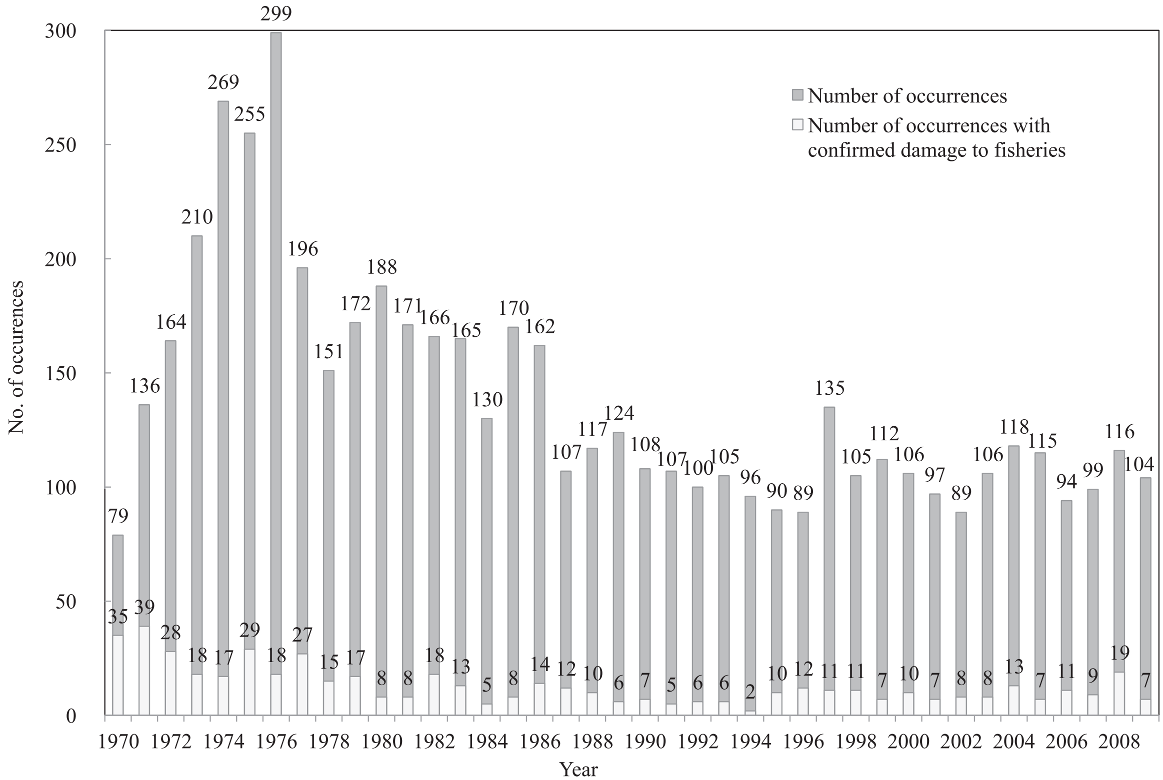

Figure 13.3 Confirmed red tides in the Seto Inland Sea
Source: Setonaikai Fisheries Coordination Office, Fisheries Agency (2010) *Red Tides in the Seto Inland Sea*. Kobe: Setonaikai Coordination Office, Fisheries Agency (in Japanese).

the seaweed bed as “the cradle of the sea”. These functions are categorized as regulating services within the ecosystem services.

However, the area of the seaweed bed and tidal flats in the Seto Inland Sea has decreased significantly. The eelgrass beds, one of the main types of seaweed beds in the Seto Inland Sea, have decreased from approximately 22,600 ha in 1960 to around 6,400 ha 30 years later in 1990 – in other words, to less than one third. There has been a long term trend of large declines in area of seagrass bed but recent active regeneration efforts in various regions have seen a small number of localized increases in eelgrass bed areas.

There is close to 100 years of statistics on the transformation of tidal flat areas. In 1898, the tidal flat areas were estimated to be approximately 25,200 ha but a gradual decrease brought the area down to 11,700 ha by around 1990. This means that the various regulating service functions provided by the tidal flats have been drastically lost.

13.3.3 Long-term changes in small coastal animals and distinct rare creatures

Many small animals on the waterfront are easily sighted and quite familiar. At the same time they are an important constituent of the ecosystem. Despite this fact, there is little objective data tracking their transition over a longer period. Considering this, the results of continued observation at six locations around Kure City since 1960 are worth attention (Figure 13.4). The sighting of small coastal animals started to decline rapidly from the late 1960s through the early 1970s, gradually slowing to a moderate decline and hitting a low in the late 1980s. It is assumed that the worst environmental conditions for the survival and reproduction of small coastal animals were widespread during this period. After 1994, the number of species gradually showed an increase, indicating that habitat conditions had started to take a turn for the better. However, the number of sighted species is still a far lower than the number at the start of the 1960s. Out of the six locations, the estuaries were the first to show a rapid decrease in the number of sighted species and the islands showed the latest and more gradual decrease. Although this transition pattern is based on observation results from a limited area, they include points from estuaries to the islands. It can also be qualitatively inferred that similar transition patterns have been occurring in various locations across the Seto Inland Sea.

As typical examples of rare animals under threat of extinction, we will look at the prevalence of the *Tachypleus tridentatus* (Japanese horseshoe crab) and the *Neophocaena phocaenoides* (finless porpoise). At one time, the *T. tridentalus* (Japanese horseshoe crab) made most of the Seto Inland Sea and Northern Kyushu its habitat and was commonly observed at least

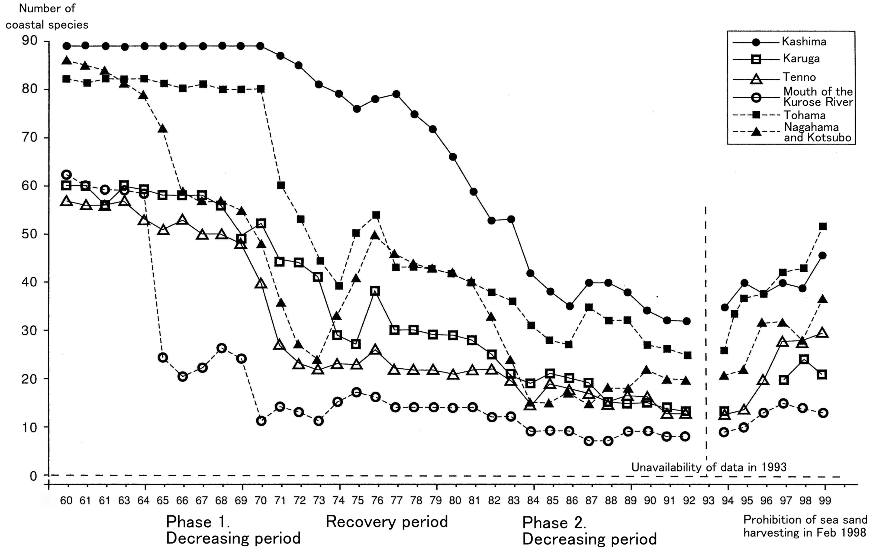

Figure 13.4 Change in the number of small animals inhabiting the coastal area of Kure City by location and year
Source: Fujioka, Y. (2009) "Changes in Coastal Ecosystems in Hiroshima", *Technologies and Humans* 29(2): 32–43 (in Japanese); and private communication.

until around the 1960s. After this period, there was a rapid decrease and the *T. tridentalus* (Japanese horseshoe crab) was classified as an endangered species by the Fisheries Agency in 1994. In Oehama, Kasaoka Bay (Kasaoka City, Okayama Prefecture) where it was designated as a protected species prior to World War II, larvae sightings ceased in 1980 and even eggs were not identified in 1985. *N. phocaenoides* (finless porpoise) is a small dolphin at the top of the food chain in the Seto Inland Sea. Since its numbers are reflective of other species and their habitat conditions, they are considered to be a symbolic indicator species of the Seto Inland Sea. In the 1970s, the number of *N. phocaenoides* (finless porpoise) living in the Seto Inland Sea was estimated at around 5,000. Since then, the number continued to decline, but some reports show the recovery of the population from 2000 in the mid regions of the Seto Inland Sea. The *N. phocaenoides* (finless porpoise) is designated as an endangered species (Washington Convention (CITES) Appendix I) and various conservation efforts are underway.

13.3.4 The use of provisioning services through fishing

The productivity of the biological community composed of the approximately 800 flora and 3400 fauna that inhabit the Seto Inland Sea supplies

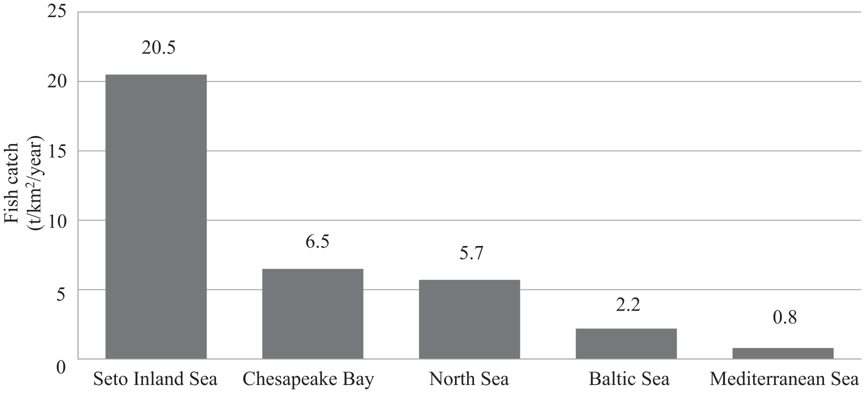

Figure 13.5 Fish catches in major closed seas
Source: Okaichi, T. and T. Yanagi (eds) (1997) *Sustainable Development in the Seto Inland Sea, Japan: From the Viewpoint of Fisheries*. Tokyo: TERRAPUB.

marine products as a biological resource which is renewed year after year. This is one of the representations of the ecosystem services provided by the Seto Inland Sea. If we compare the annual fish catch per unit area of the Seto Inland Sea with that of the major enclosed coastal seas of the world such as the Mediterranean Sea, Baltic Sea, North Sea and Chesapeake Bay, the average fish catch of the Seto Inland Sea in the 1970s and 1980s is overwhelmingly high, about 25 times that of the Mediterranean (Figure 13.5). In recent years, the product yield from the Seto Inland Sea has dropped to approximately half of what it was at its peak but its annual fish catch per unit area is still the highest level in the world. From this, we know that Seto Inland Sea is fundamentally an extremely rich sea.

If we look at the annual fish catch from the Seto Inland Sea as the total fish, shellfish and other marine life (excluding seaweed and aquaculture products), this increased gradually from 300,000 tons in 1965 and reached its peak in the 1970s to the 1980s at the height of the eutrophication of the Seto Inland Sea (Figure 13.6). The recorded maximum annual haul was 470,000 tons in 1982. However, the late 1980s showed a sharp decline with the total falling to under 200,000 tons in 2005.

The decline in the fish catch over the last 20 years is due largely to the decrease of small epipelagic fish such as the *Sardinops melanostictus* (Japanese sardine), *Engraulis japonica* (Japanese anchovy), whitebait (primarily young *E. yaponica* [Japanese anchovy]) and *Ammodytes personatus* (Japanese sand lance). Since small fish are food for larger fish-eating fish, the decrease in small fish stock is the cause of the poor fish catches of larger fish. Mackerel and Pleuronectidae (righteye flounders) fish catches have stayed constant but Carangidae (e.g. jack mackerels) and octopus

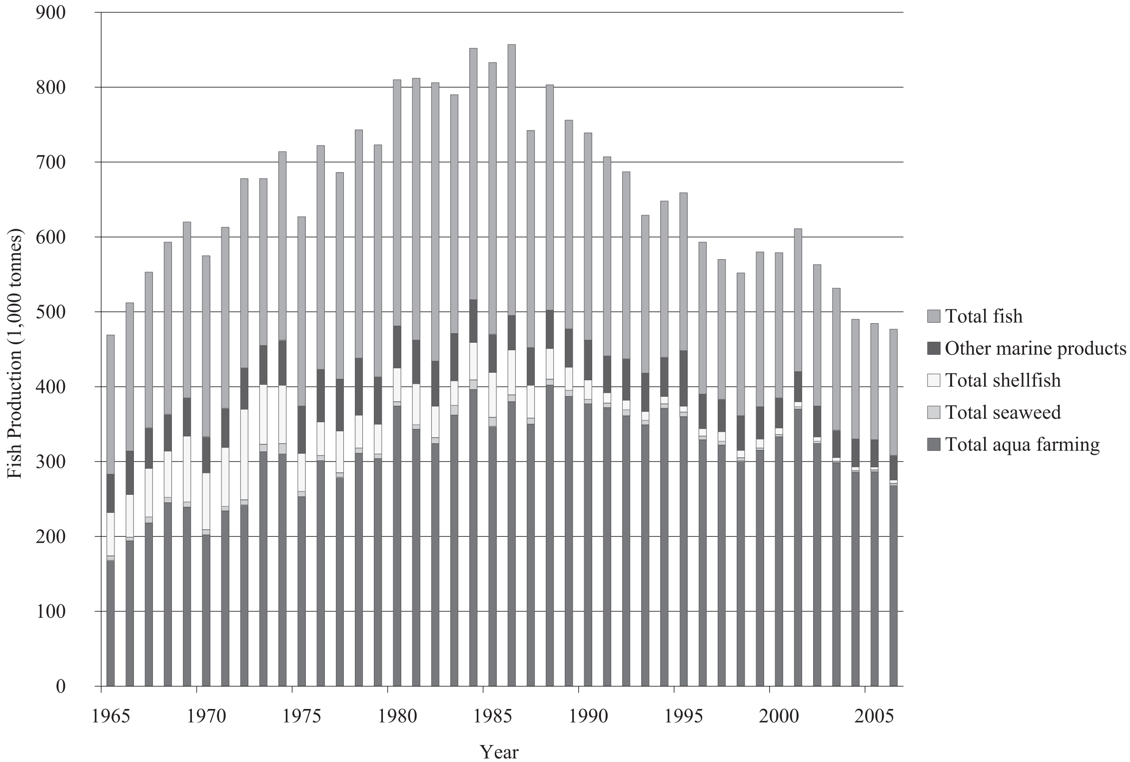

Figure 13.6 Change in fish catch in the Seto Inland Sea
Source: Setouchi Net website (in Japanese) (http://www.seto.or.jp/seto/kankyojoho/shakaikeizai/sangyo-3.htm)
Note: Created based on Statistics Department, Chugoku-Shikoku Regional Agricultural Administration Office, Ministry of Agriculture, Forestry and Fisheries, Japan, *Fishery Trends in the Seto Inland Sea Area and the Southern Pacific*. Okayama: Chugoku-Shikoku Regional Agricultural Administration Office, Ministry of Agriculture, Forestry and Fisheries.

fish catches have shown a slight increase in recent years. On the other hand, *Ruditapes philippinarum* (Japanese littleneck) yields, which are the most important amongst, shellfish have declined sharply over the last few years.

13.3.5 Use of sea sand

The sea sand from the bottom of the Seto Inland Sea is a source of the fine aggregate required in concrete construction and has been used in the maintenance of public infrastructure. In western Japan, sea sand is the most commonly used fine aggregate and the Seto Inland Sea has been an important centre of production. However, as of March 2006 the collecting of sea sand has been all terminated across the entire Seto Inland Sea area. Data is available on the transition of sea sand collected volumes since 1968. The total collected volume up until 1999 was said to be 730 million m^3 with Kagawa, Okayama, Hiroshima and Ehime Prefectures collecting the most. Collected volume increased suddenly from 1968 and reached a peak in 1987 after which it tapered off. Sea sand collecting provided a resource necessary for people's lives and industrial activity but the aftermath of coastline erosion, land subsidence, loss of seaweed beds, changes in the ecosystem and modified currents have been problematic. From this perspective, sea sand collecting has been one of the drivers of change in the ecosystems and ecosystem services.

13.3.6 Well-being and recreation as cultural services

The Seto Inland Sea is an outstandingly scenic area and has a large number of parks including national and quasi-national parks. Setonaikai National Park was established in 1934 and is one of the first national parks in Japan. Of the Japanese national parks it has the second largest number of visitors after Fuji-Hakone-Izu National Park, with more than 37 million visitors per year according to 2007 data. However, compared to the over 47 million tourist visitors in 1998, the numbers are on an annual decline.

In the Seto Inland Sea, 25 per cent of the entire coast line is designated as Setonaikai National Park. However, on the other hand, only 36.7 per cent of the coast has retained its natural coastline – even in comparison to the national average of 55.2 per cent, this is very low. We consider this to be a hindrance to the various services that people might enjoy at a natural seashore. Even under these circumstances, bathing is the biggest summer leisure activity for citizens at Seto Inland Sea. Although there has been a decrease compared to before the high economic growth period, water quality tests indicated 121 of the remaining beaches were fit for use in 1998. In 2007, the number had increased slightly to 136 locations.

Table 13.1 Overview of trends in ecosystem services (Seto Inland Sea, Western Japan)

Ecosystem services	Subcategory	Human use	Enhancement/ degradation	Remarks
1. Provisioning services				
Food (category)	Fish production	▼	▼	In the Seto Inland Sea marine production in 2005 (200,000 tons) decreased to half the production in the peak period of 1982 (470,000 tons). It is possible that marine production is attributed to the synergy of a "failure to catch fish" and a "cessation of attempting to catch fish".
	Shellfish production	▼	▼	
	Production of seafood other than fish or shellfish	▼	▼	
	Seawater culture	▼	▼	Seawater culture production accounts for more than 50 per cent of total marine production. The main products are oysters and dried laver seaweed. Fish farming is insignificant. A slight decline in marine culture has been observed in recent years.
Food (by item)	*E. japonica* (Japanese anchovy)	▼	▼	
	A. personatus (Japanese sand eel)	▼	▼	The harvesting of sea sand has impaired the sand eel habitats resulting in a decline in sand eel catches.
	Mackerel	+/–	+/–	
	R. philippinarum (Japanese littleneck)	▼	▼	There has been a drastic decline due to a decrease in the area of tidal flat, an increase in inhibitory factors that impair clam habitats, damage by predators and other reasons.

Table 13.1 (cont.)

Ecosystem services	Subcategory	Human use	Enhancement/ degradation	Remarks
2. Regulating services				
	Sea grass bed (reproduction)	▼	▼	Area mass of sea grass bed has declined to one third of the area mass around 1960. However, localized recovery has been observed in recent years.
	Tidal flats (purification function)	▼	▼	Compared to masses observed around 1898, the area mass of tidal flats has decreased by a half.
	Natural coast	▼	▼	Natural coast accounts for 36.7 per cent of the total length of the coastal lines in Seto Inland Sea. However, this is much lower than the average ratio of 55.2 per cent in Japan.
	Benthos	+/–	+/–	
	Small coastal animals (in specific regions)	▼	▼	In the coast near Kure City, the number of small coastal animals drastically decreased after the late 1960s. However, a slight increase has been observed since around 1990.
3. Cultural services				
Recreational activities	Tourism	▼	▼	The number of visitors to Seto Inland Sea reached a peak in 1998 and has been decreasing since then.
	Sea bathing	▲	▲	An improvement of the water environment in the Seto Inland Sea has contributed to an increase in the number of swimming beaches from 121 in 1998 to 136 in 2007.
	Aesthetic benefits	▼	▼	The amount of natural coast has been decreasing due to various factors, such as land reclamation, resulting in a decline in aesthetic benefits.
	Spiritual benefits	▼	▼	A decline in the amount of natural coast and biodiversity has resulted in a decline in spiritual benefits.

4. Supporting services			
	Area of the sea	†	†
	Water quality (COD)	†	†
	Water quality (TN)	†	†
	Water quality (TP)	†	†
	Sediment (COD)	†	†

Notes: ▲ = Increase (the column of human use) or enhancement (the column of enhancement/degradation)
▼ = Decrease (the column of human use) or degradation (the column of enhancement/degradation)
+/− = Mixed (both increase and decrease trends have been observed over the past 50 years, or there has been an increase in some items or regions but a decrease in other items or regions)
NA = The item was not evaluated in this assessment. In some cases, no discussion was conducted regarding the service. In other cases, discussion was carried out regarding the service, but the evaluation of the conditions and trends of human use based on available information and data was not possible.
† = The classifications of "human use" and "enhancement/degradation" have not been applied to supporting services. This is based on the definition of supporting services that the services will not be directly used by human beings (if indirect impact was included, cost and benefit would be counted redundantly). Changes in supporting services have an impact on provisioning, cultural and regulating services. These services can be both enhanced and degraded through human use.

13.4 Drivers of changes

13.4.1 Industry and human life

During the times of rapid economic growth, the Seto Inland Sea region experienced gradual changes in its industrial structure and population distribution. This caused Seto Inland Sea coastal prefectures to simultaneously experience a rise in concentration of the population in urban areas, and depopulation of the island areas as well as the hilly and mountainous areas. A steady increase in gross production between 1965 and 1995 continued to be observed in the 13 prefectures surrounding the Seto Inland Sea. However, production has levelled off since 1996 (Figure 13.7). Industrial goods shipments show that the production capacity in this area accounted for over 30 per cent of total shipments in Japan, resulting from

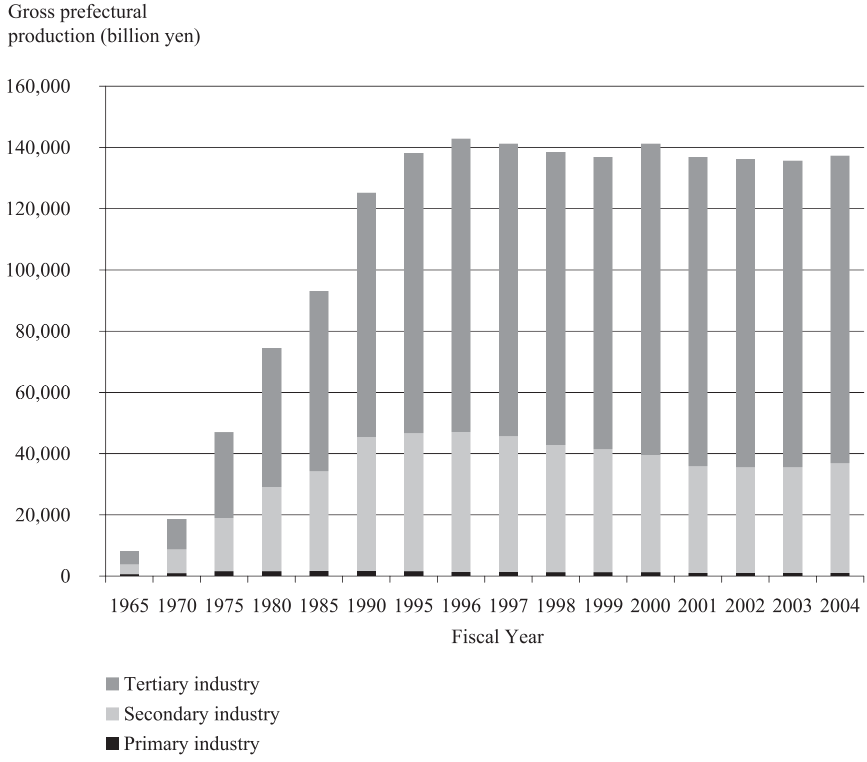

Figure 13.7 Changes in gross production in the 13 prefectures surrounding the Seto Inland Sea
Sources: Cabinet Office, *Annual Statistics on Prefectural Household Income* and *Annual System of Prefectural Accounts*.

the development of heavy industry in the Seto Inland Sea area during the rapid economic growth period. Manufactured goods shipments continued to increase until 1990 in this area, but have not changed drastically since 1991.

13.4.2 Land reclamation and artificial alteration of coastline geometry

Since the 1950s most littoral regions have been reclaimed to develop sites for factories and to build port facilities. Reclaimed land areas overwhelmingly grew to the largest levels between 1965 and 1972 (Figure 13.8). Since 1973, however, the amount of reclaimed areas has sharply decreased. This is greatly attributed to the effect of the Interim Law Concerning Provisional Measures for the Conservation of the Environment in the Seto Inland Sea ("Seto Inland Sea Law") that was enacted in 1973. Land has been reclaimed up to a total of 455 km^2 since 1898. This is the equivalent to approximately 70 per cent of the area of Awaji Island, which is the largest island in the Seto Inland Sea. This means that approximately 20 per cent of the neritic zone with a depth of 10 metres or less has been reclaimed through this large-scale land reclamation. After World War II, 354 square kilometres of land was reclaimed, accounting for 77.8 per cent

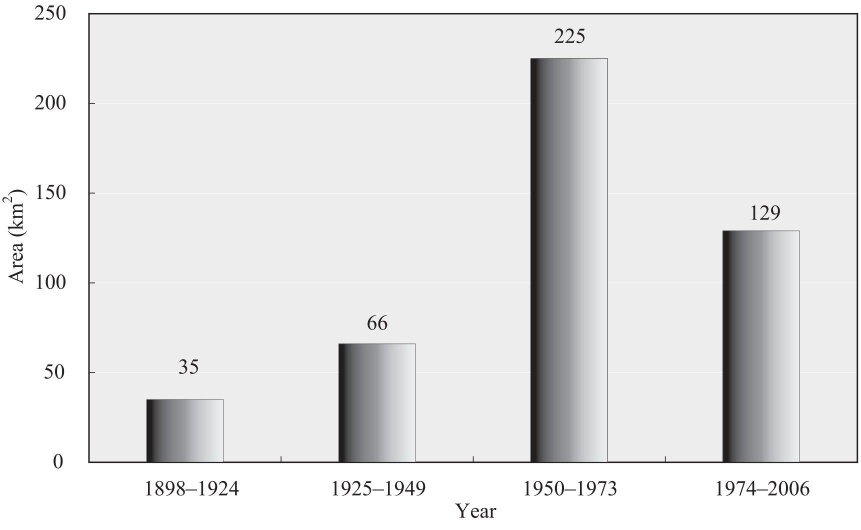

Figure 13.8 Area of landfill in the Seto Inland Sea region
Source: Setouchi Net website (in Japanese)
http://www.seto.or.jp/seto/kankyojoho/shakaikeizai/01umetate-1.htm.
Note: Created based on a survey by the Ministry of the Environment, Japan.

of the total land reclamation area. This rapid land reclamation has destroyed ecosystems including seaweed beds and tidelands.

Large-scale agricultural land reclamation has also had a significant impact on *T. tridentatus* (Japanese horseshoe crab) in Kasaoka Bay. *T. tridentatus* (Japanese horseshoe crab) larva disappeared in 1980, five years after the construction of dykes in the reclaimed area. Similarly, it is considered that land reclamation and subsequent changes in the ecosystems have adversely affected the habitat conditions for *N. phocaenoides* (finless porpoise) and have resulted in the decline of its population.

13.4.3 Amount of pollution and eutrophication

Estimating the amount of influent pollution approximately every five years through calculating the theoretical oxygen demand (ThOD) demonstrates that the value steeply increased after 1957, reaching a peak in 1972, then gradually diminishing (Figure 13.9). This decreasing trend indicates the effects of the Seto Inland Law enacted in 1973.

Looking at changes in the rough amounts of chemical oxygen demand (COD), total phosphorus (TP) and total nitrogen (TN) influent over the past 30 years, it is clear that COD gradually declined after 1979. The COD reduction mainly derived from life activity sources and industrial sources, making COD reduction in "other type" sources (non-point source

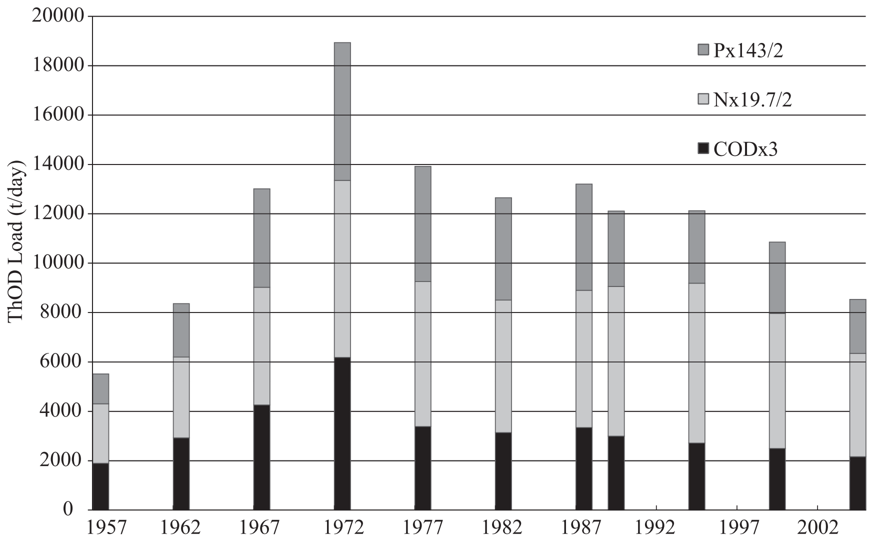

Figure 13.9 Change in ThOD load in the Seto Inland Sea
Note: ThOD = 3COD + (19.7N + 143P)/2

load such as agricultural fields) less significant. Influent TN load did not substantially change between 1979 and around 1994, and has since been in decline. TN load was reduced almost evenly from life activity sources, industrial sources and "other type" sources. Reduction in "other type" sources may overtake that from life activity sources and industrial sources. TP load gradually diminished after 1979 from life activity sources, industrial sources and "other type" sources at even levels. A certain relationship is observed between influent COD, TP and TN load, and water quality. As a whole, there is a proportional correlation between COD, TP and TN load per unit sea surface area and COD, TP and TN concentration in upper sea water.

Focusing on the relationship between the ThOD load mentioned above and fishery production allows us to understand that a load increase, that is to say, eutrophication, caused fishery production to increase for 15 years between 1957 and 1972 (Figure 13.10).

13.4.4 *Fishing intensity*

The decrease in fish catch in recent years, as is discussed above, has resulted from a decrease in marine resources and/or fishing intensity. In short, the decrease has been caused by two combined factors: "failed to

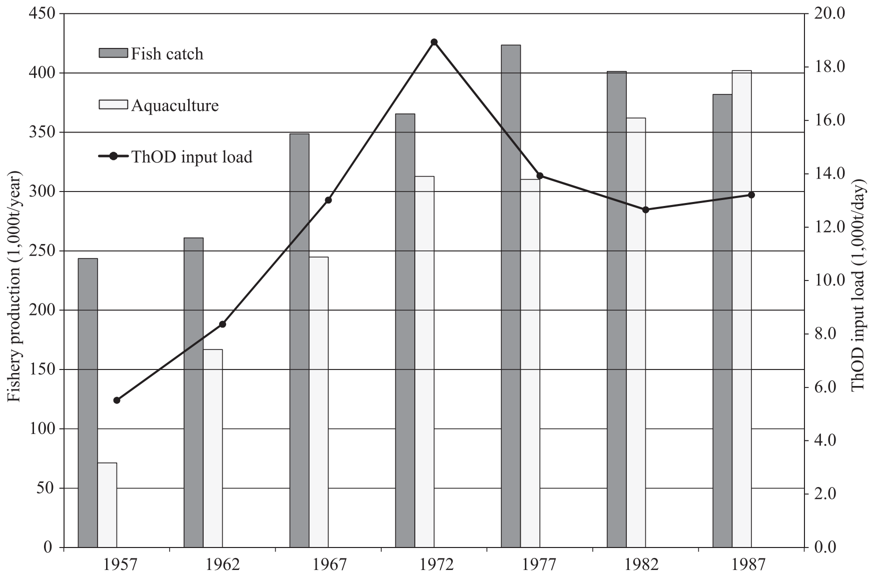

Figure 13.10 Relationship between ThOD load and fish catches (1957–1987)

catch fish" and "ceased to attempt to fish". Therefore, it is not possible to estimate fishing intensity (impact of fishery on the decrease in marine resources) only based on fish catches. For this reason, the quantity of resources (an indicator for "failed to catch fish") and fishing intensity (an indicator for "ceased to attempt to fish") have been estimated through marine resource analysis. The estimated resource quantity and fishing intensity for each major fish species is as follows:

- *Engraulis japonica* (Japanese anchovy) and whitebait: From the standpoint of fishing intensity, we have concluded that the target of *E. japonica* (Japanese anchovy) fishing has shifted from its parent fish to whitebait in the Seto Inland Sea, keeping the fishing intensity for young fish high. However, the resource quantity of parent fish is recovering.
- *Scomberomorus niphonius* (Japanese Spanish mackerel): Although the fishing intensity for young fish has decreased, that for the parent fish remains high. Both parent fish and young fish are small in numbers.
- *Pagrus major* (red seabream): Fishing intensity for both young fish and parent fish are decreasing, and number of parent fish is recovering.
- *Paralichthys olivaceus* (olive flounder): Fishing intensity for both young fish and parent fish remain constant, indicating no improvement. The numbers are decreasing in both young fish and parent fish.
- *Pleuronectes yokohamae* (marbled sole): Fishing intensity for both young fish and parent fish remain constant, indicating no improvement. The numbers are small in both young fish and parent fish.

As mentioned above, with regard to the fish which indicate a recovery in the quantity of resources, the fishing intensity of parent fish is on the decrease, such as *E. japonica* (Japanese anchovy) and *P. major* (red seabream). On the other hand, fishing intensity remains high for those reflecting decreasing resources or low standard levels, such as the *S. niphonius* (Japanese Spanish mackerel), *P. oliyaceus* (olive flounder) and *P. yokohamae* (marbled sole). There have been attempts to replenish the numbers of low resource fish through artificially raising the young fish and releasing them into the sea. However, reducing fishing intensity is necessary for true recovery.

With the exception of *S. niphonius* (Japanese Spanish mackerel), in recent years, young fish reproduced from parent fish have been decreasing in numbers. Another suggested factor responsible for the decline in the level of resources is environmental factors. Environmental factors have interfered with reproduction mechanisms which otherwise would determine the amount of replenishment in accordance with parent resources. In short, it is believed that the healthy "parent-child relationship (reproduction mechanism)" has been changing in Seto Inland Sea due to a rise in water temperature as well as the loss of sea grass beds and tidal lands.

13.4.5 Deterioration of biological habitats

We have already discussed drastic decline in seaweed bed and tidal flat as a biological habitat. In addition, the factors which may interfere with reproduction mechanisms have been presented in the previous section. These interfering factors have been largely attributed to a loss of shallow water areas including seaweed bed and tidal flat, which have functioned as egg-laying and rearing sites for young fish just like a "cradle in the sea". Thus, it is possible to guess that this deteriorated regulating service has resulted in a decrease in marine resources, and therefore a decline in provisioning services.

13.4.6 Sea sand collection

Through the collecting of sea sand, a resource has been provided. On the other hand, the activity of collecting sea sand has had substantial impact on the ocean environment and ecosystems. The direct impact of the excavation has consisted of changes in submarine topography, water depth and bottom sediments. All of which has resulted in changes in sea water flow and biological habitat. The activity of collecting sea sand has produced turbid sea water. The water turbidity has also impaired sea water transparency or settled out in the seaweed bed adversely affecting the growth of *Zostera marina* (common eelgrass) and marine algae.

13.5 Responses

It has been 40 years since the necessity for environmental conservation in the Seto Inland Sea was first advocated. Referred to as the "dying sea", Seto Inland Sea was at risk in the 1970s. After that, a variety of countermeasures and initiatives were implemented. Currently, it is still not possible to say that the sea is in the best condition. However, contaminant input load has been substantially reduced, contributing to water quality stabilization. This is why the Seto Inland Sea is called an "experimental sea area for environmental management". Responses that have been implemented in Seto Inland Sea are extremely diverse. Hence, we would like to discuss some representative and distinctive responses.

13.5.1 Establishment of the Governors and Mayors' Conference on the Environmental Protection of the Seto Inland Sea

To address nationwide environmental pollution, the Japanese government enacted the Basic Law for Environmental Control in 1966 and arranged related laws. However, it was difficult to stop pollution in the Seto Inland Sea through only nationwide uniform regulations. Therefore, various investigations and discussions were undertaken. In response to the rise in local interest towards environmental consideration, the "Governors and Mayors' Conference for Environmental Conservation of the Seto Inland Sea" (Governors and Mayors' Conference) was officially inaugurated in 1971. In this Conference of Governors and Mayors, the enactment of the Seto Inland Sea Charter on Environment Conservation, the establishment of the Seto Inland Sea environmental conservation promotion system, the formulation of the Seto Inland Sea pollution prevention plan and the establishment of red tide preventative measures were unanimously adopted. The Environment Agency (presently the Ministry of the Environment) was established in Japan for the first time in 1971. Advancement of initiatives in the Seto Inland Sea are evident.

13.5.2 Enactment of the Interim Law Concerning Provisional Measures for the Conservation of the Environment of the Seto Inland Sea

In the second Governors and Mayors' Conference for Environmental Conservation of the Seto Inland Sea that was held in 1972, the enactment of the Law Concerning Measures for the Conservation of the Environment of the Seto Inland Sea (tentative) was approved and a strong request was submitted to the Japanese government. In addition to the Governors and Mayors' Conference for Environmental Conservation of the Seto Inland Sea, enthusiastic Diet members and related parties enabled the enactment of the Interim Law for the Conservation of the Environment of the Seto Inland Sea as temporary legislation with a three-year time limit in 1973. Temporary legislation was unusual at that time. This law came into force in November 1973. It is highly important that the Seto Inland Sea Office (predecessor of the current Office of Environmental Management of Enclosed Coastal Seas) was also established in the Environment Agency to deal with administrative tasks for the law. The enactment of the law made it possible to establish a total pollution control system, realizing the reduction of total load. In addition, subsequent data shows that this law significantly restrained the expansion of land reclamation areas. The Interim Law for the Conservation of the Environment of the Seto Inland Sea became a permanent law as the Law Concerning Special Measures for Conservation of the Environment of the Seto Inland Sea in 1978. More than 35 years have passed since the enactment of the "Seto Inland Sea Law". Although it still contains various problems, there is no doubt that it has played an extraordinarily great role in the conservation of the environment and ecosystems in the

Seto Inland Sea. It is not an exaggeration to say that various other concrete measures have been implemented under the spirit of the "Seto Inland Sea Law" or in its framework.

13.5.3 Establishment of organizations throughout the Seto Inland Sea

Based on the historical background mentioned above, all industries, governments, academic institutions and citizens are actively participating in a variety of environmental conservation activities. Recently, this has also included natural restoration activities in the Seto Inland Sea. It is possible to cite the early establishment of organizations throughout Seto Inland Sea as the background of these vigorous initiatives. That is to say, it can be said that the establishment of these organizations has constituted a fundamental factor that has promoted these "countermeasures". These types of coastal area organizations are not commonly seen in other coastal areas. In addition to the Conference of Governors and Mayors mentioned above, highly public organizations have provided information about the Seto Inland Sea, issued periodical journals and organized events. For example, the Association for the Environmental Conservation of the Seto Inland Sea, International EMECS Center and The Research Institute for the Seto Inland Sea are included among these organizations. We consider that these activities have also contributed to the formation of fundamental conditions to promote "countermeasures" on a long term basis.

13.6 Conclusion

Over a long period of time, prominent characteristics were formed through various interactions between human livelihoods and coastal sea areas in the Seto Inland Sea. However, these characteristics have experienced a drastic change since the post-war high economic growth period. Particularly, urban population concentration and the development of coastal industrial zones caused an increase in the pollution load and promoted the reclamation of shallow water areas. Not only did land reclamation directly lead to the loss of sea grass beds and tidal flats, but it also impaired the various functions provided by these areas such as water purification capabilities. Furthermore, due to the fact that land reclamation has an impact on seawater flow, reclamation has also created a mechanism in which the pollution load from land areas directly affects sea areas. The loss of sea grass beds and tidal flats, which are the "cradle of the sea", has consequently brought about a decline in biological resource reproduction and provisioning services of marine resources. In addition, eutrophication and the increase in the pollution load have resulted in the occurrence of harmful algal blooms and hypoxic water masses. This has exerted enormous impact on biological habitats, ecosystems and biodiversity. Unsurprisingly, urbanization, industrialization and seawater pollution have adversely affected landscapes and cultural services as well. Considering the fact that the sea is strongly affected by rivers, it is believed that water conservation and river management projects such as the construction of dams and estuary barrages as well as the situation of *satoyama* in a broader sense have had significant direct or indirect impact on marine ecosystem services.

Appendix A

Classification structure and indicators of *satoyama* and *satoumi* ecosystem services

Satoyama–satoumi *ecosystems and human well-being: Socio-ecological production landscapes of Japan, Duraiappah, Nakamura, Takeuchi, Watanabe and Nishi (eds), United Nations University Press, 2012, ISBN 978-92-808-1210-7*

Table A1 Classification structure and indicators of *satoyama* and *satoumi* ecosystem services discussed in cluster reports

Upper tier	Middle tier	Lower tier	Indicators
Provisioning services	Energy	Fuel (charcoal)	Forestry production index numbers and charcoal production volume
		Electric power (water, wind)	Generated power energy
	Foods	Drinking water	Water supply
		Terrestrial animals (animal husbandry)	Agricultural production index numbers
		Terrestrial animals (hunting)	Number of animals hunted
		Fish (fishery and aquaculture)	Fish catches
		Plants (crops)	Agricultural production index numbers, crop yields, and self-sufficiency ratio (on a calorie basis)
		Plants (Non-wood forest products)	Agricultural production index numbers and crop yields
	Fabric	Plants (timber)	Forestry production index numbers and timber production
		Plants (thatch)	Crop yields
		Natural fabric (silk, cotton, hemp)	Crop yields
	Decor	Plants (flower, aroma)	Crop yields
		Animals (leather, shell)	Number of animals hunted and sales volume
	Biochemical substance	Natural medicine, natural cosmetics	Production volume
Regulating services	Air quality purification		Temperature change and precipitation change
	Local climate regulation		Density of NOx (nitrogen oxide), density of SOx (sulphur oxide), and the amount of airborne substances (yellow sand and endocrine disruptors)
	Water regulation	Flood control	Area of rice paddies and the number of reservoirs
		Drought prevention, water supply	Number of reservoirs and the ratio of water channel development

	Water purification		Area of forests, the amount of chemical fertilizer and agrochemical, as well as the penetration ratio of sewage treatment systems
	Soil erosion regulation		Area of forests, the area of abandoned cultivated land, seacoast sediment supply, and the area of collapsed areas
	Pest regulation		Amount of agrochemicals used, the area of abandoned cultivated land, and forest cover change
Cultural services	Spiritual	Religion (shrines, temples, rituals)	Number of shrines and temples and the area of forests around religious areas
		Festival	Number of types of festivals and the use of *Bon* flowers
		Scenery (landscape and townscape)	Number of sites that are registered as the Best 100 *Satoyama*
	Recreation	Education (environmental education, outdoor observation session, and outdoor play)	Number of participants, the number of *satoyama* NGOs, the land area that is covered by activities, and hours spent on outdoor play by children
		Game-hunting, leisure fishing, gathering clams/wild vegetables	Number of participants (Leisure Whitepaper) and the number of facilities
		Mountain climbing, sightseeing, and green-tourism	Number of participants (Leisure Whitepaper) and the number of facilities
	Art	Traditional art (music, dance, art, literature, craftwork)	Number of people engaged in art, production volume, average age (development of successors)
		Contemporary art (music, dance, art, literature, craftwork)	Number of people engaged in art, production volume, average age (development of successors)
Supporting services		Soil formation	Land cover, vegetation cover, farmland
		Photosynthesis	Primary production, carbon stock
		Nutrient circulation	Eutrophication/oligotrophication
		Water circulation	Changes in construction in the rivers
			Changes in artificial beaches

Appendix B

Assessed responses for *satoyama* and *satoumi* landscapes

With regard to the main responses concerning *satoyama* and *satoumi* landscapes in Japan, Table B1 shows the domains to which the responses can be applied, a description of the responses, applicable MA response typologies (please see Table 5.1), effect-manifestation periods, decision-making stakeholders, ecosystem service types that form the primary response objectives and response assessments (efficiency, effectiveness and trade-offs). In this table, when functional improvements to *satoyama* and *satoumi* ecosystem services commenced is noted in the effects-manifestation period column. For example, in the case of legal responses, the time for revision is noted, not the less important time of enactment.

The following abbreviations are used for decision-making stakeholders: International organizations (GI), national government (GN), local government bodies (GL), the industrial sector (B), non-governmental organizations (NGO), citizen groups (C) and research groups (R).

In accordance with the explanations given in this book, the efficiency and effectiveness of the assessments have been established as given below.

1) Assessment of efficiency

++: Responses where cost-benefit analysis is systemically obligatory.
+: Responses where even though cost-benefit analysis is not systemically obligatory, cost-benefit analysis is applied on a trial basis through case

Satoyama–satoumi *ecosystems and human well-being: Socio-ecological production landscapes of Japan, Duraiappah, Nakamura, Takeuchi, Watanabe and Nishi (eds), United Nations University Press, 2012, ISBN 978-92-808-1210-7*

studies or similar means, or otherwise responses where the application of lifecycle cost analysis and cost-effectiveness analysis is considered possible.
Blank: Providing an efficient assessment would prove difficult given the circumstances

2) Assessment of effectiveness

++: Responses that have as their main objective improvements in ecosystem services, or responses that are recognized as being especially effective (responses identified by case studies and the like).
+: Responses that incorporate secondary improvements to ecosystem services, or responses that, while not applicable to present conditions, are thought to hold promise for the future.
Blank: Responses that do not correspond to the above

3) Trade-offs and so on

Even if particular ecosystem services are effective, it is recognized that these may include negative effects that offset these positive effects.

Table B1 Summary of responses for *satoyama* and *satoumi* landscapes

Domains	Major relevant responses	MA response typologies	Effect-manifes-tation period	Description	Decision-making stake-holders	Response assessment: Effi-ciency	Response assessment: Effectiveness	Response assessment: Effectiveness: Tradeoffs, etc.
Satoyama								
Agricultural communities and lifestyles	Land use plan (town areas)	L9		This group of laws regulates business dealings and development of land in urban areas. They stipulate nature conservation considerations and zoning in the building permit process and help to prevent the unfettered misuse of urban green zones and *satoyama* areas. The Urban Green Space Conservation Law provides for the establishment of land preservation areas, while the Urban Park Law establishes parks and the City Planning Act establishes urban planning areas.	GL		+	○ There is the possibility that zoning plans will be created that will contribute to a decline in ecosystem services.
	Urban Green Space Conservation Law	(L7)	1973					
	Urban Park Law	(L7)	1956					
	City Planning Act	(L7)	1968					
	Rural ordinances, etc.	L9	2000–2010	Established by local government bodies, these ordinances have such aims as conserving nature and ecosystems in rural areas. While the name *satoyama* itself is not always present in these regulations, by providing for the establishment of the integration of areas targeted for conservation, they help to provide management of these *satoyama* areas.	GL		++	

Biomass utilization	E1, T1		Woody matter and other biomass resources are to be utilized as energy sources, with the expectation that moderate lumbering activities will contribute to maintenance of *satoyama* landscapes. With the implementation of region-wide biomass utilization, many municipalities are adopting the "biomass town" concept.	GN, GL, B, NGO, C	+	+	○	There is the possibility that resources will be over-utilized.
Basic Law on Promotion of Biomass Use	(L7)	Enacted in 2009						
Biomass Nippon Strategy	(K1)	Enacted in 2002						
Act on Special Measures concerning the New Energy Usage by Electric Utilities	(L7)	Enacted in 2003						
High-Speed Energy Supply Law	(L7)	Enacted in 2009						
Offset Credit System (Japanese Verified Emission Reduction: J-VER)	E2	2008	With regard to the greenhouse gas emissions of businesses and other entities, this is a system of certifying emission reductions and CO^2 absorption amounts in the form of credits. It consists of a framework where "carbon offsets" can be purchased from other entities in order mitigate emission volumes. In addition, a forest management project that verifies CO^2 absorption volumes resulting from such activities as periodic thinning and tree planting that has been carried out jointly by the Forestry Agency and the Ministry of the Environment since 2008 has also been targeted for this system. This system thus contributes to the management of *satoyama* landscapes.	GN, B		+		

Table B1 (cont.)

Domains	Major relevant responses	MA response typologies	Effect-manifestation period	Description	Decision-making stakeholders	Response assessment			
						Efficiency	Effectiveness		
									Tradeoffs, etc.
	Local production for local consumption	E2		This is a framework for joining together consumers and producers in an effort aimed at promoting the local consumption of locally produced goods. It helps to increase the consumption and production of local agricultural produce and also serves to encourage local agricultural concerns and prevent waste and the deterioration of agricultural land.	GL, B, NGO	+	+		
	The development of local special products	E2		Representing their respective localities, agricultural products serve to bring to life the climate and natural features of these locales. When established as a brand, added value is produced and, through the promotion of local agriculture, these help to prevent waste and the deterioration of agricultural land.	GL, B, NGO	+	+	○	There is the possibility that resources will be over-utilized.

	Tourism	S2, E1		This form of tourism helps engender an awareness of the importance of maintaining and conserving ecosystems – including both environmental and social ecosystems – and contributes to the development of the local and regional community. Such tourism that focuses on ecosystems is referred to as "eco tourism", while the focus of "green tourism" is on woodlands, and "blue tourism" targets ocean environments.	B, NGO, C, GL	+	+	○	There is the possibility that this response will encourage excessive tourism.
	Act on Promotion of Development of Infrastructures for Leisure Stay in Rural Areas	(L7)	Revised in 2005						
	Act on Promotion of Ecotourism	(L7)	Enacted in 2007						
Agricultural lands and rivers	The Ramsar Convention	L1	Ratified in 1980	This international treaty was created with the objective of protecting wetland ecosystems	GI, GN		++		
	Land use plan (agricultural lands)	L9		With the objectives of zoning and coordinating the use of agricultural land, this law has the effect of preventing the reckless misuse and exploitation of *satoyama* areas.	GL		++	○	There is the possibility that zoning plans will be created that will contribute to a decline in ecosystem services.
	Act on Establishment of Agricultural Promotion Regions	(L7)	1952						
	Promoting environmentally-friendly agriculture	E2		Besides promoting agriculture and self-sufficiency in foodstuffs, this law was created with the goal of maintaining and conserving the multi-functionality of agriculture.	GN, GL, B, NGO	+	++	○	Resource over-utilization and flawed management practices cannot be completely eliminated.
	Basic Law on Food, Agriculture and Rural Areas	(L7)	Enacted in 1999						

Table B1 (cont.)

Domains	Major relevant responses	MA response typologies	Effect-manifes-tation period	Description	Decision-making stake-holders	Response assessment	
						Effi-ciency	Effectiveness Tradeoffs, etc.
	Act on Promotion of Organic Agriculture	(L7)	Enacted in 2006	In the role of a standard that precludes the use of genetic recombination technology as well as chemical fertilizers and agricultural chemicals, this law was created to promote organic farming that utilizes production methods that, to the extent possible, mitigating burdens placed on the environment by agricultural activity. It is expected that with the promotion of organic farming, the utilization of *satoyama* areas that would have otherwise been neglected will be encouraged.			
	Agricultural Chemicals Regulation Law	(L7)	Enacted in 1948	This law regulates the manufacture, utilization and sales of agricultural chemicals. It is believed to have the effect of mitigating the effects that chemicals have on ecosystems.			
	Sustainable Agriculture Law ("Eco Farmer")	(L7)	Enacted in 1999	This law serves to recognize the farmers who implement environmentally friendly agricultural production methods. It also provides assistance (special aid, tax exemptions) to these farmers. Through the			

			promotion of such environmentally friendly activities as composting and abstinence from the use of chemical fertilizers, the natural environment of *satoyama* landscapes is preserved, while the *satoumi* ecosystems of downstream areas are also protected.					
Public works	T2		With the revisions of recent years, these laws have come to establish the introduction of legal objectives for environmental conservation (ecosystems, landscapes, etc.) and environmental conservation duties. They help contribute to the environmental conservation of *satoyama* areas when public works projects based on the applicable laws are being implemented. The Land Improvement Act covers the creation and maintenance of facilities related to farmlands and water for agriculture, including irrigation and drainage facilities and consolidated agricultural land. The River Act addresses the creation and maintenance of river dykes and flood control dams. The Water Resources Development Promotion Act addresses the creation and maintenance of dams built for the purpose of developing water resources.	GN, GL, B	++	+	○	The possibility that development that will cause ecosystem damage will be fostered cannot be eliminated.
Land Improvement Act	(L7)	Revised in 2001						
River Act	(L7)	Revised in 1997						
Water Resources Development Promotion Act	(L7)	Revised in 2002						

Table B1 (cont.)

Domains	Major relevant responses	MA response typologies	Effect-manifes-tation period	Description	Decision-making stake-holders	Response assessment		
						Effi-ciency	Effectiveness	Tradeoffs, etc.
	Exchanges between urban and rural areas	E2				+	++	
	Ownership program for terraced rice fields, etc.	(E2)		Utilizing the unique conditions of areas featuring terraced rice fields, arrangements are made to protect regional farmlands through the participation of urban residents and other concerned parties.	NGO, B, C			
	Rural work groups	(E2)		This project involves human resources development and dispatch activities aimed at regional vitalization. It contributes to the conservation of *satoyama* by ensuring a supply of human resources dedicated to the conservation of agricultural land and terraced rice fields in hilly and mountainous areas.	GL, C, NGO			
	System of direct payment to hilly and mountainous areas	E3	2000	Dedicated to preventing the neglect of fields and rice paddies in hilly and mountainous areas, this is a system of subsidies that is aimed at preserving the vast wealth of multi-functionality of these areas. It helps to conserve *satoyama* by joining agricultural areas and woodlands together as one.	C, GL	+	++	

	Measures to improve the preservation of agricultural lands, wetlands and other natural environments	E3	2007	This system involves grant payments to regional councils that cooperatively manage agricultural land and water, and are involved in environmentally sustainable agriculture. It helps to conserve *satoyama* by joining agricultural areas and woodlands together as one.	C, GL	+	++
	Cooperate Social Responsibility (CSR)	S2		The private sector is responsible for the influence it has on society; it is therefore charged with making appropriate decisions in response to demands from various stakeholders.	B, GN		+
	World Water Forum	K1		The objective of the Forum is to encourage thinking about the future of the planet through water-related issues, and to tie these in with action. With the hydrologic water cycle serving as the focus, attention is given to the unification of terrestrial and coastal areas.	GI, GN, R		+
Mountains	Declaration of Forest Principle	L2	1992	This mutual understanding was adopted by the United Nations Conference on Environment and Development with the aim of resolving issues related to the world's forests through the cooperation of different countries.	GI		+

Table B1 (cont.)

Domains	Major relevant responses	MA response typologies	Effect-manifestation period	Description	Decision-making stakeholders	Response assessment	
						Efficiency	Effectiveness: Tradeoffs, etc.
	Acid Deposition Monitoring Network in East Asia (EANET)	L2	2001	This network was set up to prevent the negative impacts on the environment associated with acid rain by carrying out international cooperative efforts, monitoring, information exchanges, and research and studies on this phenomenon. Its core operations are in East Asia.	NGO, GI, GN		+
	Temperate and boreal forests: Montreal Process	L4	1995	As a follow-up that embodies the Declaration of Forest Principle adopted at the Earth Summit in 1992, criteria and indicators for sustainable forest management for countries in boreal and temperate regions were advanced and, in 1995, seven criteria and 67 indicators were selected with the revisions finally taking place in 2007. The Montreal Process is the process involved in this sequence of follow-up work.	GI, GN		+

Forest Act	L7	Revised in 2004	This law stipulates forest management planning, forest reserves and other basic items. The revision of 2004, which provides for a compulsory management system centring on periodic forest thinning, has contributed to the management of *satoyama* areas.	GN	+	○	There is the possibility that planted forests will increase
Forest Reserve System	L7		This is a system whereby the National Forest Service stipulates boundaries and safeguards forestlands by carrying out administrative management aimed at prohibiting logging, etc. The goals of this system are to provide a positive contribution to the maintenance of natural environments consisting of primitive forest ecosystems, the safeguarding of flora and fauna, the preservation of genetic resources and the development of management and administrative technology.	GN, GL	++		

Table B1 (cont.)

Domains	Major relevant responses	MA response typologies	Effect-manifes-tation period	Description	Decision-making stake-holders	Response assessment		
						Effi-ciency	Effectiveness	Tradeoffs, etc.
	Basic Law for Forest and Forestry	L7	Revised in 2001	This law is related to forestlands and forestry where sustainable development of forestry forms a defining principle. With the amendment of this act, the multifaceted features of forestlands have been defined in detail. The Act expresses concrete measures that are conducive to the display of these multifaceted *satoyama* features as expressed in the Basic Plan for Forest and Forestry that was established by the national government.	GN		+	
	Ordinances to conserve *satoyama* and other natural features	L9		Created by local governments, these ordinances aim to promote ecosystem conservation of *satoyama* areas, as well as leisure and educational activities. Contributions to the management of *satoyama* areas are realized through the encouragement of participatory planning by NPOs, citizens and other constituents at the time of integration and designation of areas targeted for conservation management.	GL		++	

	Forest therapy	S2, E1		Relaxing in a woodland setting has been clinically demonstrated to provide health benefits for the body as well as the mind. Forest therapy constitutes an effort to take advantage of this phenomenon.	B	+	+
	Forest environmental taxes (headwaters user fees), etc.	E2	2003	Local governments are charged with carrying out their own woodland improvement projects. Introduced as a special tax for a specific purpose, this user fee is designed to defray costs associated with these projects by requesting that citizens help with this burden. These fees often bear the names of the headwaters of rivers and streams, and are referred to as "headwater user fees."	GL	+	++
	Forest certification systems	E2	1993	This system involves applying a certification mark to timber produced from woodlands that are the subjects of proper management; thus it promotes the utilization and preservation of sustainable woodlands.	GI, GN	+	++
Oceans	United Nations Convention on the Law of the Sea	L1	Ratified in 1996	This convention is designed to create a new, worldwide system for organizing the world's oceans by summing up all systems of law related to oceans into one treaty. It establishes national obligations related to the environmental conservation of inland waters, enclosed seas and semi-enclosed seas.	GI, GN		+

Table B1 (cont.)

Domains	Major relevant responses	MA response typologies	Effect-manifes-tation period	Description	Decision-making stake-holders	Response assessment		
						Effi-ciency	Effectiveness	
								Tradeoffs, etc.
	Northwest Pacific Action Plan (NOWPAP)	L2	1994	This regional ocean project is designed to conserve the natural environment of the Sea of Japan and the Yellow Sea. In recent years, the project has been responsible for activities related to garbage that washes up on ocean beaches. In this way it contributes to the management of *satoumi* areas.	GI, GN		+	
	Partnerships in Environmental Management for the Seas of East Asia (PEMSEA)	L2	2002	This is a framework for sustainable development that is aimed at balancing the development and conservation of oceans in Asia and Southeast Asia. It is known as a proactive effort aimed at the management of coastal zones.	GI, GN		+	
	Ocean pollution prevention					+	++	
	Convention on the Prevention of Marine Pollution by the Dumping of Wastes and other Matter	L1	Ratified in 1980	With the goal of preventing pollution in the oceans, this international convention is intended to restrict the dumping of waste matter originating on land into the seas as well incineration at sea and similar disposal methods. It is also endowed with provisions for regulating inland waters and coastal zones.	GI, GN			

International Convention on Oil Pollution Preparedness, Response and Cooperation (OPRC Convention)	L1	Ratified in 1995	With the goal of establishing a country-by-country system of preparedness, response and cooperation in anticipation of oil spills, this international convention is designed to create a system for international cooperation as well as to effect appropriate domestic upgrades. It also contains provisions for the preservation of coastal environments.	GI, GN
International Convention on the Control of Harmful Anti-fouling Systems on Ships (AFS Convention)	L1	Went into effect in 2008	This convention bans the use of organotin-based paints used on ships (TBT ship paints), including TBTs (tributyltine compounds), which negatively impact marine life.	GI, GN
Activities related to ocean waste in Japan, Korea, China, and Russia	L2	2006	This implementation plan was adopted after acceptance of a basic agreement related to initiatives aimed at marine pollution as a part of NOWPAP. It contributes to the management of *satoumi* ecosystems by addressing the problem of garbage drifting ashore along coastal areas.	GI, GN
Law Relating to the Prevention of Marine Pollution and Maritime Disaster	L6	Revised in 2007	The aim of this law is the prevention of marine pollution and maritime disasters. It is also closely related to the environmental conservation of coastal areas.	GN

Table B1 (cont.)

Domains	Major relevant responses	MA response typologies	Effect-manifes-tation period	Description	Decision-making stake-holders	Response assessment		
						Effi-ciency	Effectiveness	
								Tradeoffs, etc.
	UNEP Global Programme of Action for the Protection of the Marine Environment from Land-based Activities	L2	2001	This action plan was established with the objective of promoting environmental conservation and the sustainable use of the seas by preventing marine pollution that can be traced to origins on land, such as the flow of effluents into ocean waters. It is closely related to the environmental conservation of *satoumi* areas.	GI, GN			
	Water quality regulations					+	++	
	Water Pollution Control Law	L6	Revised in 2006	This law regulates emissions from factories and businesses into public waters, as well as the absorption of such emission into the groundwater. The waters of rivers, wetlands, bays and coastal areas are included as targets; this law is thus closely tied to the environmental conservation of *satoumi* areas.	GN			

Law Concerning Special Measures for Conservation of Lake Water Quality	L6	Revised in 2005	This law provides for the regulation of measures and plans related to the water quality of wetlands as well as facilities that emit pollutants into these waters; it is closely related to the environmental conservation of *satoumi* areas.	GN			
Environmental Sensitivity Index Map	T2	1995	This is the ESI (Environmental Sensitivity Index) as well as related information that are essential to timely and accurate environmental conservation efforts in the case of oil spills.	GN			
Fisheries				GN, GL, B	+	○	The possibility that resources will be over-utilized cannot be eliminated.
Fisheries Resource Protection Law	L6	Revised in 2007	With the goal of conserving and cultivating marine resources, this law replaced the Act for Preventing Depletion of Fishery Resources of 1950. It defines waters that are to be protected as fishery spawning areas, areas for fry development or otherwise areas that are appropriate for fishery eggs and hatchlings; it is closely related to the environmental conservation of *satoumi* areas.				
Act on Preservation and Control of Living Marine Resources	L6	1996	This law was established to preserve marine resources and to assure a stable supply of marine products.				

Table B1 (cont.)

Domains	Major relevant responses	MA response typologies	Effect-manifes-tation period	Description	Decision-making stake-holders	Response assessment: Effi-ciency	Response assessment: Effectiveness: Tradeoffs, etc.
	Fisheries Basic Act	L7	2001	This law assures the sustainable use of fishery resources and a stable supply of marine products, as well as the development of the fisheries industry. It was the first marine products-related law to specify in writing that marine products are a part of the ecosystem. In addition to preserving water quality and protecting and maintaining the breeding grounds of marine life, it also contends that the national government is to take necessary regulatory measures for the preservation and upkeep of woodlands. This law thus contributes to the management of *satoumi* ecosystems.			
	Fisheries Act	L7	Revised in 2005	This law seeks to introduce the democratic process to the fisheries industry through comprehensive utilization of waters by means of mechanisms for effecting fine-tuning and increased productivity in the fisheries industry. Workers from the fisheries industry are to contribute to the management of *satoumi* areas.			

Public Waters Reclamation Act	L6	Revised in 2004	This law regulates the reclamation of land for industrial parks and airports, as well as other landfill activities involving public waters, where these waters are defined as rivers, the ocean and wetlands. It is closely related to the management of *satoumi* areas.	GN	+
Act on Special Measures concerning Conservation of the Environment of the Seto Inland Sea	L6	1978	The aim of this law is to preserve the natural environment of the Seto Inland Sea. It prescribes an environmental plan for the Seto Inland Sea and regulates the designation of natural seaside areas and similar locations. The law also promotes the cooperation of local public bodies of the Seto Inland Sea coastal zone, and is positioned as a pioneer force for the integrated coastal zone management of the restricted marine areas. It acts as a contributor to the management of *satoumi* areas.	GN, GL	+

Table B1 (cont.)

Domains	Major relevant responses	MA response typologies	Effect-manifestation period	Description	Decision-making stakeholders	Response assessment: Efficiency	Response assessment: Effectiveness – Tradeoffs, etc.
	Act on Special Measures concerning the Rejuvenation of the Ariake Sea and Yatsushiro Sea	L6	2002	The aim of this law is to protect water quality, maintain and improve the filtering effects of tidal wetlands, bring improvements to harbours and beaches and improve the features of woodlands by means of basic policies and plans related to the revitalization of the Ariake and Yatsushiro Seas. In this way it contributes to the management of *satoumi* areas.	GN, GL		+
	Basic Act on Ocean Policy	L7	2007	This law was established as a comprehensive initiative by the national government to establish a new institutional framework for ocean policies. Bearing in mind that the numerous issues confronting coastal areas are often caused by activities on land, this law provides for necessary corrective measures to enable appropriate management of coastal and land areas where unified policies should be enacted. The Basic Plans for Ocean Policy that were established by this same law are especially useful in the management of *satoumi* areas.	GN		+

Public works	T2		These laws are related to public works in *satoumi* areas. The Ports and Harbours Act addresses the appropriate management of harbours, while the Act on Development of Fishing Ports and Grounds covers the operation and maintenance of fishing harbours and fishing grounds and the Coast Act covers facilities for protecting watersheds and the care and maintenance of the coastal environment. With recent amendments to these laws, environmental considerations have been added as objectives and these laws have come to play a contributory role in the environmental preservation of *satoumi* areas.	GN, GL	++	+	○	The possibility that there will be development that will damage ecosystems cannot be eliminated.
Ports and Harbours Act	(L7)	Revised in 2008						
Act on Development of Fishing Ports and Grounds	(L7)	Revised in 2005						
Coast Act	(L7)	Revised in 1999						
Ordinances for Conservation of *Satoumi* Areas	L9		These include rules and regulations aimed at protecting seas turtles in Kiho Town in Mie Prefecture, Minami-izu Town in Shizuoka Prefecture and Kagoshima Prefecture, as well as ordinances designed to protect coral in Okinawa Prefecture by preventing the erosion of red clay-rich soil. They contribute to the management of *satoumi* areas.	GL		++		
International Coral Reef Initiative	K1	1994	This international framework was established as a means of conserving coral reefs.	GI, GN		+		

Table B1 (cont.)

Domains	Major relevant responses	MA response typologies	Effect-manifes-tation period	Description	Decision-making stake-holders	Response assessment		
						Effi-ciency	Effectiveness	
								Tradeoffs, etc.
Biodiversity	Convention on Biological Diversity	L1	Ratified in 1993	This international convention is aimed at the conservation of biological diversity, sustainable use of its components, and fair and equitable sharing of benefits arising from genetic resources.	GI, GN		++	
	Cartagena Protocol on Biosafety to the Convention on Biological Diversity	L1	Ratified in 2003	This protocol is aimed at holding in check potentially negative influences on the conservation and sustainable use of biological diversity by organisms that have undergone modern biotechnological transformations. It was drawn up at negotiations based on Article 19, paragraph 3 of the Convention on Biological Diversity.	GI, GN		+	
	Act on the Conservation and Sustainable Use of Biological Diversity through Regulations on the Use of Living Modified Organisms (Cartagena Law)	L6	Went into effect in 2003	Utilizing international cooperation, this law seeks to restrict the utilization of genetically modified organisms with the idea of conserving biodiversity; it is aimed at effecting the accurate and smooth implementation of the Cartagena Protocol.	GN		+	

Basic Act on Biodiversity	L6	Went into effect in 2008	This basic law serves to enforce comprehensive policy measures related to the conservation of biodiversity. This law describes crises in biodiversity, presenting the spectre of deterioration in *satoyama* areas due to the decrease in desirable human activities that accompanies socio-economic changes, and specifies the creation of mechanisms and measures to assure the conservation of these areas.	GN	+
National Biodiversity Strategy	L6	1995	Based on the Basic Act on Biodiversity, this is a national strategy that has as its goal the conservation and sustainable use of biodiversity. It describes crises in biodiversity, presenting the spectre of deterioration in *satoyama* areas due to the decrease in desirable human activities that accompanies socio-economic changes, and specifies the creation of mechanisms and measures to assure the conservation of these areas.	GN	+

Table B1 (cont.)

Domains	Major relevant responses	MA response typologies	Effect-manifes-tation period	Description	Decision-making stake-holders	Response assessment		
						Effi-ciency	Effectiveness	Tradeoffs, etc.
	Local Biodiversity Strategy	L9		Subject to the Basic Act on Biodiversity, local governments can develop their own biodiversity strategy on the basis of the national one. The local biodiversity strategy can be a vehicle for local governments to address *satoyama* and *satoumi* issues and their management in their own words.	GL		+	
	Endangered Species Conservation Act (Act on Conservation of Endangered Species of Wild Fauna and Flora)	L6	Went into effect in 1992	This law seeks to preserve endangered species. In order to achieve this aim, specific species are identified and the trapping and sales of these species are restricted; habitats for these species are also assured in the form of designated zoning that provides the necessary habitat for the species in question.	GN		++	
	Invasive Alien Species Act	L6	Went into effect in 2004	In an effort to prevent ecosystem damage by alien species, this law designates specific non-native species to be invasive species, and restricts the breeding, importation and handling of these species. It also stipulates pest control and similar measures.	GN, GL		++	

	Act on Wildlife Protection and Hunting	L7	Revised in 2002	This law was created in an effort to conserve the environment and advance farming, fishing and forestry through the safeguarding of wildlife and the prevention of various forms of damage caused by wildlife. With the revision that occurred in 2002, the maintenance of biodiversity became an additional goal of this law, and with the revision that followed in 2006, conservation activities in wildlife protection areas were established.	GL	+
	Ecological Network	T2		This is an attempt at ecosystem restoration and the conservation of biodiversity by means of wildlife habitat consolidation. Ever since 1998, "green corridors" have been established in national forests across Japan, and by April 2007 22 such corridors had been created.	GL, C, NGO	+
All areas	Convention concerning the Protection of the World Cultural and Natural Heritage	L1	Ratified in 1992	This international treaty was adopted by UNESCO with the goal of protecting cultural as well as natural heritage properties. The part applicable to natural heritage properties is closely related to the management of *satoyama* and *satoumi* areas.	GI, GN	+

Table B1 (cont.)

Domains	Major relevant responses	MA response typologies	Effect-manifes-tation period	Description	Decision-making stake-holders	Response assessment		
						Effi-ciency	Effectiveness	
								Tradeoffs, etc.
	Rio Declaration on Environment and Development	L2	1992	Based on the idea of sustainable development, this international document is a proclamation of the coexistence of the environment and development in the international community. It was instrumental in the development of later international environmental laws and policies.	GI, GN		+	
	Agenda 21	L2	1992	Agenda 21 serves as a plan of action for implementation of the Rio Declaration, which summarizes realization of sustainable development appropriate for the twenty-first century. While it is not legally binding like a treaty, it is endowed with important features to guide countries in this effort.	GI, GN		++	
	Johannesburg Declaration on Sustainable Development	L2	2002	Marking the tenth anniversary of the Rio Declaration, this international document identifies for the international community the purpose of sustainable development. In the future, the sure execution of the implementation plan that was adopted at the same time will become the focus of attention.	GI, GN		+	

Declaration of the United Nations Conference on the Human Environment (Stockholm Declaration)	L3	1972	This is the first international document to announce global initiatives aimed at global environmental issues. It clarifies the general rules applicable when tackling environmental issues, and forms a cornerstone for proposals regarding future international environmental laws.	GI, GN	+
Environmental Impact Assessment Law	L6	Enacted in 1997	This law stipulates procedures for carrying out environmental impact assessments of large-scale development. There are many small-scale reformations of *satoyama* areas and, as such, there are quite a few cases not covered by this law.	GN, GL	++
Environmental assessment ordinances	L9		Targeting activities not covered by the Environmental Impact Assessment Law, these ordinances, which are related to the magnification of environmental factors, post-project survey obligations and the like, are established independently by local governments.	GL	++

Table B1 (cont.)

Domains	Major relevant responses	MA response typologies	Effect-manifes-tation period	Description	Decision-making stake-holders	Response assessment		
						Effi-ciency	Effectiveness	Tradeoffs, etc.
	Basic Environment Law	L6	Enacted in 1993	This law outlines the basic principles of environmental conservation, the duties and obligations of different stakeholders and the foundation of related policies. Based on this law, the basic environmental plan that is to be established will identify the necessity of comprehensive efforts and related structure creation in a broad-based, cross-cutting manner that transcends regions and sectors. Moreover, the law clarifies that a diverse menu of mechanisms that go beyond regulatory measures are to be continued to be widely applied, and that comprehensive conservation measures are to be advanced as a part of individual human and production activities at the local level.	GN		+	
	Landscape Act	L6	Enacted in 2005	The Landscape Act serves as a means of comprehensively implementing beautification projects and other measures that have been established to encourage the formation of favourable scenery in both urban and rural areas. This law allows for a comprehensive	GN, GL, NGO, C, B		+	

			perspective of terraced rice fields, settlements and adjacent woodlands in *satoyama* areas in an effort to create a unified landscape.		
Natural Parks Law	L6		This law is aimed at supporting citizen health, as well as providing recreation and edification opportunities by promoting the utilization and preservation of areas with outstanding natural features. The law also seeks to help maintain biodiversity. By including *satoyama* areas in natural parks by way of legally designated zoning, this law is conducive to the management of these areas.	GN	+
Law for Protection of Cultural Properties	L7	Revised in 2004	This law seeks to upgrade the culture of the nation by means of the preservation and utilization of cultural assets. With the revisions of 2004, the scope of cultural assets was enlarged, with the outstanding landscapes of *satoyama* areas and terraced rice fields defined as cultural landscapes. With regards to especially important landscapes, the national government is able to select "important cultural landscapes." In the Kanto region, the Oya Stone Quarry of Tochigi Prefecture and the terraced rice fields of Oyama in Chiba Prefecture have been selected as model cultural landscape projects.	GL, C, B	+

Table B1 (cont.)

Domains	Major relevant responses	MA response typologies	Effect-manifes-tation period	Description	Decision-making stake-holders	Response assessment: Effi-ciency	Effectiveness	Tradeoffs, etc.
	National Spatial Planning Act (Comprehensive National Land Development Act)	L7	Revised in 2005	A revision to the former Comprehensive National Land Development Act, this act is comprehensive in nature, establishing land development plans and other measures in an effort to promote the utilization, servicing and conservation of public lands. The National Spatial Planning Act alludes to national administration of public lands, ecological networks and similar ideas; it is thus conducive to the management of *satoyama* areas.	GN		+	○ The possibility cannot be eliminated that this will promote development that damages ecosystems.
	Comprehensive Resort Areas Development Law (Resort Law)	L7		This law stipulates that prefectural and city governments determine administrative plans for the enrichment of leisure activities, the promotion of the recreation industry, local development and related activities. In cases where the national government recognizes these plans, the law also stipulates that various support measures be taken, such as providing favourable tax treatment. This law is thus related to the development of *satoyama* areas.	GL	++	+	○ The possibility cannot be eliminated that development will cause damage to ecosystems.

Act on Promotion of Decentralization Reform	L7	Enacted in 1999	This law is made up of the amendments to some 475 different laws. These revisions were necessary to promote decentralization of power. This law is thus related to the implementation at the regional level of *satoyama* and *satoumi* management efforts.	GL	+		There are variations in the degree of awareness different local governments have with regards to ecosystems.
Development of information technology (spread of the Internet)	S2		With its continued spread in recent years, the Internet is being proactively utilized by such bodies as the Ministry of the Environment and local governments for information dissemination purposes. It is anticipated that this activity will have the effect of supporting the activities of related organizations and volunteers related to *satoyama* and *satoumi*.	B, C, NGO	+	○	Depending on the content of the information, there is the possibility of over-utilization of *satoyama* and *satoumi* ecosystems due to an increase in visitors to those areas.
Contests, etc.	S2		Various contests targeting terraced rice fields, canals, *sato* areas and similar sites are carried out by government, with the expectation that this will lead to recognition of the value of *satoyama* and *satoumi* areas by the general public.	GN, GL, B	+		

Table B1 (cont.)

Domains	Major relevant responses	MA response typologies	Effect-manifes-tation period	Description	Decision-making stake-holders	Response assessment: Effi-ciency	Response assessment: Effectiveness	Tradeoffs, etc.
	Act on Promotion of Specified Non-profit Activities (NPO Law)	S3, L7	Enacted in 1998	This law was established with the objective of encouraging the activities of NPOs, which contribute to society through their volunteer activities and are recognized as legal entities with non-commercial objectives. Through the bolstering of the financial footing of these NPOs, conservation efforts are promoted through NPO activities that target *satoyama* and *satoumi* areas. The terms "NPO" and "NGO" are easily confused. In Japan, "NGO" generally refers to the case where the emphasis is on private organizations versus government entities, while "NPO" is used to stress non-profit objectives versus business goals.	GN, NGO, R		++	
	Environmental education	S2		This act promotes educational activities to be carried out with a view towards heightening interest and awareness regarding the environment and environmental issues, as well as gaining critical knowledge, techniques and perspectives in this area.	GL, GN, NGO		+	
	Act on Enhancing Motivation on Environmental Conservation and Promoting of Environmental Education	(L6)	Enacted in 2003					

Nature restoration projects	T2		In an effort to proactively revive a natural world that has largely been lost, activities with the immediate goal of restoring the soundness of ecosystems are currently being carried out under this law. Examples of these include the restoration of wetlands bordering rivers that have been returned to their original, meandering state after having been straightened, the restoration of tidelands in coastal cities and tree-planting activities.	GN, GL	+	++
Law for the Promotion of Nature Restoration	(L6)	Enacted in 2003				
Satoyama Initiative	K1		With the vision of realizing societies in harmony with nature, comprising human communities where the maintenance and development of socio-economic activities align with natural processes, this initiative promotes activities worldwide, that are intended to maintain and rebuild landscapes, including *satoyama* and *satoumi* landscapes, in which land and natural resources are used and managed in a more sustainable manner.	GN		+

Table B1 (cont.)

Domains	Major relevant responses	MA response typologies	Effect-manifes-tation period	Description	Decision-making stake-holders	Response assessment		
						Effi-ciency	Effectiveness	
								Tradeoffs, etc.
	Scientific research by local University and government	K2		Scientific research and education among local universities and governments tend to focus on local *satoyama* and *satoumi*. The scientific findings contribute to the sustainable management of local *satoyama* and *satoumi* directly.	GN, B, R		+	
	Re-building of regional cooperative bodies (New Commons)	K2		The idea of a commons refers to a system of co-management of natural resources. Research institutes and government propose a new system based on a commons for sustaining the ecosystem services provided by *satoyama* and *satoumi*.	GN, GL, C		+	

Appendix C

Maps of Japanese locations

Satoyama–satoumi *ecosystems and human well-being: Socio-ecological production landscapes of Japan, Duraiappah, Nakamura, Takeuchi, Watanabe and Nishi (eds), United Nations University Press, 2012, ISBN 978-92-808-1210-7*

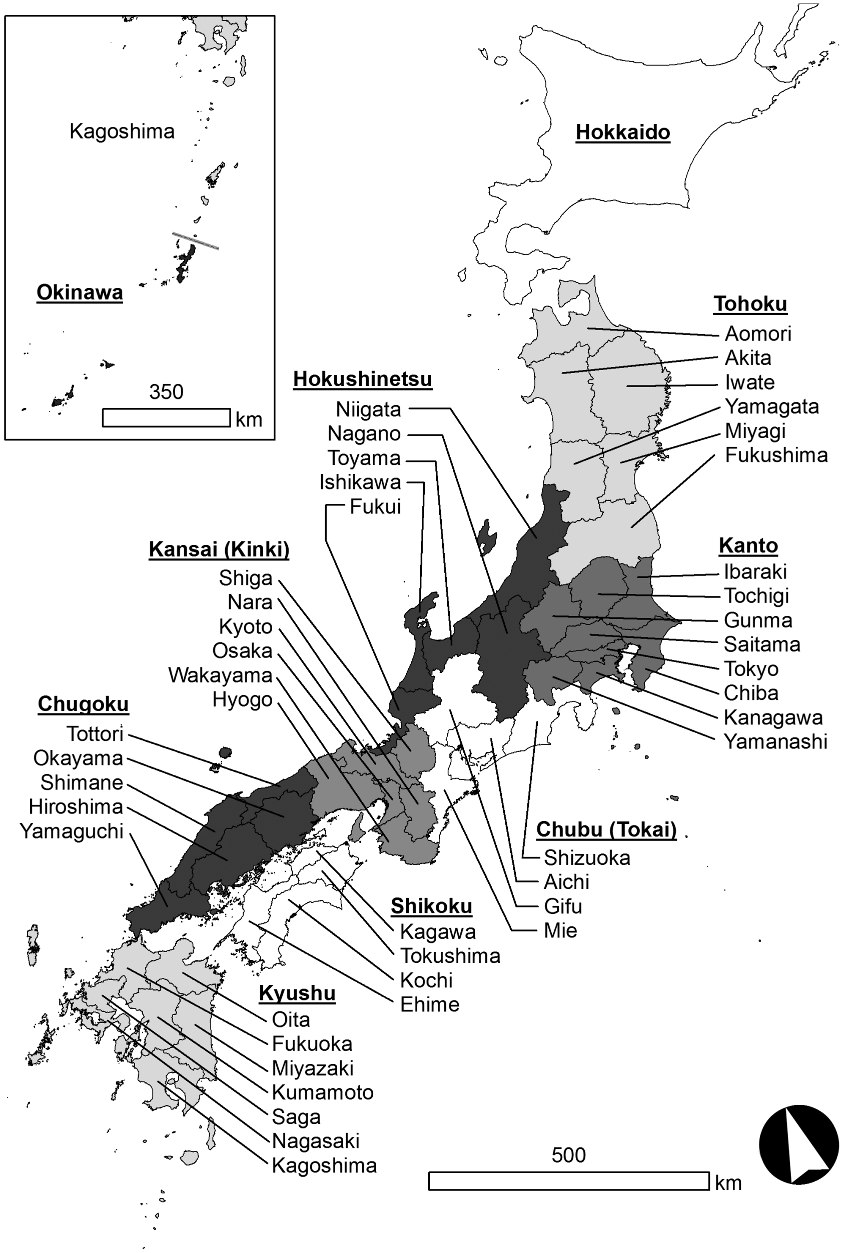

Figure C1 Prefectures and regions in Japan

Note: In the extended definition of the Chubu region the prefectures in the Hokushinetsu region and Yamanashi Prefecture are included; when this definition is used, the region is not called Tokai. Mie Prefecture is sometimes included in the Kansai (Kinki) region, depending on the definition.

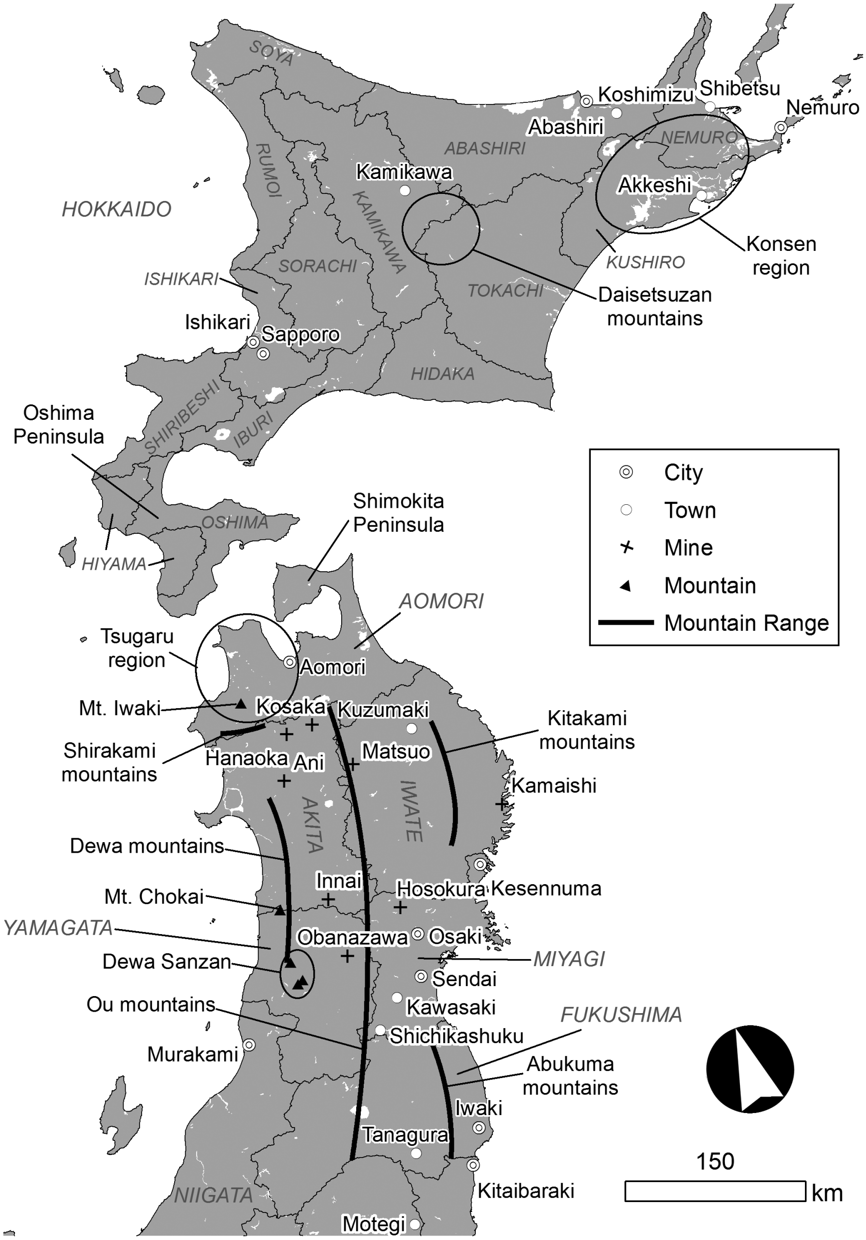

Figure C2 Map of northeastern Japan (Hokkaido and Tohoku regions)
Note: This map shows cities, towns, mines and mountains, etc. that are mentioned in the text. Names in capital letters and italics are prefectures or subprefectures (in the case of Hokkaido).]

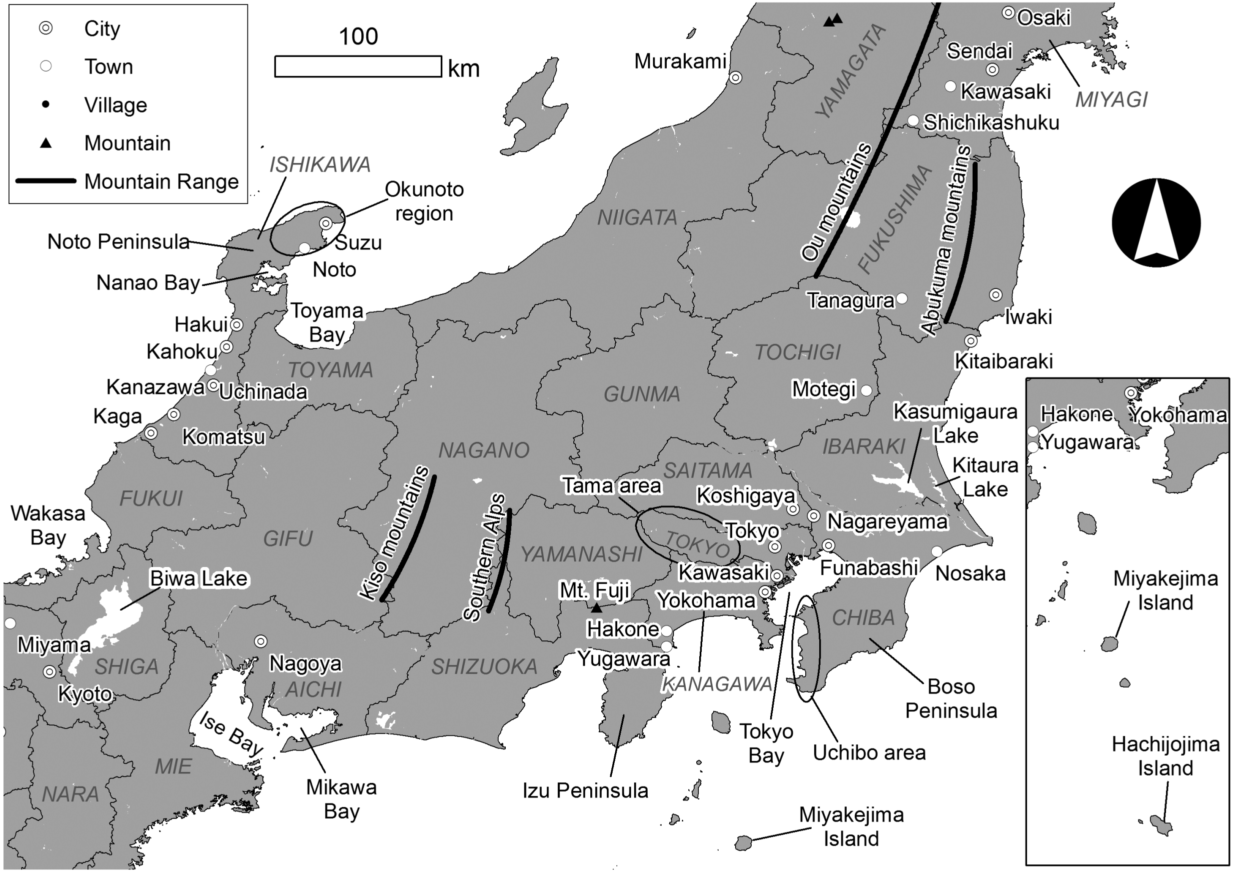

Figure C3 Map of central Japan (Kanto, Chubu and Hokushinetsu regions)
Note: This map shows cities, towns and mountains, etc. that are mentioned in the text. Names in capital letters and italics are prefectures.

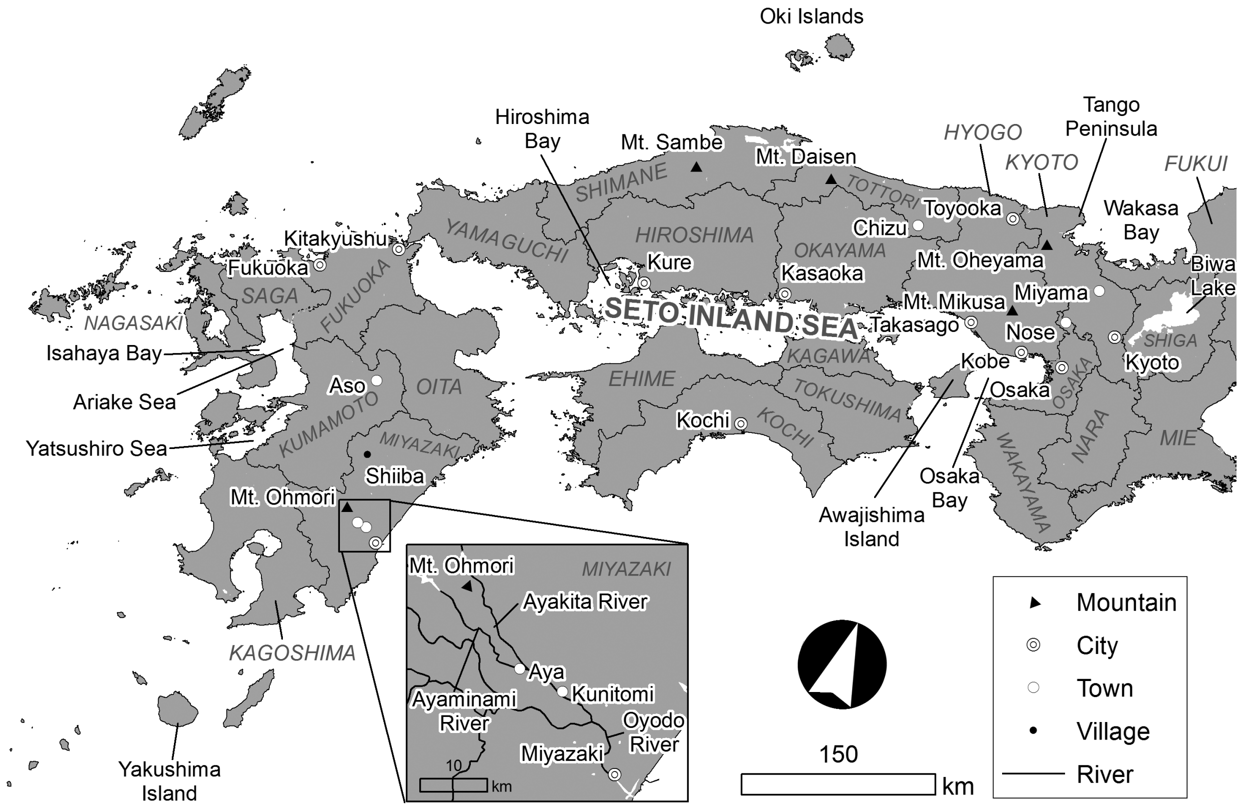

Figure C4 Map of western Japan (Kansai, Chugoku, Shikoku and Kyushu regions)
This map shows cities, towns, mountains and rivers, etc. that are mentioned in the text. Names in capital letters and italic are prefectures.

Glossary

Landscape

"Golley (1996) has defined landscape as a relatively large open system which is located between the largest scale, the earth, and ecotope, patch or corridor, which is a minimum unit of a uniform system in a spatial hierarchy with numerous scales. In order to understand the structures and functions of a landscape, it is essential to take human activities into account. Thus, landscape ecology is considered to be an academic area that encompasses various academic fields related to space and society such as ecology, sociology, anthropology and economics."
Source: Ecological Society of Japan, Y. Iwasa, K. Kikuzawa and T. Matsumoto (eds) (2003) *Ecology Encyclopedia*. Tokyo: Kyoritsu Shuppan, p. 138.

Mosaic

Satoyama and *satoumi* are complexes which show a mosaic combination of a variety of land use and spatial types such as secondary forest, coniferous forest plantation, farmland, meadow, grazing land, water channels, reservoirs, human settlements, tidelands, sea-grass beds and fish farms. In addition, the mosaic structure exists in individual land-use types such as farmlands and forests. For example, different logging and regeneration periods create a patch mosaic structure in a forest.

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Furthermore, Japan has four clearly distinct seasons. In Japan, even within the same spatial type, conditions and usage dynamically change in every season (e.g. deciduous forest, rice paddies, ocean current, and drift ice). In this way, spatial mosaic structures are distributed in an embedded manner. The conditions and human use of these structures dynamically change. It would be fair to say that these characteristics are sources of abundant biodiversity in *satoyama* and *satoumi*.

Interlinkage

Human well-being is improved through the acquisition of ecosystem services. However, excess use of ecosystem services with the objective of enhancing well-being will result in a deterioration of ecosystem services. Thus, ecosystem services and well-being are interrelated. In addition, each ecosystem service is also interrelated. For example, among ecosystem services, the reinforcement of provisioning services might impair regulating services and cultural services. Similarly, the components of human well-being are also interrelated. In this book, these interrelationships (linkages) are generally referred to as interlinkages. Not only do interlinkages include direct-proportional relationships and synergy in which related elements are mutually interlocked and enhance (or decrease), but they also include inverse relationships (trade-offs). This happens when one of the related elements increases and the other element decreases.

Ecosystem

"An ecosystem is a dynamic complex of plant, animal, microorganism communities and the nonliving environment interacting as a functional unit. Humans are an integral part of ecosystems. Ecosystems vary enormously in size; a temporary pond in a tree hollow and an ocean basin can both be ecosystems."
Source: Millennium Ecosystem Assessment (2005) *Ecosystems and Human Well-being: A Framework for Assessment*. Washington, DC: Island Press, p. 3.

Ecosystem services

"Ecosystem services are the benefits people obtain from ecosystems. These include provisioning services such as food and water; regulating

services such as regulation of floods, drought, land degradation, and diseases; supporting services such as soil formation and nutrient cycling; and cultural services such as recreational, spiritual, religious and other nonmaterial benefits."
Source: Millennium Ecosystem Assessment (2005) *Ecosystems and Human Well-being: A Framework for Assessment*. Washington, DC: Island Press, p3.

Well-being

Human well-being has multiple constituents, including as basic material for a good life, freedom and choice, health, good social relations and security. Well-being is at the opposite end of a continuum from poverty, which has been defined as "pronounced deprivation in well-being". The constituents of well-being, as experienced and perceived by people, are situation dependent, reflecting local geography, culture and ecological circumstances.
Source: Millennium Ecosystem Assessment (2005) *Ecosystems and Human Well-being: A Framework for Assessment*. Washington, DC: Island Press, p3.

Resilience

Resilience describes the ability of a system (social systems or ecosystems) to return to its original state after a disturbance. There are two types of resilience: engineering resilience and ecological resilience. Engineering resilience focuses on a requirement for efficiency and predictability in man-made systems and processes and assumes the existence of a single, optimal state. Ecological resilience can be measured by the level of disturbance that an ecosystem can undergo without crossing a threshold to a state with a different structure or output. It accepts variability and the concept of multiple states of equilibrium. The ecosystems in *satoyama* and *satoumi* have been developed and maintained on dynamic interaction and balance between human disturbance and ecological resilience. Thus, the state of ecological equilibrium would shift to another state when *satoyama* and *satoumi* are over exploited or abandoned without human management. When we focus on resilience of *satoyama-satoumi* landscapes, this can be measured in terms of the stability and availability of diverse ecosystem services, and magnitude of disturbance that can be absorbed by *satoyama* and *satoumi* as socio-ecological coupled systems.

Sources: Millennium Ecosystem Assessment (2005) *Ecosystems and Human Well-being: A Framework for Assessment*. Washington, DC: Island Press; Walker, B., S. Carpenter, J. Anderies, N. Abel, G. Cumming, M. Janssen, L. Lebel, J. Norberg, G.D. Peterson and R. Pritchard (2002) "Resilience management in social-ecological systems: A working hypothesis for a participatory approach", *Conservation Ecology* 6(1): 14. Available at: http://www.consecol.org/vol6/iss1/art14; Wilkinson, A., S. Elahi and E. Eidinow (2003) "Riskworld scenarios", *Journal of Risk Research* 6(4–6): 297–234.

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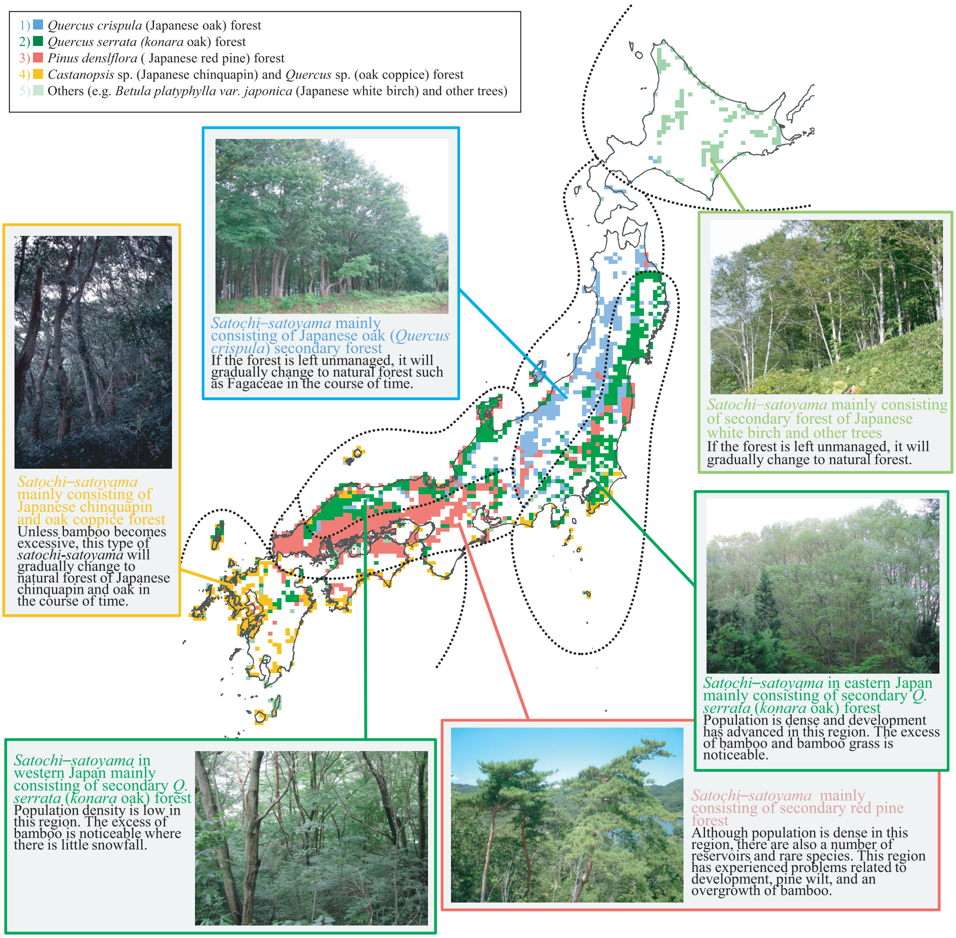
Figure 2.1 Concept and characteristics of *satoyama*

Notes: 1. a: coppice woodland for firewood and charcoal; b: coniferous plantation; c: *Pinus densiflora* (red pine) woods; d: homestead woodland; e: bamboo grove; f: grassland; g: rice paddy field; h: field; i: irrigation channel; j: irrigation pond; k: settlements; l: livestock (cattle and chicken); m: wild vegetables and mushrooms; n: prescribed burning of grassland; o: maintenance of irrigation channel; p: management of coppice woodland and bamboo grove; q: management of coniferous plantation; r: collecting leaves of deciduous woodland for manure production; s: charcoal burning; t: shiitake mushroom production; u: shrine; v: accipiter *gentilis* (northern goshawk); w: salamander; x: *Alcedo atthis* (common kingfisher); y: farmers and foresters; z: hikers.

2. Please see Page 19 for this figure's placement in the text.

Figure 2.2 Concept and characteristics of *satoumi*
Notes: 1. a: river; b: beach; c: tidal flat; d: coral reef; e: sea-grass bed; f: diverse fish and shellfish; g: plankton; h: nutrient matters and sand; i: oyster aquaculture; j: fishing settlements; k: pine trees; l: fishermen; m: sea bathing; n: shellfish gathering; o: angler; p: nature observation; q: urban area; r: *satoyama*.
2. Please see the Page 25 for this figure's placement in the book.



Regional Block	*Q. crispula*		*Q. serrata* (*konara* oak)		*P. densiflora* (Japanese red pine)		coppiced *Castanopsis-Quercus* (chinquapin-oak)		Others (*)	
	No. of blocks of area grid	Composition ratio (%)	No. of blocks of area grid	Composition ratio (%)	No. of blocks of area grid	Composition ratio (%)	No. of blocks of area grid	Composition ratio (%)	No. of blocks of area grid	Composition ratio (%)
Hokkaido	140	0.8	0	0.0	0	0.0	0	0.0	2,639	52.4
Tohoku	7,843	43.0	6,087	27.0	1,300	5.7	0	0.0	98	1.9
Kanto	1,747	9.6	2,512	11.2	427	1.9	345	4.1	102	2.0
Chubu	6,994	38.3	4,374	19.4	3,315	14.6	155	1.8	579	11.5
Kinki	643	3.5	2,512	11.4	5,441	23.9	1,456	17.2	346	6.9
Chugoku	735	4.0	4,772	21.2	9,130	40.2	568	6.7	167	3.3
Shikoku	125	0.7	848	3.8	2,486	10.9	1,694	20.1	374	7.4
Kyushu	15	0.1	1,362	6.0	639	2.8	4,223	50.0	729	14.5
Japan	18,242	100.0	22,526	100.0	22,738	100.0	8,441	100.0	5,034	100.0
Ratio to the secondary forest in Japan (%)		23.7		29.3		29.5		11.0		6.5

Figure 2.3 Distribution of *satochi–satoyama* according to secondary forest vegetation type
Note: Please see Page 33 for this figure's placement in the text.

Figure 2.7 Relationship between abundant rice paddy environments and people involved in rice production

Note: Please see Page 42 for this figure's placement in the text.

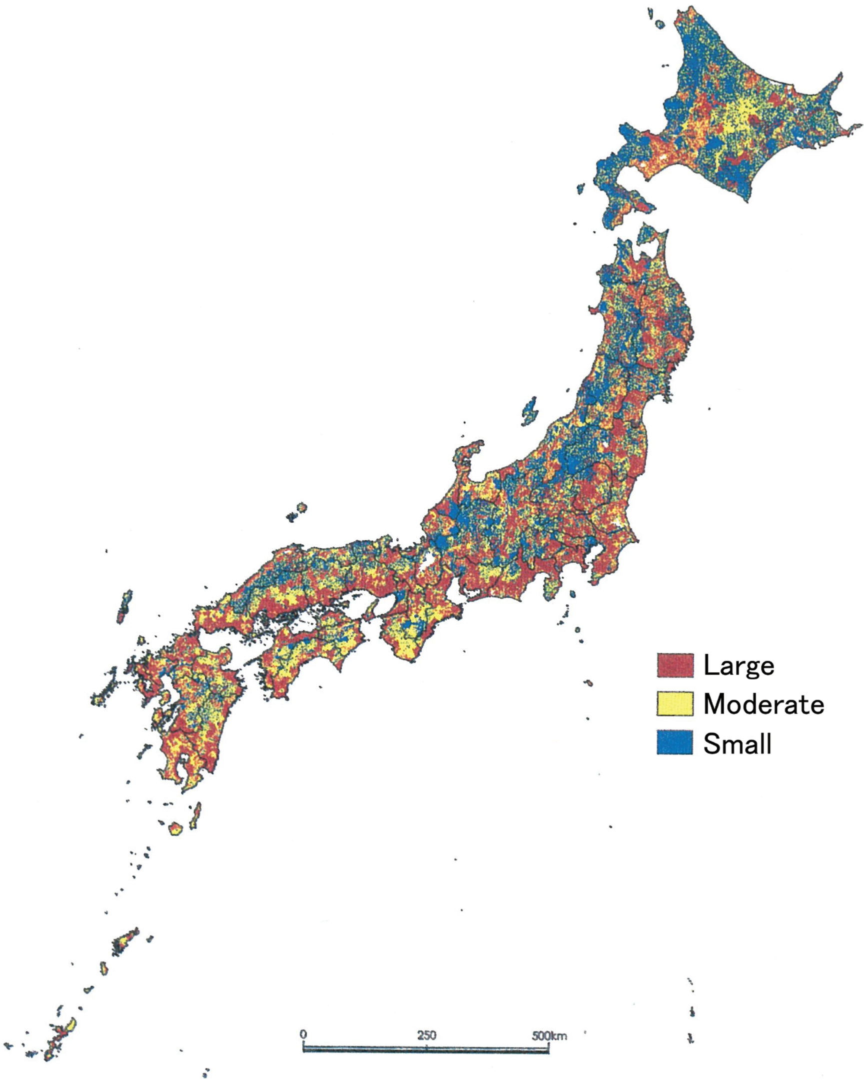


Figure 3.30 Air purification function of agricultural and forest lands in terms of NOS absorption quantity
Note: Please see Page 96 for this figure's placement in the text.

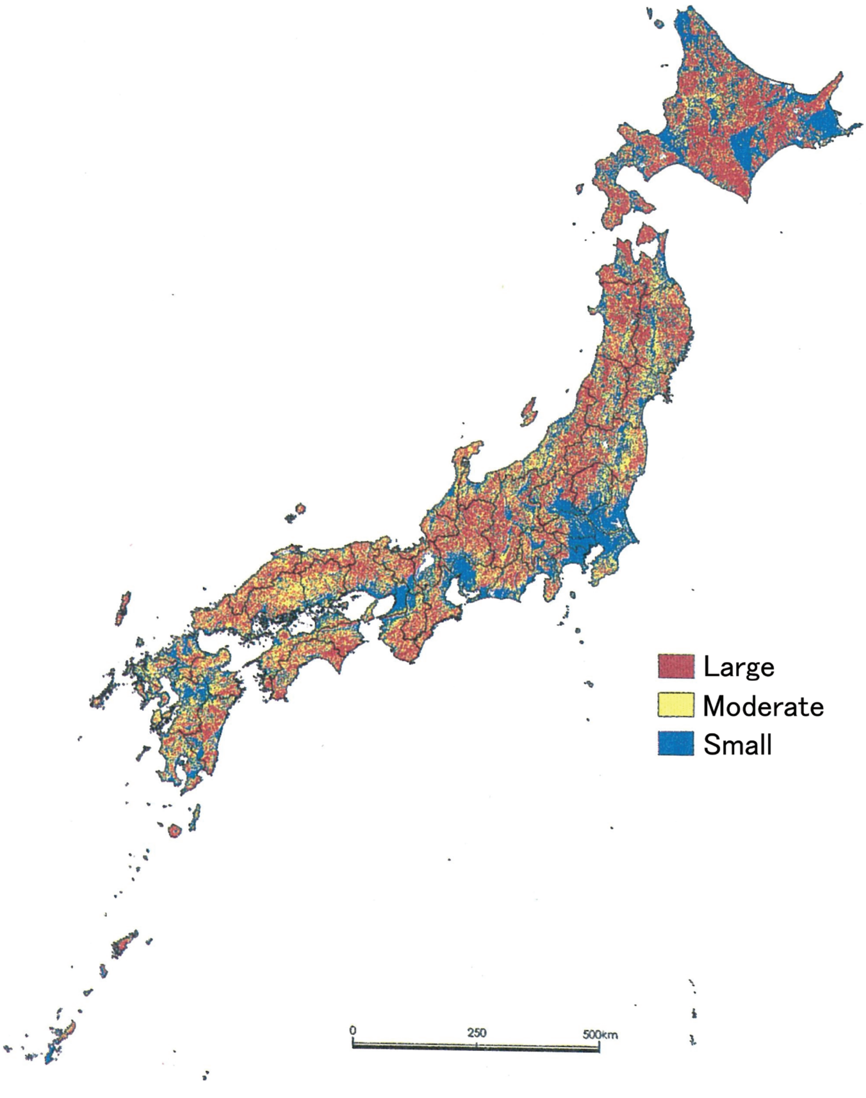


Figure 3.36 Erosion prevention functions of agricultural and forest land
Note: Please see Page 104 for this figure's placement in the text.

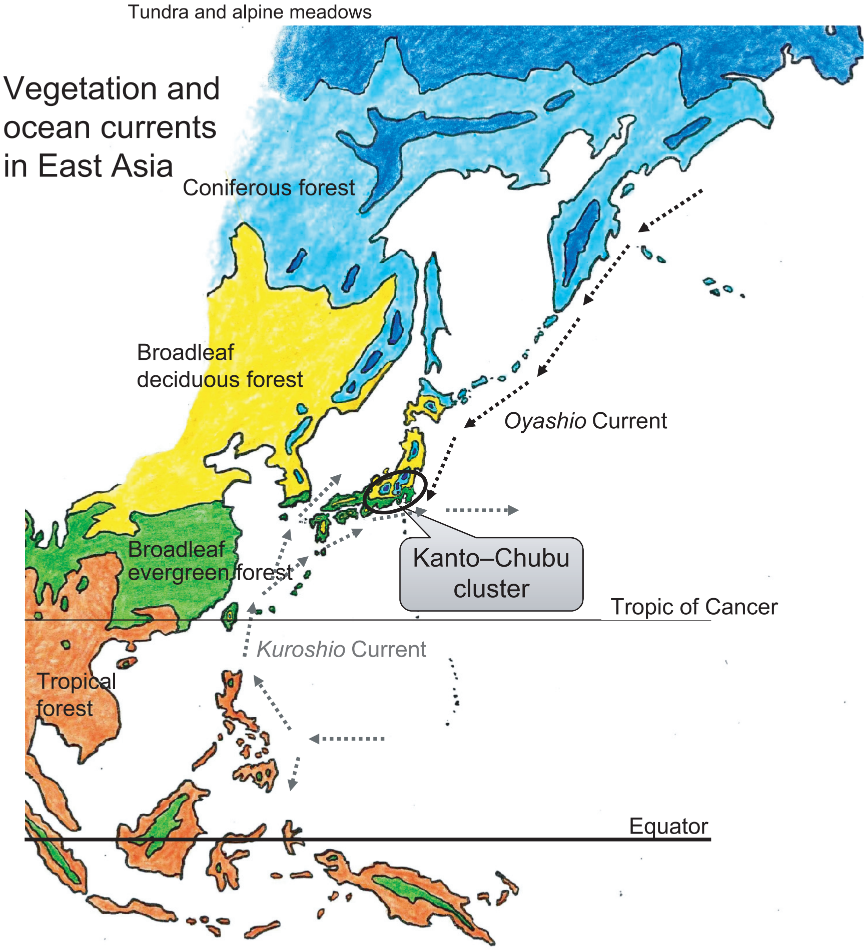
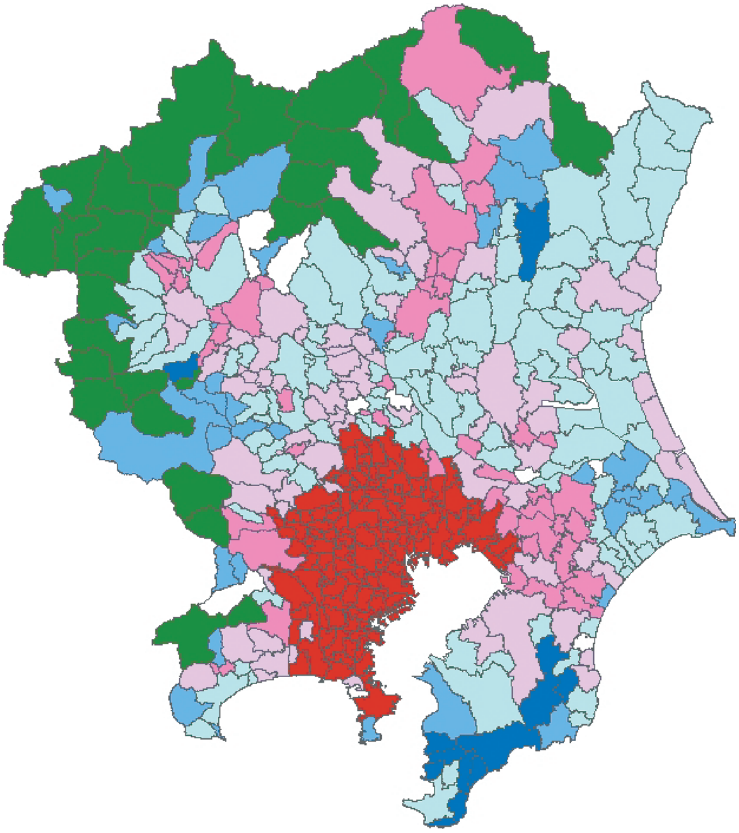


Figure 11.1 Location of the Kanto–Chubu cluster in East Asia
Note: Please see Page 329 for this figure's placement in the text.



		Population density (people/km^2)	Population increase-decrease ratio (%)	Ratio of elderly people (%)
	Okuyama	Less than 100		
	Depopulation and ageing	100 ～ 4,000	Less than -5	30 or more
	Population decrease and ageing	100 ～ 4,000	0 ～ - 5	30 or more
	Population decrease	100 ～ 4,000	0 ～ -5	
	Population increase	100 ～ 4,000	5 ～ 0	
	Accelerated urbanization	100 ～ 4,000	5 or more	Less than 20
	Cities	4,000 or more		

For population density and the ratio of elderly people, data in 2005 is used.
The population increase-decrease ratio is calculated based on the population in 1995 and 2005.

Figure 11.4 Social and regional classifications of municipalities in the Kanto region
Note: Please see Page 334 for this figure's placement in the text.