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Nobukazu Nakagoshi *Editors*

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Preface

Landscape ecology is a sub-subject of ecology; however, it covers wide range of ecosystems and landscapes on their structures, function, and spatiotemporal changes. It has been contributing to the human life and the shifts of socio-economic paradigms in the changing modern world. Global warming has been influencing the universal life patterns of mankind in the past several hundreds of years of having been maintained. It has also been having influences on international social problems as well as economic problems. The diverse plannings outlined for adapting to climate changes have been the topic of conservations not only ecologists but also administrators internationally. Unfortunately, it is the reality that the speed of the environmental changes including loss of biodiversities has been quicker than the time it takes to complete outline and implement the solutions.

In order to maintain the sustainable earth environments and sustainable societies, the role of landscape ecology has been coming to the fore. The theories and methodologies of the landscape ecology have been applied to multidisciplinary research by going beyond the general/scientific research categories of ecology. These include the maximization of efficiencies of land spaces, management of ecosystems in where biological diversity can be maintained, utilization of vital natural and cultural resources necessary to human beings such as water, energy, foods. It is considered that the utilizations and the applications of landscape ecology are very much needed for the diagnoses and evaluations of global environmental problems which have been rapidly processing in the modernity.

This volume is not comprised of general remarks that explain the theories and methods of the landscape ecology. Based on the basic theories of landscape ecology, the contributors have already conducted investigations on farm villages, cities, and coastal ecosystems where they have to suggest certain plans. Through space analyses and interpretations, the structures and function of the landscapes addressed were analyzed. The varied ecosystems and landscape ecological methodologies regarding land use have been presented here. The core of this book, however, focuses more on what role landscape ecology must play for materialization of a sustainable society at the present and for future. Sustainable agriculture will be presented regarding in farm villages, and on the contrary in the cities the discussions on the naturalized green stocks and the renewal energies will be proceeded in relation to the urban infrastructures. A thesis on the safety of the life zones of residents adjacent to the sea and on the conservation of the island ecosystems complex/landscapes is hopefully presented here.

The sustainable society is a system that is formed by having sustainable development as a basis. It is considered to be one aspect within a sustainable process. This is in regard to how the natural world and the human world coexist, and are in a harmonious symbiotic relationship. In order to maintain biodiversity in terms of ecosystem services, the reasonable adjustments of human activities, such as use of the resources, are absolutely necessary. Without biological resources, the cultural diversity of human beings can not exist. Consequentially, there are many examples internationally that have been put forth recently that express the biocultural diversity by linking biological diversity with cultural diversity. In this publication, the role of landscape ecology as an academic link which connects these two sets of diversities is highly expected. It can be named a combined-term "bioculture" and then the significant landscape is inevitably a biocultural landscape. It can also be said that this concept is the interconnection of multidisciplinary spaces that must be dealt with in modern landscape ecology.

All the editors are researchers who have developed landscape ecology and the environmental planning study discipline based on ecology. The second editor of the book, in particular, is an international leader on the landscape ecological researches in Asia. The researchers who participated with regard to this book are his colleagues and students who carried out the research with him. Even these researches have owned strong fortes of ecology (see in Chap. 1), and they have to work on the real landscape issues. It is intended, through this volume, to present a new directionality which can contribute to a sustainable society and at the same time uphold the organization of the theories and methodologies of landscape ecology.

Mokpo, Korea (Republic of) Sun-Kee Hong
Higashi-Hiroshima, Japan Nobukazu Nakagoshi
March 2018

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Contents

About the Editors

Sun-Kee Hong (Mokpo, Republic of Korea) is currently Humanities Korea Professor of the Institution for Marine and Island Cultures (MIC) of Mokpo National University. He obtained a master's degree in Plant Ecology at Chungnam National University (1985). He obtained a Ph.D. degree in Landscape Ecology and Environmental Planning at Hiroshima University, Japan, in 1994; his thesis dealt with vegetation ecology and human impact in Asian cultural landscapes. He has organized 20 international symposia on global issues, landscape ecology and biocultural diversity relating "islandscapes" and urban–rural landscapes issues during IUCN, IALE, INTECOL, and EAFES. He published international books of Ecological Issues in a Changing World (Kluwer, 2004), Landscape Ecological Applications in Man-influenced Areas: Linking Man and Nature Systems (Springer, 2007), Landscape Ecology in Asian Cultures (Springer, Tokyo, 2011), Biocultural Landscapes (Springer, 2014), and 70 papers. He was secretary general of the 8th INTECOL (2002, Seoul) and the chairperson of the local organizing committee of the 55th IAVS conference (2012, Mokpo). He is the Founder and Editor in Chief of the Journal of Marine and Island Cultures. He is a board member of INTECOL (The International Association for Ecology). He is the Director of the Center for Island Sustainability (CIS) at Mokpo National University.

Nobukazu Nakagoshi (Higashi-Hiroshima, Japan) is Professor Emeritus of Hiroshima University (HU) and lecturing at Graduate School for International Development and Cooperation, HU, as a Special Appointed Professor from 2017. He is Invited Professor of Ecology at Capital Normal University, Beijing, from 2004 and Inner Mongolia University, Hohhot, China, from 2008. He obtained a master's degree in Plant Ecology at HU (1976) and a degree Doctor of Science (Botany) in Plant Ecology at HU (1979); his thesis dealt with soil seed banks in temperate forests. He has organized scores international symposia on community and landscape ecologies during INTECOL, IAVS, IALE (International Association for Landscape Ecology), Eco-Summit, ICB, and EAFES. He published international books Coniferous Forest Ecology, from an International Perspectives (SPB Academic Publishing bv, 1991) with Frank B. Golley, Designing Low Carbon Societies in Landscapes (Springer, 2014) with Jhonamie A. Mabuhay, and 298 papers. He was President of Japan Association for Landscape Ecology (2000–2007) and a Vice President of IALE (2003–2007). His current scientific interests are ecotourism in natural landscapes, sustainable managements of cultural landscapes, and green infrastructures associated with resilience in urban landscapes.

Part I
Concept and Approaches

Chapter 1
Guiding Young Scholars in Order to Integrate Their Various Research into Landscape Ecology

Nobukazu Nakagoshi

Abstract The scientific contributions especially landscape ecological efforts of the author were described in three significant periods. The three periods were symbolized as "stone," "scissors," and "paper" ecology, respectively. The first period was a challenging time for new findings on soil seed banks in forests. In the later periods, the author and his colleagues and students attempted to publish research efforts in landscape ecology. As for the recollections of these scientific contributions, the author explained several important publications and classified them into fields of subjects separated from landscape ecology. The total number of selected publications was 147, including 6 books, 13 chapter articles, and 128 journal papers. The last period continues up to present. However, its early years strongly depended on big financial support by the Japanese government. The author made several comments on these two big projects in relation to graduate school education programs and ecological efforts. Finally, future aspects of landscape ecology were suggested from the author's view.

1 Introduction

Since I was an undergraduate student, I certainly believed that "ecology will save our planet." This chapter shows several achievements of my scientific and educational contributions on this belief. In particular, I shared text how I guided my students in the field of landscape ecology which will save the terrestrial part on earth. My academic history started from March 1979 when I got the degree of Doctor of Science (Botany) at the Graduate School of Science, Hiroshima University. It took five years to complete the submitted doctoral thesis on buried viable seeds under temperate forests in Japan. Due to the traditional rule on thesis publication, the entire pages of thesis were published five years later (Nakagoshi 1984). My institutional

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career started at the Department of Environment Studies, Faculty of Integrated Arts and Sciences, Hiroshima University, in 1986 and lasted until March 2006. In August of the same year, I fortunately attended the IV International Congress of Ecology (INTECOL) and made presentation a paper on fire ecology (Nakagoshi et al. 1987) in New York, USA.

A year after I recognized landscape ecology as one of the deep ecologies in the International Association for Landscape Ecology (IALE) meeting in Münster, Federal Republic of Germany (FRG), and published a proceeding paper (Nakagoshi and Rim 1988). This meeting was stimulating and lively for a novice landscape ecologist, compared with XIV International Botanical Congress Berlin (West) in the following week.

As the Secretary General, and later as the President of IALE-Japan (presently Japan Association for Landscape Ecology, JALE), I and my colleagues intensively promoted landscape ecology in the country (Nakagoshi and Hara 2004), East Asia region (Nakagoshi et al. 1999; Xiao et al. 2003; Yokohari et al. 2005), and the world (Hong et al. 2007, 2011). At the university, I held a professorship at the Department of Biological Resources Development in a newly instituted graduate school named Graduate School for International Development and Cooperation (IDEC), which was fully administered and managed in English in 1994. April 2006 was as critical event as the university asked me to officially transfer to the reorganized Department of Development Technology of IDEC. Finally, I decided to move and consider changing research strategy and education plans, namely from "scissors" to "paper." In IDEC, majority of the student population is international graduate students and officially has no undergraduate students, who are juveniles for ecologists. I also had to allocate most of the time for research and education on wider range of environmental sciences and technologies in both of master and doctoral courses. In every period, I studied and worked to consider institutional mission adapted to ecology. Deep consideration for each mission forced me to behave like as a legendary "Samurai". This article is based on my commemorative lectures as a full professor of Hiroshima University. I hope you can find several useful ideas throughout the lectures.

2 Landscape Ecological Interpretation and the Leader's Views on Our Scientific Achievements

In this chapter, the oldest publication dates back to 1984 and the newest is 2017. There is a 33-year difference, and the studies on landscape ecology were carried out after 1990s. One of the memorial journal papers published in the journal "Landscape Ecology" is a small island issue (Nakagoshi and Ohta 1992). We chose an island because it had limited terrestrial area and was isolated from the mainland. These conditions were easy to analyze driving factors of cultural landscape changes. Another publication is a chapter article in a UNESCO publication (Nakagoshi 1995b). This book was published for UNESCO's World Heritage List and the World Heritage Committee. In the preface of the book, the Director-General of UNESCO, Mr. Federico Mayor, said, "The aim of this book is to guide the community in the identification and nomination of cultural landscapes and to promote the safeguarding of our common heritage for the benefit of present and future generations." It was a good beginning for me to aim research and education in landscape ecology. Through these two publications, we could show the results of research. The total number of my selected publications is 147, including 6 books, 13 chapter articles, and 128 journal papers, which are listed in References. In most of the papers listed, I was the leader of research and worked on promoting them. There are several publications with no relation to landscape ecology. However, they are necessary to understand this chapter. These publications were classified into subjects including landscape ecology and given a brief introduction in the text. If you want to look at these journal papers you would be able to read them at "ResearchGate." Also, you can get the PDF of each journal paper from this service. In the References section, there is one book citation (Leck et al. 1989) without my authorship.

2.1 The Soil Seed Bank Study in Forest Ecosystems as an Example "Stone" Ecology

The first period of my research life began as a graduate school student followed by post-doctoral research work at Hiroshima University. I previously stated that buried seed population had great significance for plant demography since it had been regarded as the potential or initial coenopopulation (Nakagoshi 1985). Buried viable seed population in soil was definitely the initial stage of plant life history, population structure, community, and vegetation. Buried seeds in diverse communities in temperate forests in Japan were analyzed. The population density of buried seeds increases in early stage of ecological succession, came to a maximum in the secondary forest, and decreased later in the climax forest along the ecological succession. This fluctuation of densities was caused by a high seed production of the species in the felling site and secondary forest, and a low seed production in the climax forest. The seed banks of the main species consisted of three types: no reserve of seeds in the growth season, reduced seed bank, and permanent seed bank. The dominant species were classified into nine groups based principally on their seed bank type and life form. Each of these nine functional groups had its own reproductive pattern. Each functional group presented a particular stage during the process of vegetation change. It was suggested that these diverse patterns evolved in forest vegetation with a mosaic structure having cyclic vegetation changes: Forest vegetation was a complex association consisting of species which had diverse life history patterns. The population densities were analyzed in numbers and compared with above-ground vegetation dominance (Nakagoshi 1984).

Secondary processes in establishment, staged from buried seeds to seedlings, were discussed (Nakagoshi 1985), and finally, both population densities of soil seed banks and vegetation were summarized in the process of forest succession (Nakagoshi and Wada 1990). This research was really challenging (Fig. 1) because of few publications in the world (Leck et al. 1989). In this period, I learned many ecological facts and principles. However, most of them were already found by successive methods and materials in common ecology. My ecological contributions from researches on soil seed banks were interpreted scientifically and summarized appropriately in a textbook on soil seed banks (Leck et al. 1989) and referred to 26 times in the book. The potential natural vegetation in Japan is forests and consisted of laurel forests in warm temperate zone, summer green forests in temperate zone (my main target), and subalpine conifer forests in boreal/subalpine zone. Fortunately, I was able to do a culmination of work on soil seed banks and finally published a comparative study in these tree forest zones (Nakagoshi 1996). The results showed several tendencies of geographical trends performing ecological roles. At this first period, you were not able to find the relation between ecological studies on soil seed banks and landscape ecology. But there were a few contributions to landscaping through my studies. One of them was revegetation technology applied top soil usage instead of pastoral grass seeding on cut slopes in highway construction. The process was initially reserving top soils from felled down forests and pasting these soils on newly appeared, denuded, inorganic dumped, and even covered by concrete slopes beside highways. Our government and highway construction companies introduced this technology in terms of native plant diversity and natural succession by established plant communities on the slopes. It was my great honor that our Majesty the late Emperor Hirohito (Showa Emperor) pointed the naturalness in this project from Higashi-Fuji Goko Highway, Yamanashi Prefecture in "Miyuki, Emperor's Gyoko," in 1986. I worked in this project as a main supervisor for application in highway construction sites.

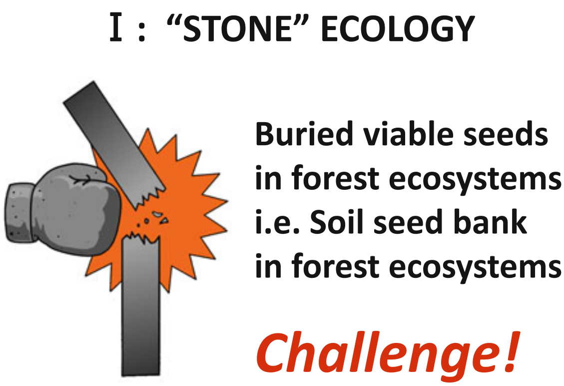

Fig. 1 Ecology symbolized by "stone." The first period of ecology was a series of researches on buried viable seeds in forests. The category of ecology corresponds to a synthesized population ecology of component species of forest communities. The main concept was challenged to discover new ecological facts

2.2 *Leading Young Scholars to the Ecology of "Scissors" and Establishment of IALE-Japan*

After returning from the IV INTECOL 1986 in New York, my scientific activities were concentrated into two main directions. One was the management and accomplishment of a series of landscape ecological studies with my students in Hiroshima University who wished to be specialists in ecology. Another was the establishment of the Japanese Chapter of IALE, International Association for Landscape Ecology: IALE-Japan. In the beginning of landscape ecological research, we used mainly land use maps based on actual vegetation maps and air photos (Nakagoshi and Ohta 1992; Nakagoshi and Abe 1995; Kamada and Nakagoshi 1996).

The early publications on landscape ecology were naturally written in Japanese due to deep understanding of the international standard. These were not shown in the References because their contribution was limited within Japan nor the international academic societies by an oriental language. After wider application of land unit classification, it came to standard of ecotope typology by overlay (Nakagoshi and Ohta 2000; Nakagoshi et al. 2004). One of the powerful databases on landscape ecology was Geographic Information System (GIS). It was commonly applied to analyze the target areas spatially and temporally (Nakagoshi and Kondo 2002; Yunus et al. 2003a; Abdullah and Nakagoshi 2006), and this standard method was continuously succeeded in recent works (Abdullah and Nakagoshi 2006; Suheri et al. 2014; Vannasy and Nakagoshi 2016). Modeling and numerical approaches were introduced to real landscapes (Nomura and Nakagoshi 1999) and adopted the case of urban green space work in Jinan City, China (Kong and Nakagoshi 2006).

In general, three different landscapes exist—urban, cultural, and natural—based on the intensity of primary industry and civil engineering. We challenged to study all three types to find their characteristics and further questions. The main issue in all three landscape sub-types was generally summarized on urban landscapes in Hiroshima City (Nakagoshi and Moriguchi 1999; Nakagoshi et al. 2006), cultural landscapes in Hiroshima Prefecture as a regional level (Nakagoshi 1995b; Nakagoshi and Hong 2001), and natural landscapes in Japan on a national scale (Nakagoshi and Numata 1996; Nakagoshi et al. 1998; Kamei and Nakagoshi 2006), respectively. I was a committee member of the symposium organizers in the V INTECOL 1990 in Yokohama, Japan. The symposium was entitled "Perspectives on Pine Forest Ecology" and the organizers were Prof. D.H. Knight and I. In the INTECOL, there was another symposium on conifer forests entitled "Spruce Forests and Other Boreal Forests in Global Perspectives" and its organizers were Profs. H. Hytteborn and Y. Tadaki. Both organizers of the second symposium agreed that I would be a corresponding editor of the proceeding book from these two symposia. After the success of both symposiums, I proposed to publish a proceeding book entitled "Coniferous Forest Ecology, from an International Perspective" to the congress committee, and it was permitted because the president of the congress the V INTECOL Prof. F. B. Golley earnestly wished to publish memorial books from congress results. In fact, he invited me to edit the book in the University of Georgia, Athens, USA and cooperated with my editing work during my stay in 1990. It was successfully done (Nakagoshi and Golley 1991). Among the 13 chapters of this proceeding, there were four articles directly related to landscape ecology and the other eight showed ecological characteristics of pine and boreal forests. My introductory chapter, however, could not cover the whole cultural and natural coniferous forest landscapes due to a large gap between them. Later, this landscape gap was filled through field works and literature review including the full Chinese publication by myself at least in East Asia region (Nakagoshi 1995a). We had a semi-official meeting on IALE in the INTECOL meeting place in August 1990 in Yokohama. The meeting chairman was Prof. M. Numata. He invited me probably because of my more extensive knowledge on IALE. I met the leaders of IALE and they asked us to organize IALE-Japan. They also suggested that the tentative president would be Prof. Numata and the tentative secretary-general would be me, possibly because they knew of our interests on landscape ecology. Prof. Numata and I accepted their proposal and promised to organize IALE-Japan. My colleagues and I intensively worked on establishing the Japanese branch after the Yokohama meeting just before IALE meeting in 1991 at Ottawa, Canada.

The establishment and registration of IALE-Japan were successfully voted at the general assembly of IALE in 1991. JALE (former IALE-Japan) organized annual meetings 25 times, from 1992 to 2017, under the regulations of IALE. I also contributed to publish a new international journal “Landscape and Ecological Engineering” in 2005 when I was the second president of JALE, succeeding Prof. Numata. This Springer’s international journal was published by the International Consortium of Landscape and Ecological Engineering (ICLEE) and consisted seven academic societies for applied ecology in the East Asian region.

The seven societies were Chinese Landscape Architects Society in Taiwan, Ecology and Civil Engineering Society, Japan Association for Landscape Ecology (JALE), Japanese Institute of Landscape Architecture, Japanese Society of Revegetation Technology, Korea Institute of Landscape Architecture, and Korea Society for Environmental Restoration and Revegetation Technology. These leaders’ activities explicitly encouraged students to publish our studies in landscape ecology (Nakagoshi and Ohta 1992; Kamada and Nakagoshi 1996, 1997; Nakagoshi et al. 1998, 2006; Nakagoshi and Moriguchi 1999; Nomura and Nakagoshi 1999; Yamaba and Nakagoshi 2000; Nakagoshi and Hong 2001; Nakagoshi and Kondo 2002; Nagashima et al. 2001, 2002, 2003; Nagashima and Nakagoshi 2003; Kondo and Nakagoshi 2002; Iiyama et al. 2005; Hong et al. 2005; Kamei and Nakagoshi 2006; Ohta and Nakagoshi 2007).

My planning for graduate school students was not only to contribute to landscape ecology but also support their competitive abilities in particular ecological fields. Therefore, they selected own interest field in ecology such as wetland ecology (Nakagoshi and Abe 1995; Kikuchi et al. 2003), river/watershed ecology (Maekawa and Nakagoshi 1997; Tanimoto and Nakagoshi 1999; Inoue and

Nakagoshi 2001; Kohri et al. 2002, 2011; Nakagoshi and Inoue 2003; Yamashita et al. 2004), forest ecology and forestry (Kamada and Nakagoshi 1993; Nakagoshi and Rim 1994; Sharp et al. 1999; Nakagoshi and Ohta 2000; Yamaba and Nakagoshi 2000; Mabuhay et al. 2006c), population ecology (Hong et al. 1993; Ida and Nakagoshi 1996, 1998; Naito et al. 1999; Kameyama et al. 1999), community ecology (Hong et al. 1995; Touyama et al. 1997, 1998, 2002; Yamamoto et al. 2001; Mabuhay et al. 2004a, b), fire ecology (Isagi and Nakagoshi 1990; Mabuhay et al. 2003, 2004a, b, 2006a, b), conservation ecology (Naito and Nakagoshi 1995; Yamaba and Nakagoshi 2000), species ecology and biology (Urasaki et al. 1987; Kaneko et al. 2005), and genetic/molecular ecology (Naito et al. 1998; Kameyama et al. 2000, 2001, 2002; Kaneko et al. 2007). For example, a wetland ecology paper (Nakagoshi and Abe 1995) summarized the retrogressive succession on mire communities in species composition and dominance. However, it showed that one of the causes in areal reduction in the past 50 years originated from the shape of the wetland. This is a general contribution to landscape ecology. My idea of "scissors" ecology is illustrated in Fig. 2. For future plans of integration and synthesis on new landscape ecology, I guided students as they majored in different fields of landscape ecology. The publication of this volume was a good example on the series of landscape ecology among the alumni during second period of "scissors" ecology. This occasion is not the first edition because we edited one volume on Asian cultural landscapes before (Hong et al. 2011).

In our landscape ecological studies, I introduced three different models to find new landscape patterns in relation to traditional landscape ecological studies. The representative examples indicated by DNA are Japanese azaleas studies. Seedling safe sites (Kameyama et al. 1999), ecotypes in varied habitats (Naito et al. 1999), and species regional evolution (Kondo et al. 2009) were reflections of landscape ecological events (Nakagoshi and Hara 2004) from small to large scales using spatial and temporal molecular biological methods. The second predictive models were a series of island cultural landscape studies in the Seto Inland Sea region, Japan. Site primary productivities (Nakagoshi and Ohta 2000), ecotope and patch

Fig. 2 Ecology symbolized by "scissors". The second period of ecology was wide and its range of ecological researches extended from molecular ecology to landscape ecology. For future young fellows in ecology, I introduced and guided different fields of ecology considering their own abilities and personalities as their professor awarding Ph.D.

dynamics (Nakagoshi and Ohta 1992), and future landscapes in the whole archipelago (Ohta and Nakagoshi 2007, 2011) were interdisciplinary studies in both ecological and socioeconomical aspects. The third typical examples are a series of "Satoyama" pine forest studies in East Asia. Seedling safe sites (Hong et al. 1993), ecotope and patch dynamics (Hong et al. 1995), regional distribution (Nakagoshi 1995a) and conceptual explanation of "Satoyama" landscapes (Nakagoshi and Hong 2001, Chap. 6). The last examples were looked a traditional model; however, their landscape ecological characteristics in size, space, and time were discussed under the different cultural management. There are no missing scales from individual demography of plants to whole regions in the first and third models.

Concerning compulsory school years, they are two very short years in master program and three years in doctoral program in Japan. Landscape ecology is an interdisciplinary field that aims to understand and improve the relationships among structure, function, change, and culture in landscapes. This difference between experimental ecologies and measuring ecologies is one of the obstacles to major landscape ecology among the younger graduate school students. Under these time-limited conditions, we had an exceptional series of landscape ecological studies in New Zealand. This was the finding on modern forestry landscapes which showed the reconsideration on traditional land use zonation from economics, originated by J. H. von Thünen in 1842, about 160 years after its initial exploration (Nagashima et al. 2001, 2002, 2003). This international contribution was completed by the cooperation of our New Zealander colleagues from the University of Canterbury in Christchurch. In a conclusion, the best strategy is to encourage young scholars by introducing them to methods regarding ecology within the proper graduate school time and later guiding to pursue landscape ecology.

2.3 "Paper" Ecology to Institute Ecological Standardization Among Young International Scholars

In April 2006, it was really big event for me to adapt officially into the reorganized Department of Development Technology in the IDEC of the same university. Most of the graduate students and Ph.D. candidates had public jobs in their countries of origin and contracts with their governments to receive degrees in the particular fields. Inevitably, my supervision had to cover wider range of environmental sciences and technologies. But there were no changes in research direction on ecological concepts for me. However, it was a fact that several students have difficulties learning ecological thinking.

I continuously tried to develop landscape ecology among the students, and some of them followed my direction and supervision toward landscape ecology. There were advanced education programs in IDEC that originally had three professors—a main advisor and two sub-advisors—teaching each student and having their own responsibilities. In my case, I was the chief of ecosystem and energy research group and collaborated with professors of environmental chemistry, environmental engineering, and animal science, together with ecologists. These specialists had enough facilities for experiments and computing to analyze many samples and statistical data including GIS and remote sensing data. In this period, we had good conditions on GIS usage for landscape ecology, because of many improved and useful softwares such as ArcInfo and ArcView.

This might help the students to major on landscape ecology in third period of "paper" ecology. Considering the goal of each landscape ecological study, I kept three target areas, namely urban, cultural/rural, and regional/natural landscapes. There are issues on urban landscapes (Kang et al. 2000; Kong and Nakagoshi 2006; Kong et al. 2005, 2007, 2010, 2012; Pham and Nakagoshi 2007, 2008; Arifin and Nakagoshi 2011; Byomkesh et al. 2012), cultural and rural landscapes (Kim et al. 2006; Abdullah and Nakagoshi 2006, 2007, 2008; Suzuki and Nakagoshi 2008; Tokuoka et al. 2011) and regional/natural landscapes (Yunus and Nakagoshi 2004; Yunus et al. 2003b; Nakagoshi and Kim 2007; Firdaus et al. 2014; Suheri et al. 2014). We were able to publish papers successfully in international journals and academic books.

The following were subjects on sciences and technologies excluding landscape ecology, and each paper was shown in parenthesis: vegetation science (Nakagoshi et al. 2004, 2016; Lin et al. 2009); agriculture (Biswas and Nakagoshi 2004; Biswas et al. 2005; Parveen et al. 2003; Tran et al. 2012); forestry (Nakagoshi et al. 2014, 2016; Tokuoka et al. 2015, 2016); ecology (Zhao et al. 2004, 2005; Leksono et al. 2005a, b, 2006; Abe et al. 2008; Mabuhay and Nakagoshi 2012; Nakagoshi et al. 2016); biology (Rodiyati et al. 2005; Kaneko et al. 2008; Kondo et al. 2009); and animal husbandry (Pradhan et al. 2008) in order to distance between each subject and landscape ecology. Landscape ecology can be designated as one of the applied sciences. The following applied issues were closely related to landscape ecology: urban planning (Zhao et al. 2003b; Pham and Nakagoshi 2008; Arifin and Nakagoshi 2011); GIS (Yunus et al. 2003a; Raharjo and Nakagoshi 2014; Vannasy and Nakagoshi 2016); EIA (Dehkordi et al. 2003; Dehkordi and Nakagoshi 2004; Parveen et al. 2004; Zhao et al. 2003a; Kozaki et al. 2008; Vannasy and Nakagoshi 2016); ecotourism (Hakim et al. 2007, 2008); and policy (Sharp and Nakagoshi 2006; Byomkesh et al. 2009; Nakagoshi 2011).

In IDEC, I organized several time-limited research groups for tackling environmental studies. Fortunately, I was able to do collaborative research work in IDEC and other institutions not belonging Hiroshima University. We carried out joint researches and contributed to different fields of sciences and technologies using advanced experimental equipment and machines. We published our results in varied subjects such as biochemistry (Parveen et al. 2005a, b; Diep et al. 2012b, c, 2014, 2015); analytical chemistry (Nakatani et al. 2009a, b, 2011); remote sensing (Lee et al. 2011); geography (Pan et al. 2008, 2011; Diep et al. 2012a, 2014); thermal technology (Alikulov et al. 2017; Aminov et al. 2016); hygienics (Gama and Nakagoshi 2014). Looking at Fig. 3, varieties on original scientific fields but ecological matters were discussed in two papers on thermal technology in

Fig. 3 Ecology symbolized by "paper." The third period of environmental sciences and technologies covered the different subjects of science and technology in my leading group. The principal idea on research and education in this period is ecology which is able to realize a sustainable world. Due to two big research and education projects and related missions of a newly established graduate school IDEC, Hiroshima University, it was necessary to foster international scholars for master and Ph.D. degrees. The total number of countries of graduates was 22 in and these young specialists major in specific science and technology even in the same institute of their country of origin

Uzbekistan (Alikulov et al. 2017; Aminov et al. 2016). Furthermore, there were various nationalities of graduates and course completion students in our laboratory, and the number of countries is 22 in total (Fig. 3).

3 Ideal Structures and Management Technologies for Ecological Projects

It was a standard for both graduate and doctoral courses to prepare educational efforts in each division of graduate school. Our graduate school, IDEC, has the similar education system in general. The twenty-first century Center of Excellence (COE) program was inaugurated at IDEC to pioneer a new field of knowledge geared toward innovations in international cooperation. The COE program was an initiative by the Ministry of Education, Culture, Science and Technology (MEXT) to actively support the establishment of a world-level base for education and scientific research in Japan. Our program was selected as one of the first-term programs from April 2003 to March 2008. This program was centered on IDEC, and its support organ the Hiroshima International Center for Environmental Cooperation, for the academic base of a program, established at the same time. The program name is "COE for Social Capacity Development for Environmental Management and International Cooperation." The social capacity for environmental management, an important concept of the program, was defined as the capacity to self-manage environmental issues (e.g., of urban green spaces, Nakagoshi et al. 2006). This social capacity is based on the separate abilities of government, enterprise, and citizens, on how those abilities interact and on relationship between the state and local levels, and is defined as the functionality of Social Environmental Management System (SEMS). The primary research goals of this program were to analyze dynamic developmental processes in SEMS centered on developing Asian countries and to identify SEMS developmental stages. In the last financial year, 2007, I became the succeeding leader of this program and rebuilt the organization to summarize its program and achievement.

The COE program may contribute the next big educational project of “Global Environmental Leaders (GELs) Education Program for Designing a Low-Carbon World” for 5 years, from April 2008 to March 2013, with the support of MEXT. The program’s main objective was to find out solutions for global environmental issues such as climate change and to achieve a low-carbon society. Throughout the full period, I served as a sub-leader of the program and the chief of group on Wise Use of Biomass Resources for realizing low-carbon societies in the same time. We intensely published our scientific achievements listed up in References. A Springer book “Designing Low Carbon Societies in Landscapes” (Nakagoshi and Mabuhay 2014) is one of the products from the GELs program. Under the GELs program, we had developed environmental leaders for future societies through interdisciplinary research integrating theories and applications including the aspects of humanity and science. Limiting only the MEXT supporting period, the program produced 299 graduates, including doctors and masters in our school and short course completion such as four summer courses each year organized in Higashi-Hiroshima (Japan), Bogor (Indonesia), Beijing (China), and Manila (Philippines), and 65 students who obtained certified credits for their own graduate schools, including International Joint Master’s Program in Sustainable Development in University of Graz, Austria. In Fig. 4, international count shows number of students whose nationalities are differed from own locations of his/her graduate schools excluding IDEC, HU.

Overall, the GELs program made an environmental leaders network of 364 young fellows in the world (Fig. 4). The financial support provided by MEXT ended in 2013. However, this program carries on as a special education and research program in IDEC. We will continue to propose new measures for emerging environmental issues including ecosystems and landscape management to realize the sustainable development of society from an interdisciplinary perspective. Among the various ecologies, I can conclude that landscape ecology has the highest potential to guide young researchers who can contribute to realizing sustainable society. It is very powerful to promote a project organized by different subject groups in the same organization. In the organization, new ideas will be born through progressive proposals and critical debates.

Landscape ecology is still a smart science in varied subjects concerning environmental issues. Its contribution through research is generally limited to complicated conditions of real world because it does not consist in a single element or matter. Establishment of young researcher network means a successful maintenance

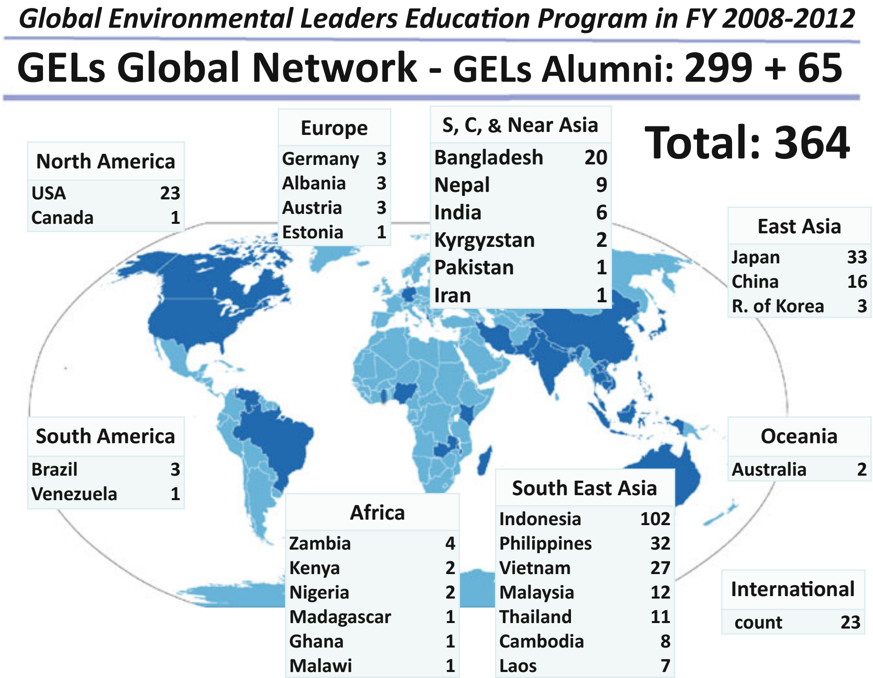

Fig. 4 The global environmental leaders network newly established in the period of financing by the Ministry of Education, Culture, Sports and Technology (MEXT). The theme of educational project is "Global Environmental Leaders (GELs) Education Program for Designing a Low-Carbon World," and it carried out for 5 years from April 2008 to March 2013 at IDEC, Hiroshima University. The program consisted of five groups including my group produced 299 graduates, including doctors and masters in our school and short course completion such as four summer courses in each year, and 65 students who could obtain certified credits partially fill their own program at their original graduate schools. The total member of young fellows in newly established GELs network is 364. The number of their original countries is 31.

and sustainable management of core site and its function. The next big question will depend on both feasibility and flexibility of core and personal members in the network.

4 A Retrospect and Perspectives

There are many academic histories of professors. However, most of them are rather simple due to their subject, material, method, technology, application, repetition, and so on. My history as a research specialist is significantly uniquely affected by institutional missions and my own ideas. After sifting the center of gravity from plant population ecology, from "stone" ecology to landscape ecology, I and my students worked intensively on a wide range of ecology, the so-called scissors ecology, for the development of landscape ecology. The second change in leading plan was adaptive management for fostering young scholars with particular science and technology which sometime far from ecology. Even in this caustic situation, ecological guidance, the so-called paper ecology, was successful because it was acceptable in different subjects by fundamental roles.

Concerning the role of landscape ecology in sustainable society, there are several perspectives.

First, every element of landscape, ecosystems/ecotopes has structure and function reflecting stocks and follows. For future sustainability and resilience of landscapes, function and ecosystem services are first and outlooks are second in a changing world.

Second, we have to pay attention to organic alternative landscapes for saving materials and energy toward the future. Excluding culturally protected landscapes, we try to design and develop new landscapes from the viewpoint of new adaptable landscapes on our planet. Energy saving and effective recycling landscapes are welcome to future society particularly on cost performance and economy.

Third, both humanity and ruled society on landscapes are key issues to keep healthy landscapes. Numerous agreements and consensus are required for maintaining societies and landscapes. We are not able to escape these fundamentals in the democratic world. Landscape ecologists must suggest better scenarios to stakeholders in concerned areas.

This action is one of the most important tasks for landscape ecologists. I hope you do it.

Acknowledgements I thank all my colleagues and alumni students during my research life, especially those who proceeded the ecological studies, including landscape ecology, with me. This chapter is one of my recollections. I was born on September 11, 1951, in Hiroshima, Japan. My birthday and birthplace were certainly coincidences. However, I always pray for peace to sustain through scientific works. In that sense, I deeply express gratitude to Professors R. T. T. Forman, W. Haber, Z. Naveh, M. Numata, M. Ruzicka, and I. S. Zonneveld and the other senior landscape ecologists who made me realize the importance of landscape ecology.

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Chapter 2
Island Biocultural Diversity Initiative for Sustainable Society in Asia-Pacific Island Regions

Sun-Kee Hong, Jae-Eun Kim and Tae Ho Ro

Abstract At the World Conservation Congress (WCC) 2012 of the International Union for Conservation of Nature (IUCN), the agendum of 'Strengthening Biocultural Diversity and Traditional Ecological Knowledge in Asia-Pacific Island Regions' was adopted as a resolution (IUCN Resolution 5.115). As a result, there is a need for the Ministry of Environment (Republic of Korea) to organize an aggressive implementation program for the realization of the agendum by cooperating with the IUCN according to the above results. In addition, there is a need to actively respond by possessing the international leadership regarding the related subjects in the future. Together with the Small Island Developing States (SIDS), the IUCN Resolution 5.115 widened the opportunities for the island countries in the surroundings of the Asia-Pacific to aggressively respond to the diverse issues regarding the preservation of the traditional, ecological knowledge of the biological culture, the preservation of the ecosystem, and the sustainable development by mutually cooperating. Especially, regarding Korea, as a country that possesses over 3,400 islands, the use of the resources by the global island residents, the maintenance of the cultural resources, the environmental protection, and the improvement of the quality of life are directly connected to the policies of Korea too. In the IUCN Resolution 5.115, the biocultural diversity, the use of the biological resources, and the contents of the traditional knowledge industry that are related to them, which not only the IUCN but, also, the CBD, the UNESCO, etc. are interested in, are included. In particular, at a time point when the interest in the island nations and the island regions that are very vulnerable to the rise of the seal level resulting from the changes of the earth environment has been heightening, the need for the preservation of the biological diversity regarding the islands and the need regarding the international interest and support for the traditional knowledge and the safety of the residents have been included. Because, although the level of interest regarding these

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have been getting heightened at the IUCN and the CBD already, the main activities have been concentrating on the marine biological diversity, the problems related to the islands on which the human beings reside. However, the indigenous biological resources of the islands, and the culture and the life of the islanders who have been using the indigenous biological resources have been considered in less. It is in this regard that the IUCN Resolution 5.115 has the purpose in overcoming such a viewpoint and intensively heightening the level of the international interest regarding the preservation of the biological resources of the islands and the culture and safety of the residents who use them and in expanding the support through a global network. An initiative regarding the biocultural diversity of the global islands for preserving the ecosystems and the biological diversities needed for the biological diversity, the governance, and the sustainability of the islands of the world, for the wise utilization of the ecological knowledge, for establishing an international network regarding the sustainability of the cultural diversity, and others of the like, and for playing the central role of developing, operating, and putting into practice the programs together with the IUCN is needed.

1 The Background of the Initiative for the Biocultural Diversity of the Global Islands

In the dynamic process in which the interactions among the biological diversity, the cultural diversity, and the traditional knowledge act within the complicated ecosystem, cultural system, and social system, the biocultural diversity has been manifested (CBD 2013; Maffi and Woodley 2010). The human beings have been finding the resources needed for life from nature and have been utilizing them (Hong 2013). In addition, they have been developing the new breeds through the cultivations. Through the utilization of the biological diversity, it became a background for promoting the cultural developments, including the food culture and the residential culture. The ecological knowledge that has been accumulated in the process has been transmitted by going beyond the nearby regions (UNESCO Declaration on Cultural Diversity). In the same way as the past, the survival of the human beings in the future will greatly depend on the biological diversity. In addition, the eco-cultural flexibility and the sustainability that appear in the mutual relationship between such biological diversity and cultural diversity have been used as a model of the harmonious coexistence with the ecosystem, which can support the existence of the mankind in the future.

It can be evaluated that the adoption of the initiative ‘Strengthening Biocultural Diversity and Traditional Ecological Knowledge in Asia-Pacific Island Regions’ as a resolution at the fifth World Conservation Congress (WCC) is a concentration of the results of the efforts by the international society which have been proceeded until now. The international, non-governmental organizations (NGOs) and others of the like, such as *Terralingua*, which has its headquarters in Canada, including the international organizations like the UNESCO, the Commission on Environmental, Economic, and Social Policy (CEESP), which is affiliated with the IUCN, etc., have already defined the concept of 'biocultural diversity,' and they have established the considerable, international networks (Hong et al. 2013). In addition, the fact that the environments of the island regions in the Asia-Pacific, including the Korean Peninsula, have been rapidly changing due to climate change can be seen as the result of this initiative getting around to possessing the common recognition internationally. The pursuit for the international initiative for the agendum 'The biocultural diversity of the coastal regions of the islands in the Asia-Pacific and the spreading of the traditional, ecological knowledge,' which is suitable to the international situation that has been changing, including the global climate change, the international sharing of the awareness, the invigoration of the network, the organization of the previously existent concepts, is indispensable.

Eventually, the vision of the formation of this initiative is to understand the development of the biocultural diversity, including the cultural diversity that takes place by using the biological resources and the special characteristics of the maintenance mechanisms based on the preservation of the biological diversity and the ecological knowledge of the island-coastal regions (countries), which are the ecosystems that are very vulnerable to the climate change and the developmental process, and, at the same time, to internationally cooperate in establishing a system that can sustainably preserve and maintain. In addition, it is to formulate a preservation strategy by having the administration, the research organizations, and the researchers in the related region cooperate and to induce the cooperation by the international organizations so that the long-term support is possible.

2 The Spreading of the Concept of 'Biocultural Diversity' to the Islands

The human beings have been using the environments in which the organisms exist. They have been showing their own, unique method of adapting to the environment by race (Rapport 2006). Moreover, we have been expressing its manifestation as the 'culture.' The UNESCO has conceptualized the special characteristics of the lives of the human beings who adapt to the diverse biological environments from an ecological and anthropological viewpoint by utilizing the term 'bioculture' (Maffi and Woodley 2010). In addition, the academia has been using it by interpreting it more wide-range. The diversity is shown in the process in which the actions between the traditional knowledge circulate within the complicated ecological system. This has been defined as 'biocultural diversity' (Hong 2013; Hong et al. 2013).

While proposing the Sustainable Development Goals (SDGs), the climatologists, the environmental scientists, and the ecologists have been demanding the changes of the awareness on the part of the executives and the politicians of the advanced countries regarding the seriousness of the climate change and the indiscriminate developments. The environmental anthropologists have been explaining how much the humankind has been depending on the organisms and the ecosystems, how the culture has been linked to the biological diversity, and how the culture has been generated through the diverse case examples. An international symposium on the Convention on Biological Diversity (CBD) was held in Montreal, Canada, from June 8 to June 10, 2010. It can be said that the meaning of this international conference is very big because the meeting was proceeded with on the topic of 'Biological and Cultural Diversity for Development' jointly together with the executives and the UNESCO together especially (Fig. 1). In addition, during the period of this conference, there was a meeting on the topic of 'Development for diversity—Diversity for development.' Moreover, with the attendance by the environmental development companies of North America, the international organizations related to energy, the politicians, etc., they discussed about heightening the awareness of the global executives regarding the changes of the earth environment and the crisis of the biological diversity (UNESCO Declaration on Cultural Diversity). Especially, regarding the issues of diversity, green economy, and new models of growth, the roles of, and the cooperation by, the executives and the environmental assimilationists were emphasized. The interests that were more than anything else were the discussions between UNESCO, UNDP, and the politicians regarding 'the energy, sustainable development, and diversity' and 'the biological and cultural diversity for sustainable development' (Hong 2013).


International Conference on Biological and Cultural Diversity: Diversity for Development- Development for Diversity
(8-10 June 2010, Montreal, Canada, Working Document)

A proposed joint programme of work on biological and cultural diversity led by the secretariat of the convention on biological diversity and UNESCO

Definitions of *Biocultural diversity*

The inextricable link between biological diversity and cultural diversity received international recognition through the Declaration of Belem (1988). Loh and Harmon (2005) define **Biocultural diversity as the total sum of the world's differences, no matter what their origin**. This concept encompasses biological diversity at all its levels and cultural diversity in all its manifestations. **Biocultural diversity is derived from the myriad ways in which humans have interacted with their natural surroundings**. Their co-evolution has generated local ecological knowledge and practices: a vital reservoir of experience, methods and skills that help different societies to manage their resources. Diverse worldviews and ethical approaches to life have emerged in tandem with this co-evolution of nature and culture. **The biocultural concept is critical to making progress on building mutual understanding and support between these two diversities**

1 Convention on Biological Diversity http://www.cbd.int/
2 UNESCO Declaration on Cultural Diversity http://unesdoc.unesco.org/images/0012/001271/127160m.pdflink
3 Loh, J. and Harmon, D., 2005. A global index of biocultural diversity. Ecol. Indic. 5(3):231–41.

Fig. 1 A joint meeting between the CBD and the UNESCO that was held in Montreal from June 8 to June 10, 2010. It was decided to cooperate with each other while emphasizing the importance of the biocultural diversity. At this time, the definition of 'biocultural diversity' was definitely decided

As such, as an index needed for discussing the sustainability regarding the earth environments and the societies, the interest in the cooperation between the biological diversity and the cultural diversity has already possessed the international importance.

The Southwestern Sea, which is a representative islands-coastal region of Korea, was designated as a UNESCO Biosphere Reserve for the third time for Korea in the year 2009 by receiving the recognition for its indigenous ecosystem, excellent biodiversity, geographical landscapes, and unique eco-cultural values (Hong et al. 2011). Regarding the archipelago region of Korea, it has the unique ecosystem because it has been continuously preserved for the past decades, and the traditional, ecological knowledge of the people adapting to it is abundant (Kim 2014, 2016). Recently, with the widening of the range of the environmental developments, the consideration of the cultural diversity in addition to the biological diversity, which has been an index of the evaluation of the soundness of the ecosystem until now, has been becoming a matter that is needed for understanding the soundness of the landscape system, which is an ecosystem network. The archipelago is a type of an island that is seen not only in Korea but in Japan, China, the Mediterranean Sea in Europe, and the Pacific Ocean, too.

According to the results of the international researches, not only the values of the ecosystems and the landscapes (Whittaker and Fernandez-Palacios 2007), but also the languages and the dialects of the regions are in the forms that are very vulnerable to Westernization. Moreover, they are in the situation of getting extinct rapidly. As such, it can be considered that the traditional, ecological knowledge regarding the use of the natural resources is as if it is in a crisis of the biological diversity that is driven out by the indiscriminate energy development and land use. Especially, how the native knowledge that has been getting extinct due to the rapid environmental changes can be preserved as the historical inheritances is a main point of discussion. In the same way as in the past, the survival of the human beings in the future will greatly rely on the biological diversity. In addition, the eco-cultural flexibility and sustainability that are shown in the mutual relationship between the biological diversity and the cultural diversity have been used as a model of the harmonious coexistence with the ecosystem that can support the existence of the humankind in the future.

An international network regarding the ecosystem that is needed for the sustainability, the preservation of the biological diversity, the wise utilization of the ecological knowledge, and the cultural diversity must be established. Moreover, the central role of developing, managing, and putting into practice a program together with the IUCN must be played.

Although the biological diversity on the levels of the genes, the species, the population, the habitat, and the landscape and the cultural diversity of the language, the food, clothing, and shelter, the industry, etc., are the properties that are different from each other, the human beings have been repetitively developing while relying on the nature (Hong et al. 2014). Moreover, because they are in the fateful dependence relationship in which they can not exist without the utilization of the natural resources, the term 'the landscape of the biocultural diversity' was created to

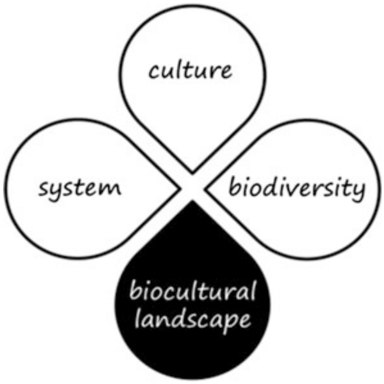

Fig. 2 Structure of a biocultural diversity landscape. The landscape is an organization that has been structurally hierarchized with the diverse systems (ecosystems) being mutually linked. In the landscape, not only the biological diversity but also the cultural diversity functions through the intrinsic combinations. (In *Preface*, Hong et al. 2014)

mean the total space in which the natural system and the human system coexist (Fig. 2). Although it is an undeniable fact that the human beings and the nature have been mutually depending, contacting, and supplementing within the ecosystem, there is a need for every stakeholder, including the international organizations, the governments, the researchers, the citizens, and the experts, to think that they are the people related. Furthermore, all stakeholders should deeply understand that the connection points have been deteriorating due to the changes of the environments of the earth, and the fact that the thoughtless development is one of the major anthropogenic impacts resulting in the decrease of the biological diversity that has been changing rapidly.

3 The Vision of the Island Biocultural Diversity Initiative for the Global Island Regions

The vision of Island Biocultural Diversities Initiative for the global island regions is 'the securing of the sustainability of the islands through the preservation of the universal values of the nature and the inheritances of the mankind.' This vision has the basic strategy for maximally maintaining the environmental accommodation ability regarding the biological and physical natural resources possessed by the islands. In other words, it is to maximally guarantee the biological diversity that has been maintaining the island landscapes and the surrounding seas and the quality of life and the cultural values of the residents who have been living based on the biological resources. In addition, a basic strategy for the qualitative improvements of the ecosystems is included. In order to realize this vision, the setting up of the goals to be accomplished both domestically and overseas must be organized harmoniously. The vision of the initiative is to clarify more the performance index by setting up the three big goals and the five plans (tasks).

3.1 The Three Big Goals

3.1.1 The Preservation and the Utilization of the Biocultural Diversity of the Islands

A strategy for heightening the international awareness regarding the island ecosystems that are vulnerable to the climate change and for preserving the precious biological diversity that has been exposed to the diverse environmental changes is formulated and shared. In addition, by discussing a plan, for making the indigenous cultural diversities that have been created by using the biological resources coexist together with the preservation of the biological diversity, it is intended to play the role of passing down the cultural diversities of the islands of the humankind, who have been in a symbiotic relationship with the biological resources. In the island regions in which the urbanization has not been proceeded with, the diverse traditional cultures and the traditional knowledge that has been maintaining them have been existing. As such traditional knowledge has the danger of disappearing according to the environmental changes of the islands and the seas in the future, it must be preserved and passed down as one of the resources of the cultures of the mankind. In order to do this, there is a need to excavate, investigate, and analyze the contents and the details that are related.

3.1.2 The Researches and the Supporting Activities

The establishment of a co-research system for Korea and overseas for the preservation, the excavation, the utilization, and the transmission of the biocultural diversity of the islands is needed. The related, international networks, including the international organizations affiliated with United Nations, IUCN, UNESCO, CBD, share the information based on the basic monitoring and researches and, at the same time, carry out the policy researches, regarding the safety based on the society and the life, the preservation of the landscapes, etc., that can respond to the climate change. Eventually, because the beneficiaries of the co-researches and supports must be the residents of the islands, in operating and managing such researches and supporting systems, the resident communities must participate, without fail, and the plans for directly and indirectly utilizing them must be considered.

3.1.3 The Cooperation Through the Organization of a Global Network

As a goal that was set up for reinforcing the islands-related information on the global level and for the materialization of an actual cooperation system, a matter must be realized in the medium term and long term. Its feasibility is high as a goal for leading the cooperation that is actual and of which the rising effect is high, and at the same time, its direction is toward globalizing the initiative. In order to realize this goal, a differentiation strategy regarding the spatial threshold on the level of the entire globe that can encompass the solidarity by region and the network of the entire globe must be considered and applied.

3.2 The Five Plans (Tasks) for Pursuing the Three Big Goals

3.2.1 The Support Regarding the Vulnerable Ecosystems

The islands are the very vulnerable ecosystems when considering the total areas, the resources, the isolation, etc. Moreover, the rapid changes of the lives of the residents of the islands who use the insufficient resources are directly related with the destructions of the ecosystems. As a result, in order to preserve the island ecosystems, the support for the awareness education, the nature preservation education, the restorations of the ecosystems, etc. in relation to the residents is required.

3.2.2 The New Understanding of the Ecosystem Services

The accurate investigations and technologies regarding the island and sea ecosystems that show the high values in the evaluations of the services for the ecosystem, including the mud flats, the coral reefs, are required. Especially, the coral reefs of the island nations, which have been evaluated as being of a simple type of the marine ecosystem, in the Pacific Ocean and the mud flat wetlands of the Asian region (especially, the Korean Peninsula), are not only the ecosystems but also the living foundations. In addition, by clearly indicating that they are the spaces in which the bioculture is created, indeed, it was publicized so that a suitable evaluation can be received when evaluating the ecosystem service.

3.2.3 The Invigoration of the Regions and the Formation of the Social Safety Networks

In the process of modernization, the speed of the urbanization and the deterioration of the traditional society have the very close relationship. However, as the island environment, too, can be managed only if the regional residents protect the island and live, a systematic device through which the regional residents can receive the economic help is demanded. The diverse programs that can be operated autonomously by the residents, including eco-tourism, cultural preservation, the sixth industrial introduction, fair international trade, etc. can be formed and guided.

3.2.4 The Preservation of the Biocultures of the Islands Resulting from the Climate Change and the Global Warming

The biocultures of the islands, which have been being disappeared gradually, are the important inheritances of the humankind. In the same way as the evaluation by the people of the world regarding the importance of the species in the crisis of getting extinct (the endangered species), the value regarding the diversities of the biocultures of the islands, too, must be evaluated importantly. Moreover, thereby, there must be the cooperation for the rating and the special management (e.g., the types like the Island Biocultural Resource Category).

3.2.5 The Understanding Regarding the Coexistence of the Nature and the Human Beings in the Limited Spaces

By researching the life wisdoms and the ecological knowledge of the residents of the islands who have been utilizing the limited spaces and resources, it became able to utilize the researches as the materials that are important to the coping strategies regarding the problem of the insufficiency of the diverse resources (food, energy, and water) which can approach the mankind in the near future. In addition, by internationally and mutually sharing the ecological and environmental importance of the islands, there is a need to emphasize that the people of the world must protect them together as not only the islands as the territories and the resources simply but also as the islands of the peaceful coexistence.

4 The Process of Unfolding the Millennium Development Goals (MDGs) for the Sustainable Development Goals (SDGs)

The medium- to long-term plans of the international vision related to the initiative must be carried out according to the three big goals and the five plans (tasks) according to the vision. Except when formulating the plans, there must be the setups by considering the flows of the directionality and the discussion matters intended to be aimed at in the future by the international society (Ro 2014). While being converted in the twenty-first century, the international society presented a specific index for pursuing the co-prosperity of the humankind by setting up the MDGs of the United Nations. Moreover, it had made a request for the efforts by each country for this. In the year 2000, at the U.N. General Assembly, the representatives of the governments of 189 countries and regions adopted the eight MDGs unanimously. In addition, at the same time, they agreed to accomplish them by the year 2015.

The eight goals were the eradications of the absolute poverty and hunger, the accomplishment of the universal elementary education, the male and female equality and the improvement of the rights and the interests of the women, the reduction of the child death rate, the improvement of the maternal and child health, the eradication of the various kinds of diseases, the sustainable preservation of the environment, and the establishment of the global partnerships for the developments. Such eight goals by category have the time period of the effectiveness of a total of 15 years from the year 2000 until the year 2015, and they encompass a system organized with each of the detailed goals and the performance indices (Indicators) of them. Although this has the meaning of having arrived at a global agreement with the participation by the diverse main agents, including the international organizations, the NGOs, together with the pending issues centered on the developing countries as the main goals and by having been set up top-down centered on the U.N., it has been receiving the evaluation that the actual effectiveness and the results are somewhat insufficient.

The Sustainable Development Goals (SDGs) were materialized by agreeing to the formulation of the new goals of the international society for the accomplishment of the sustainable development after the year 2015 at the Rio+20 in 2012. This intended to raise the participation by the diverse interested parties through the collection of the opinions of the civilians and the civil societies on the bottom-up level of the application of the flexible access that fits the situation of each country in order to overcome the limitations of the MDGs (Table 1). Regarding the period of the implementation, a total of 15 years from 2016 until 2030 has been anticipated. In addition, at the UN General Assembly in September 2015, the 17 goals proposed by the publicly disclosed working group were adopted, and they started having the effectiveness from the year 2016.

The 17 goals can be largely classified into five categories. These are distinguished into the fields of the eradication of poverty, the social development, the economic development, the environmental preservation, and the implementation cooperation. In addition, because the detailed goals are set up for each goal, it looks as though 169 detailed goals will be pursued. The field of the eradication of poverty, which is the first category, is organized with Goal 1 (The eradication of poverty in all the regions. 7 detailed goals) and Goal 2 (The alleviation of hunger, the securing of the food stability, and the sustainable agriculture. 8 detailed goals). And, in the domain of social development, which is the second category, Goal 3 (The guarantee of the healthy life and well-being of all the people in all age brackets. 13 detailed goals), Goal 4 (The guarantee of the education with the comprehensive and just quality and the promotion of the opportunity for lifelong education. 10 detailed goals), Goal 5 (The accomplishment of gender equality and the goal of strengthening the capabilities of women. 9 detailed goals), Goal 10 (The reduction of the inequalities inside the country and between the countries. 10 detailed goals), and Goal 16 (The promotion of a peaceful and comprehensive society for the sustainable development, the provision of the just accesses to everyone and the establishment of the effective, responsible, and comprehensive organizations on all levels. 12 detailed goals) are included. The category of economic growth is

Table 1 Points aimed at by, and the comparisons of, the 17 goals of the sustainable development goals that were newly organized based on the eight categories of the New Millennium development goals (cited from Ro 2014)

MDGs	Viewpoint	SDGs
Goal 1. The eradication of absolute poverty and hunger	The classifications, in detail, of the discussions on the hunger, the food problem, and the nutritive conditions. Including the new discussions on the participation by the community regarding this and the sustainable agriculture	Goal 1. The eradication of the poverty in all the regions Goal 2. The alleviation of the hunger, the securing of the food stability, and the sustainable agriculture
Goal 4. The decrease of the infant death rate Goal 5. The promotion of the maternal health Goal 6. The eradication of the diseases, including HIV/AIDS, malaria, etc.	In contrast to the fact that there is the focus on a specific age bracket (Infants, mothers, etc.) and the specific diseases, the contents and the subjects of the SDGs are comprehensive	Goal 3. The guarantee of the healthy life and the well-being of all the people in all age brackets
Goal 2. The accomplishment of universal elementary education	The guarantee of the diverse education from the previously existent elementary education to higher education, to lifelong learning, and to vocational training. Moreover, the application to the wide-ranging subjects	Goal 4. The guarantee of the comprehensive education with the fair quality fair quality and the promotion of the opportunity for lifelong education
Goal 3. Gender equality and the enhancement of the women's capabilities	There are nearly no changes	Goal 5. The accomplishment of gender equality and the strengthening of the women's capabilities
(Newly established)	The economy, the social development, and the integrated part were included additionally. On the other hand, in other words, it means that the inequality is reduced and, instead of simply increasing the number of the jobs, the worry regarding the expansion of the jobs that are is needed	Goal 8. The sustainable economic growth that is consistent and comprehensive. The productive and complete employments. Moreover, the promotion of the jobs that are for everybody Goal 9. The formation of an infrastructure that has the ability to recover, the promotion of the comprehensive and sustainable industrialization, and the fostering of the innovations Goal 10. The reduction of the inequalities inside the country and between the countries

(continued)

Table 1 (continued)

MDGs	Viewpoint	SDGs
Goal 7. The guarantee of a sustainable environment	Based on the Agenda 21 of the Copenhagen Accord, the environmental issues discussed at the Rio+20 appeared in a large amount and were subdivided Although it is a glad thing that the discussions on the sustainable environment were included, as taken at look at the Rio+20, at a time point when the participation by the advanced countries related to the reduction of the greenhouse gas and others of the like is uncertain, the worry regarding whether this can be accomplished took place	Goal 6. The guarantee of the accessibility of the water resources, the sustainable management, and the hygiene management Goal 7. The guarantee of the access to the reliable, sustainable, and modern energy with the appropriate price Goal 11. The formation of the comprehensive, safe, and sustainable city and living environment with the ability to recover Goal 12. The guarantee of the sustainable consumption and production patterns Goal 13. An emergency measure for standing up to climate change and the influences Goal 14. The protection of the marine resources for the sustainable development and the sustainable use Goal 15. The protection, the restoration, and the promotion of the utilization in the sustainable form of the ecosystem, the sustainable management of the forests, the preservation of the desertification, and the suspension of the desolation of the land and of the decrease of the biological diversity
Goal 8. The global partnership for development	During the process of putting the MDGs into practice, the partnership was carved in relief as an important element of the success. Moreover, the goal that reflects this	Goal 16. The promotion for being a peaceful and comprehensive society for the sustainable development. The provision of the just access to everyone. Moreover, the establishment of an effective, responsible, and comprehensive organization on all levels Goal 17. The strengthening of the execution tool for the sustainable development and the revitalization of the global partnership

organized with Goal 8 (The economic growth that is continuous and inclusive and the promoting of the good-quality jobs. 12 detailed goals) and Goal 9 (The formation of an infrastructure that has the recovering ability, the promotion of a comprehensive and sustainable industrialization, and the promotion of the innovations. 8 detailed goals). In the field of the implementation cooperation, there is Goal 17 (The strengthening of the implementation and the global partnership. 19 detailed goals). Lastly, the qualitative increase of the goal in the field of environmental preservation is a matter worth paying attention to. The seven goals in this field are as below.

Goal 6. The accessibility of the water resources, the sustainable management, and the guarantee of the hygiene management. 8 detailed goals.
Goal 7. The guarantee of the access to the modern energy with the appropriate price which is reliable and which is sustainable. 5 detailed goals.
Goal 11. The formation of the cities and the living environments that are comprehensive, safe, have the recovering ability, and are sustainable. 10 detailed goals.
Goal 12. The guarantee of the patterns of the sustainable consumption and the production. 11 detailed goals.
Goal 13. The emergency measures for standing up again climate change and its influences. 5 detailed goals.
Goal 14. The protection and the sustainable use of the marine resources for the sustainable developments. 10 detailed goals.
Goal 15. The protection, the restoration, and the promotion of the utilizations in the sustainable forms of the ecosystem. The sustainable management of the forests, the prevention of desertification, and the suspension of the land degradation and the reduction of the biological diversity. 12 detailed goals.

5 The Sustainable Development Goals (SDGs): The Linkage with the Action Plan of 'Island Biocultural Diversity Initiative' of the Global Island Regions

As, regarding the SDGs, nearly all the goals contain the domains that directly or indirectly have something in common with 'Island Biocultural Diversity Initiative,' they must be considered in the formulation of the medium- to long-term plans. It looks as though, when formulating the plans, it will be efficient to concentrate on some goals, distinguish between the medium-term plans through which the actual effectiveness can be obtained and the goals that must be accomplished in the long term, and approach them in parallel. Especially, it looks as though, since the pursuit for a pilot project is a domain that is suitable for carrying out in the medium to long term, it will be efficient to carry it out at a place (e.g., a country or a tribe that borrows *Hangeul* (the Korean alphabet) and uses it for the characters) that possesses the very close relationship with Korea among the island countries of Southeast Asia. For example, we can consider that the project resolving the poverty of the island nations while carrying out the preservation of the natural environment and the preservation of the traditional culture, which had failed in Korea in the past. Reinterpreting the 'Saemaeul' (new village in Korean) Movement in the framework of sustainable development and applying the reinterpretation to the 'Island Saemaeul Movement', therefore, can be the good case examples for heightening the timeliness and the experiential effects. Additionally, a project for transmitting or applying the Korean-type environmental influence evaluation system, which was in charge of the role of preserving the environment during the process of the compressed growth, can be mentioned.

Moreover, the international joint researches for the development of the international indices for the evaluation of the biocultural diversity and others of the like can be considered as the demonstration projects. By having such international, pilot projects as the stepping-stones, the organization of a project that links with the long-term goal is important. In addition, for this, the Ministry of Environment, which is the agency of primary concern, must formulate and reflect a plan for preparing the financial resources in the initial stage. In particular, in linkage with Goal 17 of the SDGs, the management of a high-level policy dialog platform of the government in the system of 'Island Biocultural Diversity Initiative' can be considered. The making of a symbolic, decision-making organization by organizing a high-ranking, working-level meeting, which is a decision-maker, once a year and by pursuing a ministerial-level meeting every other year can also be considered. Through this and by using with 'Island Biocultural Diversity Initiative,' it will prove to be an opportunity for the international society to heighten the awareness regarding the islands by one level.

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Chapter 3
Multi-Criteria Decision Analysis (MCDA) Technique for Evaluating Health Status of Landscape Ecology

Byomkesh Talukder

Abstract Health status of landscape ecology is one of the most important sustainability issues. Health status of landscape ecology is defined by many criteria and is the reflection of the overall aggregated impacts of the criteria. To understand the status of the health of a landscape, a holistic evaluation framework is required that is capable to show the impacts of the criteria separate and aggregated. Multi-Criteria Decision Analysis is a framework that can fulfill the requirement of a holistic framework. To assess applicability and understand the process of the evaluation using MCDA in this paper, some criteria are selected and a hypothetical set of data of those criteria is used. The hypothetical case study shows that MCDA is capable to assess health impacts of landscape ecology by combining different criteria. However, to understand the process and advantage and disadvantage of the MCDA framework for evaluation of the health status of a landscape, a real case study is recommended for future study.

1 Introduction

"Landscape ecology is the study of spatial variation in landscapes at a variety of scales. It includes the biophysical and societal causes and consequences of landscape heterogeneity" (IALE 2017). Landscapes are configured by the interactions of diverse ecological, social, and economic systems (Turner et al. 2001; Wu and Hobbs 2007; Minang et al. 2015). Scherr et al. (2013) define landscape as "a socio-ecological system that consists of a mosaic of natural and/or human-modified ecosystems, with a characteristic configuration of topography, vegetation, land use, and settlements that are influenced by the ecological, historical, economic, and cultural processes and activities of the area." Along with natural processes, direct

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and intentional human interaction with landscapes is responsible for changing ecological processes in landscapes (Sanderson et al. 2002). Landscape transformation is one of the primary drivers of global changes in climate, biodiversity, and biogeochemistry.

To measure and mediate long-term ecological changes, understanding the health of a landscape is essential. A landscape's health negatively affects the ecosystem goods and services of the landscape. Landscape matrices and soil are important considerations for landscape health in the land. "The idea of landscape health derives from the emerging integrative science of ecosystem health, which seeks to diagnose ecosystem condition as humans diagnose human health" (Bertollo 2001). Understanding the health status of a landscape is important for policies, plans, designs, and management strategies to respond to long-term landscape ecological management. Evaluating the health status of a landscape can help to develop a comprehensive knowledge base for building more sustainable landscapes and for environmental planning. An understanding of the landscape's health status is also a fundamental part of planning for sustainable development.

The status of a landscape's health is the outcome of multiple criteria from land use and land cover change, water pollution, biodiversity, anthropogenic activities, urbanization and so forth. Hence, evaluation of the health status of a landscape requires criteria from interdisciplinary subjects, and assessing health status requires a holistic approach that can combine multiple criteria for evaluating the status of the landscape's health. Multi-Criteria Decision Analysis (MCDA) is a technique that is capable of evaluating the health status of a landscape considering multiple criteria.

2 Criteria for Health Status of Landscape Ecology

A landscape represents the complex interactions of the domains of land, water, and air; therefore, the health status of the landscape depends on the health of these domains. Criteria of biophysical conditions must be taken into consideration for evaluating health status of a landscape (Rapport et al. 1998). A careful selection of criteria is important to draw a comprehensive picture of the health of a landscape. Criteria from the biophysical condition of a landscape represent various types of information. Some of these criteria that are important for maintaining landscape health are mentioned below. These criteria and their hypothetical values will be used in a case study to evaluate the health status of a landscape by using MCDA. It is important to remember that criteria should be selected based on the situation and objective of the study. Criteria are important for understanding performance of a landscape, but a criterion value does not completely capture the complexity of the health of a landscape; it only gives a picture of the context. The values of the criteria often rely on quantitative measurement techniques. At this point, it is also important to remember that the criteria that have been selected here are only for the purpose of this study and are used as an example for a set of criteria. Others can select their own sets of criteria and calculate their values using different quantitative methods.

2.1 Landscape Fragmentation (LF)

"Landscape fragmentation is the result of transforming large habitat patches into smaller, more isolated fragments of habitat" (EEA-FOEN 2011). Landscape fragmentation negatively affects ecosystem services and presents the greatest threats to biodiversity (Lindenmayer et al. 2006), leading to degradation of the health of the landscape. The effects of landscape fragmentation on the environment and various ecosystem services are well documented by EEA-FOEN (2011). There are many methods to quantify landscape fragmentation (Leitão et al. 2012); effective mesh size (m_{eff}) in Jaeger et al. (2008) as mentioned in EEA-FOEN (2011) could be a good criterion. "Maximum value of the effective mesh size is reached with a completely un-fragmented area. The minimum value of m_{eff} is 0 km^2; such is the case where a region is completely covered by transportation and urban structures" (EEA-FOEN 2011).

2.2 Land Degradation (LD)

Area of land degradation is an important criterion of landscape health. Land degradation has an "adverse impact on agronomic productivity, the environment, and … food security and the quality of life" (Eswaran et al. 2001). Biophysical (land use and land management, including deforestation and tillage methods), socioeconomic (e.g., land tenure, marketing, institutional support, income, and human health), and political (e.g., incentives, political stability) forces influence the effectiveness of processes and factors of land degradation" (Eswaran et al. 2001). It is measured as a percentage; the higher the percentage of land degradation, the poorer the health of the landscape is. There is no conclusive evidence about what percentage of land degradation is harmful for the landscape. It can be assumed that 0–1% land degradation is better than any other rate and that anything above 0–1% will have negative impacts on the landscape.

2.3 Water Quality Index (WQI)

Landscape ecology has great impacts on the water quality of the bodies of water of the landscape. Landscape ecological processes such as land cover and land management practices work as a factor of alteration of hydrological systems and affect the water quality (Tong and Chen 2002). Deteriorated water quality affects water-related ecosystem goods and services. Water quality of a landscape is assessed by using physical, chemical, and biological parameters, so water quality index (WQI) is one of the most effective ways to describe it (Tyagi et al. 2013). The mathematical expression for WQI is given by

$$\text{WQI} = \sum_{i=1}^{n} Q_i W_i$$

where Q_i = subindex for ith water quality parameter; W_i = weight associated with ith water quality parameter; n = number of water quality parameters[1] (Tyagi et al. 2013). WQI in the range of 91–100, 71–90, 51–70, 26–50, and 0–25 indicates excellent water quality, good water quality, medium water quality, bad water quality, and very bad water quality, respectively (Tyagi et al. 2013).

2.4 Air Quality Index (AQI)

Human activities on the landscape affect air quality. For example, scientific literature has clearly demonstrated that certain levels of acidic compounds (sulfates and nitrates) in the air have impacts on human health, air quality, lakes and streams (acidification), sensitive forests and coastal ecosystems (Saltman et al. 2005). Among acidic components, the oxides of nitrogen (NO_x) that fall to the earth can damage crops and trees by affecting the chemistry of water and soils and by making the ecosystem more vulnerable (Galloway 1995). "NO_2 is the component of greatest concern and is used as the indicator for the larger group of NO_x" (EPA 2011). According to EPA (2011), the annual average NO_2 standard is 53 parts per billion (ppb), and 0–50, 51–100, 101–150, 151–200, and 201–300 ppb range of NO_2 in air represent good, moderate, unhealthy for sensitive groups, unhealthy, and very unhealthy, respectively.

2.5 Urban Expansion (UE)

Rapid and unprecedented expansion of urban areas leads to ecosystem degradation, loss of natural habitats and species diversity, and increased human health risks (Zupancic et al. 2015) in the landscape. For example, urban areas can both modify the geomorphology and intensify the pollution of bodies of water like rivers (Zhou et al. 2012). Urban expansion is calculated as a percentage. It can be assumed that a 0–1% expansion rate indicates slow growth and may be good for landscape ecology. Anything above 0–1% will have negative impacts on the landscape.

[1]There are "nine water quality parameters such as temperature, pH, turbidity, fecal coliform, dissolved oxygen, biochemical oxygen demand, total phosphates, nitrates, and total solids" (Tyagi et al. 2013: 35)

2.6 Household Expansion (HHE)

The number of households in an area has huge impacts on landscape ecology. These impacts are well documented in Liu (2013). A household as a basic economic unit is considered as the primary consumer of ecosystem services and key entities coupled with human and natural systems. As the number of houses increases, the negative impacts on the landscape also increase as more households consume more ecosystem services and hamper the landscape (Liu 2013). HHE is calculated as a percentage. There is no conclusive evidence of what percentage of growth in households is good or bad for landscape ecology. However, it can be assumed that a lower rate is good for landscape ecology. So for the purpose of this study, it is assumed that 0–1% may be good and anything above 0–1% will be considered as bad.

3 MCDA Technique

The Multi-Criteria Decision Analysis[2] (MCDA) technique helps in evaluating a process in the presence of many criteria (Alencar and Almeida 2010; Jeon et al. 2010). At present, MCDA may be carried out by using computer software. Generally, MCDA follows several phases (Herath and Prato 2006). The nonlinear recursive process of MCDA is presented briefly in Fig. 1.

MCDA methods are widely used for environmental management (Mendoza and Martins 2006; Khalili and Duecker 2013), forest management (Wolfslehner and Seidl 2010), protection of natural areas (Geneletti and van Duren 2008), biodiversity conservation planning (Moffett and Sarkar 2006), water management (Hajkowicz and Collins 2007), wetland management (Herath 2004), management of contaminated sediments (Linkov et al. 2006), integrated catchment management (Prato and Herath 2007), agricultural resource management (Hayashi 2000), energy sector (Giampietro et al. 2006) and so forth.

There are many MCDA techniques such as Multi-Attribute Utility Theory (MAUT), Preference Ranking Organization Method for Enrichment Evaluations (PROMETHEE) I and II, Simple Multi-Attribute Rated Technique (SMART), Analytical Hierarchy Process (AHP), Simple Additive Weighting (SAW) and Novel Approach to Imprecise Assessment and Decision Environment (NAIADE) (Polatidis et al. 2006). Among these MCDA techniques, MAUT is used here for evaluating the health status of the landscape ecology. A brief description of the methodological procedure of MAUT is given below.

[2]Multiple Criteria Decision Analysis (MCDA) is also known as Multiple Criteria Decision Making (MCDM), Multi-Criteria Decision Aiding (MCDA), Multi-Attribute Decision Analysis (MADA), and Multiple Objective Decision Analysis (MODA), Single Participant-Multiple Criteria Decision Making (SPMC) (Hipel 2013).

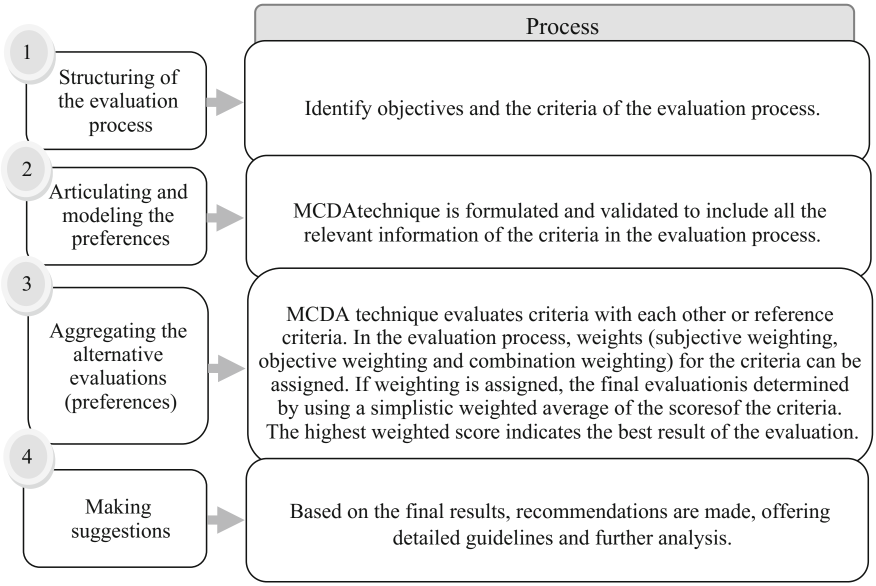

Fig. 1 Generalized phases in MCDA *Source* based on Sadok et al. (2008), Wang et al. (2009), EAF (2011)

MAUT is the simplest way to understand MCDA and is widely used in multi-criteria evaluation (Antunes et al. 2012). MAUT can be used to evaluate criteria in a reliable manner through assigning appropriate weights for criteria. The weights are considered in terms of trade-offs across criteria. Normalization is carried out in this technique for different dimensions into a common framework (Antunes et al. 2012). "MAUT resolves multiple preferences and value scores into an overall utility value for each metric criterion, enabling comparison" (Convertino et al. 2013). In MAUT, the alternatives are evaluated with respect to each attribute and the attributes are weighted according to their relative importance (Mustajoki et al. 2004). A simple case in which the attributes are not hierarchically structured and not interacting with the overall value of an alternative follows:

$$v(x) = \sum_{i=1}^{n} w_i v_i(x)$$

where
$v(x)$ = Overall value of a criterion,
n = The number of criteria,
w_i = The weight of criteria i, and
$v_i(x)$ = The rating of an alternative x with respect to criteria i.

$v_i(x)$ is normalized to the 0–1 range, and w_i is the importance weight assigned to criterion i. Through w_i, the evaluator considers the range of values from the worst to the best possible level of the criteria compared to the corresponding ranges in the other criteria (Huang et al. 2011). Here weights work as scaling factors to communicate scores among the different criteria (Marttunen and Hämäläinen 2008).

4 MCDA for Evaluating Health Status of Landscape Ecology: A Case Study

To show how MCDA evaluates the status of landscape health based on the selected criteria in Sect. 2, the scores of the criteria for a landscape named "A" are generated hypothetically (see Table 1). These criteria will be evaluated in comparison with the reference score (hypothetical) of the criteria (see Table 1). Reference scores of the criteria can be generated based on science or policy (Acosta-Alba and Van der Werf 2011). As described in Sect. 3, the selected criteria of landscape "A" will be evaluated with respect to each reference criterion and then an aggregated score will be generated to understand of the status of each criterion and the total score of landscape "A" in comparison with the reference score.

For the evaluation of health status using selected criteria, the free online software program Web-HIPRE (http://hipre.aalto.fi/) is considered. Web-HIPRE follows the procedures of MAUT. In Web-HIPRE software, the equal weight for all the criteria is used by recognizing that all the criteria are important for landscape health. In the normalization process of MAUT, all the estimated and reference scores of the criteria were proportionately normalized. These normalized scores are used to

Table 1 Criteria and their values for evaluating health status of landscape "A"

Criteria	Hypothetical	
	Estimated score of landscape "A" (ESA)	Reference score of landscape "A" (RSA)
Landscape Fragmentation (LF) (km)	50	100
Land Degradation (LD)	1	2
Water Quality Index (WQI)	1	2
Air Quality Index(AQI)	35	100
Urban Expansion (UE)	1	2
Household Expansion (HHE)	1	2

Note LD, UE, and HE are expressed in %. In all cases, 0–1% change is assumed to be good for the landscape and anything above 1% is assumed to be bad for landscape ecology. This bad and good performance is converted in a scale where 1 = bad and 2 = good. Since in MAUT criteria scores are added to get a final score, good performance needs to be converted to a higher score by using a rating scale

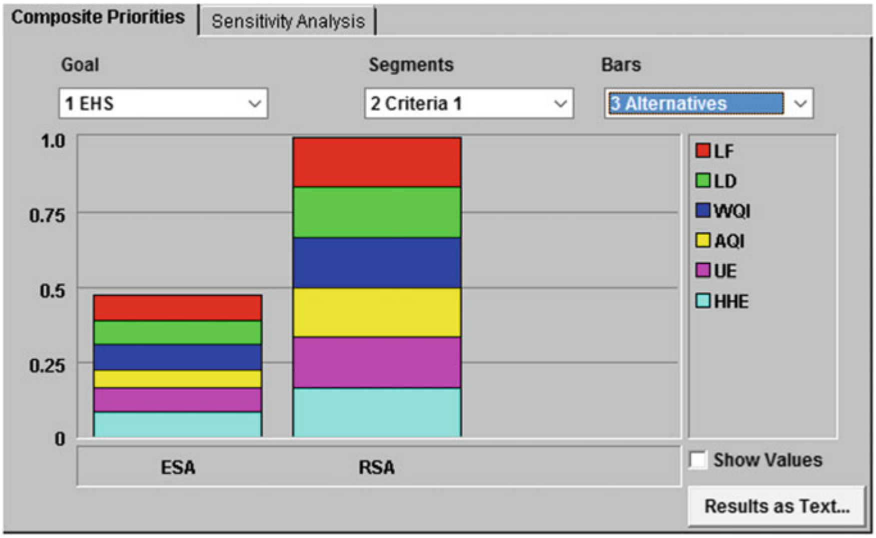

Fig. 2 Comparison of the estimated scores with reference scores of the criteria

Table 2 Overall scores of the health status of landscape "A"

Criteria score	ESA	RSA
LF	0.083	0.167
LD	0.083	0.167
WQI	0.083	0.167
AQI	0.058	0.167
UE	0.083	0.167
HHE	0.083	0.167
Overall score	0.475	1.000

Note ESA = Estimated score of landscape "A"; RSA = Reference score of landscape "A"

compare the estimated scores of the criteria in comparison with reference criteria (Fig. 2) and to generate an overall score of the health status of landscape "A" from the estimated score of the criteria (Table 2).

The overall score of health status by using estimated and reference scores of the criteria in Table 1 indicates that health status of landscape "A" is below reference standard. MCDA results in Fig. 2, represents the total picture of the criteria that is easy to interpret and it also shows all the scores of the criteria holistically. Showing the criteria scores in this way can be very useful to compare the performance of the criteria with the reference values and facilitate better decision making. This analysis can also be used as a baseline to compare with future performance related to the criteria. Showing the evaluation results in this way can be very useful for initiatives to improve the performances of the criteria. By combining all the criteria, MCDA generates a score on a 0–1 scale (Table 2) where a score near 0 indicates bad performance and near 1 indicates good performance of the health status of the landscape. The overall score depends on the performance/score of the individual criteria. Generating an overall score for evaluating health status in this way is transparent.

5 Conclusion

Using the MCDA technique for evaluating the health status of a landscape by combining multiple criteria can be a useful tool for decision making to improve the health status of a complex landscape. In this article, using hypothetical scores of six selected criteria, an assumed landscape "A" is assessed and a methodological approach is proposed to evaluate landscape health. Evaluating the criteria of the ecological health and generating an overall score of the performance of the criteria is very important for benchmarking the criteria and determining the overall score of the health status. The MCDA methodology that is proposed here is easy to apply and has the capability to be an easily applicable methodology for evaluating the status of landscape health.

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Chapter 4
Investigating Impacts of Major Events on Land Use Development of European and Asiatic Landscapes

Laura O. Petrov and Laur Ivan

Abstract Landscapes evolve continuously in a more or less chaotic way, reflecting human activities, societal processes and human–environmental interactions of a particular society at a certain moment (Antrop in Landsc Urban Plan 75:187–197, 2006). Crucial events as the Second World War, Fall of Communism and their consequences on economic development are decisive driving forces for the demography dynamics, spatial region development and its environment. This paper proposes a discussion on greenbelts and peri-urban areas with a focus on understanding their relations. We propose as starting points two researched areas: Leipzig and Hiroshima.

1 Introduction

Landscapes evolve continuously in a more or less chaotic way, reflecting human activities, societal processes and human–environmental interactions of a particular society at a certain moment (Antrop 2006). Crucial events as the Second World War, Fall of Communism and their consequences on economic development are decisive driving forces for the demography dynamics, spatial region development and its environment.

The Asian mega-cities have realized explosive growth in the post-war decades and continue to grow to accommodate people flow in from surrounding rural areas (Yokohari et al. 2000). Urbanisation has created a chaotic mixture of urban and rural land uses in the fringe of the cities (Yokohari et al. 2000), which according to

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several studies the land use mixture is now a major feature of Asian urbanization (Leaf 2002; Huang et al. 2009; Yang et al. 2010; Thapa and Murayama 2011). The goal of policy-makers was to find a sustainable land use pattern, a good balance between urban open space and built-up area. Among the major measures to keep growth under control and encourage well-ordered developments, the application of greenbelt planning concept, originated in European cities, was one of the most commonly applied concepts to Asian mega-cities.

In Europe, the land use change process has been decided by several major events such as the Second World War, Enlargement of the European Union (EU) and the Fall of Communism. The land use of Western Europe was influenced by economic re-building (after the Second World War) and EU enlargement such as 1973 (UK and Ireland) and 1983 (Portugal and Spain), while Eastern Europe land use passes through Communist regimes characterized by industrialization and centralization of agricultural production. In contrast to Western European cities, suburban areas and transport network around cities in Eastern Europe were much less developed. With the collapse of Communism regime, the cities and regions in Eastern Europe have entered into a new phase of urbanisation, which has changed dramatically the land use patterns. The most obvious signs of urbanisation are urban sprawl and peri-urban transition process. The greenbelt concept was applied post-Second World War to many European cities and continues to be used nowadays (Donis 2003; Kuhn 2003; Siedentop et al. 2016).

The greenbelt concept appeared firstly in 1890s (Howard 1898, 2007), while the peri-urban area was neglected for a long time (Elson 1986; Errington 1994). Nowadays, more and more discussions and analysis about peri-urban area are heard and seen. The main focus of this work is not to present the research results, but by using previous works the authors open a debate on both, the greenbelt concept and peri-urban areas, as either one of them or both (co)exist at the edge of the city. The two case studies: Hiroshima City Region, in Japan, and Leipzig City Region in Eastern Germany were chosen because the first author is familiar with each and had the opportunity to visit them for extended periods. Even though the two areas were analysed at different times, both were dominated by arable land and forests while after the Second World War, respectively, the Communism fall the land uses evolved similarly. They face now the same problem of chaotic mixture of land use surrounding the city in spite of existence of greenbelt, and respectively, green ring that was created to prevent the negative impact of urban sprawl.

This work focuses on understanding the 'connection' between the greenbelt and peri-urban and how the stakeholders should manage them. As mentioned above, to present the research results is not the main focus of this work, several figures and tables are not shown.

2 The Greenbelt: Separator of City and Countryside

A greenbelt usually refers to a band of green space drawn tightly around an existing urban area intended to contain urban expansion or preserve environmental and recreational resources (Amati and Yokohari 2006; Jun and Kim 2017). The greenbelt appeared firstly in 1890s being related to Ebenezer Howard's garden city scheme in the United Kingdom (UK) (Howard 1898, 2007). It was considered as a solution for the urban growth and sprawl, and the concept was adopted post-1945 in cities from North America, New Zealand and Australia, but mainly in Europe and Asia (Amati 2008a, Yokohari et al. 2000).

The greenbelt concept was intended mainly 'to preserve the integrity of the built-up areas on one side of it and the countryside on the other' (Shoard 2002). However, it ignored aspects as new urban developments will divert elsewhere, for example, beyond the greenbelt, leading to 'leap-frogging' (Seoul, Korea); it also has a social impact on communities by stimulating growth of satellite towns and favouring middle-class commuters and high income groups who can more easily afford the rising property prices (Cloke 1983; Jun and Kim 2017). Many more studies show the greenbelt did not stop the built-up area expansion in non-building zones and had ineffective influence in controlling urban growth outside of it (Taylor et al. 1995; Yokohari et al. 2000; Yang and Jinxing 2007). Moreover, the case of Hong Kong greenbelt shows that it is a transition zone rather than a zone for conservation (Tang et al. 2007).

The greenbelt is also a place for recreational activities; contribute to ecological benefits such as air pollution reduction, flood control and conservation of wildlife habitat (Kahn and Abbasi 2000; Hong and Guo 2017; Yokohari et al. 2000).

Nowadays local authorities of England allege that implementation of greenbelt does not guarantee the quality of the landscape and additional measures need to be taken (Gant et al. 2011). However, in Germany the greenbelts are among the best-known regional planning policies designated for 60% of regional plans. In contrast to many other countries, they are not implemented only in densely populated areas with high growth pressures, but also in some rural regions. Siedentop et al. (2016) show that the greenbelt planning is efficient in the preservation of the entire open space that falls within the greenbelt, but not necessarily in growth control.

For the Asian mega-cities, the greenbelts were introduced to promote the creation of well-ordered urban areas by restricting urban expansion into surrounding rural areas. In Japan, as in many Asian countries, rice farming is one of the most important industries and greatly influences regional landscapes (Iiyama et al. 2005). After post-Second World War, the economic changes from manufacturing to service sector-orientated pattern (Osada 2003) influenced dramatically the urban development and in particular, the outskirts. Below is present a brief description of the Hiroshima City Region greenbelt.

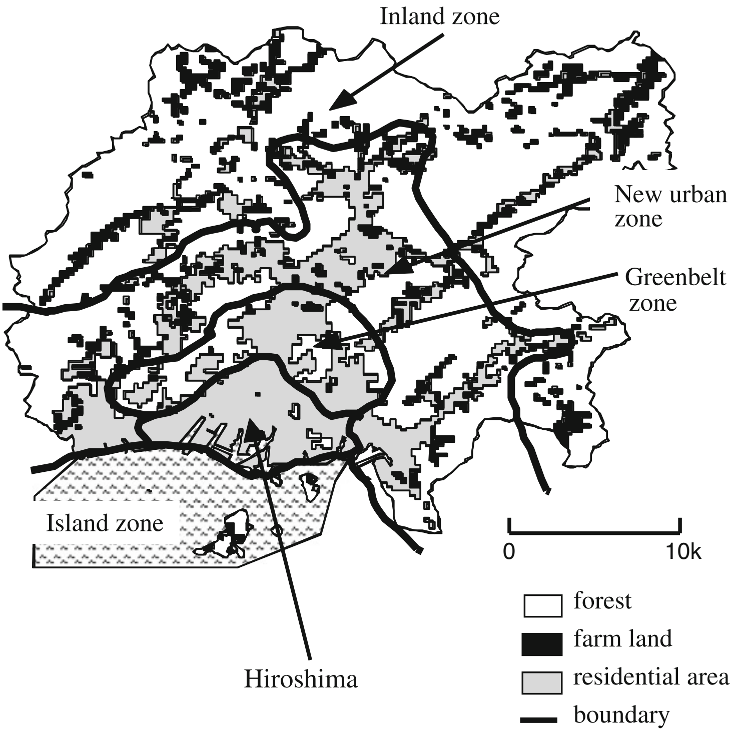

Fig. 1 Location of study area

2.1 Case Study of the Greenbelt of Hiroshima City Region, Japan

The city of Hiroshima is very well known for the atomic bomb catastrophe in 1945 at the end of Second World War. The Hiroshima City (34° 23′N, 132° 27′E) is the 13th urbanized cities of Japan and has a population of about 1.1 million on 741 km^2 of territory. It makes Hiroshima the largest city in the Chugoku District of western Honshu. Hiroshima area was classified into five zones: Inland zone, New urban zone, Aogakiyama (the greenbelt) zone, Delta urban zone, and Island zone (Fig. 1).

In the 1960s, the surrounding area of the city was characterized by a rural landscape. Later, due to re-building phase of the post-Second World War, the area was transformed from an agriculture landscape to an urbanized landscape.[1] Figure 2 illustrates the dynamics of land use of Hiroshima greenbelt.

During the 1968–1988 period, the greatest changes of land uses for Hiroshima greenbelt were in rice areas, of which 25% were converted into residential areas

[1]Details can be found in Petrov and Nakagoshi (2003)

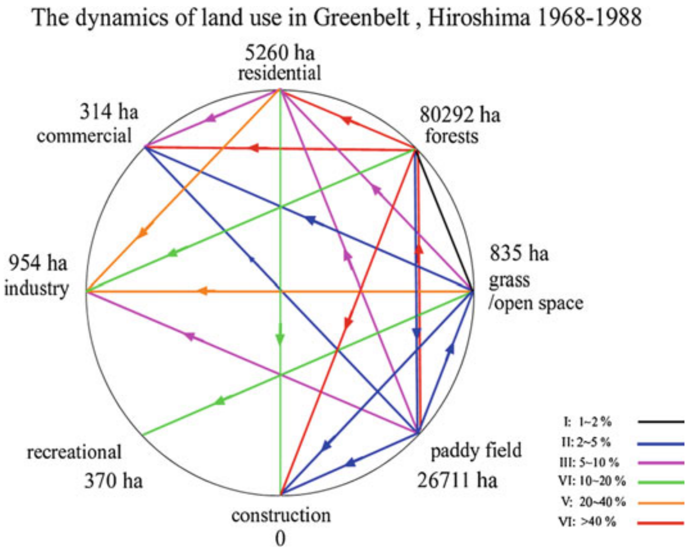

Fig. 2 Dynamics of land use in greenbelt, Hiroshima 1968–1988

while of the total forest areas only 6.3% were changed into residential. Orchards and grassland areas changed about 24 and 14% of the total area, respectively, into residential areas. Furthermore about 50% of the commercial, industrial, open space and park areas turned into residential areas. Thinking of the fragmentation of greenery space (forest, grassland, rice field, park, etc.) over this period, the results show that the forest patches were not fragmented as significantly as the agricultural land. Also, the number of park areas less than 1 ha explosively increased (detailed figures and tables are not shown[2]).

3 The Peri-Urban Area: Neither Urban nor Rural

The Council of Europe defined the peri-urban as a transition area moving from strictly rural to urban (CEMAT 2007). Peri-urban areas are dynamic zones not yet restrained by suburban or inner-city planning and legislation. They comprise an unbalanced mixture of urban and rural functions. Peri-urban areas are multifunctional and interrelated zones with continuous potential for change. The peri-urban areas as defined in the PLUREL project (2007–2010) contain built-up residential, industrial and commercial areas, and dense transport networks as well as can include in some places greenbelts, recreational facilities, urban woodlands, forested hills,

[2]Details can be found in Petrov and Nakagoshi (2003)

preserved woodlands, prime agricultural lands and important wetlands, etc. (Sullivan and Lovell 2006; Haase et al. 2010).

Salem (2015) shows that there are a lot of terminologies used for describing the peri-urban zones. For example, Pryor (1969) used the term 'rural–urban fringe', Kombe (2005) used the term 'peri-urban areas', Simon (2008) used the term 'peri-urban fringe', McGee (1991) used the term 'desakota regions', and Allen (2003) used the term 'peri-urban interface', while Bryant et al. (1982) used the term 'Urban Shadow' to describe the end of this zone.

The peri-urban areas have been traditionally approached from an urban planning perspective as the terrain for urban sprawl, the favoured location for regional and trans-regional infrastructures (Couch et al. 2007; Huang et al. 2009) and a good location for some tertiary sector structures (e.g. outlets, office parks, logistics). As a result of this planning practice, land use for agricultural production has been declining (van Eupen et al. 2012). However, this urban–rural interface cannot be understood simply in spatial terms, but rather more broadly as an array of networks connecting urban agents and rural producers (Browder 2003; Gonçalves et al. 2017).

Under the PLUREL project (www.plurel.net, 2007–2010), the Leipzig City Region, Germany was analysed, aiming to achieve a deeper understanding of the changing relationships between urban and rural land use, particularly looking at peri-urban areas in the shrinkage context (Ravetz et al. 2013). This is a representative case study concerning urban shrinkage process (Banzhaf et al. 2007; Schetke and Haase 2007).

3.1 Case Study of Leipzig City Region, Germany

Talking now about the regions across the formerly socialist east where their land use faced post-war and post-socialism, the population decline and de-industrialization are two pressing phenomena (Gross 2007). In only 10-years period, German eastern cities lost between 10 and 20% of their residents due to numerous facts such as decrease in birth rates, job-driven out-migration to other parts of the country, accompanied by a smart growth at the urban fringe/ suburbanization processes.

Looking particularly at the history of Leipzig City Region, around 1870, it was covered by 89% of arable land and forests. Between 1870 and 1940, Leipzig region evolved into a compact industrial city and on the former outskirts the number of detached and semi-detached houses increased significantly in the 1920s and 1930s. During the socialist period (1945–1989), spatial development mainly took place along the transport axes and decrease of arable and open land occurred. The Leipzig City Region faced the highest population decline and due to substantial land use change since 1990 is a representative case study concerning urban shrinkage process (Banzhaf et al. 2007; Schetke and Haase 2007). The region exhibits a complex pattern of urban development consisting in simultaneous peri-urban growth and shrinkage processes in different areas. The reasons of the shrinkage process are mainly related to three factors: a considerable level of out-migration to Western Germany just after re-unification; a massive movement from inner core city to peri-urban areas resulting in sprawl; and a decrease in birth rates and growth in death rates (Schwarz et al. 2011).

Leipzig has been supported through considerable amount of public funds since 1990, which have mobilized private investment to the city and returned Leipzig into an attractive place for services, industrial and cultural facilities (Rink et al. 2012; Grossmann et al. 2015). Associated with the economic growth started on the 2000s, the sprawl-type pattern of development of residential and commercial uses has increased considerably along the Leipzig-Halle axis (Haase et al. 2012).

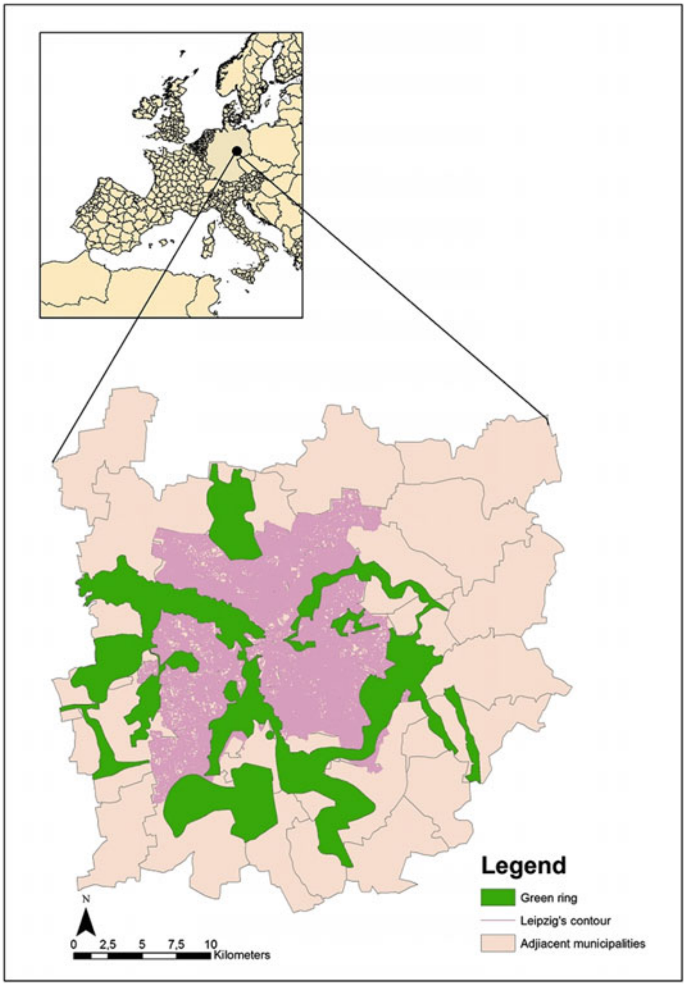

Fig. 3 Green ring of Leipzig City Region, Germany

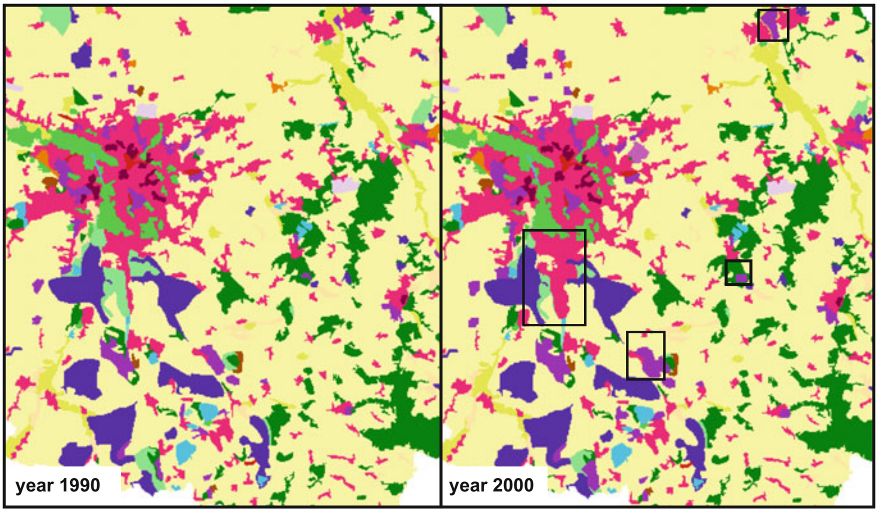

Fig. 4 Land uses of the Leipzig City and surroundings in 1990

Following the dispersal of residential and commercial development initially started in early 1990s, the ongoing loss of productive agricultural areas, natural landscape and corresponding ecosystem services is critically observable.

In 1996, Leipzig city together with 13 surrounding municipalities and counties founded the 'Green Ring Leipzig' (Fig. 3). Perceiving the negative impacts of urban sprawl after the German re-unification, planning officials in the city of Leipzig and regional authorities soon turned to primarily reserving the urban fringe for recreation, leisure, tourism, agriculture, rehabilitate and preserve the cultural landscape and biodiversity instead of further enlarging residential and commercial areas around the core cities.

The resurgence of Leipzig's inner city started in 1999 (Schwarz et al. 2011). Subsequently, population began to stabilize from 2000 onwards, considering there has been a net positive migration in the last few years. The calculation shows that between 1990 and 2000, land uses with relevant increase are the discontinuous urban areas with a growth of 104%, industrial and commercial with 136% and further construction category which had an explosive growth of approximately 454%. From the results of land use dynamics 1990–2000 (including the green ring), we can see that the future urban development of the Leipzig region is mainly governed by construction category, followed by the discontinuous urban and industrial and commercial (Fig. 4).

4 Discussion

Historically, the city and the countryside have always maintained relations of interdependence, complementing each other: the countryside produced agricultural goods while the city served as the marketplace and offered services. In the pre-war times, the agriculture was more dominant. The chaotic land use development is a production of post-war planning legislation, but also reflects the dynamic of certain components in the area that have grown as part of the complex development.

In Europe, after the Second World War, the land use change process continued to be affected by the Enlargement and the Communism fall, both a historic turning points for Europe. Their impact on economic development together with the increasing mobility, intensification of the flow of information, changes in the production process and internal market and so on, changed drastically the city–countryside relationship. In eastern Germany, the cities have undergone a substantial land use change after the Communism regime fall. The decline is accompanied by a smart growth at the urban fringe. Comparing the post-war with the post-socialist contexts, both events are characterized by a transformation period with heavy urban sprawl (Rauws 2009). In the case of Leipzig City Region, the joint coordination of regional municipalities proves the essential role of strong regional planning. It increased the readiness for shared land use planning to respond to demographic changes. It also benefited from a coordinated mix of instruments for urban–rural linkage. However, the city of Leipzig is struggling in the existing boards of regional policy for a limitation of developments in the surrounding municipalities while it has recently developed new residential neighbourhoods and industrial areas on its own periphery. An important aspect observed is that the residential areas, particularly discontinuous class plays an important role in the future land use change.

In Asian mega-cities, the peripheral zones have been pushed by urbanisation much beyond their previous extents and have spilled over into the rural villages or towns surrounding the cities. Urbanisation and growth of metropolitan regions in Asia, while showing some of the characteristics of Western urbanisation, also exhibit feature unique to Asian countries. For example, the rice farming is one of the most important industries and greatly influences regional landscape (Iiyama et al. 2005). The future of Asian urban environment can be realized by controlling the following three concerns: housing, basic services and transportation, and the greenbelt was seen as a universal solution to urban growth and sprawl. The reality in Japan, however, was considerably different because of recent land reforms, uncontrolled development and the highest post-war demand for urban housing (Amati and Parker 2007).

Even more, the Hiroshima City Region is a particular case. The atomic bomb destroyed almost all its residences and above-ground vegetation. The city government and citizens have made huge efforts to recover the greenery. In 1948, residential districts were concentrated in the central delta and farmland existed along the valley while from 1968 to 1988 due to rapid economic growth residential areas expanded and the farmlands were changed into residential areas. The land use of Hiroshima greenbelt area began to change in accordance with urbanization of Hiroshima City. The change led to creation of housing, commercial facilities, industrial areas, park and recreational areas. A significant change in the land uses of the greenbelt area had taken place from 1968 to 1988. To conclude, the character of greenbelt was transformed from a rural to an urban one. The residence development has caused of rice field and open space detriment. New areas such as schools, recreational and construction have appeared during this period. However, the forest area shows only a little fluctuation due to reforestation and strict forest protection by government.

Many projects such as greenery campaigns were leading to improvement of the greenery in the city. Greenery activities are still being conducted, but will never be terminated (Nakagoshi et al. 2006). Issues remain not only for the greenery of the city but also for outskirts (Petrov and Nakagoshi 2003) as the Hiroshima City grows, the build–up areas move outwards towards the Greenbelt. The political boundary decisions need to be made to determine continued desirability of the greenbelt (Aogakiyama) between Delta urban zone and New urban zone. Changing land uses and landscape patterns may have important ecological implication.

Reflecting on the literature mentioned above and also on the two case studies presented, two common 'behaviours' can be observed for both, the greenbelt and peri-urban area. The greenbelt is a transition zone rather than a zone for conservation (Tang et al. 2007) while within the PLUREL project the peri-urban areas are seen as 'dynamic zones with adaptive capacity, making advantage of transition processes'. Furthermore, the planning practice leads to declining the land use for agricultural production in the greenbelt of Hiroshima City Region and in the peri-urban area of Leipzig City Region. How can be understood the potential of change in both? When they coexist, how to manage them?

As a starting point, in case of the Hiroshima and Leipzig, regions were identified similar general trends of development even though the study areas are located in Asian, respectively, European contexts, one is a greenbelt and the other one is a peri-urban area, including a green ring, and also they were analysed at different times. Both study areas were dominated by arable land and forests and after the Second World War, respectively, the Communism fall the land uses evolved similarly. At present, they face the same problem of chaotic mixture of land use surrounding the city in spite of existence of greenbelt, and respectively green ring created to prevent the negative impact of urban sprawl (Table 1).

In the case of Hiroshima City Region, the focus is on the greenbelt while in the case Leipzig City Region the emphasis is on the 'transformation' of land use mixture at the fringe/peri-urban of the city. As mentioned above, the similarities can be observed between the two regions and lessons can be learnt from their experience. The creation and maintenance of a good relation between urban and rural landscape can be established in many ways. Is the Greenbelt a solution? How should we treat/manage the peri-urban areas?

From technique point of view, using a more detailed classification of residential classes, it helped to understand better the role in sprawl of each urban category,

Table 1 A comparison between Hiroshima City Region and Leipzig City Region

Characteristics	Hiroshima	Leipzig
Geography and population	Territory of 740 km^2 with a population of about 1.1 million; Hiroshima region is classified into five zones: Inland, New urban, Aogakiyama, Delta urban and Island	Territory of 297.5 km^2 with a population of about 500.000
Land use in the past	Suburban areas near the city are mainly hills, river tributaries and small river planes. In the 1960s this area was dominated by paddy fields and forests (Nakagoshi and Moriguchi 1999)	The outskirts were mainly covered by arable land and forest (Haase and Nuissl 2007)
Major events	World War II (atomic bomb)	World war II and Communism fall
Changes of land use after the major events	The atomic bomb catastrophe in 1945 destroyed downtown areas of Hiroshima city which now is completely recovered (Nakagoshi and Moriguchi 1999) Increase of population From 1968 to 1988, it was seen a significant increase in residential and commercials while from 1988 to 1995, the industrial area tripled (Petrov and Nakagoshi 2003)	After the World War II: industrialization of economy, centralization of agricultural production which led to high urbanization. Comparing to Western European cities, suburbs and satellite cities were built on a limited scale (Sagris et al. 2006). After the Communist regimes: loss of population and de-industrialization (Gross 2007); significant increase of construction class, followed by residential, commercials and industry (Petrov and Lavalle 2009)
Greenbelts	Aogakiyama, a greenery framework which surrounds the Delta urban zone. The New urban zone is characterized by housing developments and isolated open spaces. The protection of the forest in relation to urban planning is one of the problems of this zone (Nakagoshi and Moriguchi 1999). Here it can be seen a clear 'leap-frogging' phenomena Behind the New urban zone, in the Inland zone large forest areas exist around the city area	In 1996, the Green ring belt was founded by the Leipzig city together with 13 surrounding municipalities and counties
Impacts	Chaotic mixture of urban land use in the periphery (Yokohari et al. 2000; Petrov and Nakagoshi 2003)	Chaotic mixture of land use, increase of new residential and industrial areas on its own periphery (Haase and Nuissl 2007)

reflecting the dynamic of areas as part of complex or singular developments. Using policy scenarios (within the PLUREL project) helped the stakeholders to understand better how their decision will influence the future urban and regional planning and development of the Leipzig City Region. Another important aspect is that the stakeholder's focus on indicators of high relevance for their current and priority decisions as they reflect better policy and practice priorities.

5 Conclusion and Future Work

This reflection on the possible linkage/connection between greenbelt and peri-urban is done for the first time. It is a complex development within the greenbelt, respectively, the peri-urban and even more complex thinking of them together. The authors suggest here a fundamentally different perspective, new insights which can contribute to introduction of alternative spatial strategies.

What will a sustainable edge of the city (greenbelt and/or peri-urban) look like? How the stakeholders should see the coexistence between the two? What specific tools the stakeholders need?

As further work, the authors consider: extending the research to more areas (e.g. Dublin), integrating more major events (e.g. enlargement of the EU), increase the granularity of events (e.g. policies defined/implemented), defining stakeholders and their needs, and developing an overview of existing tools and their usefulness.

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Chapter 5
Developing Strategies for Landscape Sustainability: An Indonesian National Strategic Plan of Action in the Heart of Borneo

Rachmad Firdaus, Prabianto Mukti Wibowo and Yanto Rochmayanto

Abstract The activities of many governments and international organizations reflect the increasing appreciation for the value of landscape approaches which clearly demanded simultaneously protecting environment, increasing agricultural production, and improving livelihoods and represent ways to reflect the goals of sustainable development. The Heart of Borneo (HoB) initiative is a prime example of a coordinated, transboundary approach to conservation and sustainable development by three neighboring countries (Brunei Darussalam, Malaysia, and Indonesia). Then, the countries developed National Strategic Plan of Action (NSPA) for each country to establish national governance and policies. The objective is to provide understanding information for relevant stakeholders in dealing with landscape sustainability in the area of Indonesia's part of HoB. Therefore, this paper presents the values, environmental status, and challenges of the HoB development. The suggested successful keys for developing HoB landscape sustainability are also presented. This paper is merely a first step in developing and communicating suitable strategies for landscape sustainability in the HoB. The successful strategies of landscape sustainability are the process by which information is collected with a view to establishing, within a defined framework of expectations, the current status, and probable future direction of the interactions between human beings and landscapes, using certain preconditions, principles, and integrated landscape management (ILM) and its partnership.

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1 Introduction

Recently, landscape approaches have recently acquired considerable attention in the scientific literatures and international activities (Reed et al. 2017) and have been essential to some major global conservation initiatives. The approaches are gaining increasing supports at governmental and intergovernmental levels, as well as being embraced by a host of international research and development agencies. These have been implemented and tested in a wide range of environments and cultures across the globe, providing practical examples of place-based implementation which have been identified about 365 programs in Africa, Latin America, and Southeast Asia (Thaxton et al. 2015). For instance, the World Wildlife Fund (WWF) has encouraged the conservation of forests in a landscape context and has configured a significant part of its conservation portfolio into a series of Global Initiatives (Sayer et al. 2013), with case study in the landscape of HoB covering trilateral areas of Brunei Darussalam, Malaysia, and Indonesia.

Landscape dynamic has emerged as a fundamental component of global environmental change and sustainability research (Turner et al. 2007) both for basic science and applied science themes (Aspinall 2008). As a consequence, concern about the landscape sustainability is a strong motivation to better understand integrated landscape management. A landscape-based approach offers an excellent scope for the assessment and management of environmental problems (Reed et al. 2015a, b). Because sustainable landscape management is a central challenge in the context of sustainable development (Reed et al. 2015a, b), its management has to ensure human security and protect the environment from negative consequences such as ecosystem degradation, pollution, and climate change. Unfortunately, for most tropical countries, landscape approaches are still viewed from the narrow perspective of benefits to single project alone while it should be viewed in a holistic perspective (Thaxton et al. 2015). The lack of an understanding of the trends in the best practices for landscape approaches currently impedes planning processes, its management and sustainability. Therefore, this research highlights issues that require integrated principles of landscape sustainability in relation to the NSPA and provide recommendations which may contribute to the sustainability of HoB landscape. It is noted that research on developing strategies for landscape sustainability in the HoB landscape will be paramount to combating environmental degradation and better environmental resource management in tropics.

Simply put, a strategic plan is the formalized road map that describes how the implementing agency executes the chosen strategy. In the context of HoB landscape development, it provides a sense of direction and outlines measurable goals of landscape conservation. The relative priority of each strategic plan of action may differ significantly in different countries and regions depending on the regional economic agenda themselves, the natural environment or production systems involved, current management capacities, financial resources, or policies. Furthermore, to strengthen the conservation and protection of the ecological environment, comprehensive strategic planning is necessary with considerations that include balancing the social, safety, ecology, and landscape and treating the whole landscape as a landscape management unit (Reed et al. 2015a, b).

Indonesia, a developing country which is among three mega biodiversity countries in the World (Subramanian et al. 2011) and which population has grown rapidly as the fourth most populous country in the world, is among the most fragile terrestrial landscape that faces many environmental degradation including hydrological condition and the water quality (Firdaus and Nakagoshi 2013), land degradation, deforestation, and biodiversity loss (Sodhi et al. 2010). The predominance of Indonesia in tropical forest clearing accounts for 12.8% of the total forest loss (Hansen et al. 2008). As one of the Asia's last great rainforests and home to the charismatic but threatened world's biodiversity (Rautner et al. 2005), the HoB landscape was selected for this research because it is the most important landscape which encompasses the variety of ecosystems, natural communities, populations and it is a transboundary collaboration among the trilateral governments to enable conservation and sustainable development in order to minimizing deforestation, forest degradation, and the associated loss of biodiversity and ecosystem services (HoB National Working Group 2014a). Hence, region-specific information of such landscape development strategy is essential for landscape sustainability aiming at wise resource management at landscape level.

The development trends of the HoB landscape may affect the landscape sustainability. Thus, understanding HoB's strategic plan of action and its linkages to development trends is urgently needed and should be incorporated in conservation planning for sustainability. To understand the nexus, this chapter firstly explores the values, environmental status, and challenges of HoB development in HoB, Indonesia, followed by suggested successful keys for developing HoB landscape sustainability. The purpose of this study is to provide understanding information for relevant stakeholders in dealing with landscape sustainability in the area of Indonesia's part of HoB. This information is essential for any kind of natural resource management and action planning. The prior advantage of the HoB landscape study is that it is one of the most precise techniques to understand landscape dynamics that is extremely important for better landscape management.

2 Definitions

2.1 Landscape and Landscape Approaches

A landscape can refer to either spatial and ecological characteristics that help define conservation and development targets, or to governance and other social interactions and mechanisms that minimize conservation and development trade-offs (Forman 1995; Francoise and Boudry 2003). Furthermore, landscapes have been defined in several ways by multiple actors, with the aim of embedding single-sector conservation, agricultural production, and other land uses within broader landscape-scale management strategies (Reed et al. 2015a, b). Originally, landscapes can be defined as levels of organization of ecological systems which are characterized essentially by its heterogeneity and its dynamics, partly governed by human activities (Francoise and Boudry 2003). Consequently, landscapes are practicality also questioned as a result of the complexity of the associated concepts (Reed et al. 2015a, b), and in many cases, those landscapes can be defined in broad conceptual terms rather than simply as a physical space (Sayer et al. 2015).

Primarily, landscape approaches are rooted in conservation and the science of landscape ecology (Forman 1995). As a scientific approach, a landscape can be defined as a framework to integrate policy and practice for multiple competing land uses through the implementation of adaptive and integrated management systems (Reed et al. 2017). Landscape approaches have expanded prominence in the examination for solutions to resolve economic development and conservation compromises, and the term has evolved to encompass a wide variety of interpretations (Sayer et al. 2013) and provide the social-ecological systems framework (Reed et al. 2017). It means that in landscape approaches, essential natural capital is maintained by promoting the use of best practices in production, planning, and local decision-making processes to ensure the healthy provision of ecosystem services and the improvement of human well-being.

2.2 Sustainability and Landscape Sustainability

Sustainability is a dynamic concept (Bossel 1999), and it has only been recognized formally as a concept within the last half-century, with developments in contributions toward understanding the topic accelerating mainly from the late 1970s (Tuazon et al. 2013). Sustainability reveals that the subject of sustainability deals with environmental and ecological issues (Shaharir 2011) and cultural aspects (Jenkins 2003). Sustainability appears to be more complex and thus more difficult to handle concept that is connected with adaptive management, biodiversity, ecological integrity, and resilience rather than with policy, elitism, or an accent on economy (Klapka 2007). Currently, it has been estimated that some 300 definitions of ‘sustainability’ exist broadly within the domain of environmental management and the associated disciplines which link with it, either directly or indirectly (Johnston et al. 2007). Although no consensus on its emerged definition, sustainability has developed into a new paradigm (Owens 2008).

Practically, sustainability may exist in varying degrees, from weak to moderate to strong, depending on the degree of substitution of capital. Weak sustainability looks at maintaining the total capital intact, implying that different forms of capital are substitutes, at least within the boundaries of current levels of economic activity and resource endowments. Moderate sustainability requires that in addition to maintaining the total level of capital intact, some concern may be given to the composition of that capital. Strong sustainability requires maintaining individual types of capital intact, and it holds that should be absolutely protected (Jenkins 2003).

By now, it is evident that theories of sustainability have become too complex to organize with dualistic terms like strong and weak or ecocentric and anthropocentric (Jenkins 2003). The ecocentric view requires moral decisions to be taken into the account of ecological integrity advantages for its own sake, as opposed to exclusively considering human interests; on the other hand, a strong sustainability view could be held from an anthropocentric perspective by arguing that human systems depend on rich biodiversity or that human dignity requires access to natural beauty.

As a dynamic concept and a new paradigm (Owens 2008), sustainability exists broadly within the domain of environmental management and the associated disciplines which link with it, either directly or indirectly (Johnston et al. 2007) such as technical sustainability, financial sustainability, social sustainability, economic sustainability, institutional sustainability, and environmental sustainability (Saleh and Jayyousi 2008) including part of landscape sustainability such as watershed sustainability (Firdaus et al. 2014). Significant contributions from sustainability science to landscape approaches for considering and dealing with the different scales (time, space, and function), dynamics, and failures around sustainable development issues (Albert and Vargas-Moreno 2010). Therefore, as a decision-making process, sustainable landscape management should integrate and apply the most appropriate landscape management in a sustainable manner as a continuous process evolving to meet the changing need of landscape development and its sustainability (Fig. 1).

3 The Heart of Borneo: An International Initiative for Sustainable Landscape

3.1 Values and Development of HoB Landscape

The island of Borneo, the third largest island in the world, consists of Kalimantan (Indonesia), Sabah and Sarawak (Malaysia), and Brunei Darussalam covering an area of 726,000 km^2. About 30% of the island's land mass or more than 23 million hectares are situated in the center or in the middle of the island and is therefore known as the Heart of Borneo (HoB), as described in Table 1. Recognizing the value of the HoB natural capital is an essential part in encouraging such sustainable landscape development. HoB's natural values have tremendous social and economic value at local, national, and global levels including social values related to traditional knowledge and sacred sites, the values of biodiversity and ecosystems in creating resilience to a changing climate through carbon storage and sequestration, and the values of ecosystem goods and services used as inputs within multiple sectors of HoB's economy.

Home to approximately 6% of the world's biodiversity, the Heart of Borneo (HoB) is one of the earth's richest biological treasure troves (Rautner et al. 2005).

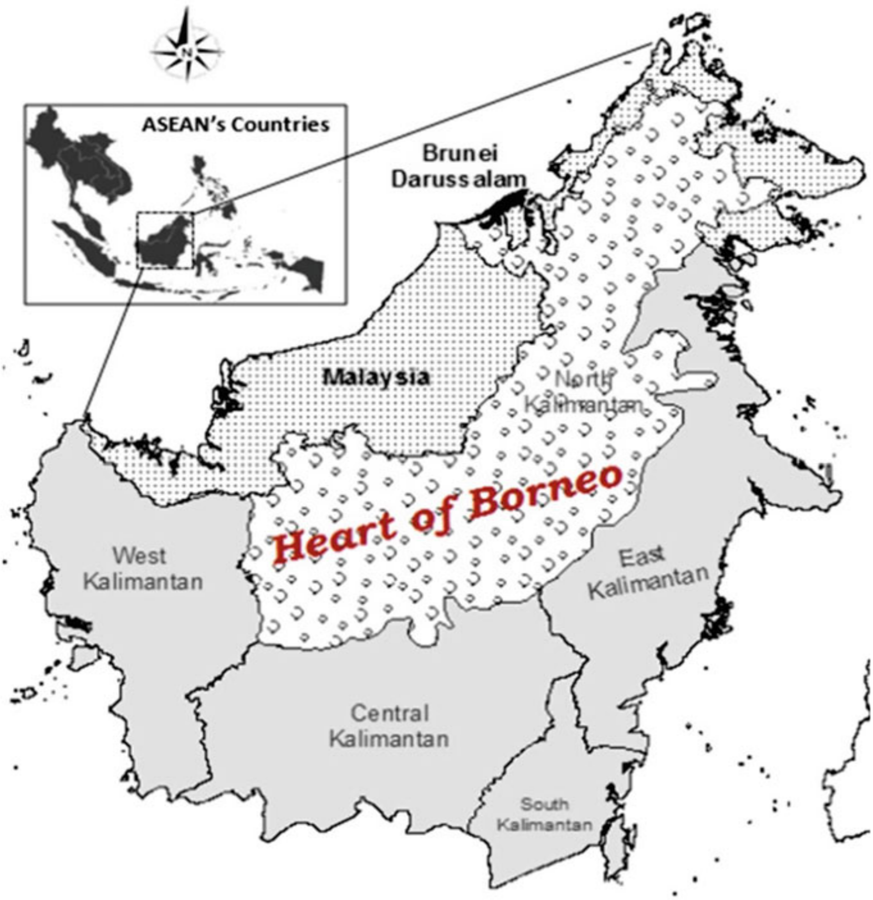

Fig. 1 Map of Heart of Borneo (HoB)

Table 1 Area and proportion of Heart of Borneo in three countries

Country/Province	Area (ha)	%
1. Indonesia (total)	16,794,300.78	72.23
1a. West Kalimantan	4,892,136.18	21.04
1b. Central Kalimantan	3,027,214.72	13.02
1c. East Kalimantan	8,874,949.88	38.17
2. Malaysia (total)	6,031,911.67	25.94
2a. Serawak	2,139,471.04	9.20
2b. Sabah	3,892,440.63	16.74
3. Brunei Darussalam (total)	424,076.66	1.82
HoB total	23,250,289.11	100.00

HoB's forests cover upstream and midstream portions of 29 river basins and provide important ecosystem services across an area of 54 million hectare, more than 70% of Borneo, benefiting over 11 million people (van Paddenburg et al. 2012). The HoB contains some of the world's most diverse forests including pygmy elephants, orangutans, rhinoceros, and clouded leopards. More than 350 species of birds, 150 reptile species, and 15,000 flowering plant species are native to Borneo's forests, as one of the planet's richest treasure troves (Rautner et al. 2005). HoB is also known for the cultural and linguistic diversity of the several ethnic groups of indigenous peoples collectively known as Dayak that directly depend on its forests for their livelihoods, food, income, water, and culture (Deavin et al. 2007).

In 2000, WWF of Malaysia and Indonesia began to work together on developing a transboundary approach to conservation on the Borneo Island. In April 2005, after years of small-scale fundraising and a great deal of networking, WWF had established an HoB project and organized a workshop in Brunei that brought together representatives of the three Bornean governments and stakeholders to seek agreement on an HoB vision. In December 2005, the ASEAN heads of government endorsed the ecological, cultural, and economic importance of HoB. In 2007, through the historic HoB declaration, the governments of Brunei Darussalam, Indonesia, and Malaysia committed to conserve and sustainably manage of contiguous 22 million hectares of tropical rainforest. It reaffirmed the commitment to develop practical programs and to create the enabling conditions required to realize inclusive and balanced development. Furthermore, the countries developed National Strategic Plan of Action (NSPA) for each country to establish national governance and policies for 2014–2019.

3.2 Environmental Status of HoB Landscape

The evaluation of environmental status of the HoB measured was measured in 2008 and 2013, respectively, using three main indicators: biological indicators, the major ecosystems and selected keystone species; threat indicators; and conservation management indicators. These assessments are used for monitoring, followed by evaluation of effectiveness and then formulation of adaptive management.

From the key of land-use status, it was found that almost 3 million hectare of the HoB is inside protected areas (national parks, nature reserves), which is 12.6% of the HoB and 17% of its forests. Conversion of natural forests into industrial plantations is the highest threat to the ecosystems of Borneo and the HoB. The total extent of timber plantations in 2012 in Borneo was 5.05 million hectare Borneo, of which 0.49 million hectare was inside the HoB. Areas that are mostly affected by conversion to plantations are lowland rainforest and peat swamp ecosystems and more than 6% of the remaining lowland rainforest is inside plantations. The total extent of palm oil plantations in 2012 in Borneo was 11.72 million hectare Borneo, of which 1.03 million hectare was inside the HoB (Wulffraat et al. 2014).

The standardized annual rate of deforestation of the HoB between 2007 and 2012 was 2.19% while for the whole of Borneo was 4.68% and mainly occurred in West Kalimantan, East Kalimantan, Central Kalimantan Sabah (Wulffraat et al. 2014). As a result, Borneo's forest fires continued to occur between 2007 and 2015 while the worst year was 2015 with 1.29 million hectare; the national 2015 fire costs Indonesia at least USD 16.1 billion (IDR 221 trillion), equivalent to 1.9% of 2015 GDP, particularly in Borneo was about USD 8.41 billion (World Bank 2016). Fires like those in 2015 are likely to make Indonesia's emissions reduction targets unattainable.

3.3 Indonesian National Strategic Planning of Action in the Heart of Borneo

The HoB Initiative is a voluntary transboundary cooperation of the three countries combining the stakeholder's interest, based on local wisdom, acknowledgement of and respect for laws, regulation, and policies of the respective countries, and taking into account relevant multilateral environmental agreements, as well as existing regional and bilateral agreements/arrangements. On April 2008, the three countries adopted the Strategic Plan of Action (SPA) of HoB as a guideline for member of country in developing National Strategic Plan of Action (NSPA) for each country. Originally, five programs were identified, namely transboundary management, protected areas management, sustainable natural resource management, ecotourism development, and capacity building. Finally, Indonesia has developed and adopted NSPA for Indonesia's Kalimantan region as the national framework for sectors, provinces, and districts, as well as for relevant stakeholders in HoB area, with the period of Indonesia's NSPA being 2015 to 2019.

The objective of the Indonesia's HoB NSPA 2015–2019 is to provide a broad but clear guidance for relevant stakeholders and key players in dealing with conservation and sustainable use of resources in the area of Indonesia's part of HoB (HoB National Working Group 2014a). There are also issues within the area under each mission of the HoB that need to be thoroughly understood and addressed in the NSPA, namely sustainable land uses, effective management of protected areas, socioeconomic welfares of local people and border areas, ecotourism development, and capacity building at all level of stakeholders.

To clearly show the power of each stakeholder against its dependency to the resources within the Heart of Borneo area, a nexus between them was described in Fig. 2 and the results were scored in Table 2. To indicate the proxy priority issues that need to be resolved or managed in the area, the stakeholders' role is plotted based on the importance of each stakeholder against the potential impacts toward the economic, social, and environment. Then, three management approaches were defined, namely intensively managed, properly managed, and monitor only. The intensively managed is defined as management that ensures positive direction and

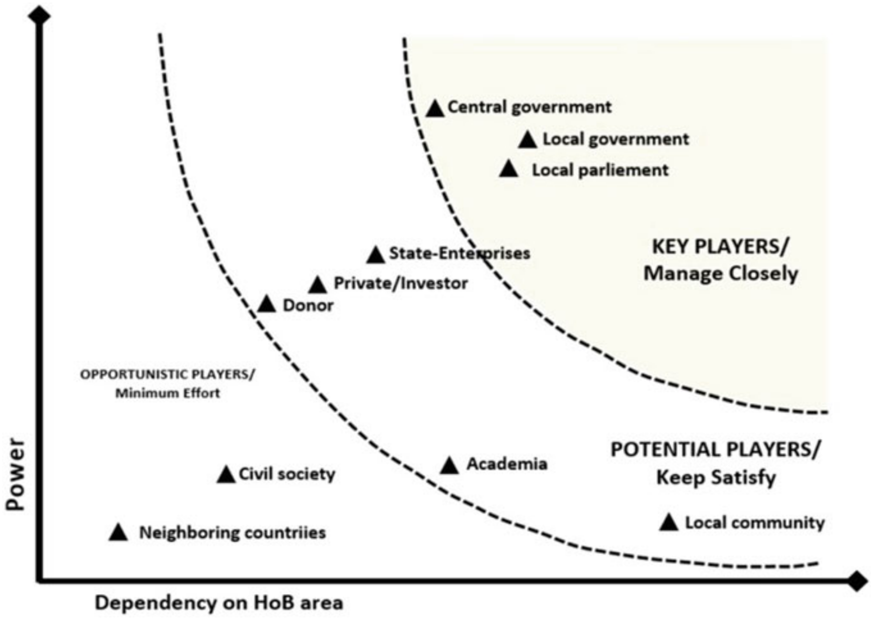

Fig. 2 Nexus between power and dependency of stakeholders in the HoB landscape

Table 2 Scores for stakeholders mapping based on power and dependency

No	Stakeholders	Scores	
		Power	Dependency
1	Central government	3	2
2	Local government	3	3
3	Local parliament	3	3
4	State-owned enterprises	2	2
5	Private companies/investors	2	2
6	Local communities	1	3
7	Academia/scientists	1	2
8	Civil societies	1	1
9	Donors	2	1
10	Neighboring countries	1	1

Scoring line high (3), moderate (2), low (1)
Source HoB National Working Group (2014a, b)

improvement of the issues within the area which eventually drive stakeholders to the same directions, e.g., the better the policy and the political will, the more attractive the area for the stakeholders. Further, the properly managed is defined as the management that follows the best practices which uphold the sustainability

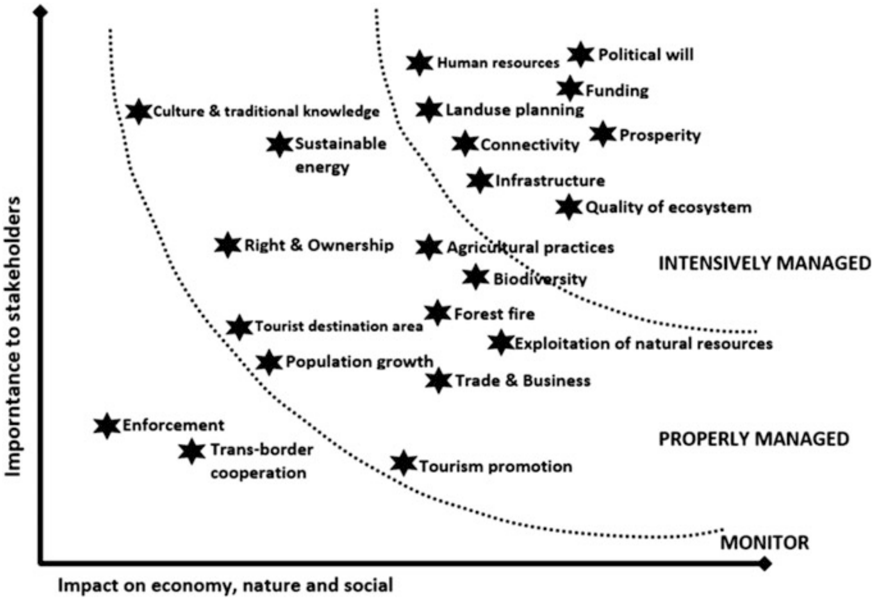

Fig. 3 Proxy priority mapping of stakeholders and their economy, nature and social impacts in the HoB landscape

principles. Monitor is defined as the management to ensure that the issues are in line with the common guidelines (Fig. 3 and Table 3).

The success and achievement of the designated programs depend entirely on the approaches of the program implementation. In the case of HoB, the live and flare—as well as the spirit of the noble idea—are in the coordination of the Coordinating Ministry of Economic Affair (CMEA). Surely, the Ministry's work should involve all stakeholders, and all stakeholders need to support and work together with the Coordinating Ministry of Economic Affairs. The key activities are coordination and integration of relevant programs under HoB framework (Fig. 4).

4 Discussion

4.1 New Challenges for Developing the HoB Landscape

4.1.1 Green Economy Opportunity in the HoB

Indonesia has been enjoying strong economic growth in recent decades and expects to maintain growth at 7% and so to move rapidly through middle-income status to reach high-income country (HIC) status in 20 years (Ministry of Finance 2015). However, there are some serious problems on this horizon that could cause

Table 3 Scores for issues mapping based on the importance of stakeholders and the socioeconomic and environmental impacts

No	Stakeholders	Scores	
		Power	Dependency
1	Agricultural practices	2	3
2	Biodiversity	2	3
3	Connectivity	3	3
4	Enforcement	1	1
5	Exploitation of natural resources	2	3
6	Funding	3	3
7	Human resources	3	3
8	Infrastructures	3	3
9	Land-use and spatial planning	3	3
10	Political will and policy	3	3
11	Prosperity	3	3
12	Quality of ecosystem	3	3
13	Transborder cooperation	1	1
14	Forest fire	2	3
15	Right and ownership of resources	2	2
16	Trade and business	2	3
17	Tourism/ecotourism promotion	1	2
18	Tourist-designated areas	2	2
19	Culture and traditional knowledge	3	1
20	Sustainable energy	2	3
21	Population growth	2	2

Scoring line high (3), moderate (2), low (1)
Source HoB National Working Group (2014a, b)

significant loss and damage, both to the country's natural resources and to economic growth and infrastructure, which would result in significant reduction in economic growth and major delays in achieving HIC status. Indonesia's impressive record on economic growth is vulnerable to environmental risks associated with climate change and the losses, degradation, and increasing damage to its natural resources.

Although the HoB plays a very vital role in the context of regional and global ecosystems, natural resources in this area have been exploited at an alarming rate (Johnson 2012). This unsustainable development has given rise to quite significant social and ecosystem costs for people and the environment. Some of the adverse impacts afflicted by this unsustainable development are declining services of the watersheds, seawater intrusion, and declining supply of water, water pollution caused by industrial discharges, increased frequency of flooding, increased or high

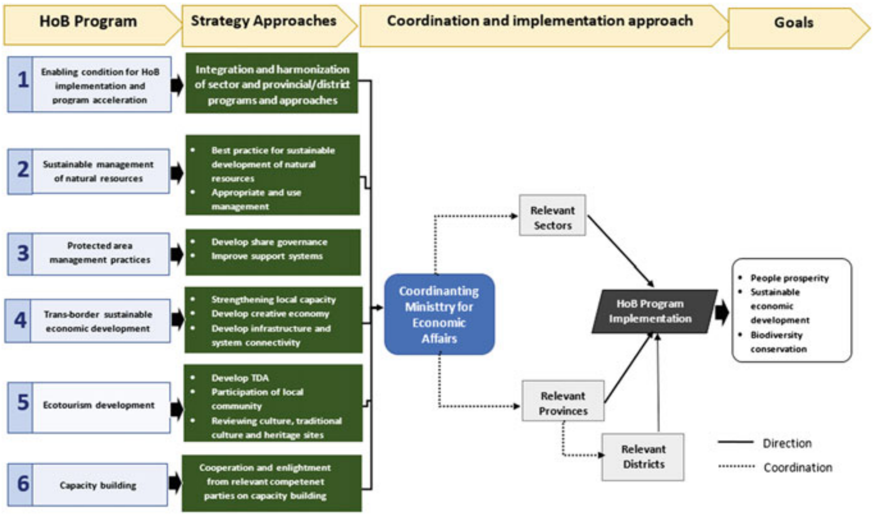

Fig. 4 Strategic and implementation approaches of HoB programs

sedimentation rate in some rivers in Kalimantan, burn-offs for land-clearing purposes (Rautner et al. 2005; Nieuwkamer 2011; van Paddenburg et al. 2012). It is mainly because, for few decades, the emphasis of Indonesia's development has been predominantly placed on economic growth through the exploitation of natural resources such as mineral resources/deposits and forests, without taking into account the intrinsic value of natural resources and environmental services. The values and roles of ecosystems, the environmental services they provide, and their contribution to people's welfare in a broader context are often overlooked as development indicators are measured solely by economic growth and Gross Domestic Product (HoB National Working Group 2014b).

A good way to make the interaction of natural capital and economic systems become more sustainable is to apply the principles of green economy—a culmination of a process seeking a formula to measure sustainable development—in economic sectors, particularly in sectors that have a major impact on people's welfare. The green economy approach is chosen for economic development strategies because it is in line with the principles of Sustainable Development Goals (SDGs). To encourage the development of green economy, there are several policy instruments that are currently being developed including spatial plan policy and spatial use within the HoB and the green economy instruments that are related to development planning, and financing and budgeting instruments.

Given the negative impacts inflicted by business activities and communities on the forest cover in the HoB, it is necessary to have an integrated policy package to preserve the HoB. The package must be based on a green economy mind-set and address the root problems in the region. Providing incentives to a community-based economy will also help greening the economy on a smaller scale and at the same time reducing pressure on natural capital and the environment. The last mechanism, which would also help develop the economy and natural capital sustainably, is to stimulate or trigger the financial sector to help develop a healthier ecosystem through green financing and fiscal sector reforms that put more priority on environmentally friendly investments. This mechanism also needs to be supported by strong institutions whose mission is clearly associated with the development of green investments in both upstream and downstream sectors.

4.1.2 Linking Sustainable Development Goals (SDGs) Through HoB Landscape Management

With its 17 sustainable development goals (SDGs), the United Nations adopted the 2030 Sustainable Development Agenda that will universally mark a momentous opportunity to catalyze new and innovative efforts to improve human well-being and social equity in line with conserving vital ecological functions (Thaxton et al. 2015). In this agreement, landscape approaches should become a prism for and a fundamental means of implementation of the Sustainable Development Goals.

In order to achieve long-term economic, environmental, and social goals, sustainable landscape management offers specific advantages for meeting SGDs, namely (1) generates solutions that achieve multiple objectives such as a cross-sector program for watershed restoration can spur economic activity, improve agricultural productivity, foster biodiversity, and contribute to climate change mitigation and adaptation, as well as improve water availability and quality and thus help enhance the health conditions of the entire population, (2) improves intersectoral coordination and cost-effectiveness at multiple levels, (3) empowers communities through multi-stakeholder processes and inclusive governance through participatory and collaborative process of all stakeholders in decision making and management of natural resources, agricultural lands, biological diversity, and culturally important resources, (4) enhances transboundary and regional cooperation because sustainable landscape management considers ecological connectivity, economic cooperation, and labor migration all in one framework, (5) contributes to national and regional strategies for addressing climate change. By bridging science, practice, and policy, sustainably managed landscapes can achieve mitigation, adaptation, and agricultural production objectives while ensuring environmental sustainability.

Considering the nexus between landscape and the urgency to achieve SDGs simultaneously, a crosscutting integrated landscape target offers a mechanism by which the international community can implement such interrelated SDGs, because such a target fits well within any number of proposed SDGs and provides clear guidance for countries, as they examine the interrelationships and impacts across all of the goals and then seek to implement integrated approaches to these interconnected challenges. Simply put, the landscape target offers a mechanism by which the international community can most effectively and efficiently implement interrelated SDGs.

4.2 Successful Keys for Developing HoB Landscape

4.2.1 Key Principles of Landscape Approaches for HoB Landscape Sustainability

Interventions in landscape inevitably affect biodiversity, so sustainability in the context of conserving landscape must be considered in relation to the goals of a landscape management plan. The first requirement for sustainability is therefore the existence of an articulated management plan. Landscape approaches provide tools and concepts for allocating and managing landscape to achieve integrated landscape development goals. Sayer et al. (2015) suggested ten preconditions which must be fulfilled if landscape approaches are to succeed: (1) inspired leadership is essential, (2) long-term adaptive commitment is required, (3) facilitation is necessary but not sufficient to achieve landscape-scale outcomes, (4) value propositions will motivate engagement, (5) conflict and entrenched views must be openly addressed, (6) strong systemic governance is essential, (7) private sector engagement is a key element of success, (8) policies without budgets and implementation commitments do not work, (9) formalization and monitoring of process outcomes are eventually needed, and (10) metrics must be developed to establish values, track progress, and enable adaptive management.

Furthermore, Sayer et al. (2013) suggested ten key principles to guide the process of decision making and to support implementation of landscape approaches that can be gradually linked and implemented for landscape sustainability in the Heart of Borneo. The principles represent the consensus opinion of a significant number of major actors on how agricultural production and environmental conservation can best be integrated at a landscape level: (1) as landscape processes are dynamic, the first principle should continually learn and practice an adaptive and collaborative landscape management, (2) building the trust among stakeholders that have different values, beliefs, and objectives; so landscape negotiations should achieve consensus on overarching stakeholder objectives, (3) addressing multiple scale issues because numerous system influences and feedbacks affect management outcomes at any scales including feedback, synergies, flows, interactions, and time lags, as well as external drivers and demands, (4) providing multiple values, purposes, and services, trade-offs existing among them need to be reconciled and managed, (5) addressing and governing conflicts and issues of trust and power among multi-stakeholders, (6) in terms of negotiation and transparency, all stakeholders need to understand and accept the general logic, legitimacy, and justification for a course of action and to be aware of the risks and uncertainties, (7) clarifying rights and responsibilities can be the core business of landscape resource management stakeholders, (8) generating and integrating the information and participation all stakeholders, (9) system-level resilience that can be increased through an active recognition of threats and vulnerabilities should be well understood in every situation through local learning and drawing lessons from elsewhere, (10) since the complex and changing nature of landscape processes requires competent and effective representation and institutions that are able to engage with all the issues raised by the process, it is important to improve stakeholders' capacity and responsibility, individually or society group.

The above preconditions probably also apply to HoB landscape to mediating conservation and development trade-offs—for instance in implementing the HoB national strategies. Perhaps in general, these preconditions are applicable to any attempt to secure vibrant and sustainable rural livelihoods and to achieve a balance between conservation and other development objectives. The principles will provide a normative basis for the landscape approach in the HoB and enable it to be applied in a more consistent way. This will allow the multiple benefits for all multi-stakeholders while managing the nexus of economy, conservation, and socio-culture. Furthermore, the principles need to be taken into account in reforming resource management of country members.

4.2.2 Integrated Landscape Management for Sustainable HoB Landscape Management

Achieving the SDGs will require support from international community to resist the business-as-usual single-sector and soloed approach to development. This provides the opportunity to achieve coherence in policies and actions across all levels and scales, from local to global. It means that collaborative planning and action at landscape scale in particular is an essential foundation for maximizing synergies across multiple sectors. Systematic mechanisms for learning and negotiation among stakeholders and deliberate efforts to reduce trade-offs and enhance synergies are imperative to ensure sufficient natural resources to meet the SDGs Goals.

Because of these inter-linkages and the complexity and interrelated nature of local needs and current global challenges, HoB as a prime example of a coordinated, transboundary approach to conservation and sustainable development by three neighboring countries' sustainable landscape management can play and contribute significantly to implementing the SDGs. Five key features characterize ILM which facilitate the achievement of multiple SDGs: (1) shared or agreed upon management objectives that encompass multiple benefits from the landscape, (2) practices that are designed to contribute to multiple objectives, (3) management of ecological, social, and economic interactions for the realization of positive synergies and the mitigation of negative trade-offs, (4) collaborative, community-engaged planning, management, and monitoring processes, and (5) the re-configuration of markets and public policies to achieve diverse landscape objectives.

Furthermore, ILM can play a key role in coordinating finance for landscape investment. Importantly, ILM provides a stable and long-term system of landscape governance, which helps create resilient institutional arrangements, decision-making processes, and underlying values in which multiple actors can pursue their individual and shared interests. An effective ILM facilitates collaborative stakeholder management and dialogue throughout the initiation, negotiation, planning, and monitoring processes. Ensuring the effectiveness and ongoing reliability of stakeholder management requires structuring local institutions and agreements to support and perpetuate community and stakeholder empowerment (Thaxton et al. 2015; Reed et al. 2015a, b).

5 Conclusion

Reviews of landscape approaches to develop HoB NSPA have revealed that this is still very much a work in progress. The NSPA of HoB Indonesia 2015–2019 tried to emphasize an adaptive management, stakeholder involvement, and multiple objectives. Various constraints are recognized, with institutional and governance concerns identified as the most severe obstacles to implementation. The dynamic complexity of Borneo tropical landscapes, stakeholders, power, and dependency means that it is not feasible to develop trilateral NSPAs that are globally relevant. It means that NSPA of HoB Indonesia constantly can be evaluated by the current practices and the most appropriate landscape management tools in a sustainable manner. The application of landscape principles might eventually lead to a spatial plan accepted by stakeholders, but landscapes are constantly changing under the influence of multiple drivers and landscape blueprints appear to be the exception rather than the rule (Sayer et al. 2015).

The successful strategies of landscape development in the context of sustainable landscape management are the process by which information is collected with a view to establishing, within a defined framework of expectations, the current status and probable future direction of the interactions between human beings and landscapes, using certain preconditions (Sayer et al. 2015), principles (Sayer et al. 2013), and integrated landscape management and its partnership (Thaxton et al. 2015). The NSPA can thus be seen as an important step in a process that describes as cycling through initial disorientation, reorientation, or choice, toward a solution or decision and suitable way to implementing actions. For tropical landscapes like the HoB, the landscape sustainability can be achieved by implementing sustainability principles of landscape approaches and developing landscape partnerships NSPA and its technical policies.

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Part II
System Management and Conservation

Chapter 6
Satoyama Landscape of Japan—Past, Present, and Future

Mahito Kamada

Abstract *Satoyama* landscape is expressed as vegetation mosaic composed of different successional stages, such as cropland, grassland, and pine and oak forests in different growth phase. The mosaic structure was dynamically sustained by use of natural resources with periodical cutting, under local rule for sharing resources without exhaustion. It is said, therefore, that *Satoyama* landscape represents people's life harmonized with nature. The landscape, however, drastically changed due to the socioeconomic change of Japan, in relation to rapid economic growth from 1955 to 1975. Since people moved from rural to urban area for getting jobs in the period, wide area of *Satoyama* at urban fringe was developed to housing estate. Materials for daily life, such as domestic fuel, fertilizer for crops, timber, were changed from natural resources collected from *Satoyama* to those of chemical and/or imported ones. Disuse of natural resources allowed vegetation to progress natural succession, and caused a change of *Satoyama* landscape from mosaic into monotonous one, and then spread of pine and oak wilt diseases. Explosive increase in Shika deer population and extreme expansion of bamboo forests have seriously damaged to *Satoyama* ecosystems. These challenges represent change into people's life disharmonized with nature. Activities for restoring and utilizing *Satoyama* have newly arisen in different regions. In urban and urban fringe areas, NPOs and other volunteers outside the area have formed theme community and taken a core role in improving supplying services of *Satoyama* ecosystems with getting cultural services. In the depopulating mountainous area with less volunteer power, social system for getting domestic energy and for circulating economy in the area has built to make an incentive of *Satoyama* restoration for community member, such as forest owners, forest owner's cooperative and store managers, under a management of NPO. The trial is to improve supporting services by getting provisioning services from the *Satoyama* forest. In every region, NPO is the key not only for player but also for producer and manager of the activities.

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1 Introduction—*Satoyama* as Representative of Entity of People's Life in Japan

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 (Duraiappah and Nakamura 2012)" as shown in Fig. 1. It is expressed as "socio-ecological production landscape" in *Satoyama* Initiative, which was established along with CBD/COP10 to realize "society in harmony with nature, comprising human communities where the maintenance and development of socioeconomic activities align with natural processes" (Takeuchi 2009; Ministry of the Environment Japan 2010).

Satoyama landscape was formed and maintained in daily activities for sustaining people's life in each region. Studies on wood materials for structuring old houses (Nunotani and Nakao 1986; Ida et al. 2010) showed that Japanese red pine (*Pinus densiflora*) and Japanese cedar (*Cryptomeria japonica*) were commonly used as timber in all over Japan. In addition to these trees, it was revealed that beech (*Fagus crenata*), oaks (*Quercus serrata*, *Quercus crispula*), Japanese horse-chestnut (*Aesculus turbinate*), Katsura (*Cercidiphyllum japonicum*), castor aralia (*Kalopanax septemlobus*), Japanese bigleaf magnolia (*Magnolia obovate*) and Japanese lime (*Tilia japonica*) were used in cool temperate region such as at Sakae and Iiyama in Nagano Pref., Shiwa in Iwate Pref., and Tsuruga in Fukui Pref. While in warm temperate region such as at Shiiba in Miyazaki Pref. and Totsukawa in Nara Pref., evergreen oaks (*Quercus* spp.) were used. Former trees are major components in summer-green forests, and the latter are typical in evergreen forests (see Fig. 8). These results represent that local people used to cut trees from neighboring forest to build a house (Fig. 2). Roof used to be covered by grass straws (Fig. 3), which were collected from grassland around the resident. *Miscanthus sinensis* has been used in almost entire region of Japan, and *M. tinctorius*, *Sasa palmate,* and *Phragmites australis* in some regions. Grasses for feed of

Fig. 1 *Satoyama* landscape at Hakui in Ishikawa Prefecture (December 20, 2013)

Fig. 2 Materials for building the house used to be collected from *Satoyama*. Old house at Tono in Iwate Prefecture (July 2, 2013)

labor animals and materials of compost and/or mulching and firewood for cooking used to be brought from neighboring ecosystems in *Satoyama* (Fig. 4). People have made irrigation channel and control water level to put water into fields and to grow rice (Fig. 5).

As shown in those examples, local people have continuously acted to surrounding ecosystems and gotten materials for daily life. These activities are the drivers forming, maintaining and altering *Satoyama* landscape. People used to work in *Satoyama* along with phenology of living things and use natural resources not to exceed resilience of ecosystems. Rich biodiversity has kept along with people's life in the *Satoyama* landscape (Katoh et al. 2009). Those images led to ideas of *Satoyama* Initiative, harmony with nature.

However, the *Satoyama* landscape, its structure as well as function, has changed due to the socioeconomic change of Japan (Kamada and Nakagoshi 1996, 1997), and perspective for reconstructing has been required (Takeuchi et al. 2016). The chapter aims to introduce pattern and process of *Satoyama* landscape in relation to change of social demands and current trends to restore *Satoyama* landscape.

Fig. 3 Roof covered by grasses. The area, Shirakawa-go in Gifu Prefecture, has been designated as world cultural heritage (June 3, 2014)

2 Component Vegetation of *Satoyama* and Socio-ecological Systems for Sustaining the Landscape

2.1 Pine Forest

Japanese red pine (*P. densiflora*) forest is one of the main components of *Satoyama* landscape, particularly in western Japan (Nakagoshi 1988, 1995; Kamada et al. 1991). Pine forests spread rapidly from 1500 B.P. under influence of human activities, such as slash-and-burn agriculture (Tsukada 1966, 1981). From that time, pine forests have been closely connected to daily life and agriculture.

According to the study at Kitahiroshima in Hiroshima Pref. (Kamada and Nakagoshi 1990; Kamada et al. 1991), dynamic mechanism for sustaining pine forest was summarizing as Fig. 6. The pine, which is a pioneer tree species, colonizes into clear-cut area and starts to develop a forest (Type A). Oak trees

Fig. 4 **a** Grass for feed of labor horse, **b** grass for fertilizer, **c** and **d** firewood are collected from *Satoyama*. (**a** October 20, 2015, at Tono in Iwate Pref., **b** August 12, 2015, at Higashi-Iya in Tokushima Pref., **c** September 4, 2015, at Kitahiroshima in Hiroshima Pref., and **d** December 20, 2013, at Wajima in Ishikawa Pref.)

(e.g., *Q. serrata*) also grow in the maturing pine forest (Type B). When people cut and remove those oaks for using firewood and/or charcoal, young pine forest without undergrowth occurs (Type B1). When the oaks are cut and used for producing charcoal with long intervals, over 20 years, oaks can regenerate and grow in pine forest as well as pine trees, and then move to the Type C. If the long interval usage is continued, C and C1 type forests are maintained cyclically.

When cutting intervals are medium, cutting shrubs once in 5 years for firewood, C1 and C2 type forests are maintained cyclically. And when the cutting interval becomes shorter, such as once a year, retrogressive succession occurs and grass, *M. sinensis*, becomes dominant on forest floor (Type C2). If people use there for mowing site, C2 type forest is maintained persistently. Finally, matured pine forest is clearly cut to obtain timber and others, and the cycle restarts from Type A.

Fig. 5 Traditional irrigation system for rice cropping at Komatsushima in Tokushima Prefecture (April 17, 2012)

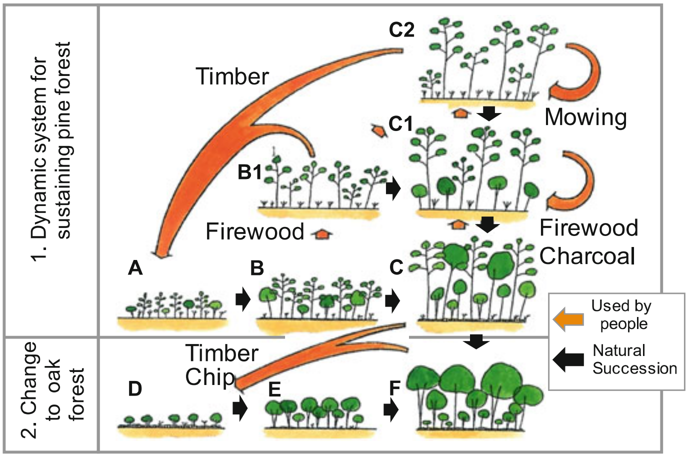

Fig. 6 Scheme of dynamic system for sustaining pine forest (Kamada et al. 1991)

2.2 Oak Forests

Evergreen and summer-green oak forests are also main components of *Satoyama* landscape as well as pine forest (Nakagoshi 1988). In northern part of Japan, summer-green oak forests of *Quercus serrata* occur at low altitude area, and those of *Q. crispula* at higher area, while evergreen oak forests occur at coastal area in southern part of Japan (Fig. 7).

Oaks have high ability of coppicing and suitable to produce charcoal (Fig. 8). Oak forests, therefore, used to be cut for producing charcoal periodically with interval of 15–25 years and regenerated by coppicing. Periodical cut used to sustain mosaic landscape dynamically.

In both pine and oak forests, people used to collect wood from their own land, and timing of cutting varied from person to person. In the situation of forested area in *Satoyama*, mosaic landscape composed of different succession stages could be maintained dynamically.

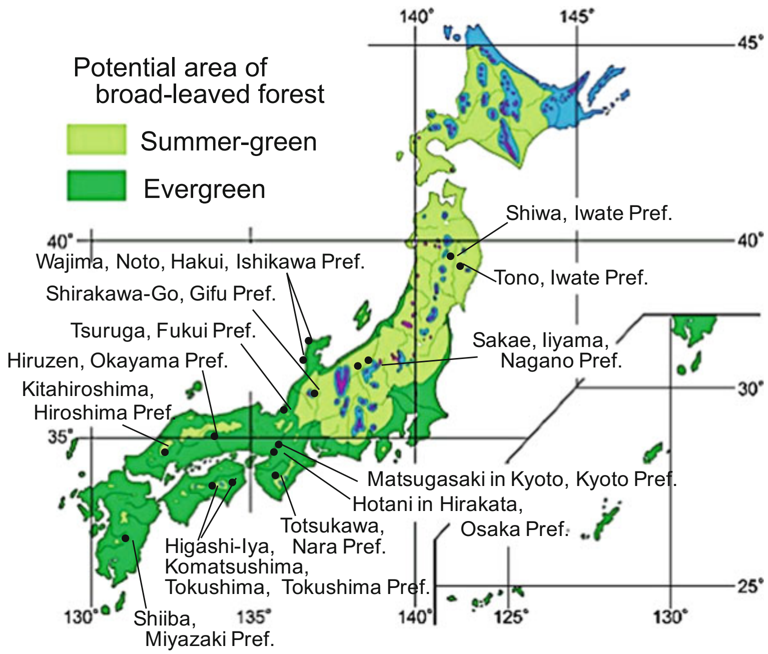

Fig. 7 Forest zone of summer-green and evergreen oaks, and places introduced in the chapter (Base map; http://gis.biodic.go.jp/webgis/sc-009.html)

Fig. 8 Oven for producing charcoal and produced charcoal (Noto in Ishikawa Pref., June 29, 2014)

2.3 Grassland

Grassland used to be a major component in *Satoyama* landscape (Fig. 9); it was kept mainly for mowing, and then meadow and pasture for labor animals such as cattle and horse. Burning was a major method for sustaining grassland in Japan.

In Higashi-Iya, which is a mountainous farm village in Tokushima Prefecture, local people had used *Miscanthus sinensis* for roofing houses and for fertilizing crops (Kamada and Nakagoshi 1997). People used to keep large grasslands (1,575 ha on average in 1960) on mountain ridge, locating from 1,200 to 1,600 m in altitude, for collecting *M. sinensis* as roof material. The grasslands were shared by community members. People used to burn the ridge every early summer to sustain the grassland, and the grass was harvested in late autumn by all households, ca. 30, of the community. Then using the grasses, a house roof was repaired by community members; one house a year in turn and thus each house could be repaired in about 30-year interval.

Fig. 9 Grassland along paddy fields for mowing grasses (Hiruzen in Okayama Pref., September 2, 2008)

While small patches of grassland (82 ha on average in 1960) were kept around crop fields on a slope in order to get *M. sinensis* for fertilizer, grass was collected at the grassland owned and managed by a household and put into the crop fields cultivated by the household.

2.4 Satoyama *Landscape as Vegetation Mosaic*

Although pattern and process of *Satoyama* landscape differ between region and region (Kamada and Nakagoshi 1996), it is common that the landscape is expressed as vegetation mosaic composed of different successional stages as shown by vegetation map of 1966 (Fig. 10). Crop fields, such as rice, wheat and vegetables, can be regarded as vegetation type covered with annual and/or biennial plants. Mowing site, meadow, and pasture are the patches of perennial grasses. Forest contains several growth phases. Land attributes, such as distance from residence, slope inclination, slope direction and soil type, are the factors for local people to determine land use type (Kamada and Nakagoshi 1997).

The mosaic structure of *Satoyama* was dynamically sustained by use of natural resources with periodical cutting, under local rule for sharing resources. The rule has been established in each region, and it has functioned to avoid "tragedy of the commons (Hardin 1968)."

However, the *Satoyama* landscape has drastically changed due to the socioeconomic change of Japan.

3 Crisis of *Satoyama* Landscape and Driving Forces

3.1 Rapid Economic Growth of Japan

After the World War II, which ended in 1945, Japan started to rehabilitate devastated land and plunged into economic growth period from 1955. Industries of steel, shipbuilding, automotive manufacturing, electric machine, chemical, petrochemical and synthetic fiber were rapidly developed. In the period until 1975, annual economic growth rate had exceeded 10% every year. The development of those industries was powered by people who moved from rural to urban areas; during the 15 years from 1960 to 1975, population of 1,533,000 moved to three metropolitan areas, Tokyo, Osaka and Nagoya. In order to accept people, wide areas of *Satoyama* were developed into housing estates, so-called new town in Japan. Expansion of urban area eliminated the landscape of *Satoyama*.

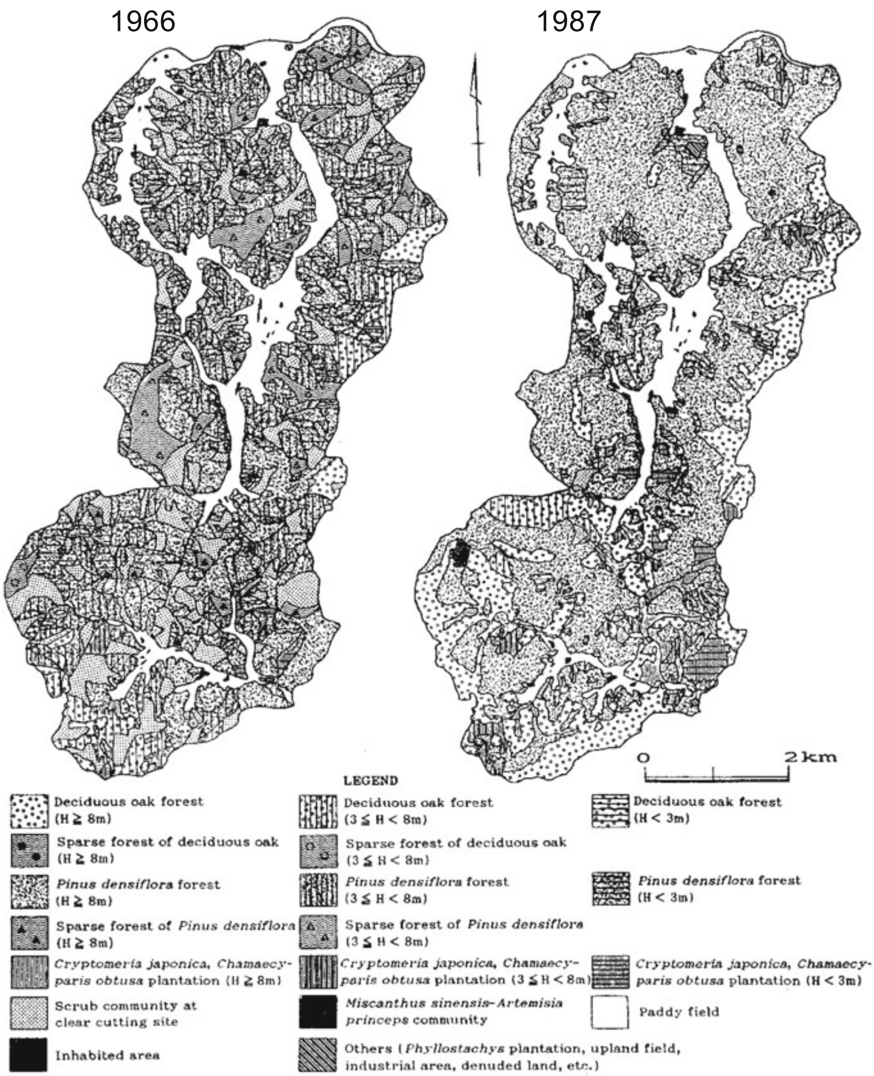

Fig. 10 Vegetation map at a part of Kitahiroshima in 1966 and 1987, during and after rapid economic growth period (Kamada and Nakagoshi 1990)

Due to increase of house construction in the period of rehabilitation and economic growth, demand for timber had increased. Japanese government, therefore, propelled afforestation policy; the government recommended rural people to plant conifer trees such as *Cryptomeria japonica* and *Chamaecyparis obtusa* as much as possible. As a result, about 40% of forested area has changed to artificial coniferous forest. In other words, the policy led to alter structure of *Satoyama* landscape.

3.2 Disuse of Natural Resources in Satoyama

In the same period, population in rural areas decreased rapidly; the number of full-time farm households was 3 million in 1950 and it decreased to 0.85 million in 1970. At the same time, materials for life as well as lifestyle drastically changed: from human and animal power to machines such as tractor and combine harvester in labor forces, from grass to tile for roofing house, from organic to chemical for fertilizer, and firewood and charcoal to gas, petroleum and electricity for domestic fuel. Amount of firewood production used to be 13,300 $\times$ 10^6 bundles in 1940, but now is almost zero (Fig. 11).

Disuse of natural resources in *Satoyama* has allowed vegetation to progress natural succession. Almost pine forest has been matured, and wide area has changed to oak forest (Fig. 12). Managed forests are few and well-developed pine forests such as Type C shown in Fig. 6 had widely occurred. In Type C forests, oak and other hardwoods can grow up and much litter is accumulated on forest floor. When these forests are felled, pine tree cannot regenerate because thick litter inhabits seeds to germinate.

While oaks can regenerate by sprouts (Type D), and very little oak coppices have been cut for charcoal production in recent Japan. Oaks, therefore, can grow to Type F successfully (Kamada et al. 1991). Thus, well-developed oak forests have increased in wide area of Japan. Pine wilt disease has killed pine trees, as mentioned later, and it has accelerated change from pine to oak forest by eliminating pine canopy from Type C forest.

In 1964, Japan started liberalization of wood trade and huge amount of wood became to be imported; population decrease in rural areas has caused shortage of labor force in forestry; and success of economic growth raised labor expenses in Japan. Thus, price of imported wood became cheaper than domestic one. As a result, wide area of forest has been abandoned and self-sufficiency rate in wood

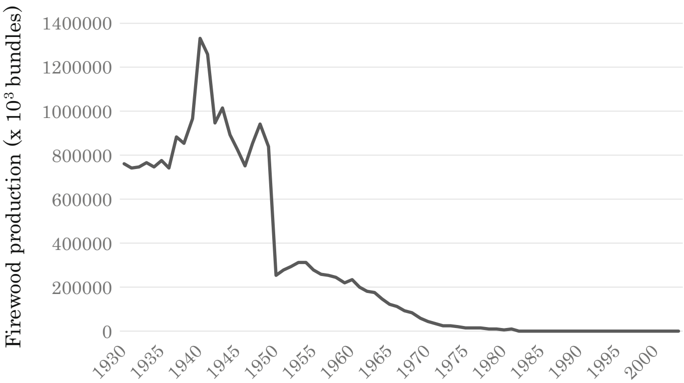

Fig. 11 Change of firewood production (Data source; Ministry of Agriculture, Forestry, and Fisheries, Japan; http://www.stat.go.jp/data/chouki/zuhyou/07-34.xls)

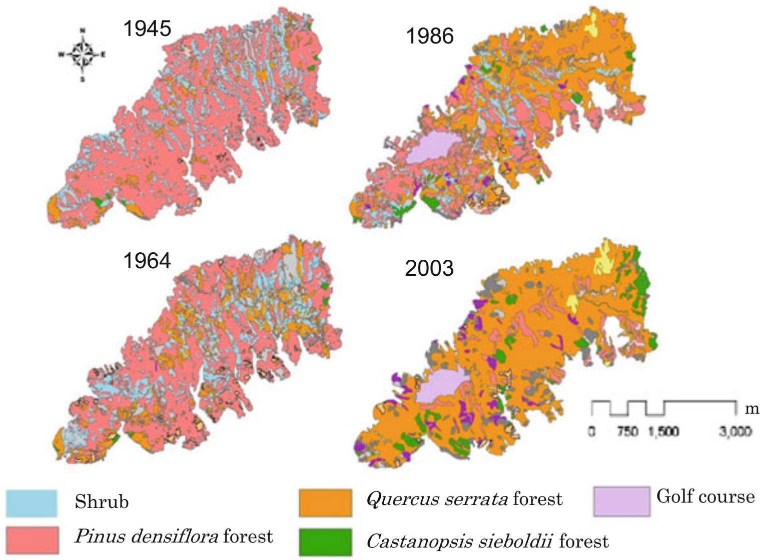

Fig. 12 Vegetation change from pine to oak forest at Mt. Bizan in Tokushima City, Tokushima Prefecture

decreased from 95% in 1955 to 28% in 2013. Globalization in relation to the economic growth has affected to the landscape of *Satoyama*.

3.3 Explosive Increase in Wildlife Population

As shown in the vegetation map in 1986 after the period of rapid economic growth (Fig. 10), mosaic structure of *Satoyama* landscape has changed into monotonous one, which is composed of well-developed pine and/or oak trees, and artificial conifer trees. Grasslands have disappeared due to replacement to mainly conifer plantation, because no grass has been necessitated for daily life. In other words, patches of early successional vegetation have disappeared from *Satoyama* and moved to late stages, and thus many species depending on early successional environments have been endangered (Kaneko et al. 2009).

Homogeneous landscape enhances disturbance if the disturbance is likely to propagate within a community such as species-specific parasite (Turner 1989). In fact, change of *Satoyama* landscape has been accelerated by pine wilt disease caused by pinewood nematode (*Bursaphelenchus xylophilus*). The nematode is carried and dispersed by Japanese pine sawyer (*Monochamus alternatus*). These pests have explosively increased their population in large area of homogeneous pine forest and blighted huge number of pine trees in Japan (Kamada et al. 1991). It has accelerated the change from pine to oak forest.

Same phenomenon has occurred in oak forests. Japanese oak wilt fungus (*Raffaelea quercivora*), which is carried and dispersed by ambrosia beetle (*Platypus quercivorus*), has attacked well-grown oaks and blighted large number of oak trees (Kuroda et al. 2012).

Outbreaks of the pests in pine and oak forests resulted from abandonment of the use of natural resources in *Satoyama*; in a situation under periodical use of woods, there was little chance for the pests to spread because infected trees were cut and removed during the activities for producing timber and/or charcoal.

Sika deer (*Cervus nippon*, including several subspecies) is explosively increasing population and expanding inhabiting area. Increase in the deer population has happened not only in rural areas but also in urbanized areas, and increased the deer population has given serious damage to *Satoyama* landscape by grazing plants on forest floor (Fig. 13).

Bamboo, mainly *Phyllostachys heterocycla* f. *pubescens*, is also the species expanding its distribution. Bamboo was planted to harvest shoots, which was important for food and cash crop for farmers. Bamboo pole was useful material for hanging crops to dry and for scaffolding. The production of bamboo shoots, however, has drastically decreased due to the import of cheap bamboo shoot from China. Bamboo pole has been replaced by steel and/or plastic. In the situation, only little farmers have managed bamboo planation, and the bamboo has become free to

Fig. 13 Disappearance of forest floor vegetation due to over-grazing by increased Sika deer population at Matsugasaki, Kyoto city in Kyoto Prefecture (photographs by K. Noda)

Fig. 14 Bamboo invasion to neighboring forest at Hotani, Hirakata City in Osaka Prefecture (April 20, 2009)

grow. The bamboo is invading into neighboring forest by stretching subterranean stem (Fig. 14).

It is predicted that the expansion will occur in wide area of Japan and cause aggravation of *Satoyama* landscape (Someya et al. 2010; Fig. 15).

Any challenges described here have been caused by rarefaction in relationship between people's life and nature that represents a current situation of people's life disharmonized with nature and will result in vanishment of tradition of Japanese culture (Berque 1986; Kamada 2016). Social system under a new paradigm, which must be suitable to the current society, is necessary to recover the harmonious relationship.

4 Movement for Reconstructing *Satoyama* Landscape in Different Geographic Regions

4.1 Urban Area—Matsugasaki in Kyoto

Matsugasaki, locates at northern fringe of downtown of Kyoto city, was a rural area in the past. Paddy fields have replaced by residence, and population in the area is increasing year by year, 7,159 (2,929/km^2) in 1990 and 8,320 (3,404/km^2) in 2010.

Part of remnant forest has used as urban park, which is owned and managed by local government of Kyoto City. Many people enjoy walking in nature and join to activities for nature observation (Fig. 16b, c). In the park, playpark has been established and open to children; children stay in the forest in creating plays by themselves (Fig. 16d, e).

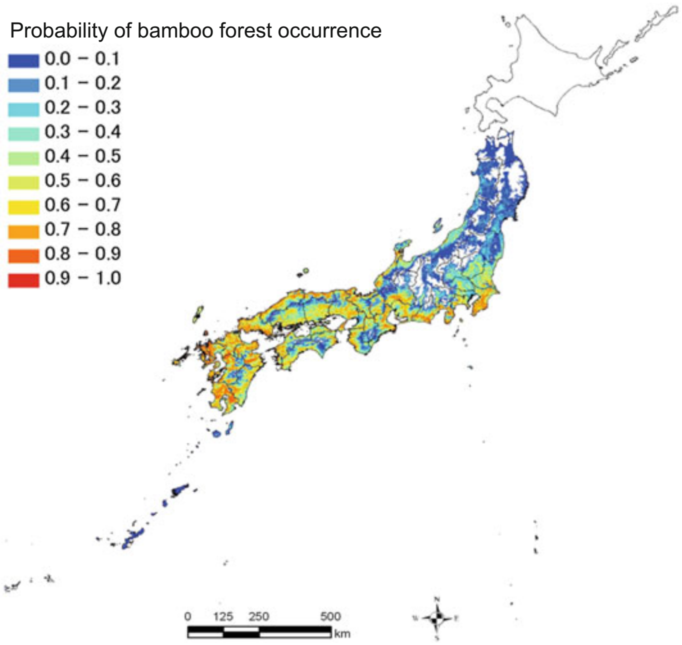

Fig. 15 Occurrence probability of bamboo forest, area with high probability has high risk of expansion (Someya et al. 2010)

For urban dweller, there is no *Satoyama* forest to go and play near their houses. Even if the forest can be found near their residence, it is not easy to play because dense shrubs grown in the forest prohibit people to enter. And thus parents, as well as school, prohibit children to go *Satoyama* forest. In addition, many young parents have no experience that played in *Satoyama* forest and do not know how to play with kids in the forest. In the situation, the playpark has become important place for children and parents, since it is safe and easy to access. Staffs in the playpark, who are the NPO (nonprofit organization) member and help to manage playpark as part-time worker, give guidance to kids how to touch with nature; the guidance includes not only fun things but also risks in the forest, which are the things learning from grandparents, parents, and elder friends if they are in traditional community. In other words, the playpark has become a center of newly formed community.

Spread of oak wilt disease and heavy grazing by increased Shika deer population, however, are damaging the forest seriously (Fig. 13). In order to restore the forest condition, the staffs of the playpark called on stakeholders to form a platform and the council was voluntarily established in cooperation with researchers in universities, officers of Kyoto city, and citizen group. In the council, ideas on measures and activities are exchanged, and goal for restoration is shared. Based on

Fig. 16 Remnant *Satoyama* forest used as urban park at Matsugasaki, Kyoto City in Kyoto Prefecture. Playpark is established in the park for children. (**a**–**c** April 7, 2013, **d** & **e** April 8, 2012)

a consensus, citizen group has started works for restoration in cooperation with researchers in universities (Fig. 17).

At the urban area, the part-time staffs of playpark, who belong to the NPO, have taken important roles: as the educator and/or storyteller, as the monitor to watch forest condition, and as the manager of platform to exchange information among different sectors and to make and share a goal.

4.2 Urban Fringe—Hotani in Hirakata City, Osaka

Hirakata city has been urbanized in accordance with economic growth of Japan; the number of household and population was 13,931 and 58,906 in 1955 and increased to 173,344 and 409,964 in 2012. A wide range of *Satoyama* landscape was altered to housing estates. Hotani area has been relieved of development, and beautiful *Satoyama* landscape has remained (Fig. 18). The landscape has been selected in the

Fig. 17 Activities for exchange information and share goal for restoration among different sectors concerned

Fig. 18 *Satoyama* landscape remaining at urban fringe, Hotani, Hirakata City in Osaka Prefecture (left, April 14, 2014; right, November 24, 2010)

Fig. 19 Voluntary work for restoring Satoyama landscape by NPO members at Hotani (November 24, 2010)

100 best *Satoyama* landscape of Japan, and thus many people visit to enjoy walking and nature observation.

Farmer's households have decreased from 79 in 1970 to 37 in 2005 and it becomes difficult to keep the landscape. Paddy fields remote from resident has been abandoned and changed to shrub, and bamboo is invading hill slope and paddy fields. (Fig. 14).

For improving the situation, NPOs have started voluntary works to maintain beautiful *Satoyama* landscape (Fig. 19). The members of the group are the people who moved from rural areas to Hirakata for getting job, and now have been retired. They feel nostalgic about *Satoyama* landscape, which is memorized as the landscape of their homeland, and want to touch with it near their home. The activities by voluntary members are the example of the trial to improve provisioning services of *Satoyama* ecosystem through getting cultural services.

Challenges in the area are an occurrence of a conflict between residential farmers and volunteers, due to the discommunication among them. Only part of residential farmers knew the volunteer groups and their purpose, and there were little chances for other residential people to know. In order to exchange and share information, a committee has been formed by an initiative of the governmental office of Osaka and the nature conservation society.

4.3 Depopulating Area—Geihoku in Kitahiroshima Town, Hiroshima

Geihoku area of Kitahiroshima town in Hiroshima Prefecture still has *Satoyama* landscape, which composed of grassland, oak forests on calm slope, and paddy fields on floodplain (Fig. 20). Population, however, is decreasing year by year, from 7,602 in 1955 to 2,490 in 2012. People have become not to use forest resources for daily life, and thus the dynamic system for sustaining *Satoyama* landscape has been lost.

Since the number of volunteers who want to work for improvement of forest conditions is little in the depopulating area in contrast with the areas of urban and urban fringe, it is necessary to establish a social system that can be operated by community members. For building restoration activities fitting to the social situation, NPO has established social system stimulating to occur autonomous flow of energy and economy in the region (Fig. 21). The system can motivate community member to participate in the activities, and it has been activated by the council formed by forest owners, store managers and NPO. This is an example of the trial to improve supporting services by getting provisioning services from the *Satoyama* forest, which has a possibility to retrieve dynamic system for sustaining *Satoyama* landscape.

Fig. 20 *Satoyama* landscape at Geihoku, Kitahiroshima in Hiroshima Prefecture (July 1, 2016)

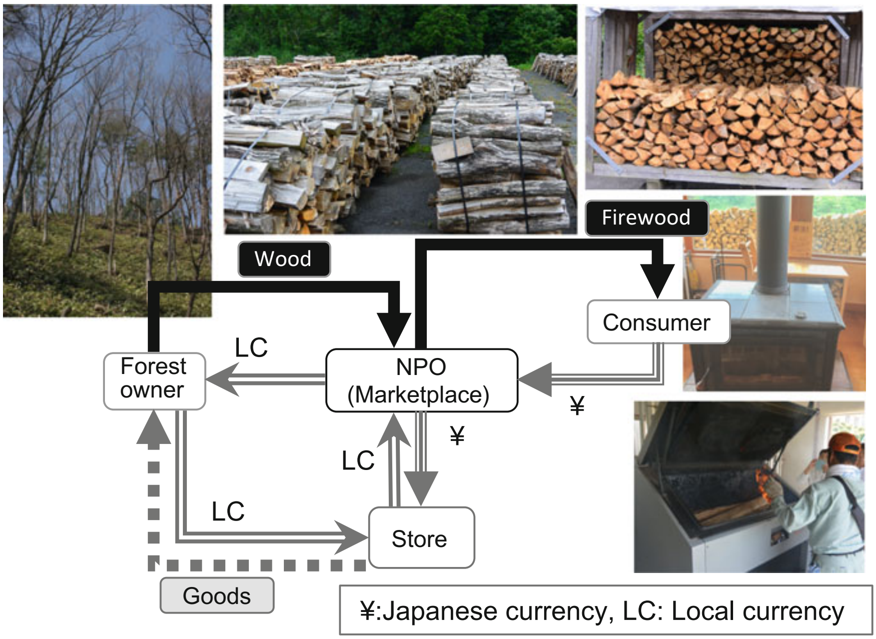

Fig. 21 Self-sufficient systems for getting domestic energy and circulating economy. The system motivates community member to participate in restoration work of *Satoyama* forest, at Geihoku in Kitahiroshima, Hiroshima Prefecture

5 Conclusions

Recent landscape of *Satoyama* represents recent life of people, which has been disharmonized with nature. In the situation, activities to retrieve the life of people harmonious with nature have started and are becoming huge movement. Participants and stakeholders are different in region-by-region (Table 1) and have changed from the period before economic growth. In the urban area, urban park has become a center for community, which has been loosely formed by urban dweller wishing to play in *Satoyama*. Another community in terms of the council has also established by stakeholders from several social sectors, under the sense of mission for giving chances to touch with nature safely to children and urban dwellers. The characteristic is that the local people who are living around the *Satoyama* have less role in decision making, because the land ownership has moved from the local community to the local government.

In the urban fringe, NPOs are voluntarily working at the private land in the traditional community, where is owned by local farmer but unmanaged. The committee composed of local people as landowner and NPOs has important role to make a decision. In a process for reconciling differences of views, equality and authority of the local government are helpful.

Table 1 Stakeholders for restoring *Satoyama* landscape in different regions

	Stakeholder					
	Local government	Land owner	Local people	NPO	Researcher	Visitor, user
Urban Matsugasaki, kyoto	●	○	△	●	●	△
Uabn fringe Hotani, Osaka	○	●		●		
Depopulating Geihoku, Hiroshima	△	●	●	●		

In the area of both urban and urban fringe, the activities for restoring and conserving *Satoyama* have been powered by urban dwellers.

Area of *Satoyama* has been decreased due to the expansion of urban area, and thus the *Satoyama* landscape has become valuable for urban dweller to be conserved. Working in the *Satoyama* itself, therefore, is the motivation for them.

The activities in depopulating mountainous area have been conducted by members of traditional community, under support of the NPO. Getting income is an incentive for the member as well as the strong wish to hold people's life in their community.

Relationship between people's life and *Satoyama* is changing in accordance with the change of social system. Things we can recognize from the three regions are that *Satoyama* has changed its domain from private to commons, and now is just the turning point moving to next phase to retrieve the life harmonious with nature by collaboration with a wide range of participants. NPO takes important roles in governance of *Satoyama* as common property: linking people/organizations concerned, creating social system, consensus building, making action, and management.

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Chapter 7
Change of Landscape and Ecosystem Services of Semi-natural Grassland in Mt. Sanbe, Shimane Prefecture, Japan

Masahito Inoue

Abstract Semi-natural grasslands existed around the country as areas for harvesting and grazing in the past. In recent years, however, the area of these grasslands has significantly reduced and now constitutes 1% or less of the national land. Moreover, the value of grasslands as landscapes and habitat areas for diverse species is currently being reconsidered. Mt. Sanbe, located in the center of the Shimane Prefecture, was previously covered with grasslands. However, this landscape has undergone significant change. In the present study, in addition to understanding the changes in the utilization of pastureland and distribution of grassland, we reorganize the value of grasslands from the perspective of ecosystem services.

1 Introduction

Semi-natural grasslands previously existed in Satoyama as areas for harvesting and grazing that were essential for the lives of the residents. In fact, this area traditionally hosted most of the seven autumnal flowers read about in the *Man'yōshū*, which are grassland-based plants. Harvesting was performed to obtain materials for cattle and horse feed, to cut and lay grass and obtain fertilizers, and to gather materials for thatched roofs and charcoal sacks. Grazing helped in reducing the labor cost for raising cattle and horses during the agricultural off-season. One of the efficient means of maintaining grasslands was burning. By introducing fire in early spring in meadows and pasturelands, the excessive growth of woody plants was prevented, and the sprouting of grass plants was further encouraged. For this reason, grasslands were considered a necessary shared resource for supporting regional

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agriculture and livestock, and they were continuously maintained and managed by the regional community (Iiguni et al. 2005).

With the dawning of the period of advanced economic growth, spread of agricultural machinery, and import of agricultural and livestock products, a significant change occurred in the situation surrounding the grasslands. As the use of agricultural machinery, such as tillers, increased, cattle and horses were no longer required. As cattle and horses were not bred in the settlements, harvesting for feed was no longer required, and the spread of chemical fertilizers led to further reduction in harvesting for obtaining green manure.

As Japan has a climate that is warm with heavy rain, there is a succession to forests, excluding high mountains, cliffy areas, and low wetlands (Miyawaki 1977). The majority of grasslands in our country have been maintained by the existence of human impact through activities such as harvesting, grazing, and burning. As these activities were reduced, the number of thick trees increased and the area covered by grasslands reduced. At the same time, the afforestation policy was formulated and many types of grassland were transformed into plantations. The grasslands that covered approximately 10% of national land area, supporting regional agriculture and livestock production (Himiyama 1995), in line with this transition have now decreased to 1% or less (Takahashi and Nakagoshi 1999; Ogura 2006).

In Mt. Sanbe, which is located in the center of the Shimane Prefecture, the mountain areas were previously covered with grasslands. Mt. Sanbe was praised for the beauty of its grasslands and the typical volcanic landforms, and the entire area was incorporated in the Daisen-Oki National Park in 1963. In recent years, there has been a significant change in this landscape owing to the attenuation of grazing, abandonment of the grasslands, and the increase in the number of trees planted. Here, we outline the changes in the utilization of pastureland and distribution of grassland in the Mt. Sanbe region. Furthermore, although the role of grasslands has diminished recently in terms of the total production area, awareness has been renewed with regard to the value of grasslands (Inoue and Takahashi 2009), and we reorganize their value in terms of ecosystem services.

2 The History of Pastureland Utilization in Mt. Sanbe

From grazing records in Mt. Sanbe, it is known that grazing was first initiated in 1643 AD (Kanei 20) as a result of the agricultural policies of the Yoshinaga Domain (Table 1). At this time, owing to the outbreak of a disease among the cattle within this domain, bulls were purchased from the Kansai area, cultivated in the Sanbe grasslands, and dispensed to the various villages within this domain (Ishimura 1984). On the other hand, Chugoku National Agricultural Experiment Station (1994) indicates that owing to the establishment of the Kumokuryo in the Taiho code in 701 AD and the various policies enacted further as part of the Engishiki, the origins of their enshrinement in the Sanbe region may have been in

Table 1 Events, pastureland, and grasslands in Mt. Sanbe

Year (Japanese calendar)		Event
1643	Kanei 20	The Yoshinaga Domain started grazing activities in Mt. Sanbe as an agricultural policy
1799	Kansei 11	A feud over harvesting rights owing to grazing in Yamaguchi village, Tsunoi village, and Shigaku village erupted between the Matsue Domain and the Omori Magistrate
1879	Meiji 12	The first competition was held on a village basis in Koyahara village, and approximately 300 cattle and horses were exhibited
1886	Meiji 19	The Hiroshima 5th Division chose the Sanbe Plateau as the location of its army exercises and started purchasing the land
1887	Meiji 20	The competition of five unions was held at Sahime village
1888	Meiji 21	Approximately 800 ha of shared land owned by Koyahara, Ikeda, Shigaku, Tane, Yamaguchi, and Tsunoi were purchased in the first period as army exercise land
1990	Meiji 33	As the first prefectural union expo held nationwide, the Chugoku five prefectural livestock expo was held in Mt. Sanbe
1910	Meiji 43	Purchase of army exercise land was complete
1949	Showa 24	The pasturelands purchased as army exercise land was sold as joint pastureland to Sahime village, Yamaguchi village, Shishi village, and Kasubuchi-cho
1952	Showa 27	Huge destruction of the sloped section (called "Oyama") in Mt. Sanbe due to heavy rain
1954	Showa 29	The peak and sloped sections of Mt. Sanbe were sold to the local forestry office. Planting of Larch started in the sloped section
1956	Showa 31	The pastureland improvement plan started from this time
1963	Showa 38	The Mt. Sanbe region was incorporated into the Daisen-Oki National Park
1969	Showa 44	In order to promote extensive grazing, the pasture establishment business was implemented and incorporated in 11 pastoral regions (293 ha; up to 1971)
1989	First year of Heisei	Burning of Nishinohara grassland was carried out by Ota City

the period between 700 and 800 AD, and grazing may have started even before the Edo period.

In terms of changes in the number of pasturage, in the early years of the Meiji era, approximately 3,000 cattle crowded the grasslands (Ishimura 1984). Furthermore, in records from the early Showa period, approximately 670 out of the 840 households in the settlements at the foot of Mt. Sanbe owned cattle, and their numbers exceeded 1,700 (Inoue and Takahashi 2009). In the early 1950s, the number of pasturage in the

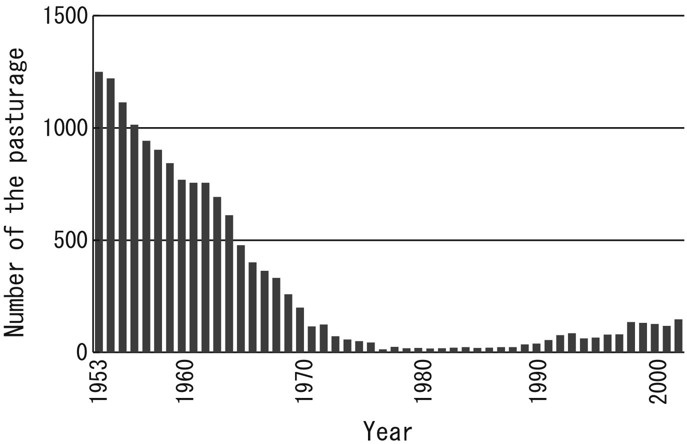

Fig. 1 Change of the number of the pasturage

Mt. Sanbe grasslands reached 1,200, but this has gradually decreased to around 100 in recent years (Fig. 1, Senda 1997; Iiguni 2009).

Against this background, with the introduction of agricultural machinery, the demand for cattle for work purposes decreased. In addition, with the spread of chemical fertilizers, the necessity of compost made from cattle and horse waste and wild grass decreased. The Mt. Sanbe grasslands were a location for obtaining cattle feed and cut and laid grass, as well as a grazing area for cattle without requiring human effort during the off-season, and thus traditionally provided support for agriculture and livestock.

Furthermore, with the change in the type of roof of people's houses from thatched to tiled, demand for thatch, as the raw material for thatched roofs, greatly decreased.

With these changes in the structure of society, there was a significant decrease in the grassland area around Mt. Sanbe. Based on past topographical maps and aerial photographs, this area was 24 km^2 around 1900 AD but decreased to 12.5 km^2 around 1950 and 3 km^2 around 2000–2009 (Fig. 2). The grassland area around 2000–2009 also included pasturelands, and thus the area covered by semi-natural grasslands was even less.

3 Changes in Ecosystem Services Related to Semi-Natural Grasslands

3.1 Changes in Supply Services

Considering the value of the various ecosystems brought about by forests and grasslands, recently, attention has been focused on the services provided to

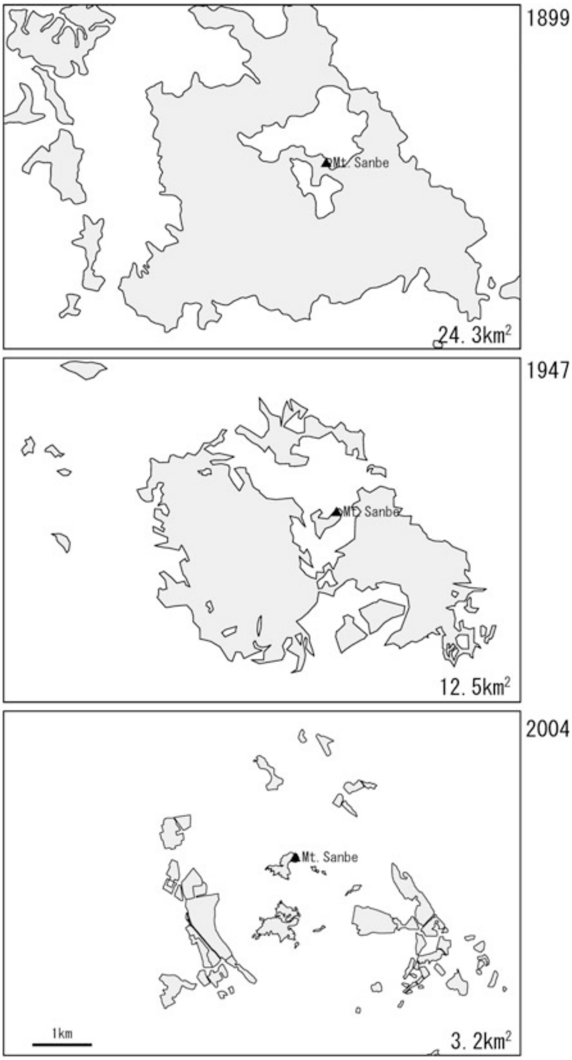

Fig. 2 Change of grassland area in Mt. Sanbe

mankind by the ecosystem, that is, ecosystem services (Yokohama National University twenty-first Century COE Translation Committee translation 2007). We compared ecosystem services provided during two periods: the one before advanced economic growth, when traditional grassland use continued, and the present day (Table 2). Until the period of advanced economic growth, when the circulation of chemical fertilizers and agricultural machinery became commonplace, these grasslands mainly provided the necessary grass resources for agriculture and livestock in the region, such as cattle and horse feed, cutting and laying grass for cattle and horses, and materials for green manure and compost for the fields. As previously described, in Mt. Sanbe, cattle were reared in majority of the settlements

Table 2 Changes of ecosystem services of the grassland

Ecosystem service	Before the period of high economic growth	Present	Notes
Supply services			
Cattle and horse feed	◎	△	Food for cattle and horses
Material for cutting and laying	◎	△	Cutting and laying in barns (used for manure after mixing with waste)
Green manure/compost materials	◎	○	Green manure for paddy fields, multi-materials
Produce/food	◎	△	Wild plants such as bracken, wild grass tea, medicinal herbs, flowers
Livestock	◎	○	
Thatch	◎	○	Material for thatched roofs
Material for biomass fuel	×	○	Use as herbaceous biomass fuel
Regulation services			
Absorption of CO_2	▲	○	Deposition of charcoal and plant residue
Water conservation	▲	○	Groundwater replenishment
Cultural services			
Customs/traditions	◎	○	Potted flowers, object of Japanese poems and Haiku, festivals
Landscapes	▲	◎	Tourist resource, tourism materials, natural parks
Area for environmental study/outdoor learning	▲	◎	
Recreation	▲	◎	Walking area, tourist resource

Symbols in the table

Supplied service: ◎ major use; ○ minor use; △ partial use; × not used
Regulation/cultural services: ◎ largely present; ○ present; ▲ exists but no awareness/perception

around the beginning of the Showa period. We know that most of the cattle feed and cutting and laying grass were obtained from the Mt. Sanbe grasslands, and its presence supported traditional agriculture and livestock. With the later drop in demand for cattle and horses, the demand for wild grass for feed and grass for cutting and laying also decreased. Combined with the decrease in the demand for compost owing to the circulation of chemical fertilizers and for materials for thatch owing to fewer thatched roofs, the demand for majority of the supply services provided here also reduced, and these services were only partially used.

The value of using grass resources from grasslands is undergoing review. Although the high demand that once existed does not exist anymore, there is a large demand for materials for roof thatches for conserving and repairing traditional thatched roofs, and high-quality materials are traded at high prices. Grass also continues to be used in fertilizers and feed. Moreover, in the Aso region, wild grass is used as a raw material for compost in the cultivation of high-quality vegetables and flowers (Otaki 2001). Considering the measures taken against global warming and the realization of an environmental society in recent years, biomass production has significantly increased, making a major contribution to herbaceous energy plants requiring a small injection of energy (Takahashi 2008; Washitani 2008).

3.2 Changes in Regulation and Cultural Services

Although regulation and cultural services existed before the period of advanced economic growth, the awareness and perception of these was low. For example, landscapes, including grasslands, are areas visited by large numbers of people for sightseeing and recreation purposes. In the case of the Aso and Kuju regions in the "Aso Kuju National Park," the Hiruzen and Oki regions, and Mt. Sanbe in the "Daisen Oki National Park," national park requirements dictate that the grassland and pastoral landscapes are interwoven. Indeed, grasslands are included in many national parks, adding natural scenic beauty. This comes to show how much this landscape is loved by Japanese people. The Aso region is visited by 19 million tourists per year, and the focus is this grandeur of grasslands. Considering the economic benefits, the total cost for maintaining the grasslands may increase to several billion yen (Table 3). Before advanced economic growth, the same or an even greater grassland landscape existed. Tourism and recreation has brought prosperity along with the "comfort" created by economic growth, and this can be said to be an example of the value that has expanded or for which awareness has grown in recent years.

Owing to the sense of release found in the grasslands, they are an excellent location for a variety of recreation activities. Nishinohara grassland in Mt. Sanbe in the Shimane Prefecture is equipped with a cross-country course that appears to weave through the grasslands. A large-scale event is held once a year at this course. The course runs through the grasslands and is very popular because of the unobstructed view and fresh atmosphere, and approximately 1500 people visit it every year (Fig. 3). At other times, it is used as a course for daily exercise and nature

Table 3 Example of the economic value of the grassland landscape

Site	Prefecture	Area (ha)	Object person	Amount of mean payment will (yen)	Number of visitors or households (thousand people)	Amount of total payment will (million yen)	Source of references
Aso	Kumamoto	23,000	Citizen of Tokyo	1493	12,000	17,920	Yabe (2001)
Aso	Kumamoto	23,000	Citizen of Kumamoto	430	594	260	Yabe (2001)
Mt. Sanbe	Shimane	2600	Visitor	6485	628	4070	Shoji et al. (1999)
Mt. Sanbe	Shimane	2600	citizen of Shimane and Hiroshima	31,818	1170	15,000	Shinbo (2001)
Osasa pastureland	Tochigi	362	–	612	1000	6120	Kato (1999)
Appi pastureland	Iwate	81	–	2230	4	9	Ohashi et al. (2001)

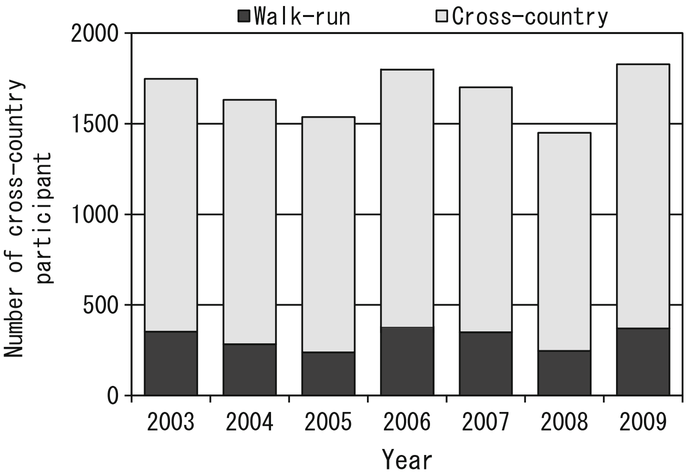

Fig. 3 Number of cross-country participant

walks. The sense of release found in the grasslands is seen as a key factor drawing a large number of people to the Mt. Sanbe course.

3.3 Grasslands as an Area for Conserving Biodiversity

It is known that grasslands house many species facing the risk of extinction. Among the plants found in the grasslands, such as *Pulsatilla cernua*, *Platycodon grandiflorus,* and *Echinops latifolius*, there are many species facing extinction throughout the country (Japanese Society for Plant Systematics 1993). Furthermore, many butterflies inhabiting these grasslands are described in the prefectural Red Data Book (Imura 2008). The grasslands in which these rare creatures and plants live are small, but have been indicated as a potential hot spot for endangered plants (Fujii 1999; Kaneko et al. 2009).

The total number of endangered plants included in the Red Data Book that inhabit both San-in region (Shimane prefecture and Tottori prefecture) amounts to one-fourth of the forestry in the Shimane Prefecture and approximately half of that in the Tottori Prefecture (Fig. 4). Using the mesh data from the Ministry of the Environment, the area of these habitats was roughly calculated. The number of grassland meshes was low in both prefectures, and the rate was less than 1%. On the other hand, the number of forest meshes was highest among the habitats, and in both prefectures, this made up approximately 70–80% of the prefectural land. Consequently, although there are a low number of endangered plants within the grasslands, the habitats make up a significantly small distribution area of these grasslands. On the contrary, in the forests, there are a large number of endangered plants, and the habitats make up a large distribution area. Considering these

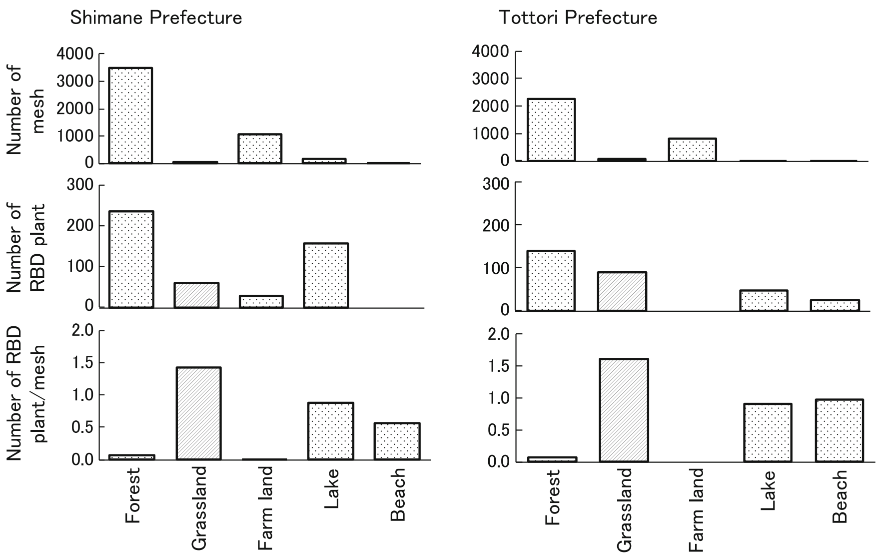

Fig. 4 Number of the endangered plants according to the growth environment in San-in region

differences in distribution area and by calculating the number of endangered species per mesh, the grasslands give the highest value. Although it cannot be said that the number of actual endangered plants is high, the number of endangered plants living in the small grassland area is clearly relatively high. In existing studies, it has been reported that grasslands are an important region as the habitat of endangered plants (Serizawa 1997; Takahashi and Nakagoshi 1999; Fujii 1999), and in this study, in addition to clarifying the same kind of trend; we provide a quantitative basis for these studies.

4 Summary

As described above, the value of grasslands habitats, including Mt. Sanbe, has changed significantly with time. It has been suggested that grasslands may attain new value in the next generation. On the other hand, to manage and maintain semi-natural grasslands, human activities such as burning and weeding are essential. There are many regions where maintenance and management has become difficult owing to the aging of the population. To resolve this problem, support for securing human labor through urban volunteers has been provided (Yamauchi and Takahashi 2002), and there has been progress in constructing new frameworks for maintaining grasslands.

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Chapter 8
Diverse Patterns of Vegetation Change after Upland Field Abandonment in Japan

Yoshinori Tokuoka and Nobukazu Nakagoshi

Abstract Vegetation changes in abandoned farmland that deviates from locally targeted states pose conservation and restoration problems in various parts of the world. Here, we review the patterns of vegetation change after upland field abandonment in Japan. Inconsistent invasiveness and weediness of exotic species such as *Phyllostachys edulis* and *Leucaena leucocephala* in rural habitats indicated that even if an exotic species is present in a focal area, its impacts on revegetation pathways vary depending on the local species pool, species recruitment order, and interspecific competition. Improved soil nutrients for crop production before abandonment decreased the presence of native grasses and forbs during early successional stages. Buried seeds and resprouting plants maintained under slash-and-burn cultivation led to the dominance of native tree species. After the recent abandonment of conventional farming in warm-temperate regions of Japan, competitive clonal native species such as a dwarf bamboo (*Pleioblastus chino*) and kudzu (*Pueraria lobata*) became dominant and limited the seedling establishment of various native tree species. The drastic decrease of grassland areas in the past century suggests that many fewer seeds of *Miscanthus sinensis*, which serves as a facilitator of various plants in grassland systems, are dispersing into abandoned fields than in the past. Studies of wildlife in abandoned farmland in Japan indicated that herbivore damage by rodents, Japanese hare, and sika deer are potent factors affecting forest recovery. These results suggest that vegetation change after upland field abandonment occurs in diverse ways, reflecting historical differences in environmental factors such as local flora and fauna, agricultural technologies and

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practices, and landscape mosaics. This implies that revegetation pathways after upland field abandonment tend toward novel states and that deterministic predictions of upland field succession will be easily violated in many cases.

1 Introduction

Farmland abandonment has been increasing globally due to socioeconomic changes and agro-environmental restrictions such as soil degradation, climate change, and desertification (Benayas et al. 2007). Old fields were a traditional focus of research on succession in various ecosystems (Rejmanek and Van Katwyk 2005). The classic model of old-field succession is the systematic shift in the dominant species from early- to mid- to late-successional species (e.g., Miller 1994; Kamijo 2011). Although this perceived trajectory has been the basis for vegetation management and restoration in many practical situations, vegetation succession of old fields deviating from an envisaged regional pathway has been reported from many regions (e.g., Cramer and Hobbs 2007). Recently, these deviated states have posed social and ecological challenges due to the implied uncertainty of the long-term biodiversity recovery process (Hobbs et al. 2006).

A variety of factors determine the pattern and rate of succession in old fields. For example, old-field succession in the northern USA is affected by the season of abandonment, last sown crops, whether the field was plowed or left fallow after abandonment, field size, and distance from forest margin, the soil environment, herbivory, seed predation, invasive plants, and climate variation (Hobbs and Walker 2007). Although the difficulty of generalizing the process of old-field succession has been recognized in various ecosystems (e.g., Keever 1983; Finegan and Delgado 2000; Hobbs and Cramer 2007), identifying the important factors that affect the rate and trends of old-field succession is necessary for vegetation management in rural landscapes.

In Japan, farmland abandonment has been increasing since the 1980s because of stagnation in the agricultural industry and aging of farmers. In 2015, the upland field area, including grassland and orchards, was 45.6% (2.05 million hectare) of the total farmland in Japan (Ministry of Agriculture, Forestry and Fisheries [MAFF] 2015). This vast area with historical anthropogenic influences is an important terrestrial environment located near residential areas, and it has a strong influence on the provisioning of various ecosystem services. With the current declining population trend in rural areas of Japan, converting some abandoned upland fields into forest ecosystems will be a cost-effective land management choice.

One of the factors determining the revegetation trajectory of an abandoned arable field is the soil moisture content. In natural flooded wetlands in cool to temperate regions of Japan, trees such as *Salix* and *Alnus* species establish in late-successional forest stands (Inoue and Nakagoshi 2001; Nakamura et al. 2002). When wet paddy fields were abandoned, those wetland tree species were recruited several years to decades after abandonment (Arita and Ohkuro 2007; Arai and

Yonebayashi 2011). However, in abandoned paddy fields where the natural soil condition was dry and fields were formerly managed with artificial irrigation, succession analogous to that of dry sites proceeds (Kaneko and Ohno 2004; Kusumoto et al. 2005; Ishizuka et al. 2011). Here, we focus mainly on succession of abandoned upland fields formerly cultivated with crops such as vegetables, beans, grains, lawn grass, and fruits.

In this chapter, nomenclature for plants follows Yonekura and Kajita (2003). We first briefly outline the history of upland agriculture in Japan. Then, various patterns of vegetation change after upland field abandonment are reviewed by focusing on the influence of exotic species, permanency of upland field use, competitive and perhaps facilitative native plants, and plant–animal interactions. Finally, we discuss the future challenges for understanding succession in abandoned upland fields and vegetation management toward the recovery of natural forest vegetation in abandoned upland fields.

2 History of Upland Agriculture and Its Abandonment in Japan

Slash-and-burn cultivation is one of the oldest agricultural practices in Japan. After the late nineteenth century, many slash-and-burn fields were converted into permanent fields and forests, but more than 10,000 ha of land were still used as slash-and-burn fields in 1950 (MAFF n.d. a). According to Sugimoto (1995), between the twelfth and fifteenth centuries, cultivation moved from shifting to permanent use of upland fields in Japan. At that time, wheat, barley, and soybean were cultivated as agricultural taxes and coarse cereals, vegetables, hemp, and cotton were cultivated as subsistence crops. In the fifteenth and sixteenth centuries, double-cropping of wheat (or barley) and soybean was established. After the seventeenth century, crops in permanent upland fields were diversified and a variety of vegetables, cotton, tobacco, and oilseed rape were commercially cultivated. Thereafter, cropping systems adapted to local environments were established by rotating various crops. In the nineteenth century, the cultivation of mulberry leaves for sericulture increased. From the late nineteenth century onward, orchards increased.

As shown in Fig. 1, beginning in the mid-nineteenth century, agricultural technologies and many crop species were imported from western countries, but subsistence farming based on the local farmers' knowledge still continued. Before World War II, most cultivation was conducted by human and animal power. Soil fertility was mainly maintained with organic manures produced by smallholders themselves and fish meal. After the turn of the twentieth century, use of commercial fertilizers such as soy meal, superphosphate, and ammonium sulfate gradually increased. After World War II, mechanization and heavy manure using chemical fertilizers proliferated across the country. Cropping systems also shifted from multi-cropping of cash crops and subsistence crops to single-cropping of commercial crops. During the economic growth in the 1970s, the primary sector of agriculture became less lucrative than secondary and tertiary sectors. Farmland abandonment has continued to increase since the 1980s. According to MAFF (n. d. a), in 2010, the abandoned farmland area in Japan was 385,791 ha (about 11% of the total farmland).

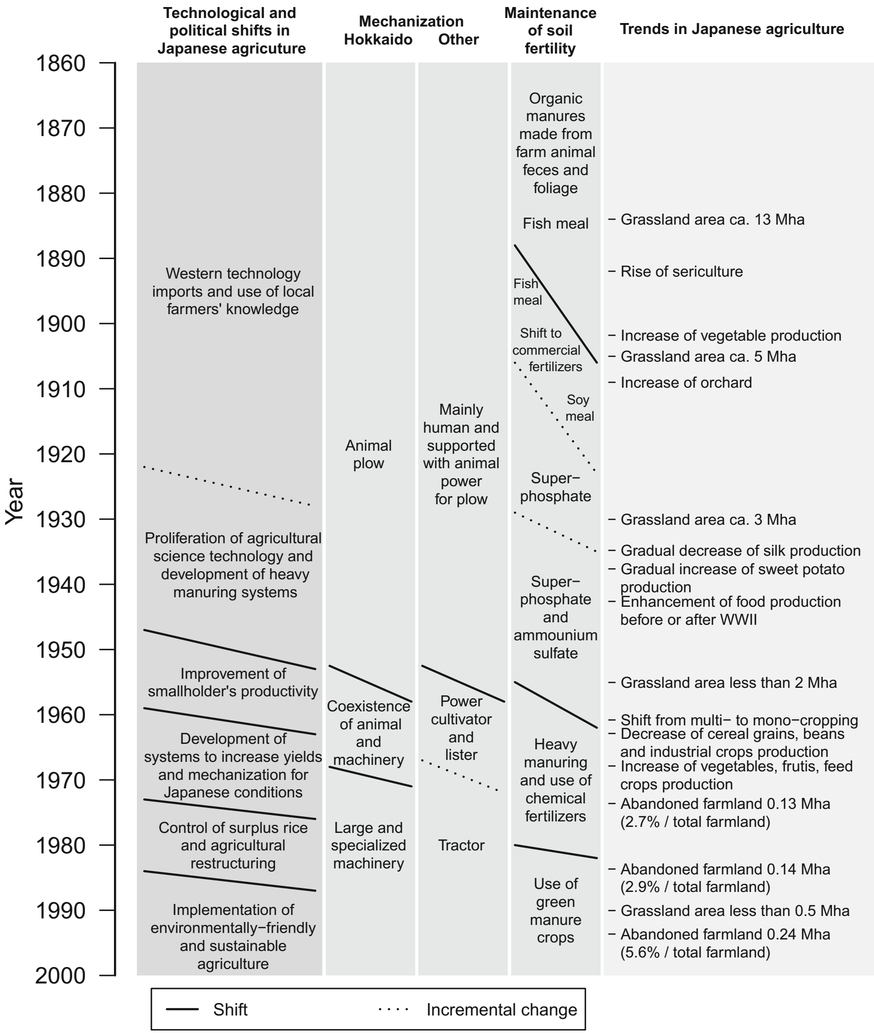

Fig. 1 Chronology of upland field history in Japan since the mid-nineteenth century. Data in this figure are from Tobata (1958) and Sugimoto (1995), supplemented with statistical information on abandoned farmland area (MAFF 2015) and grassland area (Ogura 2006)

3 Restoration Targets

The Japanese archipelago spans many climatic zones, from subarctic to cool-temperate to warm-temperate and subtropical zones. Restoration targets for abandoned upland fields are the secondary or old-growth forests in each zone. For example, according to an overview of the plant composition of old-growth forests (Suzuki 1966), conifer forests composed of *Abies* and *Picea* species are established in lowland subarctic regions. In cool-temperate regions, beech (*Fagus*) forests are established as old-growth forests (Hukusima et al. 2013). In warm-temperate and subtropical zones, lucidophyllous forests composed of *Castanopsis*, *Cinnamomum*, *Machilus*, *Neolitsea*, *Ilex*, and *Quercus* species are established as old-growth forests (Hattori et al. 2012). In secondary forests, various light-demanding trees are recruited, such as *Betula platyphylla*, *Alnus hirsuta*, and *Quercus crispula* in the subarctic zone (Numata 1969) and *Pinus densiflora*, *Quercus serrata,* and *Q. crispula* in cool- and warm-temperate zones (Nakagoshi 1995; Kamada and Nakagoshi 1996). In the subtropical zone, evergreen trees such as *Castanopsis sieboldii*, *Machilus thunbergii*, and *Daphniphyllum teijsmannii* grow in secondary forests (Kubota et al. 2005).

Although, from a restoration perspective, it is ideal to compare the plant community composition of abandoned upland fields and old-growth forests across many localities, it is difficult to obtain these data. Therefore, in this review, we considered the hindered recruitment of such native tree species or dominance by weedy plants as an indication of some limitation on forest development in abandoned upland fields.

4 Factors Affecting Upland Field Succession in Japan

Vegetation changes after upland field abandonment have not been well reported for each climatic zone in Japan. However, based on the results of some experiments and field observation, we discuss the factors affecting the succession of abandoned upland fields in Japan.

4.1 Exotic Species

Exotic plant species naturalized in Japan have been rapidly increasing since the late nineteenth century, with more than 1,000 exotic plant species now naturalized in Japan (Shimizu 2003). Most naturalized exotic species are annual and subordinately biennial and perennial species, which are adapted to ruderal environments and quickly invade during cropping or early stages of field abandonment. In general, most of ruderal exotic species disappear within several years of abandonment (Meiners et al. 2001).

However, some of exotic species are competitive against later recruiting native plants in Japan. The bamboo *Phyllostachys edulis*, introduced for bamboo shoot production and culm use for various tools across a wide range of temperate climate regions, is one of the most competitive exotic species that limit the establishment of native plants in Japan. After the stagnation of bamboo usage in many rural areas, abandoned bamboos vegetatively invaded various adjacent lands, including abandoned upland fields but not old-growth forests (Suzuki and Nakagoshi 2011; Suzuki 2015). Although the deciduous shrub *Leucaena leucocephala*, known as one of the world's worst invasive plant species (Lowe et al. 2000), grew during the early successional stage in an abandoned sugar cane field on Okinawa Island, subsequently, a forest composed of native trees including *Machilus thunbergii* and *Cinnamomum yabunikkei* recovered (Yoshida and Oka 2001). On the Ogasawara Islands, however, after the dominance of *L. leucocephala*, other alien species such as *Bischofia javanica*, *Morus australis*, and *Pleioblastus simonii* became dominant in abandoned farmlands (Yamamura et al. 1999; Yoshida and Oka 2000). These different forest recovery trajectories of abandoned upland fields and other habitats where *P. edulis* or *L. leucocephala* had been established indicate that even if an exotic species is present in a focal area, its invasiveness changes depending on the local species pool, species recruitment order, and interspecific competition.

4.2 Permanency of Upland Fields

Field permanency is an agricultural legacy that drives the revegetation process. The soil nutrient conditions after farmland abandonment vary depending on the duration and intensity of fertilizer application (Vitousek et al. 1989). Sugawara (1978), focusing on the influence of manure and calcium carbonate application, experimentally compared the revegetation patterns over 15 years in an abandoned field that was reclaimed from a non-forested waste land. The study showed that more native grass and forb species such as *Imperata cylindrica*, *Zoysia japonica*, *Miscanthus sinensis*, *Fallopia japonica* var. *japonica,* and *Houttuynia cordata* appeared continuously after field abandonment when no manure and calcium carbonate were applied. However, when manure (1000 kg/1000 m^2) and calcium carbonate (200 kg/1000 m^2) were applied, ruderal weeds such as *Rorippa indica*, *Capsella bursa-pastoris*, *Cerastium glomeratum*, and *Acalypha australis* appeared from 2 to 6 years after abandonment and the abovementioned native species disappeared within 7 years. From 8 years after abandonment onward, the ruderal weeds remained. This result suggests that, even if applied just once, manure and calcium carbonate change upland field vegetation from a natural to a ruderal community during the early successional stages. As noted in Sect. 4.4, the disappearance of *M. sinensis* in the early successional stage may have a negative influence on the recruitment of native tree species after upland field abandonment.

The state of the seed bank and presence of native trees are also affected by field permanency. Successful recruitment or dominance of native tree species was observed in fields after slash-and-burn cultivation in Japan. Goto et al. (1996) reported that seedlings emerged both from seed and from resprouting of many native tree species recruited after fires in former slash-and-burn fields left unmanaged for more than 30 years in the temperate region. In cool-temperate northern Japan, a mixed forest of *B. platyphylla*, *Acer pictum*, and *Salix* species (Kuwabara 1957) and of *Q. crispula* (Tozawa 1989) recovered after slash-and-burn cultivation. Kamada et al. (1987) reported that incorporating burning in shifting cultivation stimulated seed germination of pioneer native trees like *Rhus javanica*.

Thus, field permanency affects edaphic conditions and the state of the seed bank and resprouting species and therefore plays important roles in shaping the plant community of abandoned upland fields. After deforestation and transformation to agricultural fields, diaspores of forest plant species could survive for less than a few decades (Hermy and Verheyen 2007). Most conventional upland fields in Japan have been exposed to heavy manuring and intensive weed control for more than a few decades. Therefore, the potential for successful recruitment and growth of native grasses, forbs, and trees after abandonment of conventional upland fields is expected to be weaker than is observed in fields formerly managed with slash-and-burn cultivation.

4.3 Competitive Clonal Native Plants

Not only exotic species but also some native species become barriers to the recovery of forest vegetation after the abandonment of upland fields. In the temperate lowland Kanto Plain in eastern Japan, where crops such as vegetables, beans, and lawn grass have been cultivated conventionally with heavy manuring and pesticides in recent decades, the dominance of dwarf bamboo (*Pleioblastus chino*) and kudzu (*Pueraria lobata*) is common in abandoned upland fields (Table 1). According to surveys of tree seedlings in abandoned upland fields, native tree seedlings were less abundant in fields dominated by *P. chino* and *P. lobata* than in those dominated by the exotic perennial *Solidago altissima* and the native grass *M. sinensis* (Tokuoka et al. 2011). The dominance of *P. chino* and *P. lobata* was observed in fields abandoned for a few decades to half a century (Tokuoka et al. 2011; Ohashi et al. 2013). Field experiments in which native tree seeds and seedlings were planted in abandoned upland fields indicated that mono-dominance of *P. chino* and codominance of *P. chino* and *P. lobata* strongly limited the establishment of various native tree species (Tokuoka et al. 2015, 2016). The establishment of *P. lobata* has been reported as a major obstacle to tree growth in plantations in Japan (Miyake 1962; Kajisa et al. 2011). Although the amount of fertilizer input affected the degree of coverage by dominant plants, *S. altissima* and *P. lobata* increased within 5 years of abandonment of fields under conventional soil management on the Kanto Plain (Usami et al. 1990). The dominance of clonal native plants was also reported in western Japan. Abandoned orchards dominated by *P. lobata* were reported in the Seto Inland Sea area (Ohta and Nakagoshi 2011) and in Oita Prefecture (Hayashi et al. 2006). Abandoned chestnut fields in Shimane Prefecture were dominated by *Pleioblastus argenteostriatus* (Senda 2004).

These competitive clonal plants commonly grow in forest-edge environments. Therefore, when an upland field close to a forest is abandoned, the field is prone to invasion by such native clonal plants. The recent increase of abandoned upland fields dominated by these species also means that these plants can vegetatively invade from abandoned fields into adjacent newly abandoned fields. Although the contribution of seed dispersal to the spread of these clonal plants is poorly understood, we do know that the spread of these competitive clonal natives by vegetative growth will accelerate if the present stagnant state of farmland usage continues in temperate agricultural landscapes.

4.4 Grassland Decline

The decline of grassland in rural areas might be another important factor affecting patterns of plant recruitment into abandoned upland fields. In the late nineteenth century, the area of semi-natural grassland, likely mainly composed of *M. sinensis*, was estimated to be about 13 million hectare (more than one-third of the land area) in Japan (Ogura 2006). However, in line with the proliferation of commercial fertilizer use in the late nineteenth and early twentieth centuries (Fig. 1, Tobata 1958), such grasslands were converted into other land uses. It appears that the grassland area diminished to about 5 million hectare at the beginning of the twentieth century and to less than 2 million hectare in the mid-twentieth century, and it was only 0.34 million hectare in 2001 (Ogura 2006). Although *M. sinensis* was a main component of forest-floor vegetation in secondary forests managed for the production of firewood, green manure, and fodder until the mid-twentieth century, such forests have also been abandoned and the abundance of *M. sinensis* decreased over the course of succession (Fujii 1981; Hong et al. 1995; Yamamoto et al. 2000). The historical decrease of *M. sinensis* grasslands in rural landscapes suggests that the amount of grass seed that can be wind-dispersed into abandoned upland fields is much less now than in the past.

Heterogeneous light environments in clumped *M. sinensis* grasslands support the survival and growth of some *Q. serrata* seedlings (Tang et al. 1992) and native threatened plants (Osawa 2011). Seedlings of *P. densiflora* and *Larix kaempferi* were frequently observed in abandoned grasslands dominated by *M. sinensis* (Hayashi 1967). *M. sinensis* is used as an indicator of successful forest recovery among different types of grassland vegetation (Tsuyuzaki 2005; Saito 2012). Likewise, the amount of *M. sinensis* in abandoned upland fields may be an indicator of facilitation of future forest recovery. However, as shown in Fig. 1 and the study by Sugawara (1978), the amount of *M. sinensis* has diminished due to land-use changes and is likely to be suppressed by heavy manuring in rural landscapes in

Table 1 Types of abandoned upland field vegetation surveyed in 15 localities on the Kanto plain in autumn 2008. Vegetation types were based on the composition and abundance of dominant plants in the vine and groundcover layers.

Dominant plant type	Vine cover	Groundcover layer	Vegetation height (m)	Area in ha (% of total area of abandoned fields)	Total number of patches
Annual or biennial				16.21 (36.5)	138
		Amaranthus sp., *Avena fatua*, *Chenopodium album*, *Commelina communis*, *Digitaria ciliaris*, *Erigeron annuus*, *Erigeron canadensis*, *Erigeron sumatrensis*, *Galinsoga quadriradiata*, *Lolium* sp., *Setaria* sp.	< 3	14.76	125
	Humulus scandens		< 3	1.45	13
Vines				10.57 (23.8)	78
	Humulus scandens, *Pueraria lobata*		< 3	2.89	21
	Pueraria lobata	*Pleioblastus chino*	< 3	1.67	10
	Humulus scandens, *Pueraria lobata*	*Pleioblastus chino*	< 3	1.28	10
	Pueraria lobata	*Solidago altissima*	< 3	1.27	9
	Pueraria lobata		< 3	1.26	10
	Pueraria lobata	*Pleioblastus chino*	3–5	1.01	8
	Pueraria lobata	*Miscanthus sinensis*	< 3	0.37	1
	Trichosanthes cucumeroides	*Pleioblastus chino*	3–5	0.36	3
	Humulus scandens, *Pueraria lobata*	*Solidago altissima*	< 3	0.24	2
	Cayratia japonica	*Pleioblastus chino*	< 3	0.13	2
	Cayratia japonica		< 3	0.07	1
	Trichosanthes cucumeroides		< 3	0.02	1
Dwarf bamboo				6.51 (14.7)	53
		Pleioblastus chino	3–5	3.89	21
	Humulus scandens	*Pleioblastus chino*	< 3	1.29	12
		Pleioblastus chino	< 3	1.22	18
		Pleioblastus chino, *Solidago altissima*	< 3	0.11	2
Solidago altissima				5.50 (12.4)	61
		Solidago altissima	< 3	4.08	44
		Solidago altissima, *Miscanthus sinensis*	< 3	0.95	11
	Humulus scandens	*Solidago altissima*	< 3	0.21	3
		Solidago altissima, *Miscanthus sinensis*, *Pleioblastus chino*	< 3	0.14	1
	Humulus scandens	*Solidago altissima*, *Pleioblastus chino*	< 3	0.12	2
Bamboos					
		Phyllostachys spp.	> 8	3.20 (7.2)	25
Broad-leaved forests				1.83 (4.1)	17
		Aphananthe aspera, *Celtis sinensis*, *Zelkova serrata*	> 8	0.65	4
		Quercus acutissima, *Quercus serrata*	> 8	0.47	4
		Quercus acutissima, *Quercus serrata*	5–8	0.28	4
		Aphananthe aspera, *Castanopsis sieboldii*, *Celtis sinensis*, *Quercus myrsinifolia*, *Quercus serrata*	> 8	0.25	2
		Rhus javanica	5–8	0.18	3
Miscanthus				0.59 (1.3)	7
		Miscanthus sacchariflorus, *Solidago altissima*	< 3	0.19	3
		Miscanthus sinensis	< 3	0.19	2
	Humulus scandens	*Miscanthus sinensis*	< 3	0.12	1
		Miscanthus sinensis, *Pleioblastus chino*	< 3	0.09	1
			Total	44.41	379

This table was summarized and translated from Tokuoka (2011)

Japan. Therefore, a passive approach to abandoned upland fields will lead to the dominance of plants other than *M. sinensis*, such as dwarf bamboos and kudzu, as observed on the Kanto Plain (Table 1).

4.5 Plant–Animal Interactions

The influence of plant–animal interactions is another important factor affecting the forest recovery process in abandoned upland fields. For example, a field experiment in which native tree seedlings were transplanted into *P. chino*–dominated stands and gaps revealed that not only shading by the dwarf bamboo but also predation by Japanese hare (*Lepus brachyurus*; nomenclature for mammals follows Ohdachi 2009) limited the survival of *Quercus myrsinifolia*, *Q. serrata*, *Aphananthe aspera*, and *Toxicodendron sylvestre* to different degrees (Tokuoka et al. 2016). Predation on seeds planted in gaps and stands codominated by *P. chino* and *P. lobata* was likely to be caused by field mice (Tokuoka et al. 2015). Faunal composition and density were shown to be heterogeneous along urban–rural gradients in Japan (Saito and Koike 2013). Therefore, the magnitude of herbivory damage on the seedlings caused by the hare and mice in abandoned upland fields will vary among rural landscapes.

In Japan, browsing by high-density Sika deer (*Cervus nippon*) populations has become a major driver in the decline of forest biodiversity (Takatsuki 2009). Okumura et al. (2009) reported that farmland abandonment accelerated the recent expansion of the sika deer distribution in Japan. Moreover, it is expected that the range of sika deer will expand in the future due to decreased snow cover periods and increased land abandonment in rural areas (Ohashi et al. 2016). Although no study has directly evaluated the impact of deer herbivory on the vegetation of abandoned upland fields, the present and future impact of this factor cannot be ignored because crop damage by sika deer is obvious in the subarctic and cool- and warm-temperate areas of Japan (MAFF n.d. b).

5 Implications from the Forest Recovered Cases

Although we have discussed several factors that limit forest recovery in abandoned crop fields in the previous section, insights from some successful cases are available not only after traditional slash-and-burn cultivation (e.g., Kuwabara 1957; Tozawa 1989; Goto et al. 1996) but also after some other agricultural systems. For example, secondary forests composed of various bird-dispersed trees such as *Cerasus jamasakura*, *Cinnamomum yabunikkei*, *D. teijsmannii*, *M. thunbergii, Mallotus japonicus*, and *Toxicodendron succedaneum* recovered in about 50 years after the abandonment of terraced fields on the Yura Peninsula, Ehime Prefecture in a coastal warm-temperate region (Tokuoka and Hashigoe 2015). In the region, subsistence farming of wheat (or barley) and sweet potato using organic manure made from human waste and rotten fish had continued for centuries before abandonment in the 1960s (Harada 1994; Miyamoto 2006). On Sado Island, Niigata Prefecture, after the abandonment of terraced paddy fields in the 1970s, secondary forests composed of species such as *Q. serrata*, *Castanea crenata*, and *Carpinus tschonoskii* developed (Ishizuka et al. 2011). On the Izu Peninsula, Shizuoka Prefecture, a forest dominated by *Quercus phillyreoides* had developed about 40 years after upland field abandonment (Konta et al. 2006). At that time in the three localities, surrounding forests were commonly utilized for charcoal and firewood production. On the Yura Peninsula and the Izu Peninsula, some parts of surrounding habitats were grasslands (Harada 1994; Konta et al. 2006). These examples suggest that the combination of extensive forms of agriculture (e.g., terracing, not consolidated, and organic manure use) and surrounding young forests and grasslands may be a requirement of forest recovery after upland field abandonment in Japan.

6 Conclusions

Over the past century, agricultural systems and techniques, local species pools, and rural landscape mosaics have been changing across Japan. Reflecting the historical differences in such environmental factors, vegetation change after upland field abandonment occurs in diverse ways. Agricultural landscapes are innately unstable because farmers generally need to change their crops and farming practices to keep economic interests in line with the shifts in agro-economic conditions and technological innovation. In addition, the complex influences of external factors such as climate change, invasion of new plant and animal species, and changes in surrounding land use due to urbanization and abandonment are difficult to predict. Therefore, the combination of biotic and abiotic conditions in abandoned upland fields can easily become novel states, and the deterministic view of old-field succession will be violated in many cases.

It is impossible to identify the processes underlying successful forest recovery of abandoned fields directly from the limited number of previous field observations. Thus, in future research, meta-analysis studies at various localities are needed to find common agricultural and landscape histories that ensure the smooth recovery of locally targeted forest states. With that information, we will be able to devise restoration schemes for the increasing number of abandoned fields to overcome undesired vegetation states and convert them into targeted sources of ecosystem services.

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Chapter 9
Traditional Ecological Knowledge Determined Tree Species Choice in the Construction of Traditional Folk Houses in a Snowy Rural Landscape in Central Japan

Hideyuki Ida

Abstract To elucidate the selection of tree species for timber in traditional folk house construction, I examined the species used in seven houses in four rural villages in central Honshu, Japan, a region subject to heavy snowfall. All houses were mainly constructed of beech (*Fagus crenata*), cedar (*Cryptomeria japonica*), and oak (*Quercus crispula* and/or *Quercus serrata*). The species composition was similar to that of the current surrounding woodlands, suggesting that these species grew in the region when the houses were built, although the vegetation structure changed in the interim. Beech, cedar, and oak trees grow and maintain their upright structure even in environments that experience heavy snowfall; therefore, these species may have appeared to be the best choices for construction timber in this region. Beech was mainly used for its bending strength, in slanting or horizontal structural elements; cedar in elements used as structural reinforcement; and oak in various elements, complementing the selection of beech or cedar. Important structural beams are typically made of beech timber. Its high bending strength was considered to reflect the nature of living beech trees, which form dominant stands in regions with heavy snow in Japan, due to their sturdiness and ability to stand upright under heavy snow loads. Although beech timber is currently considered to be unsuitable for construction due to its trait such as easy to twist or easy to rot, the results of this study suggest that selecting beech timber for structural elements that bear heavy snow loads was feasible for indigenous builders when the traditional houses were constructed. Consequently, beech-dominated forests may have influenced the architectural style of houses with large-beamed structures and may have been a factor contributing to the settlement of this region. Understanding traditional ecological knowledge may contribute to the promotion of sustainable wood resource use in the future.

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1 Introduction

The importance of traditional ecological knowledge (TEK) of sustainable natural resource management has been recognized on a global scale, following the proposal of the Satoyama Initiative in the 10th meeting of the Conference of the Parties to the Convention on Biological Diversity in 2010 (CBD-COP10) (Takeuchi 2010). Understanding and applying TEK, which has been held for countless generations by indigenous local communities, is indispensable in supporting the development of a sustainable society and ensuring future socio-ecological resilience (Gómez-Baggethun et al. 2013). However, such knowledge is in danger of decline without ecological evaluation.

In this study, I focused on the Japanese traditional wooden folk house (*kominka*), an important element of the rural landscape (*satoyama*) that embodies rich ecological knowledge on the utilization of natural resources. *Kominka* are as diverse as the natural features of the Japanese archipelago (Kawashima 1986). Most existing *kominka* were built between the seventeenth century and the mid-twentieth century, and almost all of their building materials were natural resources such as wood, grass, soil, and stone. Thus, the houses reflect not only the building techniques and rural lifestyles of the building period, but also the types of resources available, which traditionally depended on the natural environment. In particular, the plant species used in building materials are likely to reflect the surrounding vegetation of the period because they were probably collected locally. An ecological evaluation of the plant species selected for *kominka* construction will contribute to our understanding of the traditional uses of plant resources available according to the natural environment of the region.

Most of the studies on *kominka* have aimed to describe traditional local mannerisms, customs, housing environment, and architectural techniques from the perspectives of folklore, geography, housing, architecture, and history; they have rarely taken an ecological approach (Nunotani and Nakao 1986). Unfortunately, they have been written in Japanese, and there have been only a few international articles (Itagaki et al. 2005; Oku et al. 2009). *Kominka* are now rapidly decreasing in number in Japan; thus, it is imperative to accumulate and evaluate their TEK internationally before they are lost.

The aim of this study was to systematize TEK of the sustainable management of plant resources by clarifying the ecological link between plant resource use and the surrounding vegetation. Specifically, my objective was to elucidate the selection of tree species chosen for the construction of traditional folk houses. I examined the species used for timber in *kominka* in rural central Japan, in a landscape where the amount of snowfall placed restrictions on people's way of life and on the growth of plants, to systematize TEK developed under harsh natural environments.

2 Materials and Methods

2.1 Study Area

Iiyama City, in the northern part of Nagano Prefecture, is one of Japan's foremost heavy snowfall areas, designated as a special heavy snowfall zone in accordance with the Act on Special Measures concerning Countermeasures for Heavy Snowfall Areas by the Ministry of Land, Infrastructure, and Transport and Tourism of Japan. The maximum snow depth in this semi-mountainous residential area is normally within the range of 100–300 cm. The city is located at an altitude of 300–1,288 m, and the upper mountainous area (>900 m a.s.l.) mainly comprises mature beech (*Fagus crenata*) woodlands, which are old-growth or secondary stands originating from coppices (Ida et al. 2007). Residential areas (ca. 300–500 m a.s.l.) in this region are characterized by farm villages and rice paddy fields. The rural woodlands distributed at ca. 300–900 m a.s.l. are dominated by two oak species (*Quercus crispula*, *Q. serrata*) and cultivated Japanese cedar (*Cryptomeria japonica*), with sparse distributions of fragmented beech stands (Ida et al. 2010). Both oak and beech woodlands were sustainably coppiced to produce firewood and charcoal until the 1970s and thereafter have developed into secondary forest.

2.2 Traditional Folk Houses

I used data on tree species and size of structural timbers used in seven *kominka* in four semi-mountainous rural villages in Iiyama, described in previous original articles (Fig. 1, Table 1; Ida et al. 2010; Shoji et al. 2010; Nakama et al. 2014a; Nakama et al. 2016a, b; Hoyano et al. 2017). The exact construction year was not known for all *kominka* because the dates on their *munafuda* (wooden tags commemorating the foundation of the building) could not be confirmed; these ages have been estimated to range between roughly 100 and 250 years, judging from their architectural styles and/or local oral history. Some of the houses were occupied at the time of the survey. Their basic framework has remained unchanged, although they have been expanded and/or renovated to some extent. These houses displayed styles typical of their building periods, from the seventeenth to mid-twentieth century, in regions with heavy snowfall. Particularly, all of the houses surveyed were constructed of thick timbers in places and formed firm structures, suggesting that their building materials were strong enough to tolerate heavy snow loads (Fig. 2). Abandoned woodlands (e.g., oak or beech coppices or cedar plantations) currently surround the houses. The mean annual temperature and annual precipitation in the region were 9.9–11.1 °C and 1,758.6–2,288.0 mm (1981–2010), respectively, and the maximum snow depth ranged from 169 to 262 cm annually, according to Mesh Climate Data 2010 (Japan Meteorological Agency 2012).

Fig. 1 Traditional folk houses in Karayama village (2 July 2015), one of the villages studied in Iiyama City in central Japan. Their original thatched roofs have been covered with tin allow the accumulated snow to slide down naturally

2.3 Identification of Tree Species in Structural Timber

The width and length of the structural timbers were measured from 2008 to 2015 (Ida et al. 2010; Shoji et al. 2010; Nakama et al. 2014a; Nakama et al. 2016a, b; Hoyano et al. 2017). To identify the tree species in these timbers, a small piece (approximately 1–3 cm^3) containing at least 2–3 annual rings was cut from each timber using a chisel and saw. These wood pieces were brought to the laboratory, and the species were identified by observing the cellular tissues in 24–28-µm-thick slices (butt end, radial section, and cross grain) with a microscope (Nakama et al. 2014b). In the current study, the identified species were classified into four types of structural elements (Fig. 3): vertical elements (VE), such as pillars (*hasira*) and short supports (*tsuka*); horizontal elements (HE), such as beams (*hari*), girders (*keta*), roof purlins (*moya*), and ridgepoles (*munagi*); slanting elements (SE), including rafters (*taruki*) and crucks (*sasu*); and foundation elements (FE) (*dodai*), including sleepers (*ôbiki*) and joists (*neda*). Among all inspected elements (1,079 in total), those judged clearly supplementary (due to extension or remodeling) and unidentified species were excluded from the data analysis.

Table 1 Site description of the surveyed houses

House ID	KY1	KY2	KY3	KY4	N	KK	KS
Village name	Karayama	Karayama	Karayama	Karayama	Nishi-otaki	Kami-kuwanagawa	Kosuge
Altitude (m)	503	510	512	509	315	329	500
Maximum snowfall (m)[a]	262	262	241	241	258	230	169
Annual precipitation (mm)[a]	2288.0	2288.0	2281.9	2281.9	2250.7	2129.8	1758.6
Annual average temperature (°C)[a]	10	10	9.9	9.9	11.1	11	10.7
Monthly mean temperature in the warmest month (°C)[a]	23.1 (Aug.)	23.1 (Aug.)	22.9 (Aug.)	22.9 (Aug.)	24.1 (Aug.)	24.1 (Aug.)	24.0 (Aug.)
Monthly mean temperature in the coldest month (°C)[a]	−2.1 (Jan.)	−2.1 (Jan.)	−2.2 (Jan.)	−2.2 (Jan.)	−0.8 (Jan.)	−1.0 (Jan.)	−1.7 (Jan.)
Citation	Nakama et al. (2016b)	Nakama et al. (2016b)	Nakama et al. (2016b)	Shoji et al. (2010), Ida et al. (2010), Nakama et al. (2016b)	Nakama et al. (2016a)	Nakama et al. (2014a)	Hoyano et al. (2017)

[a]Data for 1981–2010 are from the Mesh Climate Data 2010 (Japan Meteorological Agency 2012)

Fig. 2 A traditional folk house in snow cover (ca. 350—400 cm deep) in Karayama village described in Fig. 1 (19 February 2015)

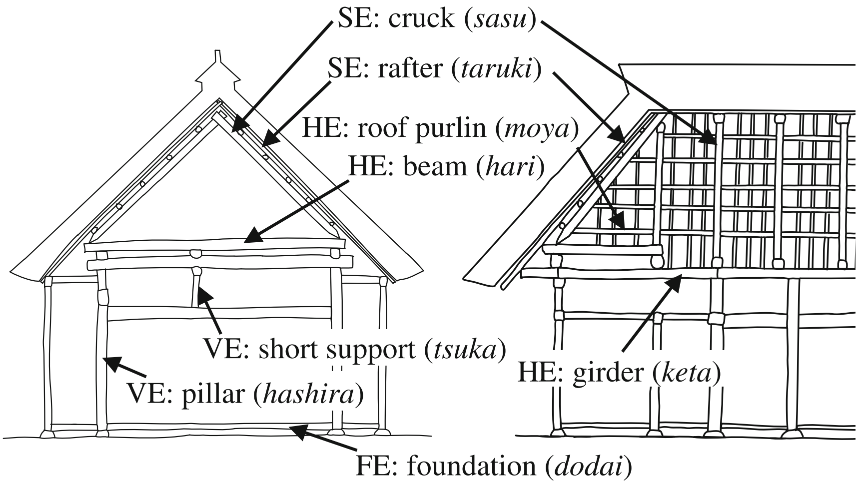


Fig. 3 Definition of the timber names of main structural elements of the Japanese traditional folk house: foundation elements (FE); vertical elements (VE); horizontal elements (HE); and slanting elements (SE)

3 Results

I recorded 853 structural elements of known tree species, ranging from 76 to 191 elements per house (Table 2). The number of tree species ranged from three to ten per house. Cedar (55.1%), beech (25.8%), and oak (11.3%) were used in all seven houses, and these three genera (hereafter called species) accounted for 92.2%

Table 2 Species composition of structural timbers for each house

Tree species	House ID							Total number of timbers identified species		Summed volume of timbers identified species	
	KY1	KY2	KY3	KY4	N	KK	KS	*n*	%	m^3 (*n*)[a]	%
Cryptomeria japonica	68	25	69	116	35	104	53	470	55.1	21.43 (389)	37.8
Fagus crenata	31	26	32	38	40	35	18	220	25.8	23.24 (193)	41.0
Quercus spp. (*Q. crispula* or *Q. serrata*)	14	23	16	30	2	6	5	96	11.3	8.45 (80)	14.9
Pinus densiflora					2	4	12	18	2.1	0.46 (8)	0.8
Aesculus turbinata					1	6	3	10	1.2	1.36 (7)	2.4
Phellodendron insulare						7	1	8	0.9	0.89 (8)	1.6
Zelkova serrata				7			1	8	0.9	0.23 (7)	0.4
Larix kaempferi						6		6	0.7	0.17 (4)	0.3
Acer pictum	1				1	3		5	0.6	0.09 (3)	0.2
Juglans mandshurica var. *sachalinensis*						1	4	5	0.6	0.05 (2)	0.1
Castanea crenata		2			2		1	5	0.6	0.04 (5)	0.1
Magnolia kobus							1	1	0.1	0.26 (1)	0.5
Kalopanax septemlobus					1			1	0.1	nd	nd
Number of timbers identified species	114	76	117	191	84	172	99	853	100.0	56.68 (707)	100.0

[a]Numerals in parentheses indicate the number of timbers calculated volume

(n = 786) of the total number of elements. The total volume of the three species accounted for 93.7% (53.12 m^3, n = 662) of the total (56.68 m^3, n = 707). Beech timbers accounted for the highest volume (41.0%), followed by cedar (37.8%) and oak (14.9%). Each of the other ten species comprised less than 1% of the total volume. Among these were *Pinus densiflora*, *Aesculus turbinata*, *Phellodendron amurense*, *Zelkova serrata*, *Larix kaempferi*, *Acer pictum*, *Juglans mandshurica* var. *sachalinensis,* or *Castanea crenata* in a few houses. *Magnolia kobus* and *Kalopanax septemlobus* were each found in one house. All of these timber species are currently components of woodlands in the study area, although cedar and larch (*L. kaempferi*) timbers were likely derived from afforestation (Ida et al. 2010). Specifically, the larch timbers found in one house may have been used in supplementary construction; however, this could not be confirmed.

Timber size was not significantly different between beech and oak; beech and oak timbers were both significantly larger than cedar (Fig. 4). Beech timbers, averaging 16.8 cm (standard deviation ±7.4) in thickness, 3.9 m (±1.7) in length, and 0.120 m^3 (±0.114) in total volume per house, were frequently used as HE and SE (Fig. 5). Beech timber size had a wider range than cedar and oak. Specifically, longer timbers with larger cross sections were commonly used as beams and girders (Fig. 6). Longer and straighter beech timbers were frequently used as SE, in a range of sizes; among these, logs approximately 10 cm in diameter were typically used as rafters. The proportion of beech used as VE and FE was relatively low, although some thick beech timbers were used as pillars or sleepers (Nakama et al. 2016a, b).

Cedar timbers averaged 13.7 cm (±4.2) in thickness, 2.9 m (±2.0) in length, and 0.055 m^3 (±0.064) in total volume per house (Fig. 4). The proportion of cedar used for VE was higher than that of beech and oak (Fig. 5). Less cedar was used as HE; however, the absolute number was approximately the same as that of beech timbers. Among cedar timbers, those with a large cross section were used as main pillars, whereas smaller timbers (cross section: 10–15 cm) sawn in the same shape were frequently used as side posts (Fig. 4). A remarkably small proportion of cedar was used as SE (Fig. 5).

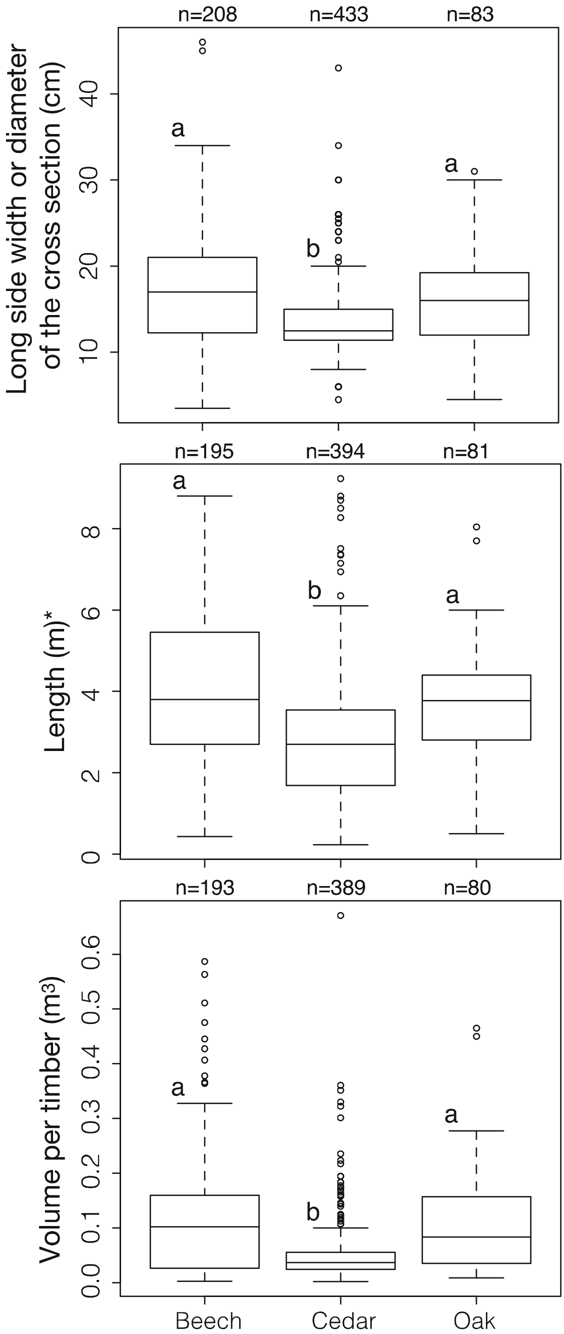
Oak timber size averaged 16.2 cm (±5.2) in thickness, 3.7 cm (±1.4) in length, and 0.106 m^3 (±0.089) in total volume per house. Oak timbers were used to some extent in various structural elements; there was no clear trend distinguishing their use, as observed in beech or cedar.

4 Discussion

4.1 Relationship Between Tree Species Used as Structural Timber and the Surrounding Vegetation

In the study area, which typically experiences heavy snowfall, beech, cedar, and oak comprised most of the house timbers (Table 2); the current surrounding woodlands consist of secondary beech and oak stands and cedar plantations

Fig. 4 Size of structural timbers for the main three species. Different letters represent significant differences among species (Tukey's HSD test, $p < 0.001$). Asterisks—the five cedar timbers >10 m in length were omitted from the statistical analysis because they consisted of two or three parts each but the joints were unclear



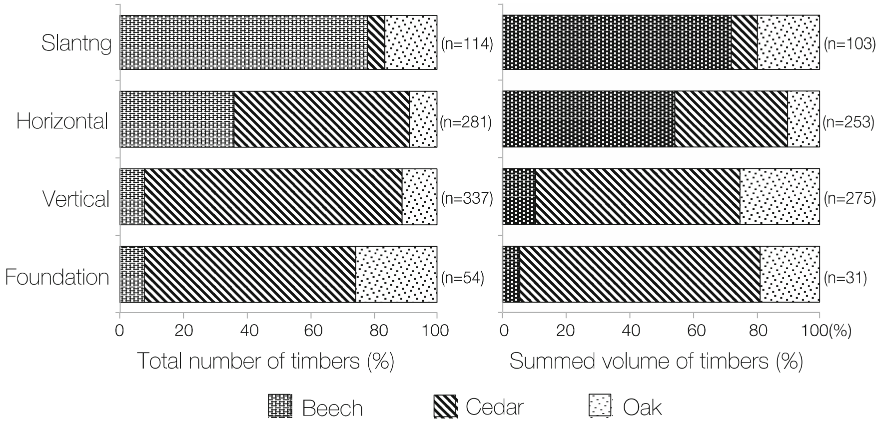
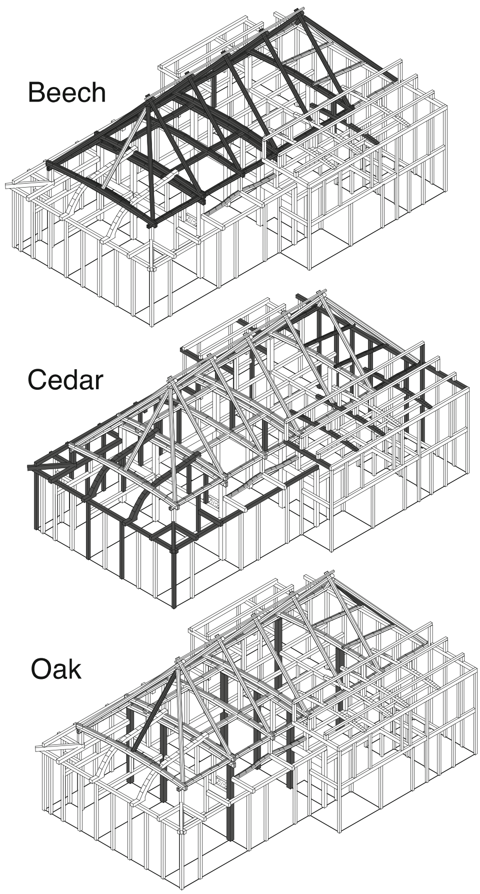


Fig. 5 Tree species composition of house timbers for each structural element

Fig. 6 An example of framework showing the part of use (solid part) for each tree species in the house KY3 (modified from Nakama et al. 2016b)



(Ida et al. 2010; Ida 2017). Because the common people's house timbers had likely been cut from local trees, the species used as timber must have grown near the houses when they were built. In a region with heavy snow where snow load prevents the growth of large-diameter trees, wood construction materials must necessarily be limited to the large, strong timber species in the region (Shoji et al. 2010). Beech, cedar, and oak trees grow and stand upright even in regions with heavy snow. According to some interviews with local elders, the people used these tree species as building materials (A. Goto, personal communication). In the study area, snowy winters have persisted since the houses were built. Therefore, the surrounding woodlands were managed and maintained continuously until recent years, and although the current vegetation structure is not identical, large amounts of beech, cedar, and oak remain (Fig. 7).

The construction of the surveyed houses depended on not only the surrounding vegetation but also its regeneration and management (Ida et al. 2010). In the *satoyama* woodland investigated, which appears to have served as a timber source, the local residents sustainably managed a mosaic of stands containing small patches of the tree species suitable for construction. According to the diary written by a departed elder lived there, stand regeneration appears to have been artificially promoted by transplanting beech saplings to suitable areas. Additionally, the current stand structure suggested that large-sized beech trees intentionally would have been left sparsely uncut to produce seed. Houses may have been maintained through repairs from these stands, repeatedly linking construction to the *satoyama* vegetation structure.

Fig. 7 Post-abandoned *satoyama* woodlands adjacent to Karayama village shown in Fig. 1 (7 November 2015), where dominated by beech (*Fagus crenata)* and had been sustainably used as coppices as well as sources for timbers

4.2 Traditional Ecological Knowledge Influenced Species Choice for House Timbers

Generally, sufficient structural strength is required in the construction of houses in regions with heavy snow to support snow accumulated on roofs. Timber size is an extremely important element that helps to ensure structural strength in wooden buildings. The *kominka* surveyed in the present study were of sturdy construction, with large timbers. Moreover, the present study suggests that tree species is also an important feature of these houses. According to local tradition, certain tree species are selected for specific structural elements in traditional wooden buildings. Beech was used in elements requiring bending strength, such as HE and SE; cedar was used mainly in elements that provided reinforcement, and oak was used in various ways as a supplementary species to beech or cedar (Fig. 5).

It should be noted that beech timbers have been frequently used for HE and SE, those had been structurally important parts of the buildings: roof structure (e.g., rafters, crucks, purlins), beams, and girders (Fig. 6). Specifically, roof structural elements require both length and bending strength to support snow loads and the deadweight load of the thatched roof directly. Hamasaki et al. (2016) suggested that beech timbers should increase in strength over time because the bending strength of older beech timbers (used in a house for at least 100 years) is superior to that of new beech and new and old cedar and oak timbers (Fig. 8). Although the mechanism has not been clarified, qualitative changes in the tissue components and crystallinity due to fireplace smoldering over many years may have contributed to this superior strength. Therefore, the use of beech for HE and SE may demonstrate architectural knowledge in ensuring sufficient bending strength for snow loads. This physical property of beech timbers may reflect the nature of the living trees (Fig. 9). The beech is known as a representative tree species dominating stands in the Japanese snowbelt by adapting to snow-related physical stress with its outstanding toughness and ability to remain upright despite heavy snow loads (Homma 1997). Similarly, in the woodlands in this study, the degree of root bending in beech trunks on slopes is smaller than that of oak trunks (Ida, unpublished data). The selection of beech for house timbers was established at least a century ago from ecological knowledge that the snow-tolerant properties of living beech trees were also displayed in timbers of the same species.

The larger cedar timbers were typically used as beams, girders, and pillars among those of beech and oak. Because uniform-sized cedar logs (10–15 cm in width of cross section) are easily obtained and easily sawn into squared timbers, these timbers were used as replacements for structural elements damaged by exposure to wind and rain.

Oak species have traditionally been coppiced to produce firewood in Japan. In the study area, *Q. crispula* and *Q. serrata* have been used mainly as firewood rather than as building materials. Judging from the number of oak timbers and their sizes (Table 2; Fig. 6), the absolute number of large-diameter oak trees was probably much lower than that of beech or cedar trees in the region, even if oak trees could

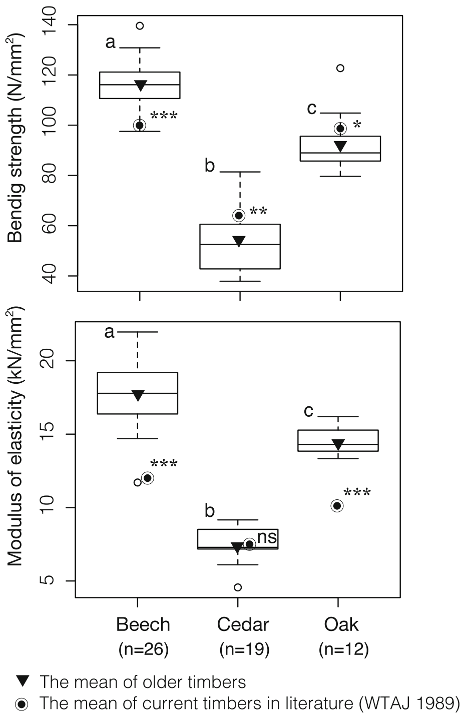


Fig. 8 Bending strength correction values (upper) and modulus of elasticity (lower: correction values of the bending Young's modulus) of older timbers used in the traditional house and mean values of current timbers for each species (Wood Technological Association of Japan 1989). Different letters represent significant differences among species (Tukey's HSD test, $p < 0.001$). The one-sample *t*-test compares the mean of older timbers with the mean of current timbers (***$p < 0.0001$, **$p < 0.01$, *$p < 0.05$, ns: $p > 0.05$). Figures were modified from Hamasaki et al. (2016)

have formed dominant stands there. Thus, the use of oak timber was likely complementary to that of beech or cedar timber because there was no clear distinction among structural elements made of oak.

In the study region, which experiences heavy snowfall, tree species were selected by their adaptation to the heavy snow environment; properties of each species determined its use in the construction of traditional folk houses, suggesting that the *kominka* represent a local source of ecological knowledge of wood resource use. Although beech timbers are currently deemed unsuitable for home construction due to its trait such as easy to twist or easy to rot, they were a feasible choice for indigenous construction under the circumstances. One factor affecting species choice for house timbers may have been socioeconomic status. In a region with heavy snowfall, logged timber could be transported anywhere in the surrounding woodlands by sliding over snow in the early spring, which would be less costly than purchasing or importing timbers from a distance. Consequently, the formation of beech-dominated forests (Fig. 10) may have been a consequence of the development of the large-timbered architectural style of these houses; the beech forests may also have contributed to the settlement of this snowy region.

Fig. 9 Beech trunks which stand upright with bending roots on the slope (1 June 2011)

Fig. 10 Beech forests spreading on the mountain ridge in Iiyama City (4 June 2013)

5 Conclusions

Species selection for the construction of traditional houses varies from region to region and may have depended on various factors such as the surrounding climate, vegetation, socio-historical background, and the designs of the craftsmen. For example, cedars were used extensively in the crucks (roof structures) of folk houses in the northern Japanese snowbelt, where beech woodlands were dominant (Itagaki et al. 2005). In regions with relatively little snowfall, Japanese red pine (*Pinus densiflora*) was used for horizontal structural elements or roof elements instead of beech or cedar (Kabaya et al., unpublished data; Tsuda et al., unpublished data). Understanding such local ecological knowledge of tree species selection in the construction of traditional houses can contribute to promoting sustainable wood resource use according to the natural environment. To systematize TEK, it is necessary to add more empirical data on the species composition of remaining *kominka* in the rural landscapes of Japan.

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Chapter 10
Priorities Mapping in Landscape: Spatial Decision Support of the Indonesian Forest Landscape

Beni Raharjo and Nobukazu Nakagoshi

Abstract This study was aimed to develop and assess the application of the priorities mapping using landscape perspective in order to develop spatial decision support system for conservational forest management unit (FMU). The study was conducted in Sultan Adam Forest Park, Indonesia. It follows series of steps, i.e., formulating the prioritization framework, preparing the biophysical condition data and assessing their spatial and temporal changes, assessing the spatial and temporal patterns of the resultant preservation on each management task, formulating the proposed contribution of the forest landscape prioritization for forest zonation, and assessing the optimum proportion for conservation priority. The two identified conservation tasks, namely preservation and rehabilitation, were used as the main prioritization goals in a GIS-based multi-criteria analysis. The framework for conservation prioritization of the forest landscape was developed. It has multi-criteria of tasks, components, sub-components, and parameters. Management preference was accommodated by weighting techniques using an analytic hierarchy process (AHP). Further analyses were carried out, i.e., spatial and temporal analysis in relating parameters with the biophysical conditions (vegetation, forest fragmentation, species' status, settlement, accessibility, forest fire, soil erosion, topography, and land management). The study has shown a successful development and application of prioritization in the forest landscape with the introduction of new conservation concept, redefined criteria/component identification, and landscape approach. Spatial and temporal patterns of the biophysical conditions affect the spatial and temporal patterns of prioritization in both preservation and rehabilitation tasks. The incorporation of the threat component into preservation prioritization significantly changes the resultant priority area. In addition, the incorporation of the recoverability component into the rehabilitation prioritization also significantly changes the resultant rehabilitation priority area. Therefore, redefined criteria

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identification into value/importance and threat/urgency is crucial in prioritization. Priority area changed spatially and temporally. The acknowledgment on their patterns is indispensable for forestry planning. The concept that considers preservation and rehabilitation as the two main conservation tasks shows its usable application for prioritization. This study is valuable in providing a spatial decision support system in existing conservational area.

1 Introduction

Indonesian forest suffers from deforestation that counts the second highest rate of deforestation among the tropical countries (Margono et al. 2010). The raise of the deforestation rate was started since 1980s with the average of 1 million hectare year^{-1} (FWI/GFW 2002). The rate increased into 1.7 million hectare year^{-1} in 1990s and 2 million hectare year^{-1} in 1996 (Myers 1991). Lately, in the period of 2009–2010, Indonesian Ministry of Forestry (2012) estimated that the rate of the deforestation was 610,000 ha year^{-1}. However, the figure ignored the conversion of natural forest to plantation forest and the deforestation in non-state forestland. Hansen et al. (2013) estimated that the Indonesian deforestation rate between 2011 and 2012 was above 2 million hectare year^{-1}. The rate of the deforestation is unfortunately projected to increase in the future (Indonesian Ministry of Forestry 2011).

Besides deforestation, forest degradation is also a significant issue. Forest fragmentation is one of the distinct indicators of forest degradation. Forest fragmentation, which was defined as the process that results in the conversion of continuous forest into patches (Tejaswi 2007), is also a substantial issue in the forest landscape. Forest fragmentation is related to forest as habitat (Wulder et al. 2009); then, habitat fragmentation affects abiota and biota (Rutledge 2003), species abundance and extinction (Arroyo-Rodríguez et al. 2007). Forest degradation is, therefore, one of the major threats to biodiversity and species extinction.

The causes of deforestation and forest degradation (or forest fragmentation) can be categorized into two groups: direct causes and underlying causes (Tejaswi 2007). The landscape level analysis deals with the direct causes of deforestation. Since forest fragmentation is the result of the deforestation (Broadbent et al. 2008), direct causes of the deforestation can also the direct cause of forest fragmentation. Some significant direct causes of deforestation are logging (Broadbent et al. 2008), conversion of forested lands (Aurambout et al. 2005), cattle raising (Tejaswi 2007), urbanization (Tigas et al. 2002), road accessibility (Barber et al. 2014), and forest fire (Langner 2009). However, since it depends on the characteristics of each forest landscape, not all causes are found in every forest landscape.

Deforestation and forest degradation can cause ecological and socioeconomic effects (Alig et al. 2010). Considering that Indonesia ranks third in tropical forests endowment and posing 10% of world's biodiversity (Myers 1991; Sunderlin and Resosudarmo 1996), reducing deforestation and forest fragmentation is necessary.

Since the main achievement in managing the forest is sustainable forest management (SFM), developing the strategy to achieve the SFM is indispensable.

Forest management unit (FMU) was expected to be the key success in achieving the SFM in Indonesian forest. In accordance with the issuance of the Forestry Act (Government of the Republic of Indonesia 1999), it became mandatory that all Indonesian forests are managed under FMUs. FMU is the smallest management unit for efficient and sustainable management of the forest (Indonesian Ministry of Forestry 2011). Since there are three main forest functions of Indonesian forests, three types of FMU were developed, namely conservation FMU, protection FMU, and production FMU. However, Kartodihardjo et al. (2011) stated that the mandate on FMU was neglected in practice. There are still obstacles to the FMU development, such as legislation, mobilization of resources, and organization. Fortunately, the FMU development got more awareness, and then, its development was dramatically escalated again since 2009. Until the end of 2013, from the total Indonesian forest of 131 million ha, it had been assigned 79 million ha as FMUs. In managing FMU, forest managers need conservation planning as the tool for combating deforestation and forest degradation. The tool must be in a handy and practical form which supports decision spatially and temporally.

In order to support the forest plan, forest zonation and special zone assignment are the two main practices in forest planning in Indonesian forest (Mulyana et al. 2010). However, zonation and special zone assignment are relatively static in terms of spatial and temporal dimensions. Zonation and special zone assignment are likely preceded by a long and detailed study. On the other hand, the forest manager needs a more dynamic tool to support the decision making in forest planning. Therefore, this study proposed prioritization to support decision-making process in the form of spatial decision support system.

Prioritization has been widely practiced in determining the biodiversity preservation. Nevertheless, its application to support site-level management is not explored yet. In addition, the most common perspective in such prioritization is making prioritization on only the targeted species. This perspective has some disadvantages from neglecting other species importance. It is also a costly effort due to narrow focus and long study period. A more general, and consequently, less detail prioritization is needed in FMU management. Thus, a landscape perspective is considered as a more appropriate approach for forest landscape prioritization to support forest planning in FMU. Landscape perspective underlines that forests landscape prioritization must acknowledge the nature of the forest in FMU as landscapes. It has different characteristic compared to the species-based prioritization. In the landscape ecology discipline, it can be found some landscape characteristics that related to prioritization, namely spatial and temporal. Understanding the application of the landscape perspective in forest landscape prioritization and its spatial and temporal patterns will benefit to forest management. Therefore, the application of landscape approach for Indonesian tropical forest prioritization needs to be studied, especially on how the spatial and temporal patterns of landscape characteristics affect the resultant priority and how the resultant priority spatially and temporally changes.

The summary of the background of this research can be seen in Fig. 1. It shows that deforestation and forest degradation pressure on the Indonesian forests need to be reduced as the requirement for the SFM. Dividing all Indonesian forests into FMUs is certainly a strategic management to achieve the SFM. One of the indispensable tools for managing FMU is conservation planning that applies to all types of FMU (conservation, protection, and production). The availability of the zonation system and special zonation assignment in the FMU contributes to better forest conservation planning. However, since they are relatively static in terms of spatial and temporal and their function are mostly considered as the legal guidance in the forest planning, another tool is required. Prioritization is therefore proposed to support forest planning as the complement of the zonation or special zone assignment. It has been a useful tool for determining conservation areas. This study tries to extend prioritization function in supporting the decision making within existing conservation area.

The introduction of the prioritization in supporting the FMU conservation planning requires the study on its development and application. Conservation prioritization is commonly used to determine the area for conservation. Literally, prioritization was commonly used in determining the conservation FMU but not yet

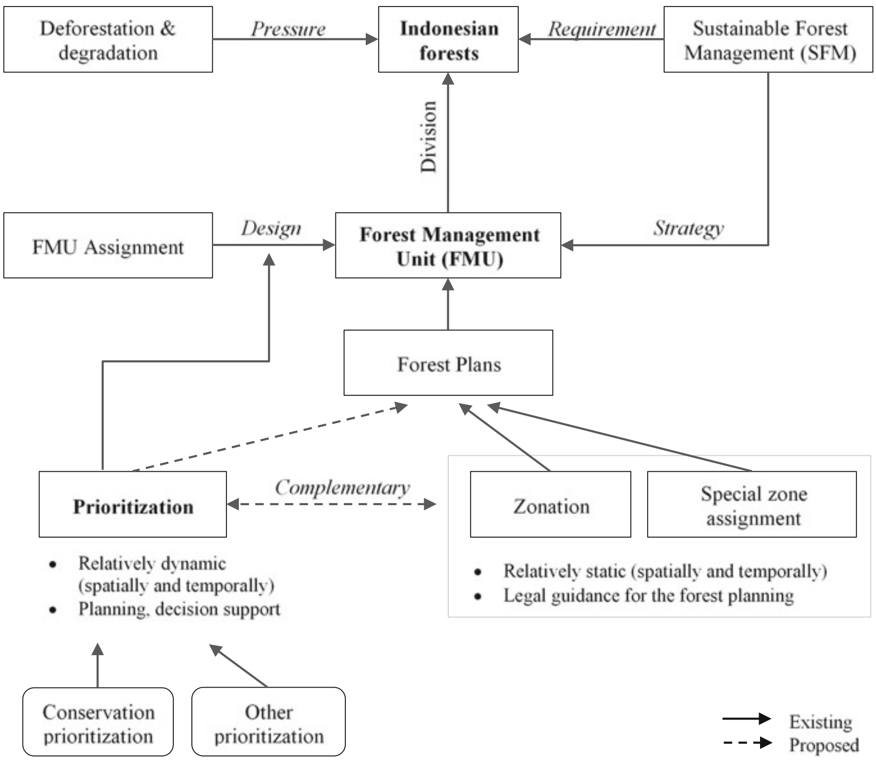

Fig. 1 Need for prioritization to achieve SFM in Indonesian FMUs

applied in prioritizing within existing FMUs. Prioritization may provide beneficiary to support the conservation planning, as the complementary for the existing zonation.

The main objective of this study is to develop and assess the application of the conservation prioritization, in terms of spatial and temporal patterns, in area prioritization of the forest landscape in order to provide a spatial decision support system. In order to achieve that main objective, several works have been done with specific objectives as follows.

1. To formulate the framework for tropical forest landscape prioritization;
2. To prepare the biophysical conditions data and assess their spatial and temporal changes;
3. To assess the spatial and temporal patterns of the preservation prioritization;
4. To assess the spatial and temporal patterns of the rehabilitation prioritization;
5. To formulate the proposed contribution of the forest landscape conservation prioritization for forest landscape zonation;
6. To assess the optimum proportion for conservation priority.

2 Study Site

Sultan Adam Forest Park (SAFP) was selected as the study site due to its wide ecosystem types and significant size. The park is managed by South Kalimantan Provincial Government. It covers about 112,000 ha with an approximately 7,000 ha artificial lake in the middle. The lake also supports irrigation and water supply to several cities downstream. This makes the forest park indispensable for the regional development. Within the park, there is one sub-district that consists of 14 villages with 2,261 households and the population of 8,304 (Government of the Banjar Regency 2009). The map of the SAFP is presented in Fig. 2.

SAFP was established by combining some forest areas. Wild preserve (*suaka margasatwa* in Indonesia) (ca. 36,400 ha), PM Noor Protected Forest (ca. 55,000 ha), Kinain Buak Protected Forest (ca. 13,000 ha), Lambung Mangkurat University Educational Forest (ca. 2,000 ha), and some part of production forest around the Riam Kanan Lake were altogether combined into SAFP (Government of the Republic of Indonesia 1989). SAFP was established with several purposes. In order to achieve those purposes and also as one of the forest management tools, SAFP has been divided into four zones in 1989 (Government of the Republic of Indonesia 1989). Further, the zonation was spatially updated in the long-term planning of SAFP in 2011 (Forestry Service of South Kalimantan Province 2011). The size proportion is shown in Fig. 3.

Zonation in SAFP assures the appropriate activities within each zone. As one of the management tools, zones are used as the legal guidance on what activities are applied in each zone. Each zone in SAFP has a different function as follows

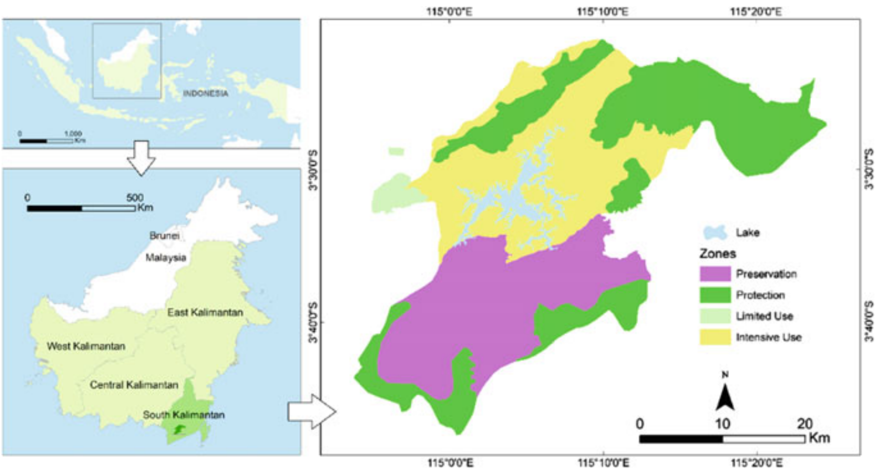

Fig. 2 Map of Sultan Adam Forest Park, Indonesia

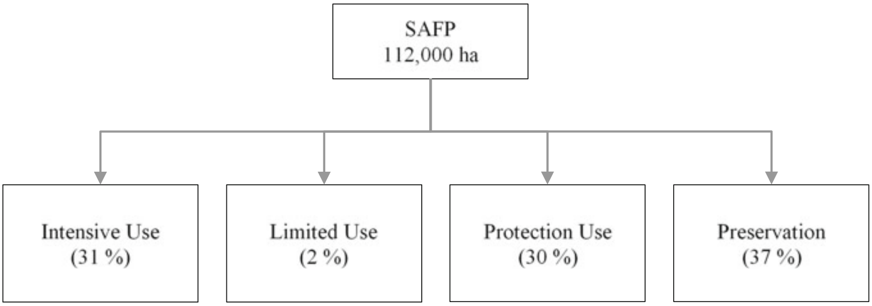

Fig. 3 Proportion of the zones in Sultan Adam Forest Park

(Forestry Service of South Kalimantan Province 2011). Preservation zone is for biodiversity protection, protection zone is for soil and water conservation, limited use zone is for education and research, and intensive use zone is for ecotourism and socioeconomic activities.

3 Framework for Priorities Mapping in Forest Landscape

3.1 Perspectives on Forest Landscape Prioritization

Prioritization is development of strategies to deal with both values/importance and threat/urgency (Nislow et al. 2010). In this stage, multi-criteria analyses (MCA) and expert judgment are often used (Phua and Minowa 2005). For simplification, it can be generalized that the priority is the interaction between value/importance and threat/urgency as showed in the following equation:

$$P_i = V_i \times T_i$$

where P_i is the priority of the i-th task, V_i is the value/importance component, and T_i is the threat/urgency component. The equation specifies that conservation priority is the interaction between value/importance and threat/urgency.

Previous researches have been performed in improving the prioritization procedure. However, the acknowledgment of forest landscape characteristic in forest prioritization is still a niche in prioritization study. Moreover, the widely available prioritization procedure needs adjustment on its application in forest landscape within FMU. Most of prioritization technique was applied for determining conservation area. Designing a new biological preservation is the main focus on the conservation activities (Carwardine et al. 2008). The prioritization in supporting the existing conservation area is lack of development and application.

3.2 A GIS-Based Multi-criteria Analysis

The first step in developing a prioritization is determining what perspective is used. Landscape was selected as the perspective in this study since it gives a better viewpoint for forest conservation. It provides flexibility in the extent and scale (Trombulak and Baldwin 2010). It also acknowledges wider processes (Nislow et al. 2010) such as the presence of inland water, upstream–downstream linkage. Further, determining management tasks has to be performed. Viñas (2005) grouped the conservation into two main tasks, namely (1) preservation and (2) restoration. The concept is relatively new in natural resource management since most studies are related to only preservation such as in Geneletti (2004), Nislow et al. (2010), Balaguru et al. (2006), and Soosairaj et al. (2007).

Preservation and restoration have different characteristics and activities. Preservation means an action taken to keep something as it is. It is the most common practice in conservation. Some studies often refer preservation as the conservation itself. The acknowledgment of preservation task has been accommodated in forest area management. Excluding a forest (or a part of the forest) from disturbance is a simple practice of forest preservation. Meanwhile, restoration is the action to alter the process to something like the original form (Viñas 2005). Restoration task has been adopted in Indonesian forest management as forest and land rehabilitation. However, Roni et al. (2005) stated that restoration and rehabilitation terms have slightly different meaning. Restoration is aimed to achieve the original state. Meanwhile, rehabilitation is to improve some aspects or ecosystems into the functional state. Therefore, in the context of forest conservation planning, the term of rehabilitation is considerably more appropriate rather than restoration.

In each conservation task (preservation or rehabilitation), components must be identified. Component identification may vary among experts or decision makers. However, since the requirement for the conservation planning is to make the procedure is repeatable (Trombulak and Baldwin 2010), different identified component and sub-component in prioritization may still be appropriate as long as the selection procedure is clearly defined. Nislow et al. (2010) gave guidance in the three steps: (1) identification of the biological diversity as the conservation targets including the current and desired status; (2) identification of threats that currently or likely to degrade the biological diversity; and (3) development of technique for prioritization. Those steps can be summarized into three keywords for component identification, namely the value, threat, and prioritization.

Defining the value component of the forest resources has not become a consensus among researchers. In fact, it has been debated for years (Secretariat of the Convention on Biological Diversity 2001). It is caused by non-agreement on defining what can be included as the values and market distortions caused by non-priced goods in forest resources (Krieger 2001). Value of the forest is commonly estimated in monetary value such as in Costanza et al. (1997). However, the precise estimation is not necessary in forest prioritization. Only relative value among forest areas (unit analysis) is required. The value component represents the importance of the activity. Biodiversity is the common component representing the value of the forest landscape (Nislow et al. 2010; Phua and Minowa 2005; Soosairaj et al. 2007). It may be further broken down into sub-component such as forest condition (Valente and Vettorazzi 2008) and vegetation types (Soosairaj et al. 2007).

On the other hand, the value component of the rehabilitation task is considered as the importance to rehabilitate the forest ecosystem. Therefore, the appropriate value in rehabilitation is the severity of the forest/land degradation. In this context, the need to conserve the forest/land for soil and water conservation is the proper value component. The higher severity of the forest/land degradation counts the higher the value for rehabilitation. Identification of the sub-component under each of the value component should be based on the prioritization context. In the forest conservation prioritization, the context of land use decision (Secretariat of the Convention on Biological Diversity 2001) is the most appropriate for identification of the sub-components.

Identified components are further detailed into sub-components. One of the relevant concepts to be considered in sub-component identification is high conservation value forest (HCVF). The Forest Stewardship Council proposed the HCVF in 1999 (Aksenov et al. 2006) as part of the requirement on C&I for SFM (The Consortium for Revision of the HCV Toolkit Indonesia 2009). The use of HCVF has been adopted in many studies with some adjustments. For example, Aksenov (2006) mapped the HCVF by analyzing the less fragmented forest landscape, naturally rare and unique forest communities, known habitat for rare and endangered plant species, and floodplain and bottomland ecosystems of intact river basins as the sub-components. Since different HCVs are often overlapped (Aksenov et al. 2006), few selected HCVs may be appropriate enough to represent the value of the forest landscape.

3.3 Framework for Forest Landscape Prioritization

Further step in developing a framework for prioritization is quantification of the management preference among each components/sub-components using weighting technique. Weights were applied to the relative preference among the criteria. Some weighting methods have been widely used in the MCA. The most common method is equal weight (Phua and Minowa 2005) which considers all criteria in the same level are evenly weighted. Another method is analytic hierarchy process (AHP) that tries to use a descriptive approach in decision making (Saaty 2005) among intangible criteria. It is a semi-qualitative method in decision making (Intarawichian and Dasananda 2010).

AHP is a semi-qualitative method in decision making (Intarawichian and Dasananda 2010) and a descriptive approach to decision making among intangible criteria (Saaty 2005). Weight for each criterion was estimated by a pairwise comparison. In each comparison, it must be decided the degree of importance between criteria based on the preference as shown in Table 1.

AHP was performed using 20 key persons in managing SAFP. Since the main goal of the prioritization is in each task, the total of all weight in each preservation or rehabilitation tasks is one. The summary of the resultant AHP is shown in Table 2.

The resultant conservation prioritization framework in SAFP is shown in Fig. 4.

Table 1 Scale preference between two criteria in AHP

Scale	Degree of preference	Explanation
1	Equally	Two activities contribute equally to the objective
3	Moderately	Experience and judgment slightly to moderately favor one activity over another
5	Strongly	Experience and judgment strongly or essentially favor one activity over another
7	Very strongly	An activity is strongly favored over another, and its dominance is showed in practice
9	Extremely	The evidence of favoring one activity over another is of the highest degree possible of an affirmation
2, 4, 6, 8	Intermediate values	Used to represent compromises between the preferences in weights 1, 3, 5, 7, and 9
Reciprocals	Opposites	Used for the inverse comparison

Adapted from Intarawichian and Dasananda (2010)

Table 2 Summary of pairwise comparison for SAFP prioritization

No.	Task/component	Component	Category	Weight
1.	Preservation	value	Vegetation	0.209
			Forest fragmentation	0.133
			Species status	0.158
		Threat	Forest fire	0.205
			Settlement	0.152
			Accessibility	0.143
2.	Forest rehabilitation	Importance and Urgency	Vegetation	0.525
			Erosion	0.205
			Topography	0.191
			Land management	0.079

4 Biophysical Assessment for Priorities Mapping

Applying landscape perspective in preservation prioritization acknowledges the fundamental concept of landscape, namely scale (King 2005), spatial and temporal (Turner et al. 2001). Scale was adopted in data selection for the analysis referring to Woolmer (2010) that the scale of 1:25,000–100,000 for feature and the resolution of 25–100 m are appropriate for landscape analysis. Spatial and temporal were assessed in the patterns of the biophysical conditions in 1993, 2003, and 2013.

Biophysical data were prepared and assessed in terms of their spatial and temporal changes. Since biophysical conditions were assessed for the parameter of conservation prioritization, consequently, biophysical conditions affect the spatial and temporal patterns of the prioritization. The biophysical conditions used in the prioritization framework are as follows.

1. Land use and land cover (LULC);
2. Forest fragmentation;
3. Species status;
4. Settlement;
5. Accessibility;
6. Forest fire;
7. Soil erosion potential;
8. Hazard prevention;
9. Topography; and
10. Land management.

Biophysical condition in SAFP has spatial and temporal changes. The changes in spatial and temporal dimensions were quantified using a Kappa statistical analysis. The change of the biophysical condition may be considered as a change (Kappa statistics < 0.4), moderate change (Kappa statistics is between 0.4 and 0.8), and no change (Kappa statistics > 0.8). The summary of all biophysical condition change

Table 3 Summary of change analysis on biophysical parameters

Parameter	Kappa statistic ($\widehat{K}$)		Change category	
	1993–2003	2003–2013	1993–2003	2003–2013
LULC/vegetation	0.696	0.808	Moderate	No change
Forest fragmentation	0.644	0.781	Moderate	Moderate
Species status	0.670	0.807	Moderate	No Change
Accessibility	0.708	0.958	Moderate	No change
Forest fire	0.113	0.261	Change	Change
Soil erosion potential	0.245	0.486	Change	Moderate

in SAFP is presented in Table 3. Some biophysical conditions were assumed unchanged due to the nature of the data.

Forest fire is the most change biophysical in the study site. In both periods of 1993–2003 and 2003–2013, forest fire was categorized as changes since both Kappa statistics in the two periods were lower than 0.4. Interestingly, there is no biophysical condition that no change in both periods of study. All biophysical condition in Table 3 has at least a moderate change in one period of analysis.

5 Preservation Prioritization

5.1 Methodology on Preservation Prioritization

A GIS-based structured hierarchy prioritization framework was developed (Fig. 4). The main task of biodiversity preservation was set as the top level of the framework. It was determined based on the purpose of the forest establishment and the criteria and indicators (C&I) for SFM in tropical forest (ITTO 2005). Components were identified at the subsequent level either value or threat. The biodiversity value was considered as value/importance component while deforestation/degradation were considered as threat/urgency component. Therefore, preservation priority is a combination of biodiversity value and deforestation/degradation threat (Fig. 5).

As the subsequent of the biodiversity value component, three sub-components were identified, namely vegetation, forest fragmentation, and species' status. Under the deforestation/degradation threat, three sub-components of settlement, accessibility, and forest fire sub-components were selected. Finally, parameters from biophysical conditions were derived in each corresponding sub-component. The preferences of the decision maker were accommodated as the weight in each component, sub-component, and parameter that were assessed by AHP as shown in Table 5.

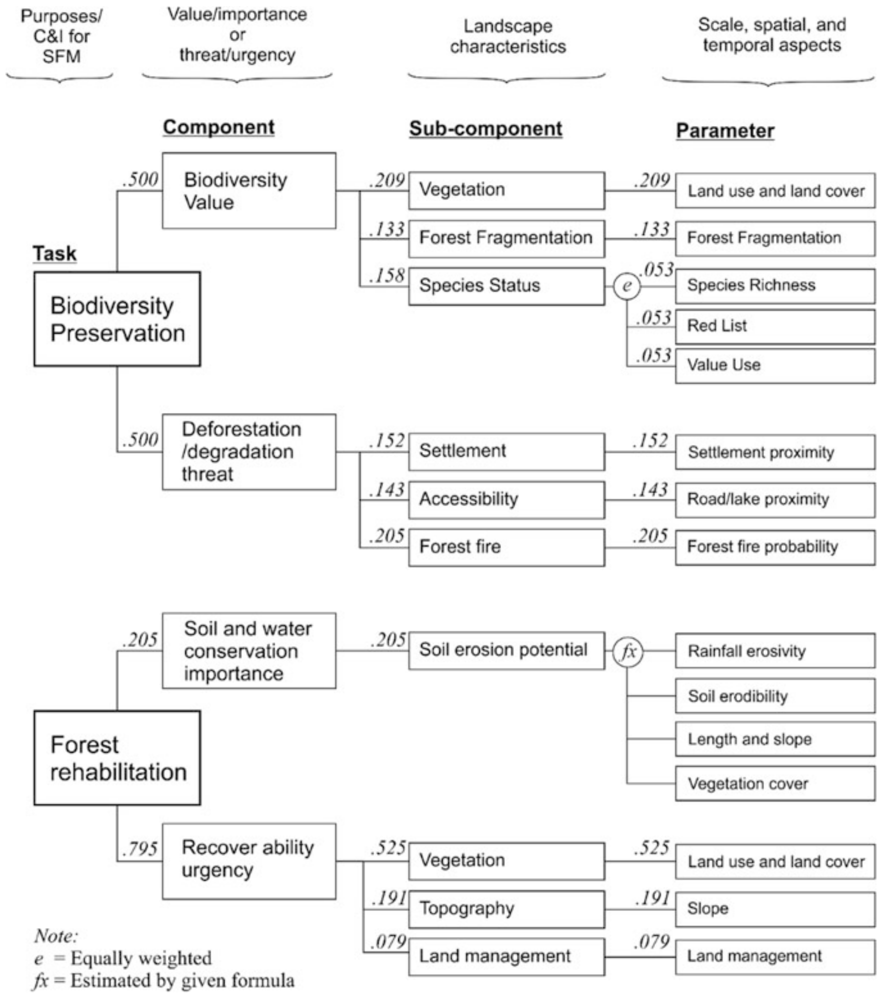

Fig. 4 Framework of conservation prioritization of SAFP

5.2 *Significance of Threat Component*

The introduction of the threat component on the preservation prioritization was assessed by performing two prioritizations: with and without the threat component in 1993, 2003, and 2013. This was performed since many studies often consider only biodiversity component in prioritization. The difference between the two prioritizations was assessed by the confusion matrix as shown in Tables 4, 5, and 6.

The addition of the threat component into preservation framework significantly changed the preservation priority area in 1993, 2003, and 2013. The Kappa statistics for the difference between with and without the threat component were

Fig. 5 Biodiversity preservation priority

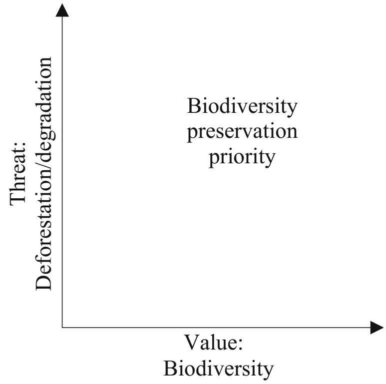

Table 4 Preservation priority area (ha) with the addition of threat component in 1993

Value component only	Value and threat components		Total
	Non-priority	Priority	
Non-priority	64,958	13,067	78,026
Priority	18,478	14,632	33,109
Total	83,436	27,699	111,135

Kappa statistic **0.288**

Table 5 Preservation priority area (ha) with the addition of threat component in 2003

Value component only	Value and threat components		Total
	Non-priority	Priority	
Non-priority	67,037	13,312	80,350
Priority	16,562	14,223	30,785
Total	83,599	27,536	111,135

Kappa statistic **0.306**

Table 6 Preservation priority area (ha) with the addition of threat component in 2013

Value component only	Value and threat components		Total
	Non-priority	Priority	
Non-priority	68,766	13,237	82,003
Priority	14,172	14,960	29,132
Total	82,938	28,197	111,135

Kappa statistic **0.356**

0.288, 0.306, and 0.356 for 1993, 2003, and 2013, respectively (Tables 4, 5 and 6). All of those values are less than 0.4 that means categorized as changes.

Table 7 Change of preservation priority area (ha) from 1993 to 2003

1993	2003		Total
	Non-priority	Priority	
Non-priority	67,559	15,877	83,436
Priority	16,040	11,659	27,699
Total	83,599	27,536	111,135

Kappa statistic **0.231**

Table 8 Change of preservation priority area (ha) from 2003 to 2013

2003	2013		Total
	Non-priority	Priority	
Non-priority	76,308	7,291	83,599
Priority	6,631	20,905	27,536
Total	82,938	28,197	111,135

Kappa statistic **0.667**

5.3 Change of Preservation Priority

The resultant preservation priority area was evaluated. Preservation priority in 2003 had a poor agreement with that in 1993 while preservation priority in 2013 had a moderate agreement with that in 2003. The temporal change of the preservation priority area was assessed by confusion matrices in order to estimate the agreement among the observation years. From 1993 to 2003, the resultant Kappa statistics was 0.231 that mean preservation priority in 2003 has a poor agreement compared to that in 1993. Meanwhile, from 2003 to 2013, the resultant Kappa statistics was 0.667 that mean preservation priority in 2013 has a moderate agreement compared to those in 2003. Both in 1993–2003 and in 2003–2013 periods, the preservation priority area changed with different Kappa statistics. The confusion matrices of preservation priority area are shown in Tables 7 and 8.

6 Rehabilitation Prioritization

6.1 Methodology on Rehabilitation Prioritization

The framework of rehabilitation prioritization was part of the whole framework as can be seen in Fig. 3. The main task of rehabilitation was set as the top level of the framework along the biodiversity preservation. It was also selected based on the purpose of the forest establishment and the criteria and indicators (C&I) for SFM in tropical forest (ITTO 2005). Components were identified at the subsequent level either importance or urgency. Soil and water conservation was considered as importance component while recoverability was considered as the urgency

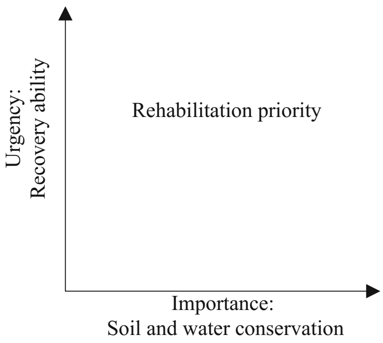

Fig. 6 Rehabilitation priority as the combination of importance and urgency components

component. Therefore, rehabilitation priority is a combination of soil and water conservation importance and recoverability urgency (Fig. 6).

As the subsequent of the soil and water conservation component, only one sub-component was identified, namely soil erosion potential. The higher rate of the soil erosion potential the higher its importance. Under the recoverability component, three sub-components of vegetation, topography, and land management were identified. Finally, parameters from biophysical conditions were derived in each of those sub-components. The preferences of the decision maker were accommodated as the weight in each component, sub-component, and parameter that were assessed by AHP as shown in Table 5.

6.2 Significance of Recoverability Component

The introduction of the recoverability component on the rehabilitation prioritization was assessed by performing two prioritizations: with and without the recoverability component in 1993, 2003, and 2013. The difference between the two prioritizations was assessed by the confusion matrix with Kappa statistics as shown in Tables 9, 10, and 11.

The addition of the recoverability component into rehabilitation framework significantly changes the rehabilitation priority in 1993, 2003, and 2013. As can be seen in Tables 9, 10, and 11 that recoverability urgency component changes significantly, the resultant priority area with all Kappa statistics is lower than 0.4.

Table 9 Rehabilitation priority area (ha) with and without recoverability urgency in 1993

Importance component only	Importance and urgency components		Total
	Non-priority	Priority	
Non-priority	82,552	27,703	110,255
Priority	–	880	880
Total	82,552	28,583	111,135

Kappa statistic **0.045**

Table 10 Rehabilitation priority area (ha) with and without recoverability urgency in 2003

Importance component only	Importance and urgency components		Total
	Non-priority	Priority	
Non-priority	82,071	25,216	107,288
Priority	869	2,978	3,847
Total	82,940	28,195	111,135

Kappa statistic **0.133**

Table 11 Rehabilitation priority area with and without recoverability urgency in 2013

Importance component only	Importance and urgency components		Total
	Non-priority	Priority	
Non-priority	81,326	25,587	106,914
Priority	1,149	3,073	4,221
Total	82,475	28,660	111,135

Kappa statistic **0.129**

6.3 Change of Rehabilitation Priority

The resultant rehabilitation priority area was evaluated by confusion matrices in order to estimate the agreement among the observation years. From 1993 to 2003, the resultant Kappa statistics was 0.264 that means the rehabilitation priority area in 2003 has a poor agreement compared to those in 1993. Meanwhile, from 2003 to 2013, the resultant Kappa statistics of 0.816 was calculated that means the rehabilitation priority area in 2013 has a good agreement compared to those in 2003. Rehabilitation priority area changed in 1993–2003 and unchanged in 2003–2013. The confusion matrices of rehabilitation priority area are shown in Tables 12 and 13.

Table 12 Change of rehabilitation priority area (ha) from 1993 to 2003

1993	2003		Total
	Non-priority	Priority	
Non-priority	75,619	6,933	82,552
Priority	7,321	21,261	28,583
Total	82,940	28,195	111,135

Kappa statistic **0.264**

Table 13 Change of rehabilitation priority area (ha) from 2003 to 2013

2003	2013		Total
	Non-priority	Priority	
Non-priority	78,823	4,117	82,940
Priority	3,652	24,543	28,195
Total	82,475	28,660	111,135

Kappa statistic **0.816**

7 Spatial Decision Support for Forest Zonation Based on Prioritization

7.1 Spatial and Temporal Patterns of Prioritization Regimes

Conservation consists of two main tasks, namely **preservation** and **rehabilitation**. Each of the tasks has different activities in practices. Preservation is focused on how to protect valuable biodiversity assets while rehabilitation is focused on how to improve the condition of the forest ecosystem into its functional state. Those two tasks were separately practiced. Thus, the combination of the two tasks may introduce a useful concept for forest landscape management, called the prioritization regime, as can be seen in Fig. 7.

Both preservation and rehabilitation priorities were categorized into two classes. The equal class limit was used which therefore 0.5 was selected as the class limit. Thus, four regions in the prioritization regimes were proposed as shown in Fig. 8, namely conservation, preservation, rehabilitation, and enhancement prioritization regimes.

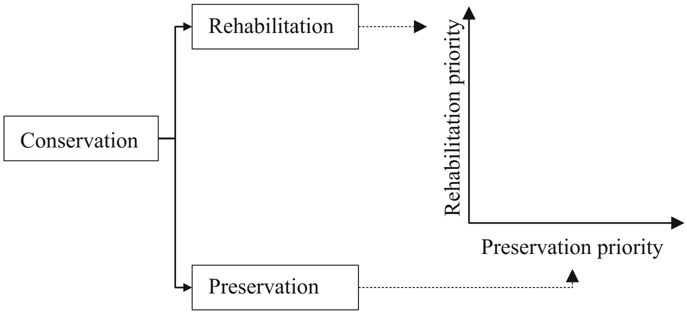

Fig. 7 Preservation and rehabilitation tasks as the base for prioritization matrix

Fig. 8 Proposed prioritization regimes

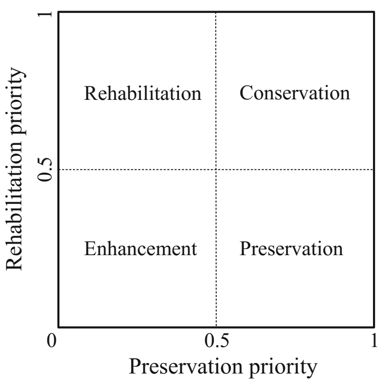

Table 14 Proposed prioritization regimes as the basis for the forest landscape zonation

No.	Prioritization regimes	Priority criteria
1.	Conservation regimes	High preservation (>0.5) High rehabilitation (>0.5)
2.	Preservation regimes	High preservation (>0.5) Low rehabilitation (<0.5)
3.	Rehabilitation regimes	Low preservation (<0.5) High rehabilitation (>0.5)
4.	Enhancement regimes	Low preservation (<0.5) Low rehabilitation (<0.5)

Table 15 Change of prioritization regimes (ha) from 1993 to 2003

Regimes (1993)	Regimes (2003)			
	Conservation	Preservation	Rehabilitation	Enhancement
Conservation	15	183	2629	7704
Preservation	20	51,039	2059	13,038
Rehabilitation	–	5	2059	3032
Enhancement	7	9517	1742	18,087

Kappa statistic **0.371**

Table 16 Change of prioritization regimes (ha) from 2003 to 2013

Regimes (2003)	Regimes (2013)			
	Conservation	Preservation	Rehabilitation	Enhancement
Conservation	1	40	–	42
Preservation	51,906	935	7886	60,743
Rehabilitation	23	8268	176	8490
Enhancement	6644	1310	33,903	41,861

Kappa statistic **0.727**

The criteria used for proposed preservation regimes in the forest landscape are shown in Table 14.

The temporal change of the proposed prioritization regime was assessed by a confusion matrix in order to estimate the agreement among the observation years. From 1993 to 2003, the resultant Kappa statistics was 0.371 that means the prioritization regime in 2003 had a poor agreement compared to those in 1993. Meanwhile, from 2003 to 2013, the resultant Kappa statistics was 0.727 that means the prioritization regime in 2013 had a good agreement compared to those in 2003. The confusion matrices of the prioritization regime are shown in Tables 15 and 16.

7.2 Forest Landscape Zonation Based on Prioritization Regimes

SAFP has four designated zones, i.e., preservation, protection, limited use, and intensive use zones. The zones were spatially distributed as can be shown in Fig. 9a. As the comparison, the proposed prioritization regimes are shown in Fig. 9b. The proposed prioritization regimes have visually agreement with the SAFP zonation. Conservation and preservation regimes were distributed in the south and east parts of SAFP. This condition is relevant to the corresponding zones (preservation and protection) that had similar spatial distribution. The middle of the park, which was dominated by intensive use zone, also has the appropriate proposed rehabilitation and enhancement regimes.

The result of the spatial analysis of comparing the zonation and prioritization regimes is presented in the confusion matrix in Table 17.

Based on the appropriateness function between prioritization regimes and zonation, the appropriateness of the current zonation was compared with the prioritization regimes with the matrix in Table 18. Preservation and protection zones were 66,011 ha (59%) appropriate and 8,736 ha (8%) not appropriate. On the other hand, the limited and intensive use zones have 25,346 ha (23%) appropriate while 11,042 ha (10%) is not appropriate.

The agreement between current zonation and prioritization regimes was assessed by Kappa statistical analysis with the resultant Kappa statistics of 0.59 was considered as a moderate agreement. It shows that the current designated zones have a good agreement with the proposed prioritization regimes. Prioritization regimes showed its possible application in evaluating the current zonation. Zonation in SAFP has a moderate agreement with the proposed conservation prioritization regimes (in 2013 condition). Since the prioritization regime was the resultant of the landscape approach, it can be expected that the prioritization regime can frequently

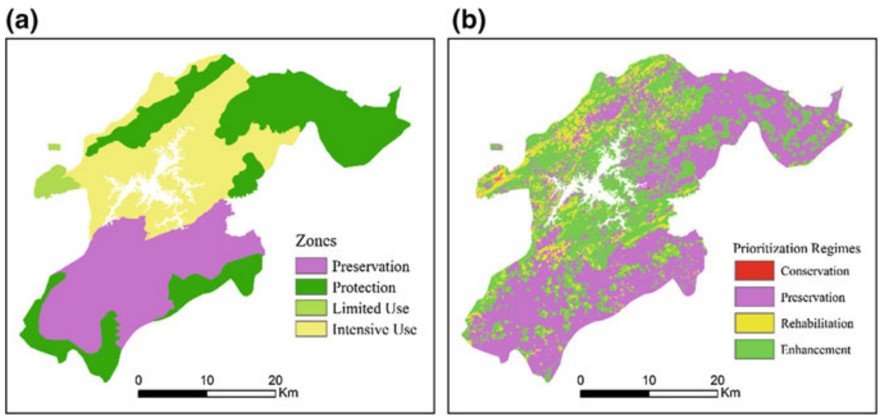

Fig. 9 Map of **a** current SAFP zones and **b** proposed prioritization regimes

Table 17 Management zones and proposed prioritization regimes in SAFP

Size (ha)		Regimes			
		Conservation	Preservation	Rehabilitation	Enhancement
Zones	Preservation	2	20,452	4131	9213
	Protection	1	27,096	4605	9248
	Limited Use	23	430	1076	600
	Intensive use	93	10,496	7555	16,115

Table 18 Review on the SAFP's zonation based on the prioritization regime (ha)

Zones	Prioritization regimes	
	Appropriate for reservation and protection zones	Appropriate for limited/ intensive uses zones
Preservation and protection	66,011	8736
Limited and intensive uses	11,042	25,346

Kappa statistic **0.59**

be analyzed. Prioritization regime is proposed as one tool in FMU zonation. Since zonation needs to be assigned in the long-term forest plan (20 years), prioritization regime is suggested in the shorter term forest plan (5-years or 1-year forest plan).

8 Optimization

Priority area is a portion of the highest priority index, which is assigned as the priority, while the rest is classed as non-priority. Defining priority area is, therefore, equal to categorizing the priority index into two classes, namely priority and non-priority. It is critical to determine the threshold between priority and non-priority. The most common practice for defining priority is by arbitrarily set the proportion which is considerably reasonable such as 5% (Woodhouse et al. 2000), 10% (Geneletti 2004), or 30% (Zhang et al. 2014) from the total area of the study. The arbitrarily set is acceptable if there is no such quantitative assessment of the optimum proportion for priority. Therefore, finding the optimum priority proportion is needed.

The resultant priority area depends on the prioritization method. However, there are many applications that use different criteria or weight in prioritization. For example, the most common criteria for the forest rehabilitation priority in Indonesia are erosion rate, land cover, slope, and land management (Indonesian Ministry of Forestry 2013). Meanwhile, on Borneo Island, Phua and Minowa (2005) used natural hazard prevention which covers landslide, drought, and flood prevention as criteria for prioritization of soil and water conservation. Liu et al. (2003) used vegetation cover, drifting sand coverage, annual desertification, and population pressure for land rehabilitation in China. Thus, criteria for conservation prioritization vary among applications. In addition, prioritization also depends on the weights of each component; whether they are equally weighted (Jiménez-Alfaro et al. 2010; Marshall and Homans 2006; Phua and Minowa 2005), weighted by key figures (Phua and Minowa 2005), or analyzed through AHP (Intarawichian and Dasananda 2010; Jaiswal et al. 2014; Saaty 2005).

Optimum proportion for determining priority area is determined by considering two main aspects as follows.

1. Temporal consistency: Temporal consistency is related to the consistency of the resultant priority area across time. It is expected that the priority area does not change significantly over time.
2. "As small as possible" principle: The principle in conservation prioritization is finding as small as possible area (Carwardine et al. 2008). Forest managers could not distribute all resource to all forest landscapes. Instead, they need only a small portion, which has relatively higher priority compared to others.

Series of prioritizations were performed by using several designated proportion for the priority area, namely 2.5, 5, 10, 20, 30, 40, 50, 60, 70, 80, 90, 95, and 97.5%. The focus of this study is only on the priority area. Therefore, the average agreement/accuracy (of producer and user accuracies) instead of Kappa statistic was used to assess the priority changes. Plots of average agreement were analyzed by regression analysis. The minimum average agreement of 80% was selected as the minimum requirement. The agreement in two periods of analyses is presented in Tables 19 and 20.

The resultant linear model to correlate between the priority proportion and the average agreement is shown in Table 21.

In order to gain 80% average agreements, it is calculated that the optimum preservation proportion for 1993–2003 was **75%** and for 2003–2013 was **35%**. Meanwhile, the optimum rehabilitation proportion for 1993–2003 was **38%** and for 2003–2013 was not able to be determined.

The study shows that there was no single optimum proportion calculated for both preservation and rehabilitation in 1993–2003 and 2003–2013. For preservation prioritization, it was calculated that the optimum proportion for preservation was 75% in 1993–2003 and 35% in 2003–2013. Higher temporal change then higher priority proportion is needed.

The optimum proportion for rehabilitation in 2003–2013 was not able to be determined. As small as 0% proportion on the linear regression model has more than 80% average agreement. The possible cause of this condition is the insignificance on the temporal rehabilitation change. This condition is relevant since the

Table 19 Agreements for the **preservation** priority proportions in 1993–2003 and 2003–2013

Proportion	1993–2003			2003–2013		
	Producer	User	Average	Producer	User	Average
2.5	24.8	25.0	24.9	29.4	25.7	27.6
5	35.0	34.5	34.7	43.8	46.5	45.2
10	40.7	37.7	39.2	62.1	64.1	63.1
20	41.5	39.6	40.6	72.9	73.5	73.2
30	45.0	42.5	43.8	76.6	79.2	77.9
40	53.1	50.6	51.9	80.6	82.8	81.7
50	61.5	59.7	60.6	72.7	94.3	83.5
60	70.1	70.9	70.5	89.8	88.8	89.3
70	78.7	78.8	78.7	91.7	91.5	91.6
80	84.5	84.2	84.4	93.5	93.2	93.4
90	91.8	91.7	91.7	96.2	96.3	96.3

Table 20 Agreements for the **rehabilitation** priority proportions in 1993–2003 and 2003–2013

Proportion	1993–2003			2003–2013		
	Producer	User	Average	Producer	User	Average
2.5	24.8	25.0	24.9	29.4	25.7	27.6
5	35.0	34.5	34.7	43.8	46.5	45.2
10	40.7	37.7	39.2	62.1	64.1	63.1
20	41.5	39.6	40.6	72.9	73.5	73.2
30	45.0	42.5	43.8	76.6	79.2	77.9
40	53.1	50.6	51.9	80.6	82.8	81.7
50	61.5	59.7	60.6	72.7	94.3	83.5
60	70.1	70.9	70.5	89.8	88.8	89.3
70	78.7	78.8	78.7	91.7	91.5	91.6
80	84.5	84.2	84.4	93.5	93.2	93.4
90	91.8	91.7	91.7	96.2	96.3	96.3

Table 21 Summary of the linear regression analysis between priority proportions and the average agreements in 1993–2003 and 2003–2013

Model	Period	Models	R^2	Fsig
Preservation	1993–2003	$y = 26.801 + 0.713x$	0.980	<0.01
	2003–2013	$y = 49.163 + 0.616x$	0.772	<0.01
Rehabilitation	1993–2003	$y = 35.243 + 0.861x$	0.755	<0.01
	2003–2013	$y = 80.4 + 0.171x$	0.865	<0.01

temporal change of the rehabilitation priority area in 2003–2013 was categorized as no change. Therefore, it also confirms that the higher temporal change then higher priority proportion is needed.

The optimum proportion is hard to be consistently defined since it depends on the spatial and temporal change of the preservation and rehabilitation prioritizations. Thus, this study confirms that arbitrary proportion for determining priority area in forest landscape still the appropriate option.

9 Conclusions

This study has found several findings in priority mapping in landscape for conservation prioritization in the study site as follows.

1. This study has successfully developed and applied the conservation prioritization in the forest landscape with the introduction of new conservation concept, redefined criteria/component identification, and landscape approach. Even the resultant framework for prioritization was developed specifically for the study site, the procedure, how to develop the prioritization framework, is a valuable guideline for the adoption.
2. Spatial and temporal patterns of the biophysical conditions affect the spatial and temporal patterns of prioritization in both preservation and rehabilitation.
3. The incorporation of the threat component into preservation prioritization significantly changes the resultant priority area. In addition, the incorporation of the recoverability component into the rehabilitation prioritization also significantly changes the resultant rehabilitation priority area. Therefore, redefined criteria identification into value/importance and threat/urgency is crucial in conservation prioritization.
4. Priority area changed spatially and temporally. Preservation priority area changed in 1993–2013 period and moderately changed in 2003–2013 period, while the rehabilitation priority area changed in 1993–2003 but did not change in 2003–2013. The acknowledgment on their patterns is indispensable for forestry planning.
5. The concept that considers preservation and rehabilitation as the two main conservation tasks shows its usable application for forest planning in order to support the spatial decision support system of the designated forest management unit. Prioritization regime as the combination between preservation and rehabilitation showed its applicability in supporting forest planning and evaluating the current zonation. Therefore, prioritization regime based is proposed as the complementary tool in FMU forest planning.
6. The optimum proportion which requires high temporal consistency and meets ‘as small as possible’ principle is hardly determined. Thus, arbitrary proportion determination is still favorable.

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Chapter 11
Forest Management Based on Site Suitability: A Case Study of Odai Town, Mie Prefecture, Japan

Keiko Nagashima

Abstract Increase in degraded plantation forests in Japan requires an integrated management system that enhances the multiple-use of forests to achieve sustainable forest management. This paper introduces the steps taken in Odai town in Mie Prefecture, Japan, to establish a forest management regime map by evaluating the site suitability for forestry. Site suitability was evaluated from two aspects: the natural site conditions and the relationship among site conditions, growth, and insect damage by *Anaglyptus subfasciatus* Pic. in *Cryptomeria japonica* D. Don and *Chamaecyparis obtusa* Sieb. et Zucc. forests. By analyzing the relationship among site conditions, growth, and insect damage based on field data obtained in plantation forests, a growth evaluation map and insect damage evaluation map were developed. Based on the natural forest investigation, natural site condition maps for *C. japonica* and *C. obtusa* were established. Furthermore, by integrating these evaluation maps with the forest road maps showing the accessibility to the forest, the forest management regime for whole of the plantation area of Odai town was established. The forest management regime map indicates sites suitable for long-rotation forestry and short-rotation forestry, and potential sites for short-rotation forestry. Sites more suitable for conversion to broadleaved forests are also identified. Based on the forest management regime map, different forest operations have begun to be implemented at each evaluated area. For sites suitable for long rotation, thinning is implemented for inferior trees and will be repeated as the trees approach the age for cutting (more than 100 years). Thinning is also conducted for the sites suitable for short rotation. However, these will be cut down more rapidly as the trees reach the age for cutting (50 years). At sites evaluated as being more suitable for conversion to broadleaved forests, clear-cutting in a small area is conducted and about 20 broadleaved species are planted in an area of

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80–120 m^2 protected by deer fences. As these measures have just begun, their effect on enhancing sustainable forest management is still being monitored. Notably, the people implementing these measures are proud of their task and work actively, which might be the most important driving force to solve the problem of plantation forest abandonment and to enhance sustainable forest management in Japan.

1 Introduction

Increase in degraded plantation forests caused by the abandonment of forest management is anticipated to reduce future timber production and the capacity to conserve soil, water, and biodiversity in Japan. An overall management regime that classifies sites for forestry that should be rehabilitated by encouraging appropriate forest management practices and plantation sites that should be converted to broadleaved forests or conifer-broadleaved mixed forest is required to enhance the multiple functions of forests to achieve sustainable forest management.

The most important consideration for sustainable forest management is to ensure that the tree species are suited to the site conditions (Ray and Broome 2003). Traditionally, forest sites were evaluated by using the site index, which is the mean height of dominant trees at a reference age. It was developed to assess site productivity of mono-cultural even-aged stands (Pokharel and Dech 2011), and it has been used worldwide, including in Japan (Hagglund 1981; Monserud et al. 1990; Mitsuda et al. 2007). However, several drawbacks have been observed with this method, such as the difficulty to determine site indexes in degraded stands and uneven-aged stands (Pokharel and Froese 2009). As an alternative approach, ecological land classification (ELC) began to attract attention. ELC is an approach that stratifies the landscape into ecologically meaningful units (ecosites) based on biotic, climatic, and soil conditions (Pokharel and Dech 2011) and uses this classification as a common base to understand the forest attributes of interest. Applying the predicted ecosite-base productivity derived from the stand-level studies to the ecosite map, which represents a combination of accounted substrate and vegetation types, allows us to understand productivity at the landscape level. In addition, the interaction of ecosites with other forest attributes, such as wildlife habitat, biodiversity, and non-timber forest products, might support decision-making regarding integrated forest management (Pokharel and Dech 2011).

The ELC approach might be useful to establish an overall management regime showing where to continue forestry and where to convert plantations to broadleaved forests in Japan. However, this approach is not without its challenges. This paper introduces these challenges in Odai town in Mie Prefecture of Japan where sites suitable for forestry were classified by applying ELC for forest management.

2 Study Area

Odai town is located in the central south-western part of Mie Prefecture (34°39′ N, 136°40′ E), central Japan (Fig. 1). More than 90% of the area (36,294 ha) is covered by forests, which are mostly privately owned (27,989 ha), and 59% of the private forests (16,500 ha) comprise plantation forests (Mie Prefectural Government 2011). The area is largely mountainous, mostly covered by steep slopes of more than 30°. The climate is temperate with an annual mean temperature of 15.5 °C and heavy rains with annual precipitation of 3147 mm from the year 1981 to 2010 (Japan Meteorological Agency 2013). Forestry is one of the main industries of the town. However, as with other forestry areas in Japan, it had been influenced by the difficulties currently faced by Japanese forestry (e.g., falling timber prices, increasing operational costs, and aging and declining forestry workforce) which have resulted in an increase in the number of forestry sites that have abandoned forest management practices.

With a view to normalize and enhance forestry in the town, the Odai town government decided to establish a forest management regime based on site suitability by cooperating with the forestry cooperatives who implement forest management practices in Odai town. The objective of the regime was to enhance the multiple functions of forests together with improving the economic efficiency of plantation forests. In concrete, it aimed to determine the site suitability of *Cryptomeria japonica* D. Don and *Chamaecyparis obtusa* Sieb. et Zucc., the main species in the plantation, by using geographic information system (GIS) data and identify suitable sites to continue with forestry for each species and suitable sites for converting plantations to broadleaved forests.

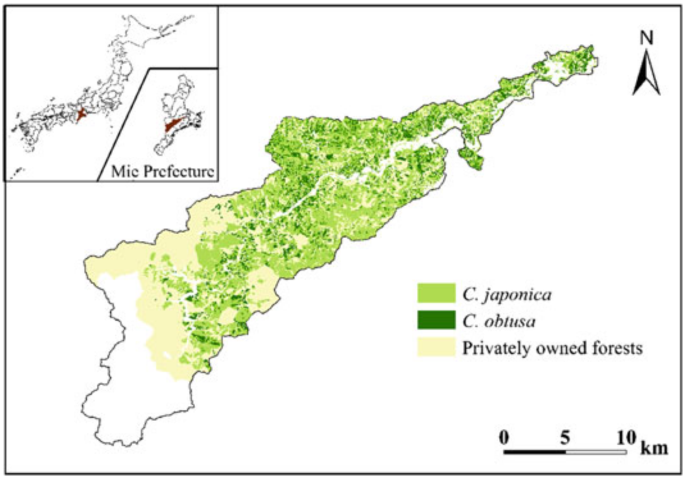

Fig. 1 Location of Odai town and its plantation area of *C. japonica* and *C. obtusa* forest (modified from Nagashima et al. 2017)

3 Evaluation of Site Suitability

3.1 Steps of Site Suitability Evaluation

Site suitability was evaluated mainly from two aspects: the natural distribution in natural forests and growth and insect damage in plantation forests (Fig. 2). The former was aimed at understanding the original or natural site suitability of the two main plantation species (*C. japonica* and *C. obtusa*), which might provide knowledge for long-rotation forestry. The latter aimed to evaluate the site not only for productivity but also for the quality of the timber, which influences the timber price at the plantation forests. By analyzing the relationships among site conditions, growth, and insect damage based on the field data obtained in the plantation forests, a growth evaluation map and an insect damage evaluation map were developed. Based on the natural forest investigation, natural site condition maps for

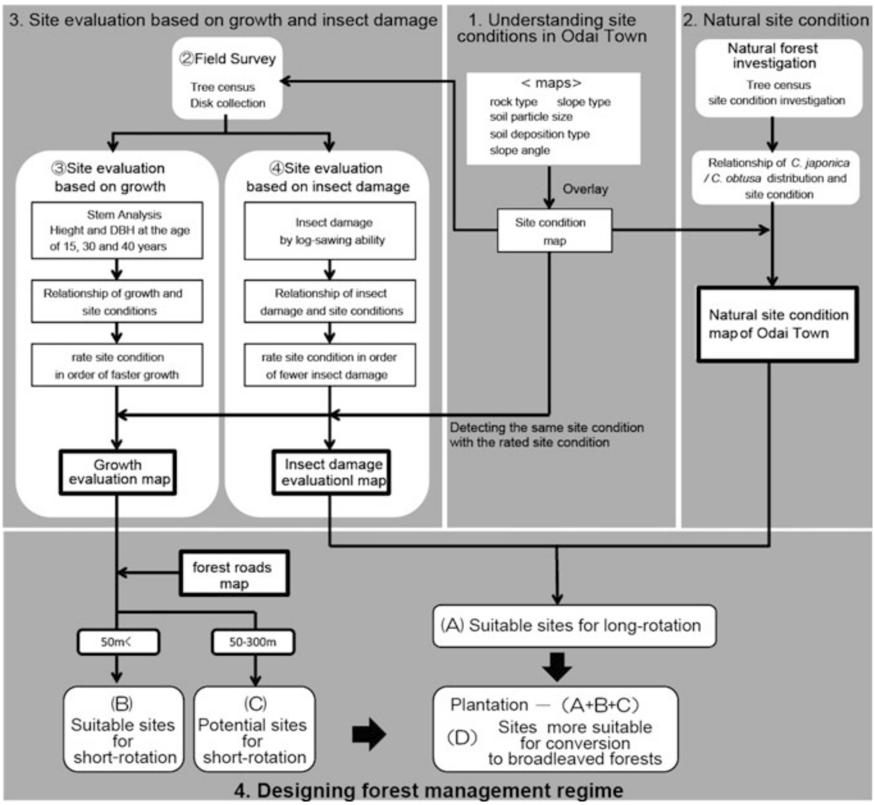

Fig. 2 Steps of site suitability evaluation (modified from Nagashima 2013)

C. japonica and *C. obtusa* were established. By integrating these evaluation maps with the forest road maps showing the accessibility to the forest, the forest management regime was determined for whole of the plantation of Odai town.

3.2 Understanding Site Conditions in Odai Town

The first step of site evaluation was to understand the site conditions of Odai town (Fig. 2). The site condition was interpreted by overlaying the maps of rock type, slope type, soil particle size, soil deposition type, and slope angle by using GIS. The 1/200,000 scaled seamless digital geological map (The National Institute of Advanced Industrial Science and Technology 2010) was used as a rock type map. The slope angle map was obtained by calculating the slope angle based on the 5 m digital elevation model provided by Odai town, which was then divided into three classes: gentle slope (0°–20°), moderately steep (21°–30°), and steep (31° and above). The slope type, soil particle size, and soil deposition type maps were developed by interpretation of topographical maps and confirmation in the field. The obtained site condition map consisted of polygons representing combinations of the attributes, which are recognized as ecosites using the ELC approach.

3.3 Site Evaluation Based on Natural Distribution

3.3.1 Understanding the Natural Site Conditions of *C. obtusa*

For understanding the natural site conditions of *C. obtusa*, Odaigahara in Yoshino-Kumano National Park of Nara Prefecture (Fig. 3), where natural *C. obtusa* forests are distributed, was selected as a study site. Fifty 10×10 m^2 study plots were established in the western Odai area, and tree census (tree species, diameter at breast height (DBH), and height) and site conditions (slope type, slope angle, deposition type, and soil particle size) were investigated. The average DBH of *C. obtusa* was 43.0 cm and the maximum DBH was 104.3 cm. The average height was 17.4 m and the maximum height was 30.7 m. The study plots were divided into vegetation groups based on the proportion of accumulated basal area of each species for each study plot by cluster analysis, and the relationship between vegetation groups and site condition was analyzed using decision tree analysis. A group was thus identified dominated by *C. obtusa* showing a tendency to distribute on the convex site with residual deposits and soil particle size of clay (Tsuchida 2013).

Therefore, by detecting the site combination of convex slope type and residual deposits with clay from the site condition map, the natural site condition map for *C. obtusa* in Odai town was developed as shown in Fig. 4.

Fig. 3 Natural *C. obtusa* forest in Odaigahara, Yoshino-Kumano National Park of Nara Prefecture

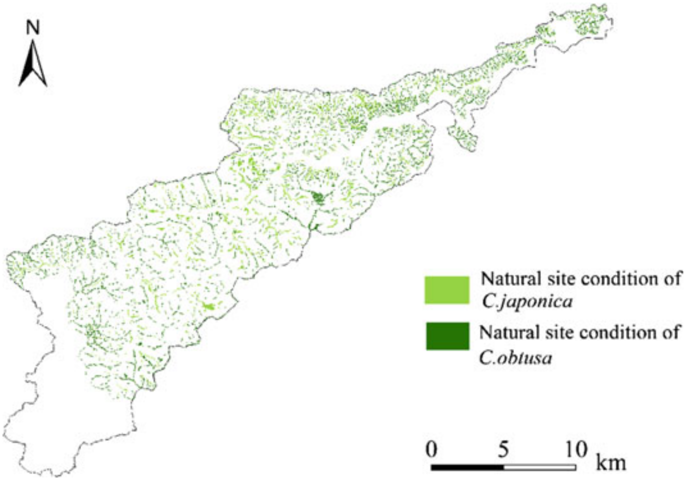

Fig. 4 Natural site condition map for *C. japonica* and *C. obtusa*

3.3.2 Understanding the Natural Site Condition of *C. japonica*

It is known that *C. japonica* could be divided into two groups genetically: the group mainly distributed along the Sea of Japan and that distributed along the Pacific Ocean (Kimura et al. 2014; Shiraishi et al. 2016). The natural forests of the Pacific Ocean of the type *C. japonica*, which is the same type as that planted in Odai town, are rarely found. Therefore, we investigated a 190-year-old *C. japonica* stand at Omata national forest in Mie Prefecture (Fig. 5), which consists of large *C. japonica* stands similar to those in the natural forests and might provide insight for site suitability assessments.

Fig. 5 190-year-old *C. japonica* stand at Omata national forest, Mie Prefecture

Three 30 × 30 m^2 study plots and one 30 × 10 m^2 study plot were established in the 190-year-old *C. japonica* stand, and DBH, tree height, and site conditions (slope type, slope angle, deposition type, and soil particle size) were investigated. The average DBH of the stand was 89.5 cm with a maximum of 140.7 cm. The mean height was 39.8 m with a maximum of 50.8 m. The site was covered by silt with colluvial deposits, which was considered to have high potential for growing large *C. japonica* trees. In other words, the site was considered to be suitable for long-rotation forestry (Tsuchida 2013).

Therefore, the site combination of silt with colluvial deposits was identified using the site condition map, and the natural site condition map for *C. japonica* in Odai town was developed as shown in Fig. 4.

3.4 Site Evaluation Based on Growth and Insect Damage

3.4.1 Field Survey

In order to understand the relationship among site conditions, growth, and insect damage, 11 plantation sites with main site conditions in Odai town were detected. In total, 153 study plots with dimensions of 10 × 10 m^2 were set up in a *C. japonica* forest stand and 142 plots in a *C. obtusa* forest stand at the 11 detected plantation sites. Tree census (DBH, height) was conducted, and, based on the tree census data, three trees (dominant, intermediate, and inferior) were selected and cut down for disk collection. Disks were collected at heights of 0, 0.2, and 1.2 m, and at 2-m intervals afterward to the top of the tree; these were used for both stem analysis and insect damage investigation.

3.4.2 Site Evaluation Based on Growth

By measuring the tree ring width of the disks collected during the field survey, the DBH and height of trees aged 15, 30, and 40 years were calculated for each tree. Then, the average DBH and height at the age of 15, 30, and 40 years were calculated for each plot. As site condition information based on the GIS data was already available for each plot, the data with the same site conditions were pooled to calculate the average DBH and height at the age of 15, 30, and 40 years for each site condition. Cluster analysis was then performed to divide site conditions into groups with the same tendency of growth of DBH and height.

Four groups of site conditions with the same tendency of growth of DBH and height were identified by cluster analysis, for *C. japonica* and five groups for *C. obtusa* forests. The clusters were ranked by the rate of growth, mainly considering the growth rate of DBH (Fig. 6), and the site conditions classified into each rated group were confirmed. As for *C. japonica,* concave sites with colluvial deposits tended to grow more quickly while convex sites with residual deposits tended to grow more slowly, as has been reported in previous studies (Makihara 1987). The higher proportion of sites with colluvial deposits in the faster growth cluster and higher proportion of sites with residual deposits in the slower growth clusters were also observed for *C. obtusa.* In addition, *C. obtusa* tended to grow slower at sites with clay soil.

Based on site conditions of each rated group, the site condition map was color-coded and growth evaluation maps were obtained for *C. japonica* and *C. obtusa* (Fig. 7).

3.4.3 Site Evaluation Based on Insect Damage

Here, insect damage refers to damage by *Anaglyptus subfasciatus* Pic. Damage by *A. subfasciatus* was considered because it was the main disturbance that occurred in plantations of Odai town, turning the timber brownish and therefore directly influencing the timber price. If a certain site has high productivity but also has a

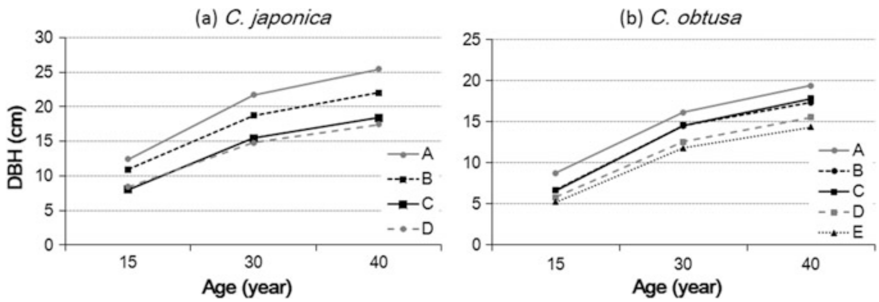

Fig. 6 Growth of DBH by ranked classes

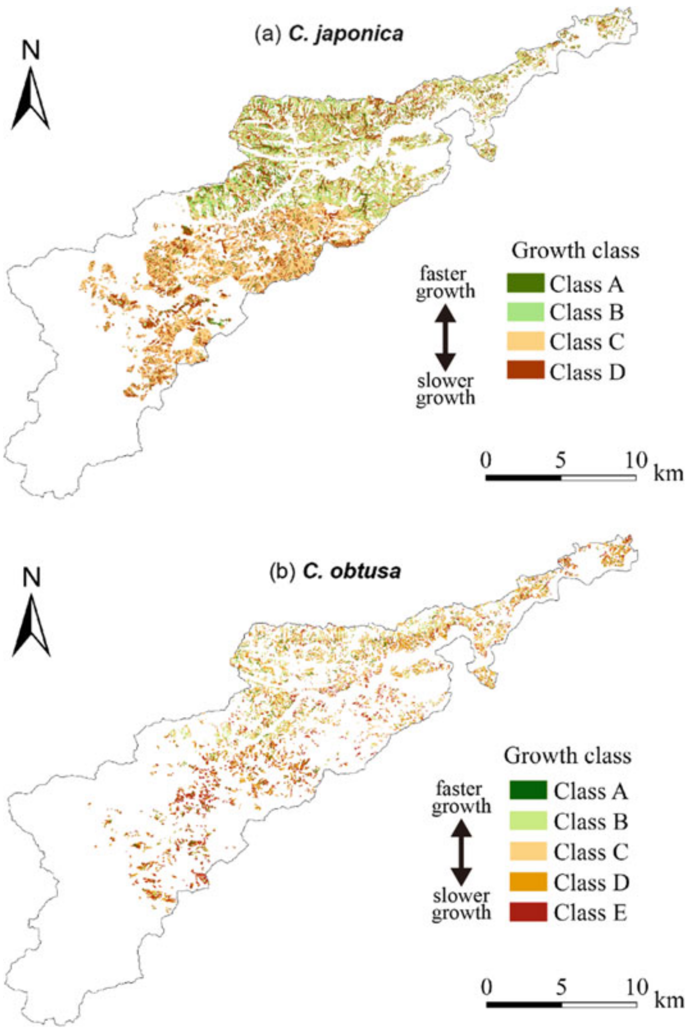

Fig. 7 Growth evaluation maps for *C. japonica* and *C. obtusa*

tendency for considerable damage by *A. subfasciatus,* the site might be difficult to evaluate as a suitable site for long-rotation forestry because the obtained timber might attract a lower price even if trees grew for a long time, increasing the cost of production. On the other hand, if a site with low productivity is not susceptible to damage, it could be considered a suitable site for long-rotation forestry, especially for *C. obtusa*, because it might provide large trees with thick tree rings, which attract high prices in the market. Thus, the quality of the log was one of the crucial points for evaluating site suitability for forestry in this study.

To understand the relationship between site condition and damage by *A. subfasciatus*, the obtained disks of each tree were divided into height levels (low: 0.2–3.2 m, medium: 5.2–9.2 m, and high: above 11.2 m) based on the height to crosscut the stem to produce bottom and the second logs. Then, the presence and absence (scored as 1 or 0, respectively) of insect damage by *A. subfasciatus* was investigated. Thereafter, the average score at each site condition was calculated and rated into three ranks in increasing order of insect damage based on log sawing ability. Damage class A indicated that both the bottom and the second logs could be sawed; class B indicated that only the bottom log could be sawed; class C indicated that only the second log could be sawed; and class D indicated heavy damage, with low probability that the bottom and second logs could be sawed.

Prior to applying the result of site evaluation, the relationship with the site condition and the damage by *A. subfasciatus* was investigated. We confirmed that concave sites with colluvial deposits, the site conditions with faster growth groups, tended to show slight damage in *C. japonica* forests. In *C. obtusa* stands, less damage was observed at clay sites where slower growth tendency was observed. Sites with colluvial deposits that showed tendency for faster growth tended to be vulnerable to damage (Nagashima et al. 2014). These sites that were not susceptible to insect damage by *A. subfasciatus* showed the same conditions as those obtained by the natural forest investigation and have historically been considered suitable sites (Saito 1959; Sakaguchi 1983). This indicates that damage by *A. subfasciatus* might decrease if *C. japonica* and *C. obtusa* are planted at suitable sites identified in this study.

By color-coding the obtained site conditions of each rated group to the site condition map, an insect damage evaluation map for both *C. japonica* and *C. obtusa* was obtained (Fig. 8).

3.5 Designing the Forest Management Regime of Odai Town

Comparing the natural site condition, growth evaluation, and insect damage evaluation maps generated in the present study might help forest managers to interpret potential site suitability for forestry. The natural site, for both *C. japonica* and *C. obtusa,* where less insect damage was observed might be suitable for long-rotation forestry because it has a high potential to grow large trees with good quality and thus high profitability. Sites that showed fast growth but were not natural distribution sites and had some insect damage were also observed. These might have potential for short-rotation forestry. However, these sites should be easy to access to reduce costs associated with short-rotation forestry. The remaining sites might have low potential for forestry and might be more suited for conversion to broadleaved forests. The process for assessing each site is explained in detail in the following sections.

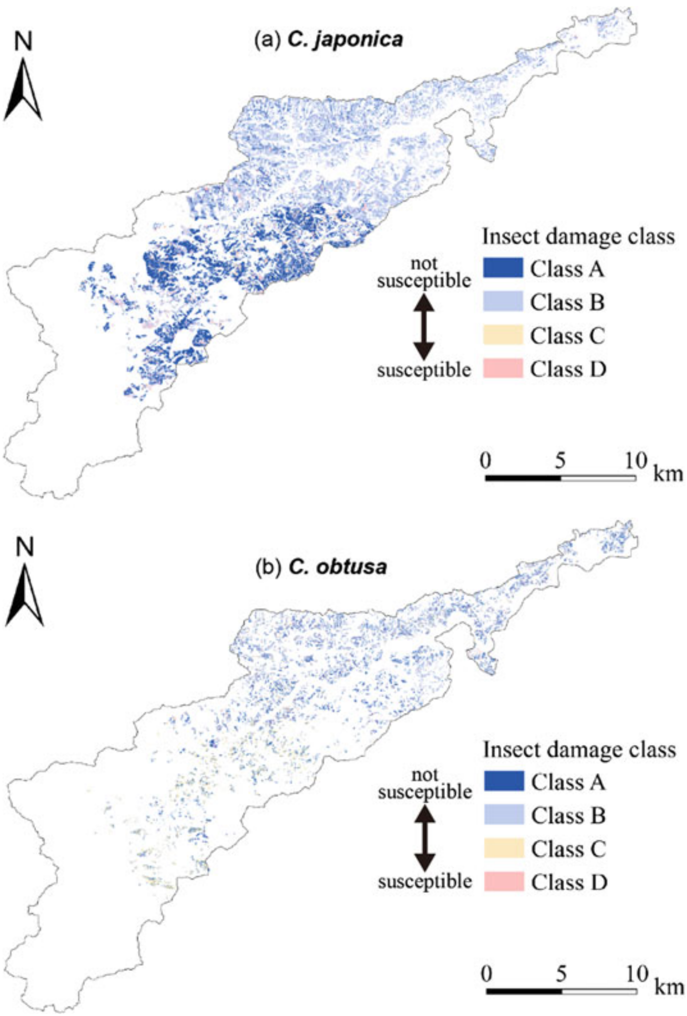

Fig. 8 Insect damage evaluation maps for *C. japonica* and *C. obtusa*

3.5.1 Suitable Sites for Long-Rotation Forestry

The natural site conditions showed high potential to provide large trees in the long term. Managing the forest over a long time is associated with higher costs for tree growth. Therefore, the site should not be susceptible to insect damage by *A. subfasciatus*, which reduces the timber price considerably, in order to be profitable. To ensure that the site least susceptible to *A. subfasciatus* damage within the natural site condition was identified, we detected the least susceptible site (rank A) using the insect damage evaluation map and overlaid it with the natural site condition map to determine suitable sites for long-rotation forestry (Fig. 9), although the natural

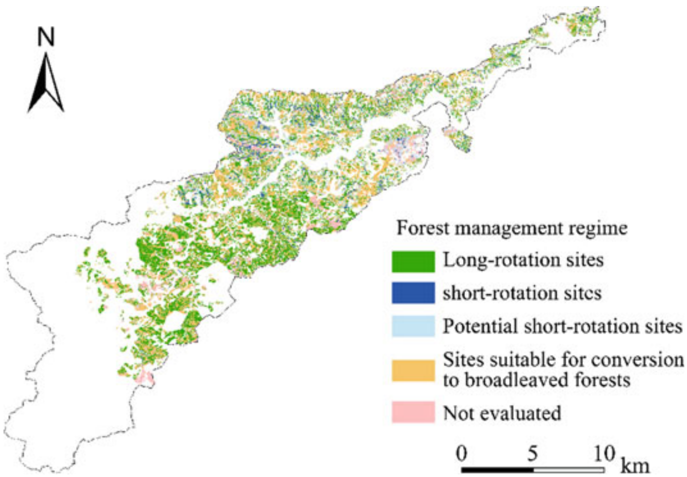

Fig. 9 Forest management regime map of Odai town

site condition itself was less vulnerable to damage by *A. subfasciatus* (Nagashima et al. 2014).

3.5.2 Suitable Sites and Potential Sites for Short-Rotation Forestry

Sites showing relatively rapid growth might have the potential for short-rotation forestry because they provide a certain size of logs in the short term. Our recent investigation indicated that the log size with the highest demand in the market is 22–24 cm in diameter for *C. japonica* and 16–18 cm for *C. obtusa* (Yamamoto et al. 2017). Although the price will decrease by approximately 1000 yen/m^3 if insect damage is observed (Yamamoto et al. 2017), the influence of insect damage on price is considered to be lower if the log size is smaller. Moreover, sites might be considered profitable if they are easy to access.

Therefore, to determine suitable sites for short-rotation forestry, we first identified sites showing relatively rapid growth (rated as ranks A and B on the growth evaluation map for *C. japonica* and *C. obtusa*). Accessibility was evaluated by drawing buffers from the current road system at a distance of 50 and 300 m outward from the polygon representing the road system by using GIS. Fifty meters is considered a suitable distance for harvest using a harvester, and 300 m is considered the harvestable distance when using the tower yarder (Umezawa et al. 2013). By overlaying the rapid growth site map, which indicates the ranks A and B of the growth evaluation map, and the accessibility map, rapid growth sites within 50 m of the current road system were identified and defined as "suitable sites for short rotation." In addition, rapid growth sites 51–300 m from the current road system were identified and defined as "potential sites for short rotation" (Fig. 9). The suitable sites for short rotation are the sites at which harvesting can be done using the operation system currently utilized by the forest cooperative. The potential sites for short rotation are sites that can become harvestable if the forest cooperative commences the use of the tower yarder system.

3.5.3 Sites More Suitable for Conversion to Broadleaved Forests

Suitable sites for long and short rotations and potential sites for short rotation are sites suitable for forestry in the area currently covered by plantations in Odai town. Plantation sites, except the areas identified as suitable sites for forestry, are the areas more suitable for conversion to broadleaved forests. Therefore, the sites more suitable for conversion to broadleaved forests were identified by eliminating suitable sites for long and short rotations and the potential suitable sites for short rotation from the map showing the current *C. japonica* and *C. obtusa* plantation area (Fig. 9).

3.5.4 The Forest Management Regime Map of Odai Town

Combining the maps showing sites for long rotation, short rotation, potential short rotation, and sites more suitable for conversion to broadleaved forests of *C. japonica* and *C. obtusa*, forest management regime map was developed. Consequently, 34.9% (3,649.9 ha) of the current *C. japonica* forest area (10,448.6 ha) was identified as suitable for long-rotation sites, while short-rotation sites and potential short-rotation sites occupied 3.2% (335 ha) and 13.0% (1,358.2 ha) of the forest area, respectively (Table 1). Sites more suitable for conversion to broadleaved forests accounted for 36.9% (3,855.5 ha) of the *C. japonica* forests, which occupied 1/3 of the area, similar to the long-rotation sites. The same tendency was observed for the *C. obtusa* forests: 35.0% (1,329.3 ha) and 33.0% (1,253.6 ha) of the *C. obtusa* forests area (3,800.4 ha), respectively. The relatively small area covered by short-rotation sites (3.6%) and potential short-rotation sites (15.7%) was also observed in the *C. obtusa* forests. The remaining area, 1,250 ha of *C. japonica* and 482 ha of *C. obtusa* forests (Table 1), had site conditions different from our investigated conditions and therefore could not be evaluated. These conditions need to be further investigated to complete the evaluation of the whole plantation area of Odai town.

4 Continuous Measures to Enhance Sustainable Forest Management

Based on the forest management regime map, the forest cooperative has begun to apply different forest operations at each evaluated area. For sites suitable for long rotation, thinning is implemented for inferior trees and will be repeated as the trees approach the age for cutting (more than 100 years). Thinning is also conducted for the sites suitable for short rotation. However, trees will be cut down soon as they reach the age for cutting (50 years). At sites evaluated as more suited for conversion to broadleaved forests, clear-cutting in a small area is conducted (Photograph 1), and about 20 broadleaved species (shrubs and trees) are planted in an area of 80–120 m^2 protected by Sika deer fences (Photograph 2). This measure is implemented to restore broadleaved forests despite browsing pressure from deer (*Cervus nippon*). On the other hand, it also ensures the use of broadleaved trees in the future, not only for wood production but also for non-wood products, which might enhance the multiple-use value of forests.

Table 1 Area of sites evaluated to each forest management regime by species

Management regime	*C. japonica*		*C. obtusa*	
	Area (ha)	Percentage (%)	Area (ha)	Percentage (%)
Long rotations	3649.9	34.9	1329.3	35.0
Short-rotation sites	335.0	3.2	137.5	3.6
Potential short-rotation sites	1358.2	13.0	597.6	15.7
Sites more suitable for conversion to broadleaved forests	3855.5	36.9	1253.6	33.0
Not evaluated	1250.0	12.0	482.5	12.7
Total	10448.6	100.0	3800.4	100.0

Photograph 1 Clear-cutting conducted at sites more suitable for conversion to broadleaved forests

Photograph 2 Planted broadleaved trees in an area protected by a Sika deer fence

These measures have just begun to be implemented, and their effects on enhancing sustainable forest management should be monitored. Based on the monitoring results, the relationships among site conditions, growth, and insect damage and the site suitability should be confirmed, which requires the forest management regime map to be updated. Such continuous measures for adaptive management might be the key to accomplish the objective of forest management in Odai town: To enhance the multiple functions of forests together with improving the economic efficiency of plantation forests. As such, the forest cooperative in Odai town has taken up the task as the main driver to monitor forest management, re-evaluate site suitability, and update the management regime map along with the Odai town government. It is notable that people in the forest cooperative and Odai town government are proud of their measures and are working actively, which might be the most important driving force to enhance sustainable forest management.

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Chapter 12
Participatory Wetland Management: A Case Study of Xe Champhone Wetland, Lao PDR

Thienthong Sopha, Choni Zangmo and Alice Sharp

Abstract In most of the developing countries, wetlands are one of the important fundamental sources as they play out a scope of ecological capacities and give various financial advantages to nearby communities and an extensive populace. However, wetlands are among the most threatened of all environmental resources. It was stated that most of the earth's wetlands have been disappeared through transformation to industrial, farming, and urban developments. The livelihood of most of the people who are living in Laos relies on its rich wetland biodiversity. Unfortunately, several wetlands in Laos remain under threat from overuse of natural resources. In addition, there has been little research and a lack of data and information about wetlands in Lao PDR, which is the major obstacle in wetland management. In addition, management of wetlands is generally done in a top-down manner, where local communities were not involved in the decision-making process. This study aimed to identify problems related to wetland management by incorporating concerns of all stakeholders into consideration as well as to develop participatory wetland management action plan. The stakeholder's analysis in the utilization of wetland resources and the management of Xe Champhone Wetland were accomplished by using strengths, weakness, and threats (SWOT) analysis and a TWOS matrix. Once the consultation with stakeholders was done, strategies and management activities were designed and a participatory wetland management action plan was developed.

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1 Introduction

One of the most important ecosystems on earth is wetlands. Wetlands have been defined as "the kidneys of the landscape" as well as "supermarkets of biology," in view of the capacities they perform in the hydrological and synthetic cycles, and in light of the broad nourishment networks and rich biodiversity, they sustain respectively (Barbier et al. 1997). Furthermore, wetlands remove pollutants and suspended particles from flowing water, shield delicate coastlines from erosion and storms and it also provides habitat for vital species of wildlife (Wang et al. 2008). However, 50% of earth's wetlands are lost and the remaining wetlands are in need of immediate actions to prevent additional degradation of wetland due to increasing activities held by individuals (Myers et al. 2013). The main causes for losses of wetland in most worldwide are due to human populace development and financial thought processes, for example, development of urban zones or agribusiness (Kozich and Halvorsen 2012). The services provided by the wetland cannot be measured in market price, many studies were carried out using various methods to estimate the non-market valuation of wetlands and the estimated results were remarkable (Woodward and Wui 2001).

Lao PDR is abundant with wetland biodiversity, and it contributes valuable services to society of Lao individuals who lives in the wetland-rich Mekong basin (Sopha 2013). Most of the people in Laos completely depend upon on wetlands for their everyday living. Nonetheless, there are numerous challenges that undermine the sustainable utilization and management of wetlands in Laos such as government approaches, socioeconomic, and population changes result in the demand for higher growth in agricultural production, construction of roads and buildings for industries, and private settlement. It is not common in Lao PDR to find natural lowland wetlands, and this shows that most wetlands are in some shape of exceedingly changed, without a doubt a growing example toward modification. (Timmins 2014). Notwithstanding the significance of wetlands in supporting for the long haul, there are additional worries over the manageability of use and upkeep of wetland advantages. This is the motivation behind why as of late much consideration has been centered on sustainable management strategies for wetlands.

The Ramsar Convention on Wetlands was established to improve the preservation of wetlands and their carefulutilization and management (Barbier et al. 1997). The Ramsar Convention on Wetlands came into force for Lao PDR on September 28, 2010 (Duckworth and Timmins 2014). At present, there are two Ramsar sites in Lao PDR and both the sites are in the southern provinces of Laos. Beung Kiat Ngong Wetlands is in Champasak Province and Xe Champhone Wetlands is in Savannakhet Province. Xe Champhone is a vital region for various species of reptiles like Siamese crocodile (*Crocodylus siamensis*), snakes (*Ramphotyphlops braminus)*, python (*Python reticulatus*), lizard (*Draco* spp.), and turtle (*Cuora* spp.) (Geiser and Nagel 2013). Savannakhet Province is extremely influenced by flood every year, and it has unfavorably influenced the cultivation of fish, production of agricultural, and destruction of infrastructures (Hazarika et al. 2008).

In spite of the fact that the land is not truly harmed by the severe flood occasion but it affects all products such as livestock, crops, and fish (e.g., the deep flood caused damages to rice and livestock production due to the strong Nock-Ten Typhoon in 2011 (Yen et al. 2015).

If there is no implementation on adaptation plans and mitigation, declining of ecosystem services is expected (Arias et al. 2014). This study aims to identify current issues and management gaps in the Xe Champhone Wetlands. This site was chosen mainly because of their high level of biodiversity and home to key threatened species. The study also attempted to examine the strengths and weaknesses of the stakeholders, as well as opportunities and threats from the external environment for Xe Champhone Wetland. The intention was to develop a strategic action plan for improving Xe Champhone Wetland planning through stakeholder-based SWOT analysis.

2 Study Site

The study area is Xe Champhone Wetlands, one of the two significant wetlands in Lao PDR which was designated as Ramsar Convention in 2010. The site covers an area of 12,400 hectares (ha) in Champhone, Xonbuly, Atsphone, and Atsaphanthong districts as shown in Fig. 1. The wetland in these districts plays an important role as source of income to the neighborhood individuals who live nearby area. In Laos, the largest paddy rice cultivation region is in Savannakhet Province

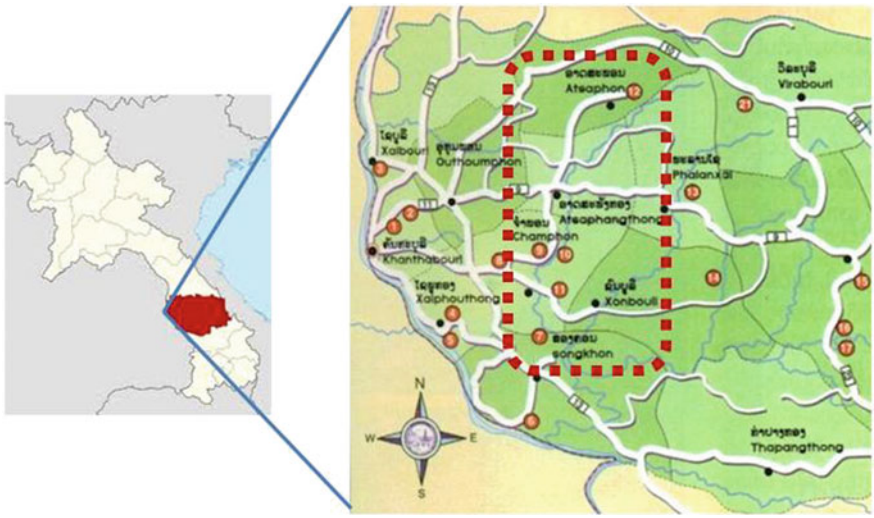

Fig. 1 Map of Savannakhet Province; the location of the four districts where Xe Champhone Wetlands is located is circled on the map

which covers 21.48% or 194,157 ha of the nation's total area of paddy rice cultivation (Boulidam 2012). There are 20,000 people from more than 40 villages settled in Champhone District and rely mostly on wetland for livestock grazing, fishing, and agricultural activities (IUCN 2011). Xe Champhone Wetlands is not just important for people who are living in Savannakhet Province, it is similarly vital for different species such as turtles, winged creatures, and Siamese crocodiles that are likewise very reliant on this wetland.

This study focuses in Champhone District where the core area of Ramsar site can be found. The district is a flat area, 54 km northeast of Savannakhet municipality with a total area of 1,114 ha, 102 villages, 16,189 households, 18,549 families, and 109,040 population (Investment 2009).

3 Methodology

The data for this research were collected using two main methods; questionnaire survey and SWOT analysis. Application of SWOT analysis is a globally accepted method which aims to identify the strengths and weaknesses of an organization and the opportunities and threats in the environment (Dyson 2004) and (Houben et al. 1999). Thus, the method was selected to be used in this study. In order to perform SWOT analysis in this research, villages and stakeholders were identified and selected for questionnaire surveys and interviews to analyze an internal and external environment of the area. Once the interview with stakeholders and local people was done, management activities were designed by using TOWS matrix. The data collections were carried out from June 2011 to December 2012.

3.1 Questionnaire Surveys

There were two sets of questionnaire surveys in this study. The first questionnaire was focused on socioeconomic benefits obtained from wetland, problems, and management gaps. It should be noted that the information discussed in this first questionnaire survey was only focused on the problems and management gaps. The second questionnaire was developed based on the solution of problems and management gaps that were identified. Respondents were asked to rate proposed management activities based on importance, impacts to wetland management, do-ability of the proposed options, and the urgency of each activity. Each criterion was rated on a score from 1 to 5, where 1 score means low importance, do-ability, impact, and not urgent, and 5 score means high in all criteria.

Table 1 Selected villages and a number of the sample for each village

No.	Villages	Group	Population	Households	At least 18% of households for questionnaire survey
1	Dong Mueang	Tourism (T)	788	120	22
2	Tha Mouang		188	122	22
3	Nong Lamchan		1903	424	76
4	Hua Mueang	Rural (R)	664	112	20
5	Xe		625	95	17
6	Tha Mueang		1142	135	24
7	Xakhuen Nuea		1710	290	52
8	Lamthen		553	92	17
9	Kengkok Nuea	Urban (U)	1880	372	67
10	Kengkok Karng		1748	292	53
Total					370

3.2 *Identification of Respondents for Questionnaire Survey*

Around Xe Champhone wetlands, there are 45 villages. Among these, 20 villages are located within 1 km from the wetland. Out of 20 villages, 10 were selected for a questionnaire survey (Table 1). In order to find a sample size, we use the formula of Taro Yamane (Taro 1973) at a confident level of 95%. The formula is shown as follows:

$$n = N/1 + Ne^2 \tag{1}$$

where

n Sample size
N Population size
e The error of Sampling

Therefore, the sample size for our study is as follows:

$$n = 2054/6.135 = 335.$$

The sample size is set to 335. However, to ensure that the number of respondent was close to the calculation result, out of the total households in each village at least 18% of households were randomly selected. Therefore, the total number of sampling size of the respondents for this study was 370. In addition, these ten villages were categorized into three groups (tourism area, rural area, and urban area) based on their social economic activities.

3.3 Stakeholders Identification for SWOT Analysis

In this study, the stakeholders were divided into three main groups as follows:

- Local communities: Local people, head of each village
- Governmental offices: Ministry of Natural Resources and Environment, Provincial Water Resources Office, Provincial Agriculture and Forestry Office, District Investment Promotion and Management Office, District Tourism Office, District Water Resources and Environment Office, District Agricultural and Forestry Office, District Land Management Office, etc.
- Non-Governmental Organizations: International Union Conservation of Nature Laos (IUCN), Mekong River Commission—Laos (MRC), World Conservation Society—Laos (WCS).

3.4 SWOT Analysis

The strengths, weaknesses, opportunities, and threats (SWOT analysis) were compiled from participatory meeting and interview with the stakeholders. Interviews with the respondents focused on the following issues: the changing situation of the Xe Champhone River and their community from the past to present, concerns, and future plan.

After SWOT was listed and analyzed, TOWS matrix or management strategies were drafted to identify preferred management activities. TOWS matrix was developed based on the four strategies:

- Maxi-Maxi Strategies (S-O)—Use strengths, to capitalize on opportunities.
- Maxi-Mini Strategies (S-T)—Use strengths, to avoid threats.
- Mini-Maxi Strategies (W-O)—Improve weaknesses, by using opportunities.
- Mini-Mini Strategies (W-T)—Avoid threats, and minimize weaknesses.

Wetland management activities were drafted from each strategy in the TOWS matrix step. All possible activities were listed based on the strategic plan and were used in the second questionnaire.

3.5 Prioritizing of Management Activities and Action Plan

Targeted villages were categorized into three main groups: tourism group (travel places in the village area), urban group (villages which are located in a municipal area), and rural group (villages which are located in a rural area). This has been done in order to prioritize the management activities from the second questionnaire, based on specific needs in different areas. In order to avoid some errors that could occur from the differences between the highest and the lowest score of each activity; the average of four criterions: importance, impact, possibility, urgency, and the range of standard deviation (SD) of each activity from each village were calculated. The ranges of SD were used to reflect the variation in opinion of local people in each village. For example, if the range of SD is low or medium, this means that local people have the same opinion for that particular activity while a high range of the standard deviation means that people in the same village think differently for that activity. By using SD value, it can be seen in the graph whether the activity is reliable or not. Hence, the activity with a high score of every criterion with low SD range was considered as the first activity to do for those villages or those groups. If the activity got a high score of every criterion and the SD range was also high, this activity was not considered as the first activity to do for those villages or those groups since there were some differences of opinion from the same community.

4 Result of the Study

4.1 Socioeconomic Benefit

Through questionnaire survey in various communities has confirmed that almost 97% of the populace depends upon on wetlands for agricultural purposes and the remaining 3% of the populace are involved in other sectors like business and government services. The major source of income for the local people in Champhone District is from crop farming, particularly rice production. In addition, raising domesticated animals, for example, chickens, ducks, buffalos, and cows are the second most essential agricultural activity for neighborhood individuals. Villagers also plant some organic products for their own consumption and sell some products to acquire extra wages. This turns into a principle alternate occupation in the community.

Aside from rice cultivating, another source of income is from seasonal crops production such as corn, cowpea, chilly, and tobacco. Villagers also engaged in fish farming activities where they have small-scale fish farms, especially Tilapia, Catfish, and Snakehead and mostly used for their own consumption in a family and to sell some of it for a good wage. As per the study carried out in ten target towns along Xe Champhone River, more than 90% of household units take part in fishing and by and depending on how much time they have spent on fishing, household units can harvest about 20 kg per month as an average.

On an average, the main income in the target villages is between the ranges of 300,000–500,000 kip per month (Fig. 2) or 37.5–62.5 USD per month (at exchange rate 800,000 kip per 100 USD in December 2012). As mentioned above, this amount of earnings is mainly through commercial farming activities like planting agriculture and horticulture, crop and livestock farming.

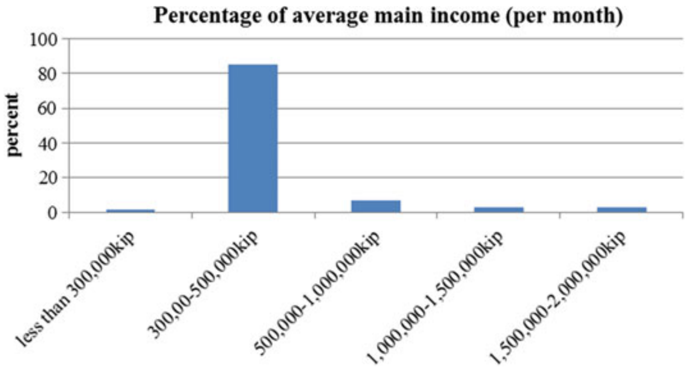

Fig. 2 Percentage of average main income

Therefore, the wetland for those who are staying nearby Xe Champhone is like a valuable land to uncover gold from it.

Respondents additionally included that they can get high production in the dry season which has a shorter growing period compared to the wet season. Development of irrigation, use of fertilizers and insecticides, building ponds for fish cultivation or aquaculture add to the expansion of production as well as increase in market prices of product in Champhone District.

4.2 Problems and Management Gaps

Local people in ten surveyed villages cited numerous problems, particularly flooding, soil erosion, drought, damaged road, chemical contamination, monkey population, and garbage. Figure 3 shows that flooding, soil erosion, and drought are the most common problems in the areas. One hundred percent of the respondents mentioned those problems as their major problems. This is due to the structure of the bank of the Xe Champhone, which is made of fine sand. This makes it unstable and easily eroded when flooded. The river has become shallower and wider with a loss of deep pools; therefore, it cannot store water in the dry season.

Besides, 74% of the respondents mentioned that transportation is another problem in the area, especially in the wet season because most of the roads have been damaged due to flooding. Some additional problems are based on village locations such as chemical contamination in Nong Lamchan village since this village is located close to the area where sugar cane was planted to support a sugar factory. People in this village mentioned that three years ago, there was pesticide contamination in the soil and water in the area, which caused the death of their livestock and illnesses of people. Local people still believe that chemical contamination in the soil and water still exists since there has not been any monitoring of water and soil quality in the area.

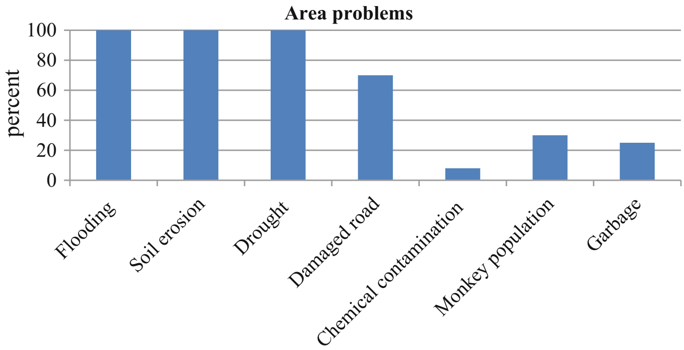

Fig. 3 Problems encountered by local residents

In addition to the results of the questionnaire survey, in-depth interviews were carried out with stakeholders to find their concerns based on activities carried out for the management of wetlands as summarized in Table 2.

4.3 SWOT Analysis

The results of the interviews based on strengths, weaknesses, opportunities, and threats in Champhone District as well as Xe Champhone management are summarized as follows.

4.3.1 Strengths

Champhone District is rich in natural resources such as land, rivers, lakes, ponds, and forest (especially bamboo forest). The area also has high biodiversity of fish and wildlife. Additionally, it contains cultural resources such as old temples, sacred places, and objects. The ethnic groups in the area include Makong and Katang. By this, customary laws and beliefs are still useful and effectively protect some wildlife species. Moreover, local people have some folk wisdom in handicrafts. Most of the people in this area are all educated at least up to primary school level. Besides, the area has a systematic infrastructure as the main road in the district connects village to village. There are additionally some roads connected to surrounding districts.

4.3.2 Weaknesses

According to the geography, Champhone District is located in a flat area, surrounded by the Xe Champhone River, with many lakes and oxbows. Hence, all the

Table 2 Stakeholders' concerns

Group/status		Activities	Concerns
Local community	Local people	• Customary use of the wetland involves allocation of use rights for paddies, fishing, etc., to villagers, as well as customary protection of sacred sites	• Flooding and soil erosion every year affect their crops products • Fish and wildlife have decreased • Need better wetland management • Need better wildlife management • Need better land and forest management
	Head of each village	• Currently implementing local customary protection • Key partner of any development of local wetlands management regulations, plans, or arrangements	• Some people still infringe the regulations, using a destructive way to catch fish or encroaching on the conserved forest or lake to catch wildlife
Governmental offices	Ministry of Natural Resources and Environment	• Coordinate with IUCN in preparation for joining Ramsar Convention	• Lack of the financial support to do wetland management • Still need to revise some laws or draft some laws or regulations to protect wetlands
	Provincial Agriculture and Forestry Office District Agricultural and Forestry Office Provincial Water Resources Office District Water Resources and Environment Office	• Responsible for agriculture, irrigation, forests and fisheries at the local level • Technically responsible for water resources management	• Due to frequent flooding and drought almost twice a year in the area, people in Champhone District have lost a lot of crops and livestock production. These organizations try to help people by providing new breeds of crops which can resist the flood and drought; however, the quantity of seeds supplied still is not enough for every household • Xe Champhone has become shallower every year because of soil erosion. Therefore, it cannot store enough water for agriculture in the area. Irrigation can partly help, but the number of pumps is still not enough for some villages

(continued)

Table 2 (continued)

Group/status		Activities	Concerns
	District Tourism Office	• Planning for promoting wetland and developing wetland to be travel places	• Still lacking the promotion of services for tourists • Some travel places are still difficult to access due to poor infrastructure • Lack of staff, such as local guide and on-site information
	District Investment Promotion and Management Office	• Responsible for ensuring the investment and concession regulation are properly implemented and monitored	• Still have some problem with land concession with local people • District office for land management could not identify clearly the boundary of local
Non-governmental offices	International Union for Conservation of Nature (IUCN)	• Wetland management plan	• Because of the financial problem, they could not continue the step of drafting a comprehensive wetland management plan in Xe Champhone
	Mekong River Commission (MRC)	• "Lower Mekong basin for basin adaption planning" project on climate change impact on wetland in Xe Champhone since 2011	• No more project after 2011
	World Conservation Society (WCS)	• Crocodile conservation project in Xe Champhone	• Most of their concerns are crocodile related such as encroachment to the hatching areas of local people to steal the crocodile's eggs

time Champhone District has been affected by natural disasters such as flooding, drought, and soil erosion. Since local income generation is mainly based on agriculture, local livelihood is affected a lot. Planting, farming, transportation, and infrastructure are affected by flooding in the wet season and/or drought in the dry season.

Despite a living style of the local people that is still based on natural resources, wildlife management in the area still has some problems such as over-hunting and illegal encroachment. In addition, the number of monkeys in Monkey Forest has increased each year in which it interrupts farming and agricultural activities nearby villages. Moreover, the area still lacks the promotion, awareness rising, and implementation of laws, regulations, and discipline for land use, chemical use, environmental, and investment for local people and investors. Additionally, support from governmental sectors is still inadequate, both in terms of human capital and financial resources.

4.3.3 Opportunities

Champhone District has a very high potential to develop as an ecotourism district according to natural resources and cultural resources. Also, local people are able to create at least one product (or one village one product) by using their folk wisdom and support from governmental offices or NGOs. With the support from related organizations, communities will be able to generate more income not only from agriculture, but also from trading local products. Besides, the city has a potential to get more investment from other countries since the 9B road, a road from Thailand through Laos to Vietnam, is in construction.

4.3.4 Threats

Flooding and drought contributes to soil erosion every year. Soil erosion continues to destroy local houses and cultural places located close to the river bank and affects crops and livestock production. The increasing temperature and rainfall can facilitate crop pests, potentially increasing production costs due to more use of chemical insecticides. In addition, crop production, particularly wet season rice, will continue to be affected by flooding, which is expected to worsen with increased flows in the Xe Champhone River. Consequently, to compensate the lost of production during wet season, production of rice during dry season has increased, thus increasing the need for irrigation infrastructure and the use of chemical fertilizers and pesticides that led to further degradation natural resources in the area.

Some other problems still need to be addressed since Xe Champhone has not had a comprehensive management plan yet. Furthermore, financing is a major part of activities. Therefore, this study will propose some management activities so managers can easily decide which management action to do. At the same time, it will additionally respond to the needs of the wetland users.

4.4 TWOS Matrix

After conducting SWOT analysis, strategic options were drafted by using a TWOS matrix (Table 3). There are 10 strategies, and 36 activities identified for the sustainable management of Xe Champhone Wetland, based on the needs of stakeholders in the area.

From each strategic option, this study has proposed management activities based on importance, impacts to wetland management, do-ability of the proposed activities, and the urgency of each activity.

We can also gather ideas of wetland management from local wetland users and wetland managers from local and central offices and Non-Governmental Organizations. Table 4 shows selected activities proposed after analyzing the first questionnaire survey and interviews with stakeholders. In total, there were 36 activities identified.

Table 3 Strategic options for the management of Xe Champhone Wetland

TWOS		External			
		Opportunities		Threats	
Internal	Strengths	S-O (maxi-maxi) strategies		S-T (maxi-mini) strategies	
		SO1	Support ecotourism in the area and conserve the traditional culture of each ethnic group	ST1	Support the customary laws in the area and also improve and implement wildlife management
		SO2	Support indigenous knowledge on handicraft to create one village one product or one district one product	ST2	Promote and educate local people about the benefit of ecotourism as well as awareness people about environmental protection
		SO3	Support investment in the area	ST3	Develop transportation as well as infrastructure in the district
	Weaknesses	W-O (mini-maxi) strategies		W-T (mini-mini) strategies	
		WO1	Improve biodiversity management	WT1	Prepare an environmental protection plan
		WO2	Improve education and public health services in the city	WT2	Prepare an adaptation plan to cope with natural disasters in the area

Table 4 Selected management activities proposed, based on each strategy identified by the TWOS matrix

Strategic option		Item	Activity
1	SO1—support ecotourism in the area and conserve the traditional culture of each ethnic group	A1	Develop and renovate some existing travel places
		A2	Provide maps and information about travel places
2	SO2—support indigenous knowledge on handicrafts to create one village one product or one district one product	B1	Organize a handicraft union
3	SO3—support investment in the area	C1	Establish an investment fund for local people to encourage local people to do service businesses such as restaurants and guesthouses to support tourism development and international investment
4	ST1—support customary laws in the area and improve and implement wildlife management	D1	Post signboards around the area with information about the wetlands conservation and the site regulations
5	ST2—promote and educate local people about the benefits of ecotourism as well as environmental protection	E1	Create some environmental activities, such as study tours in communities
6	ST3—develop transportation as well as infrastructure in the district	F1	Improve the transportation to the travel places
7	WO1—improve biodiversity management	G1	Promote breeding and releasing native fish back into the river, lakes, and ponds, in order to maintain wild fish population and sustain local livelihood
8	WO2—improve education and public health services in the city	H1	Expand schools and increase the number of educated people with higher degrees in the area, support these people to be educational resources for their hometown
9	WT1—prepare an environmental protection plan	I1	Prepare educational materials on: sustainable resources use, Ramsar Convention, organic/minimal chemical use, agriculture, environment, and socially responsible tourism
10	WT2—prepare an adaptation plan to cope with natural disasters in the area	J1	Replant trees along the river bank to prevent erosion

4.5 Prioritizing of Activities and Action Plan

4.5.1 Group-Wise Prioritizing

The study shows that the stakeholders in each group have specific needs according to the resources and potential in those particular areas. This can be clearly seen when compared between importance and urgency of various activities such as A1 (Develop and renovate existing travel places), C1 (Establish investment fund for local people), J1 (Replanting along the banks of Xe Champhone), G1, and H1. Some of these activities were discussed here in order to gain better understanding of specific needs for each group.

Result for activity A1 is shown in Fig. 4 where local people from tourism group rated a higher score in every criterion (impotence, impact, possibility, and urgency), The averages score of tourism group related to tourism strategies are quite similar (4.5–4.6), since these villages have some travel places.

Note that the villages with letter "T" in front of the name of the villages are in the tourism group, letter "R" refers to the rural group, and "U" is for the urban group.

It also shows that among the rural group, there are two villages with some possibility to create travel places in the area with a probability score around 3.3–3.5. After surveying and interviewing with the local people in these two villages (Hua Mueang and Xe village), there are possible to be developed travel places like Buk (the second biggest reservoir of Champhone district) in Hua Mueang village and Bird Lake in Xe village. Therefore, responsible organization should concentrate on building up these ranges for tourism. Local people from the tourism group rated activity A1 with an average of importance of 4.6 and 4.5 for urgency score since these villages have some travel places in their area.

Local people in the urban group highly rated for the C1 activity for the establishment of investment to support business people as shown in Fig. 5. With an average of importance 4.6 and 2.9 for urgency score, this represents that people in

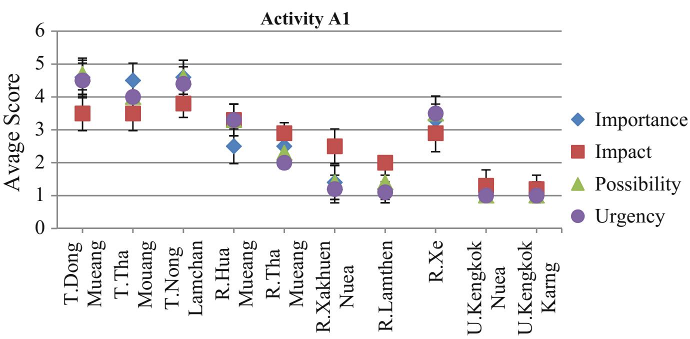

Fig. 4 Activity A1: develop and renovate existing travel places

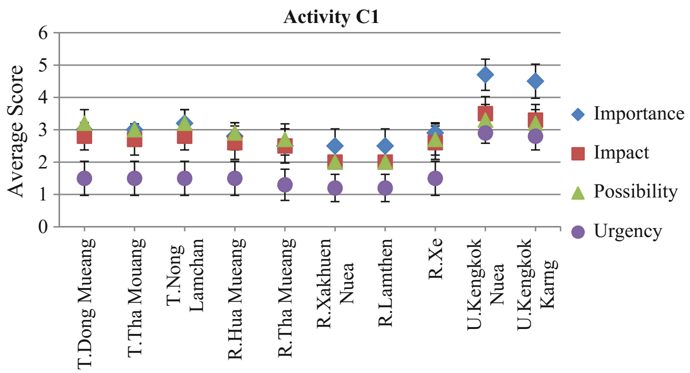

Fig. 5 Activity C1: establish investment fund for local people

the urban areas are mostly interested in business investment since their locations are more convenient to have businesses such as trading and services than other groups. However, urgency scores are still low in the C1 activity when it is compared with other activities.

Note that the villages with letter "T" in front of the name of the villages are in the tourism group, letter "R" refers to the rural group, and "U" is for the urban group.

The study shows that the three groups have the most concerns about environmental conservation and adaptation, as it can be seen in activity J2. Figure 6 shows J2 activity for replanting along the riverbank to prevent erosion. Local people gave the highest score (4.9) for impact, importance, urgency, and possibility in J2 activity when it is compared to other activities. One of the reasons for giving more impotence in this activity is due to Monkey Forest which is close to Dong Mueang and Tha Mouang villages.

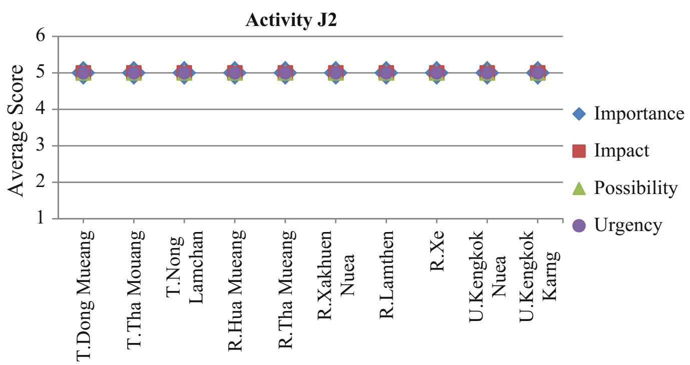

Fig. 6 Activity J2: replanting along the banks of Xe Champhone

Table 5 Example of action plan for common activity

Common activity					
Management activities		Short term	Long term	Recommendation	Responsible organization
J2	Replanting along the river bank to prevent erosion	x		• Some areas along the river bank have to be set as soil erosion control zones, for example, by planting Vetiver grass, Pangola grass, Bermuda grass, and Bahia grass	DAEO, PWRED and MAF
I6	Identify clearly the boundaries of protected areas of the wetland (lakes, forest)	x		• Create meeting and participate local people to collect their idea and opinion and let them set the rules based on some existing regulations	DAEO, PWRED and MAF and coordinate with IUCN
D2	Monitoring and patrolling, and set up of a Ramsar site office	x		• Responsible organizations should set up clearly the duties, and responsible people • Select some volunteers to monitor and patrol work	DAEO, PWRED and MAF and coordinate with IUCN
B2	Find the markets for products, both domestic and international		x	• Find markets from inside and outside the country • Join exhibitions and promote products by using media such as television or internet • Create handicraft competition in districts and join national and international competitions	DTO and DTIO
E1	Create some environmental activities, such as study tours in communities	x		• Organize some events or activities which are related to environmental protection in or outside schools such as study tours	DAEO and DTO

DAEO District Agriculture and Environmental Office; *PWRED* Provincial Water Resources and Environment Department; *MAF* Ministry of Agricultural and Forestry; *DTO* District Tourism Office; *DTIO* District Trading and Investment Office

However, increasing monkey populace is the real issue for villages and according to the customary law in this area, no monkey can be hurt by neighborhood individuals, therefore, nearby individuals in this area plant no yield in light of the fact that monkeys will destroy everything.

Note that the villages with letter "T" in front of the name of the villages are in the tourism group, letter "R" refers to the rural group, and "U" is for the urban group.

4.5.2 Action Plan Development

In order to be used as a guideline for Xe Champhone management in the future, the action plans, which cover all the needs of local people and are applicable to those particular areas, were created. There were three sets of action plan developed under this study: specific activity for groups, specific activity for villages, and common activity for all villages. Table 5 shows an example of an action plan for common activities where the recommendations as well as the responsible agencies are added.

5 Conclusion

Generally, planning and decision-making are challenged by national interests: political sensitivities, lack of transparency, insufficient information on the linkages between development projects, ecosystems and livelihoods, and assessments that are biased due to economic motivations. Therefore, this study linked research to actual decision-making by showing that Xe Champhone wetlands provides important ecosystem services and is a home to key threatened and economic species. Local income is still based on natural resources from the Xe Champhone Wetlands. People still use the wetland resources for agricultural activities such as crop farming, raising livestock, and fisheries for household food consumption, and selling for additional income.

This study examines the wetland conservation framework of the national and international organizations. Therefore, management gaps and area problems were identified, which include a lack of clear and specific national wetlands policies and specific law for wetlands. Local people in some areas still lack understanding of wetlands values. Local people cannot use Xe Champhone effectively due to flooding, soil erosion, and drought, which are the common problems in the area. In order to manage the site in a sustainable way, a participatory action plan was created. The study uses SWOT analysis to examine advantages and disadvantages of the internal and external factors from the strengths, weaknesses, opportunities, and threats in the area while a TOWS matrix helps us to see the different dimensions by matching external opportunities and threats with internal strengths and weaknesses. For each combination of external and internal environmental factors, strategic options and management activities can be created based on the need of stakeholders.

In conclusion, involving stakeholders in planning and management is a necessary condition for sustainable wetland management. Without understanding the environment, knowing how to conserve natural resources without community participation in the management will not be sustainable over time. SWOT analysis is a good tool to clarify strengths, and internal weaknesses and opportunities and threats from external factors. The combination of internal and external environmental factors in a TOWS matrix helps to get better understanding of the strategic choices and the options which could be pursued. As it can be seen from the results presented in this study, stakeholders with different socioeconomic backgrounds require different management approaches. The developed action plan for each area should be implemented accordingly. For example, a tourism group highly requires tourism support and an urban group requires investment support while a rural group mainly requires for environmental protection and an improvement of infrastructures. This is why bottom-up management practices can respond to the needs of the community while top-down management practices sometimes result in actions that local communities do not find necessary, and thus lead to poor cooperation.

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Chapter 13
Resident-initiated Practice of a Habitat of *Iris rossii*, a National Natural Monument in the Rural Landscape of Japan

Kazuaki Naito

Abstract *Iris rossii* Baker, a threatened herbaceous plant in Japan, occurs in sunny habitats such as sparse pine forest and seminatural grassland. This species is distributed in China, Korea, and Japan. Because it reaches its southern limit in Japan, some *I. rossii* habitats have been designated as national natural monuments by the Japanese government. In these habitats, resident-initiated management is often performed, which has made major contributions to conservation. This chapter describes the relation between traditional land use and the condition of the habitat of *I. rossii* in a locality in southwestern Japan, the contribution of resident-initiated habitat practice and population monitoring in this locality during recent years, and current and future challenges for conservation of this species.

1 Introduction

Iris rossii Baker, the smallest *Iris* species in Japan, flowers in April when it is only about 10 cm in height. After flowering, its leaves grow to 40–50 cm in length until early summer. The seeds, which are contained in fruits borne near the ground, are dispersed in late June–July. This species is found from Okayama Prefecture to Miyazaki Prefecture in southwestern Japan, as well as in Korea and northeastern China. It reaches the southern limit of its distribution in Japan. In Japan, it is found mainly in sunny habitats such as sparse pine forest and seminatural grassland. Because these habitats are maintained by human intervention, such as cutting, mowing, and burning, they shrink or disappear due to ecological succession if human intervention is stopped. Because the extent of the habitats and the numbers of individuals of *I. rossii* has decreased in recent decades, the species is listed in

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category IB (endangered) in the Red List of Japan (Environment Agency of Japan 2000).

Some local habitats of *I. rossii* have been designated as national natural monuments by the national government because the phytogeographic distribution of this species implies that the Japanese islands were connected to the Korean Peninsula during past Ice Ages. Because the seeds of *I. rossii* are dispersed by ants (Nakanishi 1988), their dispersal distance may be limited within a local area. Thus, *I. rossii* habitats were originally designated as national natural monuments for their scientific and phytogeographic interest rather than for the purpose of conservation.

Originally, the aim of management of national natural monuments was to preserve their original status, with less focus on positive management (Kamei and Nakagoshi 2002). However, the need for positive management has been addressed in recent years. Habitats designated as national natural monuments have often been well maintained by conservation societies organized by local people. For example, a habitat of *I. rossii* in Nutanishi, Hiroshima Prefecture, southeastern Japan, has been well managed by local residents for decades. This habitat was discovered in 1931, the first *I. rossii* habitat discovered in Hiroshima Prefecture (Horikawa 1937, 1950). In 1935, it was designated a national natural monument and was named as "Southern limit zone of the habitats for *I. rossii* located at Nutanishi," by the national government, as well as several other *I. rossii* habitats in southwestern Japan.

Although it was known that many habitats of *I. rossii* were formerly scattered in Hiroshima Prefecture (Horikawa 1950), the current status of most of those habitats is unclear, and they appear to be vulnerable to abandonment or ecological succession. It is well known that traditional land use affects species richness as well as the persistence of threatened species, and drastic changes in land use may result in the extinction of species (Naito and Nakagoshi 1994; Maurer et al. 2006; Neidrist et al. 2008; Yamaura et al. 2009). *I. rossii* inhabited limited areas among widely distributed *Pinus densiflora* forests throughout western Japan. The forests were commonly managed by local people, but as a result of pine wilt disease as well discontinuation of local management for socioeconomic reasons during the 1950s and 1960s, most of them changed to dense broad-leaved forests in recent decades (Mamiya 1988; Fujihara 1996; Toyohara and Fujihara 1998). Naito and Nakagoshi (1995) surveyed a well-preserved *I. rossii* population in Hofu, Yamaguchi Prefecture, and southwestern Japan by population demographic method and clarified that open habitat condition is the most important key for the growth and reproduction of species. The outcome of this pioneer work has been used as guidelines for conservation practice for the species.

In the designated area in Nutanishi, the Society for Preservation of *I. rossii* was organized by local residents in 1965 with the purpose of conserving the habitat and population of *I. rossii*. In recent years, the main part of the habitat has been mown twice a year in February and August by members of the society to protect the habitat from succession. The society also sponsors an event that opens the designated area to the public for 2 weeks in April when *I. rossii* flowers, contributing to public awareness and understanding of the conservation of this species.

The habitat of the *I. rossii* population in the Nutanishi designated area has been surveyed several times since Horikawa’s survey published in 1937. The latest intensive survey was done in 2002–2003 with collaboration between researchers, including the author, and the local people. The results, as well as a proposal for management of the population, were published in a report by the Mihara Municipal Board of Education (2004). After the publication of the report, monitoring of the population has been conducted with the participation of local people. This chapter considers the value of the *I. rossii* habitat as a national natural monument, focusing on traditional land use by the local people and their view of the cultural landscape of the region, and discusses the remaining issues for future conservation.

2 Methods

2.1 Vegetation in the Designated Area and Its Changes in the Surrounding Region

To clarify the status of the vegetation in the designated area in the latest intensive survey in 2002–2003, the open area without a continuous canopy was distinguished from the closed forest, including the bamboo-dominated area. The open area, which was inhabited by *I. rossii*, was subdivided into zones according to topography. The relative photon flux density (RPFD) was measured in each zone on July 3, 2003, in order to compare light conditions. The measuring points were determined by random waking, and measurements were taken at more than 20 points in each zone. Census of all individual trees taller than 1.3 m, except bamboos, was carried out. In order to understand the history of changes in the vegetation, previous reports (Horikawa 1937, 1959; Suzuki 1972) of the vegetation in the designated area were compared with the results of the latest survey.

For better understanding of the establishment and history of the current vegetation on a regional scale, changes in the distribution of paddy fields were mapped using aerial photographs taken in 1962, 1974, 1981, and 2003. This was done because mowing, a method of management of forest and grassland in this region, seemed to be tightly connected to paddy cultivation because local farmers collected organic materials such as fallen leaves and branches and small standing trees from the rural forest beside paddy field for fuel and fertilizer before decline in the use of these organic materials. At the same time, a hearing investigation for elderly local people was performed for information on former land use in the designated area in relation to farming and daily life of the local people.

It was carried out at Shosen Kaikan, the community house of the local village, on November 13, 2002. Six men, who were 67–80 years old and members of the Society for Preservation of *I. rossii*, attended the investigation. First, an interviewer, the author, asked key topics on the history and land use of the designated area and its surrounding area, and the six candidates frankly answered and commented for approximately 2 h.

The results are described in detail in a previous report (Mihara Municipal Board of Education 2004), and therefore only important topics among them are described in this chapter.

2.2 *Census of* I. rossii *Population in the Designated Area*

To clarify the distribution pattern of *I. rossii*, all individual plants in the designated area were identified. The *x* and *y* coordinates (at centimeter scale) of each individual were measured by using a total station, and a distribution map was made at a fine scale. A numbered plastic tag, diverted an anchor pin used to fix agricultural mulching sheet, was fixed to the ground beside each individual for individual identification during long-term monitoring. In 2002 and 2003, the numbers of flowers, fruits, and shoots were counted for each individual in April, July, and October, respectively. The regular survey was continued in subsequent years until 2014 for re-measurement of identified individuals. When new individuals, which were mainly seedlings and juveniles, were found during the regular survey, they were marked in the same manner as those during previous surveys. Before the first survey in 2002, some *I. rossii* plants grown in the nursery had been transplanted into the area. This transplantation was started to compensate the decreased number of individuals caused by illegal plant hunting and was continued till 2000, even after the damages by plant hunting disappeared. Because there were no detailed records on the numbers and locations of transplanted individuals, it was difficult to distinguish between planted and naturally established individuals. Therefore, the distribution and population density did not exactly reflect the habitat condition of the sites. That is why it was decided to monitor the changes in individuals, flowering, and fruiting for years to determine the effect of the condition of the natural habitat on the population dynamics of *I. rossii*.

3 Results

3.1 *Changes in Vegetation in the Designated Area*

According to Horikawa (1937), the vegetation of the designated area in the 1930s consisted of a sparse forest of *P. densiflora* trees about 25 years old with various shrubs and herbaceous plants on the forest floor. The vegetation of the surrounding area was similar. The vegetation survey found that grassland plants such as *Sanguisorba officinalis*, *Adenophora triphylla* var. *japonica*, *Atractylodes japonica*, and *Solidago virgaurea* and shrubs such as *Eurya japonica*, *Rhododendron* *kaempferi*, *Lyonia ovalifolia* var. *elliptica*, and *Pourthiaea villosa* var. *leavis* occurred in the designated area. All of those species were also found in 2002. A photograph in Horikawa's report shows tall pine trees with trunks of various sizes, a thin understory of smaller trees and shrubs, and dense vegetation on the forest floor. There were also small pine trees 1–2 m tall, indicating heterogeneous vegetation formed by pines of different heights, probably due to selective cutting in a small area. A map attached to the report shows that the valley-like area adjacent to the designated area was occupied by paddy fields at that time.

According to a later report by Suzuki (1972), the vegetation of the designated area was semi-wet forest with *P. densiflora* trees about 40 years old and dense dwarf bamboo, *Pleioblastus chino* var. *viridis*. The phytosociological survey found a top tree layer of *P. densiflora,* without a dense understory of smaller trees and shrubs, similar to the report by Horikawa (1937), but with a rich shrub layer including *E. japonica*, *Rhododendron reticulatum*, *R. kaempferi*, *Viburnum wrightii*, *Ilex crenata*, *Elaeagnus pungens*, and *P. villosa* var. *leavis*. The field layer was composed of *Miscanthus sinensis* and *P. chino* var. *viridis* as dominant species, accompanied by grassland species such as *Potentilla freyniana*, *Isodon inflexus*, *Salvia japonica*, *A. japonica*, *A. triphylla* var. *japonica*, *Cirsium japonicum*, *Aster scaber*, and *S. officinalis*. Most of these species were also found in 2002. However, Suzuki (1972) reported that the vegetation coverage of the shrub layer was 20–70%, which had almost disappeared in 2002. The change in coverage of the shrub layer is probably due to the fact that the field survey reported by Suzuki (1972) was conducted in 1961, before the Society for Preservation of *I. rossii* was founded in 1965, when little or no vegetation management was being performed. Even if the local people were still managing vegetation by mowing in 1961, they may have mowed by hand rather than using mowing machines, which probably resulted in heterogeneous vegetation.

3.2 Hearing Investigation of Local People

According to the hearing investigation for six men of the members of the Society for Preservation of *I. rossii*, when the *I. rossii* habitat was designated as a national natural monument by the government, the forest in the area was managed by periodic cutting of small trees and mowing of the forest floor. This was done to obtain understory trees and forest grasses to be used for fuel and timber around the year. The management regime was similar to that of a commons system, in which local people were allowed to cut grasses and trees except pines, the most important resource for timber production, without having proprietary rights to the land. Later, the land ownership was assigned to a financial ward, which is a special type of local public organization in Japan. The management scheme continued until gas replaced organic materials for home heating.

3.3 Changes in the Distribution of Paddy Fields in the Surrounding Region

Changes in the distribution of paddy fields are shown in Fig. 1. In 1962, the paddy fields in the region were distributed in the flat area, extending to marginal small valleys. The paddy fields had complicated shapes with long borders compared with their areas. Many of the paddy fields were adjoined by forest on the hillsides. The hearing investigation revealed that the forest next to the paddy fields was probably well managed by mowing and cutting and provided sunny habitats for plants. Some paddy fields were abandoned or converted to residential areas by 1974, but the distribution of paddy fields was roughly the same as in 1962. The landscape changed drastically by 1981, characterized by the emergence of many abandoned or fallow fields in the marginal small valleys. The residential area in the north part also expanded during the same period. By 2003, some abandoned and fallow fields had been succeeded by secondary forest, and new residential and industrial areas had reduced the area of paddy fields.

Finally, many paddy fields in small valleys disappeared and the remaining paddy fields were mostly limited to the flat area, resulting in simplification of the shapes of the paddy fields. The designated area was adjacent to paddy fields in 1962, as shown in Horikawa's report (1937), but by 2003 it was separated from the paddy fields as a result of shrinkage of the paddy area.

3.4 Characteristics of the Vegetation in the Designated Area

The designated area of 14,300 m^2 is surrounded by a protective fence. The fence was originally built to keep out plant hunters in the 1960s and was reconstructed and repaired around the year 2000 to prevent damage from digging by wild boars. Only 28.0% (4,007 m^2) of the area was seminatural grassland (open habitat) dominated by *M. sinensis*. Seminatural grassland, which was established after the decrease in pine trees due to pine wilt during the 1980s, is now quite characteristic of the area. This is apparently the result of periodic mowing carried out by local people to maintain the habitat conditions for *I. rossii*. Mowing also benefits other grassland plants that occur in the same community by preventing the establishment of broad-leaved trees in the central area. *Epipactis thunbergii*, *Epimedium diphyllum*, *Gentiana scabra* var. *buergeri*, and *Platycodon grandiflorus* are important species for the conservation of local floristic diversity that are not allowed to be collected in national and quasinational parks by the Ministry of Environment. *Polygonatum odoratum*, *Lysimachia clethroides*, *S. officinalis*, *A. japonica*, and *A. triphylla* var. *japonica* are also representative grassland plants. Most of those species are only found within the designated area, indicating that the area is functioning as a refugium for them.

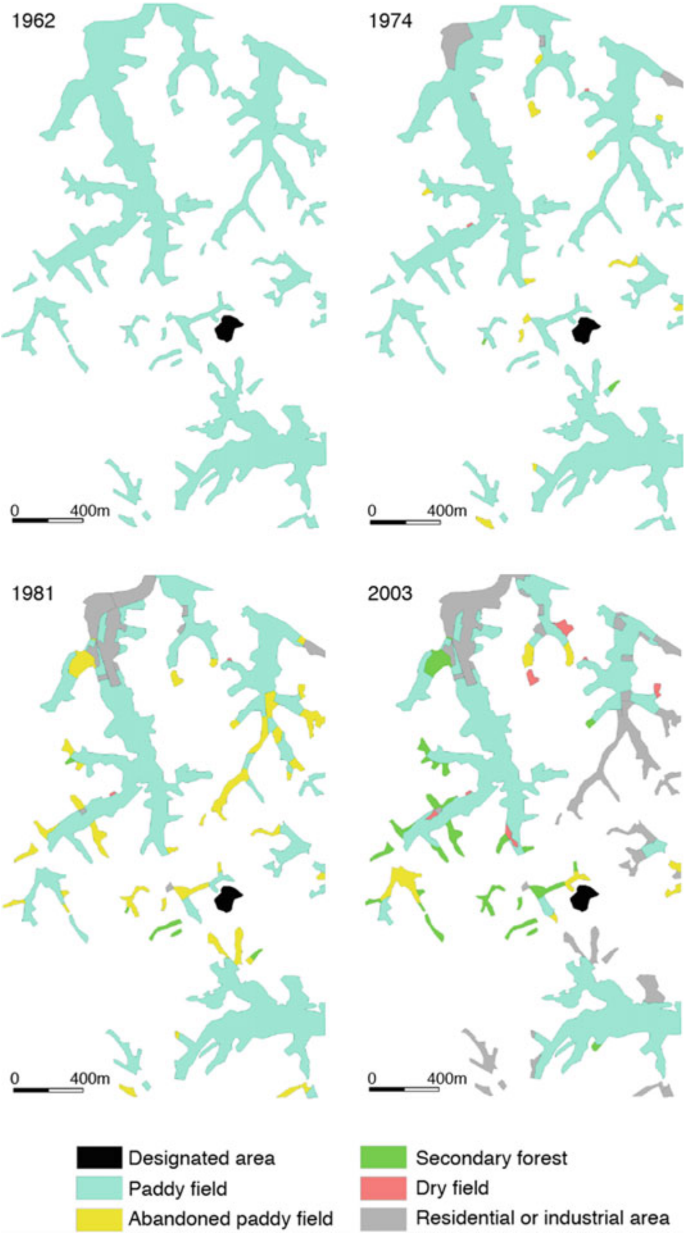

Fig. 1 Distribution map of paddy fields surrounding the designated area for the habitat of *Iris rossii* showing changes in vegetation and land use from 1962 to 2003. The designated area is indicated by black. In 1962, the paddy fields extended into the small valleys, shown as many narrow strips. Over time, these strips have gradually disappeared due to abandonment of paddy fields, resulting in simpler edges of the paddy field areas

In contrast to the seminatural grassland, the rest of the designated area is a closed broad-leaved forest dominated mainly by *Quercus serrata* and *Quercus variabilis* and partially by *Phyllostachys nigra* var. *henonis*. This forest is similar to the dominant vegetation type of the region surrounding the designated area, which is mixed broad-leaved forest that was established by succession from *P. densiflora* forest or as a result of disappearance of the pines from pine wilt disease.

3.5 Current Status of the I. rossii *Population*

I. rossii individuals were found only in the open habitat. Based on topographic features, the open habitat can be divided into four zones from north to south (Fig. 2). Zones 1 and 3 are located on concave gentle slopes. Zone 2 is located on a convex slope. Zone 4 is a small, terrace-like area surrounded by tall closed forest and located at the furthest distance from the entrance gate.

Zone 1 had the highest number of individuals, with 53.6% of the total number of individuals in 2002 (Table 1). The population density of *I. rossii* was also the highest in zone 1. Zone 1 also had the highest numbers of flowering and fruiting individuals, indicating that the zone was the main source of new individuals. The number of individuals was moderate in zones 2 and 3 and lowest in zone 4. Zone 4

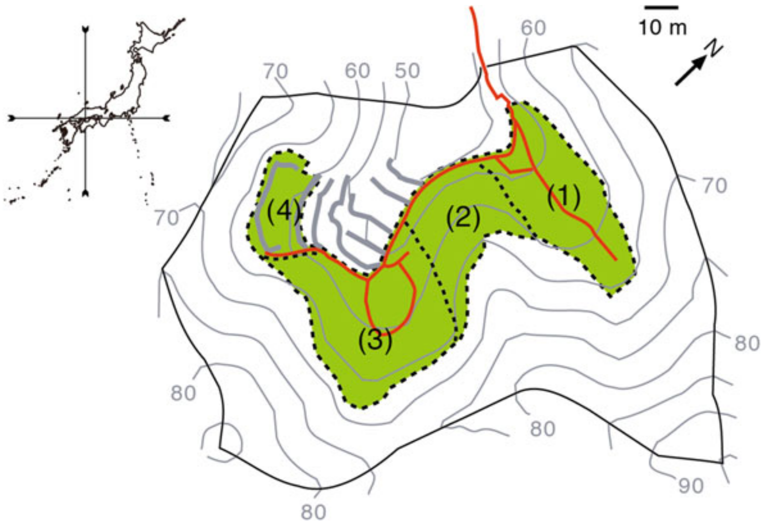

Fig. 2 Topographic map of the designated area with the location of four zones (1–4, indicated by dotted lines) dominated by grasses and dwarf bamboos (indicated by green). *Iris rossii* was found only within the four zones. The area surrounding the zones was closed forest dominated by broad-leaved trees and *P. nigra* var. *henonis*. The solid line indicates the protective fence enclosing the designated area. Red solid lines show footpaths. Numbers beside the contour lines show elevation above sea level

Table 1 Numbers of total, flowering, and fruiting individuals in each zone in 2002–2003 at the beginning stage of population monitoring

Zone	Area (m^2)	Number of individuals					
		Total		Flowering		Fruiting	
		2002	2003	2002	2003	2002	2003
1	767	319	366	245	273	128	184
2	1138	119	144	76	71	28	45
3	1059	128	166	69	86	20	62
4	564	29	39	5	10	0	0
Total	3528	595	715	395	440	176	291

had only five flowering individuals in 2002, none of which produced fruit. Individuals of *I. rossii* were uniformly distributed in zone 1. They were concentrated on the lower slope in zone 2 and at the center of the lower part of the gentle slope in zone 3. The few individuals in zone 4 were found at center to lower slope. These distributions were relatively unchanged in 2003.

The RPFD values in the four zones in July 2003 are shown in Fig. 3. The mean RPFD in the canopy of the field layer was 0.562 in zone 1, indicating the highest light conditions among the four zones, 0.490 in zone 2, 0.470 in zone 3, and only 0.173 in zone 4. The value of RPFDs within a zone was relatively similar among zone 1, 2, and 3 but lower in zone 4. The mean RPFD at ground level was 0.124 in zone 2, the highest among the four zones, 0.086 in zone 3, 0.053 in zone 1, and only 0.005 in zone 4. Remarkably, the RPFD in zone 4 was less than 0.1 at all points measured.

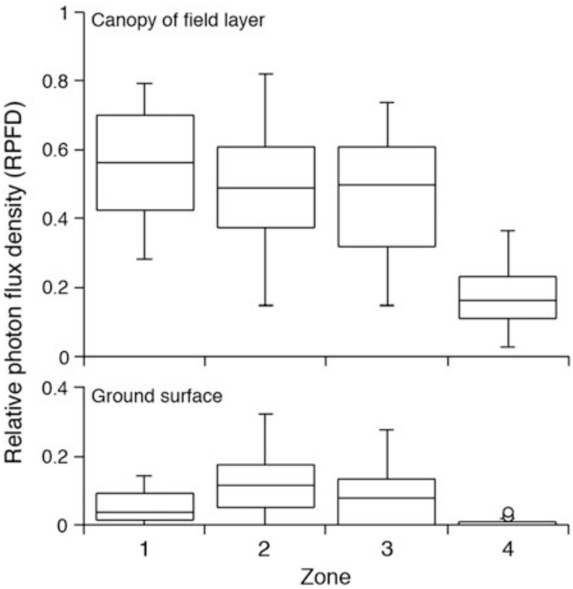

Fig. 3 Comparison of the relative photon flux density (RPFD) under diffuse light conditions in the four zones in July 2003 at the canopy of the field layer and at ground surface. The measuring points were determined by random walking within each zone. The number of samples was 23, 28, 21, and 21 at the canopy of the field layer in zones 1–4, and 24, 36, 26, and 43 at the ground surface in zones 1–4, respectively

3.6 *Changes in the Number and Distribution Pattern of* I. rossii

The observed number of individuals of *I. rossii* was 300 in 1961 (Suzuki 1972) and 595 in 2002. This doubling of the number may have resulted partially from planting of juvenile plants by the local people.

Suzuki (1972) found some areas in zones 3 and 4 where individuals of *I. rossii* were concentrated, whereas individuals were scarce in zone 1. No individuals were found in zone 2. In 2002, this trend was reversed, so that the highest population density was observed in zone 1, followed by zones 2, 3, and 4. The numbers of flowering and fruiting individuals showed the same tendency. This change reflects the changes in vegetation over 40 years, as broad-leaved trees and planted conifer trees (*Cryptomeria japonica* and *Chamaecyparis obtusa*) surrounding zone 4 grew so that they shaded the zone. During the same period, all pine trees in zones 1–4 died from disease, and the vegetation changed from sparse pine forest to grassland. At present, zone 1 seems to have the most favorable light conditions for *I. rossii*.

The population dynamics in the four zones from 2002 to 2014 are shown in Fig. 4. The total number of individuals gradually increased up to 979 in 2014. When the population dynamics are compared among zones, it is quite apparent that only zone 1 contributed to the increase in numbers. The population in zones 2 and 3 grew very slowly or was stable and decreased slightly in zone 4. The total number

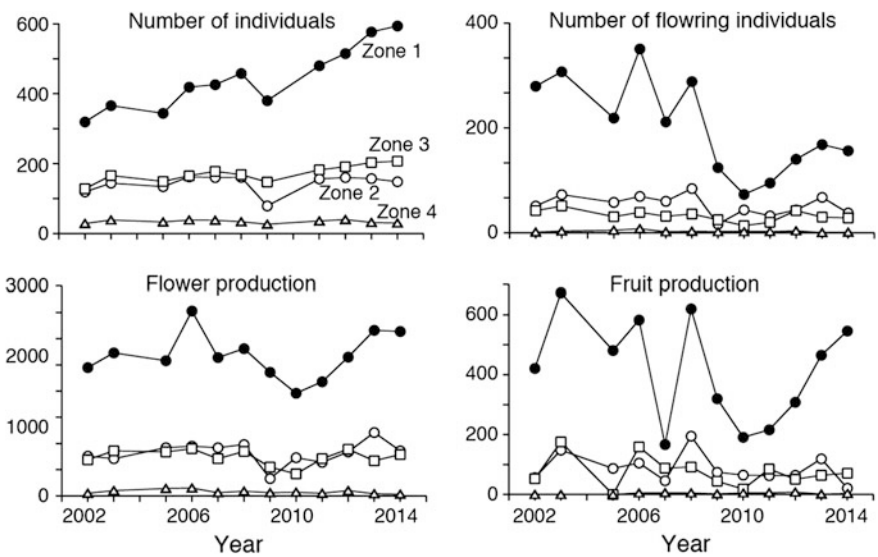

Fig. 4 Changes in the total number of individuals, the number of flowering individuals, the total number of flowers, and the total number of fruits from 2002 to 2014 in zones 1 (closed circles), 2 (open circles), 3 (open squares), and 4 (open triangles). Some data are missing because the survey was not performed due to weather conditions and/or monitors' schedules

of flowers was also highest in zone 1, although it varied among years. Fruit production was more variable than flowering but was still highest in zone 1. In summary, zone 1 produced more flowers and fruits than other zones and consequently produced more new individuals. In the other three zones, the quality of the habitat appeared to be less favorable, even when the habitat was seminatural grassland.

4 Discussion

4.1 Importance of Vegetation Management

Horikawa (1937) reported that *I. rossii* occurred in sparse pine forest and indicated the importance of vegetation management to protect the habitat from succession. Naito and Nakagoshi (1995) statistically analyzed flowering and fruiting in an *I. rossii* population located at another site that was designated as a national natural monument and had been carefully conserved like the Nutanishi locality. The analysis revealed that flowering and fruiting were influenced by tree crown conditions above individual plants. The light condition was an important factor for the persistence and reproduction of this species. Currently, in the Nutanishi designated area, the habitat is divided into two parts, one of which has changed to closed broad-leaved forest while the other has remained open grassland. The change to broad-leaved forest not only reduced the amount of habitat suitable for *I. rossii*, but also decreased the quality of the habitat in the remaining open area, typically zone 4, by shading the area and thus decreasing the amount of light.

4.2 Future Conservation Measures Considering the Historical Background

Long-term management of a national natural monument like the *I. rossii* habitat should be based on an understanding of the historical background, such as traditional land use and management by local people and current issues in conservation. This chapter describes the current status of the *I. rossii* population, habitat changes in and around the designated area, the effects of traditional vegetation management on the maintenance of the population, and future conservation measures taking into account the historical background.

The hearing investigation revealed that a sunny forest dominated by *P. densiflora* was prevalent in this area as a result of constant collection of wood and grasses for fuel, charcoal, and fertilizer by local people. The surveys of Horikawa (1937) and Suzuki (1972) reported that the *I. rossii* population survived in the pine forest in a habitat maintained by periodic growth and cutting. The forest was an essential resource for the daily life of the local people. However, its value was lost with the decline in the use of organic materials for fuel and fertilizer during the 1950s and 1960s, which resulted in the abandonment of vegetation management. Nowadays the original vegetation remains only in the designated area where typical grassland species still survive, although the tall pine trees have died. This is due to vegetation management by the Society for Preservation of *I. rossii.* The society is a key to conservation of the habitat and the population. However, the current condition of the vegetation is different than it was previously, now that the pine trees have disappeared and the sunny habitat that is preferable for *I. rossii* is limited to the central parts of the designated area, with closed forest that is unsuitable for the species in the marginal areas.

Suitable habitat has completely disappeared outside of the designated area, because the vegetation has succeeded to closed broad-leaved forest or the land has changed to residential or industrial uses. Paddy fields in the valley bottoms have been abandoned and succeeded by broad-leaved forest. Because of these changes, it is difficult to see any relations between vegetation and human activities in landscapes outside the designated area. Therefore, the designated area has a non-negligible role not only in conservation of a threatened plant and protection of a national natural monument, but also in the understanding of the history of traditional land use and the daily life of the local people.

In order to revive the previous vegetation management scheme, sparse pine forest with different growth stages should be restored in the designated area. Formerly, the pine forest was developed and carefully managed to be utilized in the daily life of the local people (Kamada et al. 1991). If some of the former vegetation can be restored, it will help visitors to understand traditional land use in the area. As described above, the designation of *I. rossii* habitat in Nuranishi as a national natural monument was originally based on scientific and phytogeographic considerations. These were the most common reasons for designating areas as national natural monuments (Kamei and Nakagoshi 2003). However, the national natural monument system is unique because it takes account of the cultural meaning of natural systems (Makita 2007). National natural monuments, especially those in rural landscapes, should be engaged with traditional land use and the daily life of the local people, offering great possibilities in the field of environmental education.

4.3 Necessity of Partnership with Non-native People and Organizations

At this time, reviving the previous vegetation management scheme is difficult for the Society for Preservation of *I. rossii*, and therefore, the marginal part of the designated area remains closed broad-leaved forest, which is not suitable for *I. rossii*. The society is organized based on the members of neighborhood association of local community, and primary members are not farmers anymore. The farmers are aged, but are able to participate in mowing and cleaning in the grassland area because these operations are relatively simple and safe. If the people outside the local community are able to participate in mowing and cleaning, it will help in promoting public awareness for the conservation.

Another critical issue for conservation is that operations like mowing and cleaning are merely insufficient for long-term conservation of the habitat because continuous succession of marginal forest is unavoidable. External support from factors, such as environmental/forest NPOs and/or forest owners' associations, is necessary in restoring the seminatural habitat of the broad-leaved forest area because more experienced workers are required in forest management to perform difficult tasks. The management authority, i.e., the local government, should connect actors and encourage partnership among them.

5 Conclusions

The principal contribution of the Society for Preservation of *I. rossii* is their continuous management of the vegetation by mowing. This has maintained the open habitat, especially in zone 1. The numbers of *I. rossii* individuals as well as fruit production in zone 1 have been increasing since 2002, indicating that the population in the zone can act as a source of new individuals for the adjacent zones. Periodic mowing is the most important conservation measure and should continue, even under minimal management. However, the population did not grow in zones 2–4, with almost no flowering in zone 4. The light in these zones is insufficient, even in the absence of a closed tree crown, because the closed forest is too close to the open area and is causing deterioration of the habitat by shading it. Therefore, recovery of the lighting condition by cutting trees and/or bamboos in the surrounding area will be an urgent issue for future management. Although this recommendation has been made, it has not been carried out because the time and labor required would be too long and too much for the Society for Preservation of *I. rossii*. This issue is becoming more serious since the trees have been growing for decades. Support and initiative from local and/or national governments will be needed to solve such issues by adjusting the conservation scheme based on the long-term perspective.

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Chapter 14
Arthropod Diversity in Conventional Citrus Orchard at Selorejo Village, East Java

Zulfaidah Penata Gama

Abstract Fruits and vegetables are one of the Indonesian agricultural products that are much favored by people from own country or abroad. Indonesia farmers have been trying to repel pests that attack plants using excessive pesticides. There is a decrease in abundance and diversity of arthropods in farms. The existence of arthropods in nature can serve as bio-indicators of environmental health because of the number and variety of species of arthropods are very high in the world. It can be assumed that if the environment is still stable and undisturbed. Conventional farming systems result in an adverse impact on the environment; therefore, the organic farming system began to be applied by farmers who have been aware of environmental health. Some due to the application of conventional farming systems are described with an example citrus farm in the Selorejo Village of Malang Regency.

1 Introduction

The use of pesticides is done continuously without considering the accumulation of residues that would be acceptable by both humans and animals (environment), a pest control concept that has long been embraced by farmers. Starting with the historical development of agribusiness starting from an agricultural revolution in Europe that occurred in 1750–1880 AD, the history of agriculture began to develop into commercial agriculture to apply the technology and pressing various limiting factors including pest control.

Furthermore, there is a development of pest management that uses DDT (dichloro diphenyl tricloroetana) in all regions of the world. Along with this, the pesticide industry is progressing very rapidly. At that time, the pest control using pesticides made from chemicals is considered the most secure way and good for farming system. Control of pests and diseases (pathogens) is performed with the use

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of pesticides and synthetic fertilizers, currently known as conventional farming systems. In general, the focus of controlling pests and diseases (pathogens) conducted by the farmers of vegetables and fruits (especially) is still on the use of synthetic pesticides.

Recently, the agricultural system in Indonesia is still conventional. The farmers use synthetic pesticides to control pests that often attack plantations. With the ever-Increased demand for quality agricultural products resulted in farmers used pesticides to maintain crop from pest attacks regardless of the health of the surrounding environment.

Spraying pesticides is done to eradicate pests before harvest with a specific schedule. The use of pesticides with conventional systems is very harmful because it causes the pest resistance to insecticides, the rise or blasting of pest populations, high residual levels on agricultural products that are not safe for consumption by humans. In addition, too frequent use of the pesticides will also lead to the killing of non-targeted insects which may result in an imbalance of ecosystems.

2 Evolving Concepts of Agriculture

Chandrasekaran et al. (2010) stated that agriculture is defined in the Agriculture Act 1947, as including “horticulture, fruit growing, seed growing, dairy farming and livestock breeding and keeping, the use of land as grazing land, meadowland, osier land, market gardens and nursery grounds, and the use of land for woodlands where that use ancillary to the farming of land for Agricultural purposes”. It is also defined as purposeful work through which elements in nature are harnessed to produce plants and animals to meet the human needs. It is a biological production process, which depends on the growth and development of selected plants and animals within the local environment.

Agriculture is defined as the art, the science, and the business of producing crops and the livestock for economic purposes.

As an art, it embraces knowledge of the way to perform the operations of the farm in a skillful manner. The skill is categorized as:

– *Physical skill*: It involves the ability and capacity to carry out the operation in an efficient way, for example handling of farm implements, animals, sowing of seeds, fertilizer, and pesticides application.
– *Mental skill*: The farmer is able to take a decision based on experience, such as (i) time and method of plugging, (ii) selection of crop and cropping system to suit soil and climate, and (iii) adopting improved farm practices.

As a science, it utilizes all modern technologies developed on scientific principles such as crop improvement/breeding, crop production, crop protection, and economics to maximize the yield and profit. For example, new crops and varieties developed by hybridization, transgenic crop varieties resistant to pests and diseases, hybrids in each crop, high fertilizer responsive varieties, water management, herbicides to control weeds, use of biocontrol agents to combat pest and diseases.

As a business, as long as agriculture is the way of life of the rural population, production is ultimately bound to consumption. But agriculture as a business aims at maximum net return through the management of land, labor, water, and capital, employing the knowledge of various sciences for production of food, feed, fiber, and fuel. In recent years, agriculture is commercialized to run as a business through mechanization.

Agriculture in Indonesia according to Estu (2014) is one of the key sectors of Indonesian economy. Although the share of agriculture sector contribution to the national gross domestic product has declined significantly in the last half-century, today, it still provides income for the majority of Indonesian households. In 2013, the agricultural sector contributed to 14.43% of national GDP, a slight decline compared to a decade earlier (2003) which reached 15.19%. In 2012, this sector provides jobs for around 49 million Indonesians, which represents 41% of the total labor force in the country. Currently, around 30% of Indonesian land area is used for agriculture purposes. Indonesian agriculture sector is overviewed and regulated by Indonesian Ministry of Agriculture (Indonesian Ministry of Agriculture 2015).

Generally, Estu (2014) believed that the agricultural sector of Indonesia comprises two types which corresponds scale:

- Large plantations either owned by state or private companies.
- Smallholder production modes, mostly traditional agricultural households.

The large plantations tend to focus on export commodities, such as palm oil and rubber, while the small-scale farmers focus on horticultural commodities to supply the food consumption of local and regional population, such as rice, soybeans, corn, fruits, and vegetables.

According to the Ministry of Agriculture in Indonesia (2015) said that Indonesia gets rain and abundant sunshine almost all the time because Indonesia is located in the tropics, where rain and sunshine are important elements for agriculture. Most of the global agricultural commodities are growing in Indonesia. The country has a fertile and vast land. Indonesia is a major producer of tropical agricultural products. Important agricultural commodities in Indonesia include palm oil, natural rubber, cocoa, coffee, tea, cassava, rice, and tropical spices that are easy to find all the time.

Over the last six years, citrus production in Indonesia has increased by about 400% to reach 2.2 million tons in 2005. Citrus represented about 10% of fruit production in 2005. Five provinces dominate citrus production—North Sumatra, East Java, South Sumatra, South Sulawesi, and West Kalimantan—accounting for 70% of Indonesia's production. East Indonesian citrus accounted for 11.9% of the volume of all citrus produced in Indonesia in 2005; this is a decline from 22.4% share of production in 1999. Over the last 6 years, production of citrus in East Indonesia has increased by only 163% compared to 392% across all provinces. South Sulawesi is the main citrus-producing province in East Indonesia

Table 1 Citrus production by province 1999–2005 (modified from BPS 2007, unit: ton)

No	Province	Year						
		1999	2000	2001	2002	2003	2004	2005
1	NAD (Aceh)	9956	17,074	13,834	32,191	31,486	20,258	11,395
2	North Sumatra	91,638	186,926	195,352	273,847	432,431	549,504	586,578
3	West Sumatra	42,470	25,643	38,543	39,040	54,491	57,212	68,675
4	Riau	19,326	50,965	58,428	69,421	57,814	112,913	85,204
5	Jambi	1865	1785	4380	5274	7438	19,605	12,038
6	South Sumatra	3962	21,218	35,332	42,638	57,664	167,689	218,397
7	Bengkulu	2155	3970	5124	5067	6187	4932	4147
8	Lampung	2141	8486	15,613	41,107	76,319	76,368	95,570
9	Bangka Belitung	–	–	1598	1143	5274	11,979	39,620
10	DKI Jakarta	11	3	8	1	1	4	15
11	West Java	32,664	37,228	23,288	26,584	22,225	20,226	21,221
12	Central Java	20,039	31,553	58,477	51,075	25,131	25,263	29,510
13	DI Yogyakarta	899	1097	976	1320	2498	2328	2980
14	East Java	40,576	46,488	67,905	150,476	421,829	467,466	395,428
15	Banten	–	–	1464	1364	1893	1732	1529
16	Bali	58,080	55,489	48,380	45,279	68,847	57,067	107,563
17	NTB	1306	1694	1536	1150	3994	4336	4183
18	NTT	17,105	19,039	21,729	24,506	23,896	24,714	21,434
19	West Kalimantan	1848	1034	1283	2402	49,435	108,211	146,314
20	Central Kalimantan	2072	2065	3379	3918	2400	2266	1112
21	South Kalimantan	17,394	10,687	19,119	19,035	75,787	95,845	114,432
22	East Kalimantan	1927	3934	5510	4200	3809	7894	7998
23	North Sulawesi	398	409	1009	1939	1281	1519	1534

(continued)

Table 1 (continued)

No	Province	Year						
		1999	2000	2001	2002	2003	2004	2005
24	Central Sulawesi	2911	1151	3212	7010	7110	17,012	46,152
25	South Sulawesi	75,791	110,120	54,708	108,174	68,731	197,825	157,783
26	S.East Sulawesi	1931	4995	9496	6374	17,093	11,400	22,557
27	Gorontalo	–	–	160	578	516	378	923
28	Maluku	162	153	5	1607	3056	3478	2952
29	North Maluku	–	–	194	603	168	1179	2525
30	Irian Jaya	904	846	1385	809	1020	481	4251
	Total	449,531	644,052	691,433	966,132	1,529,824	2,071,084	2,214,020

with 157,783 tons in 2005 (60% share) up from 75,791 tons in 1999. However, South Sulawesi's share of citrus production in Indonesia has declined from 16.9 to 7.1% over the last 6 years. The major citrus regions are in the north of South Sulawesi, representing 88% of all *Siam* citrus production. Statistics Indonesia and Directorate General of Horticulture Production Development had citrus production data as shown in Tables 1 and 2 (Phillip 2007).

2.1 What Is Conventional System of Agriculture?

Conventional farming is a term used to designate farming techniques that are traditionally, and often controversially, oriented toward using technology, pesticides, chemicals, and other synthetic tools in the cultivation of crops. Thus, "conventional" is often used as an antonym for "organic," a farming approach that alternatively seeks to limit or eradicate the introduction of synthetic elements into agriculture. According to the USDA (2005), there is no concrete example of conventional farming, as it takes different forms depending on the farm, the region, and the nation. However, some consistent features include high levels of capital investment and technological innovation as well as the frequent use of commercial pesticides. Opponents of conventional farming often associate it with less vigilant ecological practices, particularly with regard to the use of chemicals employed to manage the infiltration of weeds and pests. According to *Fresh Connect*, such practices may lead to unacceptable levels of toxicity and long-term health implications for consumers.

Kim (2011) in Fraser et al. (2005) stated that modern agriculture has been working within the global food system to feed the world's urbanized masses via a gamut of advents in farming practices to become what is now known as industrial agriculture. The mass production of food through the techniques that define modern agriculture has led to the conventionalization of agriculture in a technocratic approach to agriculture (*Fraser*, personal communication). The intensive farming that characterizes modern agriculture uses a higher amount of labor and chemicals per unit area than any other approach to farming. Much of this labor is mechanized to allow for a much more efficient use of land, providing a higher yield-*output* to human labor-input ratio. However, this conventional and mechanized form of agriculture is extremely energy intensive, requiring fossil fuels to power the machines that allow humans to farm on such a large scale (Pimentel et al. 1973, 2005). One of the defining methods that CA employs is the use of conventional fertilizers (Crews and Peoples 2004). Applied conventional fertilizers come in various standard N-PK ratios for application on a crop. Fertilizers provide renewed applications of nutrients onto the soil, effectively removing considerably long-term strategies to retain and replenish soil nutrient and soil organic carbon. Fertilizers are also the cause for one of the primary concerns of CA. Methane and nitrous oxide emissions are, respectively, the second and third most important GHGs after carbon dioxide (UNESCO-SCOPE 2007), and their emissions from agricultural fields has

Table 2 Citrus harvested by province, 1998–2005 (modified from BPS 2007, unit: hectare)

No	Province	Year							
		1998	1999	2000	2001	2002	2003	2004	2005
1	NAD (Aceh)	379	535	826	788	837	1314	946	456
2	North Sumatra	5466	6819	6219	10,354	10,321	11,239	13,842	14,521
3	West Sumatra	1292	1798	1594	2248	2819	3283	2817	3212
4	Riau	827	2212	4044	3771	4022	3014	3875	2662
5	Jambi	70	97	100	259	253	272	594	614
6	South Sumatra	1240	395	2304	2660	2728	5447	6534	5763
7	Bengkulu	105	72	234	360	258	461	200	145
8	Lampung	339	108	428	968	1950	3237	3147	3266
9	Bangka Belitung	–	–	–	92	166	752	358	1668
10	DKI Jakarta	–	–	–	–	–	–	0,2	2,0
11	West Java	871	639	808	637	481	458	617	785
12	Central Java	478	765	1463	1855	1337	1229	1538	1136
13	DI Yogyakarta	66	63	72	62	95	78	83	87
14	East Java	1883	1557	2101	2392	4421	9995	14,747	11,473
15	Banten	–	–	–	57	45	120	86	62
16	Bali	3080	2572	2503	2338	1849	7851	4066	4014
17	NTB	117	99	95	104	40	117	112	105
18	NTT	1052	1014	1423	1036	1247	2458	1564	956
19	Timor Timur	46	–	–	–	–	–	–	–
20	West Kalimantan	220	204	59	77	151	1409	3059	4594
21	Central Kalimantan	216	166	132	154	167	138	143	150
22	South Kalimantan	956	822	826	971	945	6804	2474	2481
23	East Kalimantan	172	145	240	243	95	122	210	224

(continued)

Table 2 (continued)

No	Province	Year							
		1998	1999	2000	2001	2002	2003	2004	2005
24	North Sulawesi	55	34	37	56	48	75	78	91
25	Central Sulawesi	226	273	111	221	353	203	754	1039
26	South Sulawesi	3785	4416	10,943	2956	12,513	7706	9150	6735
27	S.East Sulawesi	352	153	312	449	330	1185	961	1093
28	Gorontalo	–	–	–	10	27	17	16	35
29	Maluku	66	31	29	1	56	106	126	213
30	North Maluku	–	–	–	18	83	23	106	101
31	Irian Jaya	322	221	217	230	87	26	103	180
	Total	23,681	25,210	37,120	35,367	47,824	69,139	72,306	67,883

Sources BPS—Statistics Indonesia and Directorate General of Horticulture Production Development (2007)
Note Data not available

been greatly increased with the application of ammonium-based environmental problems that have arisen from the use of conventional fertilizers highlight the disjunction between intensive industrial farming and care for natural ecosystem processes. For example, conventional fertilizers are used to provide an abundant amount of nutrients in biochemically available forms, but the scale at which fertilizers are applied coupled with the natural water cycle has led to nutrient-loaded runoff that feeds into aquatic systems (Goetz and Zilberman 2000). The loss of dissolved oxygen driven by nutrient-laden waters has led to the eutrophication of coastal regions and lakes throughout North America, altering ecosystem dynamics of entire aquatic systems (Carpenter et al. 1998). The post-World War II Green Revolution produced another example showcasing the large divide between CA development and environmental considerations. The first suite of synthetic pesticides was produced, leading overtime to the refined synthesis and common applications of pesticides to eradicate pest insects, weeds, and other undesired organisms. Pesticides are used to control natural biological processes that disrupt the homogeneity and production efficiency of industrial crop farms by disrupting the natural chemical functions (Hussain et al. 2009) of unwanted organisms in the farm system. The problem herein lies in the chemical selectivity of the pesticides and the biological evolution of tolerance and resistance to these pesticides, rendering them ineffective and biochemically obsolete. Furthermore, human consumption of foreign and synthetically produced chemicals is an aspect of agriculture that the general public is not too comfortable with (Dunlap and Beus 1992). The introduction of GMOs presented a technocratic solution to the biological problems associated with excessive pesticide use. GMOs gave farms the ability to grow masses of phenotypically and genotypically monoculture crops, fitting into the CA system by allowing the creation of machines specialized to handle vast quantities of single crop types. Such a precise specialization of crops delivers an even higher yield output per unit of energy input (Gardner 2003), resulting in less land required for farming and leaving more natural land intact. As a whole, the mechanization of farming in today's conventionally industrial agriculture has brought about an approach to farming that is disconnected from the earth and the people it feeds. The growing number of links in the food chain renders it harder and harder to see firsthand the ecological impacts that conventional farming has (Cone and Myhre 2000), facilitating the ease with which we can forget its connection to climate change and food security. The term "conventional agriculture" as it applies to the area of agriculture can be defined as "generally used to contrast common or traditional agricultural practices featuring heavy reliance on chemical and energy inputs typical of large-scale, mechanized farms to alternative agriculture or sustainable agriculture practices. Mold-board plowing to cover stubble, routine pesticide spraying, and use of synthetic fertilizers are examples of conventional practices that contrast to alternative practices such as no-till, integrated pest management, and use of animal and green manures".

2.2 What Is Organic Farming System of Agriculture?

Organic farming is a method of crop and livestock production that involves much more than choosing not to use pesticides, fertilizers, genetically modified organisms, antibiotics, and growth hormones according to the Martin opinion (2009), while Tridjaja (2016) declared that organic farming system is a form of agriculture system which avoids or largely excludes the use of synthetic fertilizers and pesticides, plant growth regulators, and livestock feed additives. As far as possible, organic farmers rely on crop rotation, integrated pest management, crop residues, animal manures, and mechanical cultivation to maintain soil productivity and till to supply plant nutrients, and to control weeds, insects, and other pests. Definition of organic farming according to Martha et al. (2003) is organic agriculture that has both general and legal definitions. Generally, organic agriculture refers to farming systems that avoid the use of synthetic pesticides and fertilizers. In the USA, organic farming is defined by rules established by the US Department of Agriculture's National Organic Standards Board (NOSB), while based on National Standardization Agencies in Jakarta, organic farming is a form of agriculture which avoids or largely excludes the use of synthetic fertilizers and pesticides, plant growth regulators, and livestock feed additives. For animals, it means that they were reared without the routine use of antibiotics and without the use of growth hormones. In most countries, organic produce must not be genetically modified. Organic farming is now gaining popularity and is being accepted by people all over the world. A growing consumer market is naturally one of the main factors encouraging farmers to convert to organic agricultural production. Increased consumer awareness of food safety issues and environmental concerns has contributed to the growth in organic farming over the last few years (Sumner 2005).

Recently, organic foods are becoming much more widely available. Entering the twenty-first century, there emerged the "back to nature" lifestyle where people became more aware of the negative impact of *chemo-sy*nthetic inputs. Therefore, organic farming became one of the alternatives to the new lifestyle. The consumer preference to organic products had increased its demand, and consequently, organic farming continued to develop in the country. Especially, organic farming systems in Indonesia that had farmers characteristic are small farmer with large cultivation area less than 0.25 ha each and lack of technology information access and networking (Suleman 2007). Based on this situation and condition, the consumers demand for safety and healthy product and its concern to sustainable environment (eco-labeling attributes) has become a basic rationale to the Government of Indonesia to develop organic farming system and use it as an alternate agriculture to increase food production and food safety. All the regulations are contained in the Guidelines for Certification of Organic Farming.

Jahroh (2010) declared that the organic farming movement in Indonesia started in 1984 through the establishment of Bina Sarana Bakti (BSB) Foundation as the center for organic agriculture development by Rev. Agatho Elsener. It is the first organic farming training center in Indonesia that has trained more than 10,000 farmers and organizations all over the country. From 1985 to 1990, Integrated Pest Management (IPM) program was largely conducted, especially in rice farming. This program had decreased the use of pesticide up to 90%. In 1990, the first network of farmer and fishery group, SPTN-HPS, was founded in Jogjakarta. Afterward, the first Indonesian Organic Agriculture Network (JAKERPO) was established in 1998 by Biotani PAN Indonesia, SPTN-HPS, Konphalindo, PPLH Seloliman, and Gita Pertiwi during Organic Agriculture Workshop supported by International Federation for Organic Agriculture Movements (IFOAM).

2.3 Conventional Farming of Citrus in Indonesia

Orange is one kind of annual fruit crops that are widely cultivated in Indonesia. Citrus plants are generally grown in the highlands to the middle plains. Citrus is one of the important fruits in Indonesia, and its production increased from 449.5 thousand tons in 1999 to 2.5 million tons in 2006, although slightly decreased to 2.2 million tons in 2009. The condition causes the orange crop to be one option that can increase farmers' commodities in Indonesia. Oranges are considered beneficial because the selling price is quite high (Ahmada et al. 2011).

Many types of oranges that have become processed products in Indonesia, even in some areas, declared citrus plants can provide benefits for citrus farmers in the plantation area. Citrus is one of the horticultural commodities which have priority to be developed, because the farming of citrus provides high gain, so it can be used as generating fund or source of farmers income. Several kinds of citrus include *Citrus sinensis*, *Citrus reticulata*, *Citrus nobilis*, *Citrus maxima* Merr, *Citrus grandis Osbeck, Citrus aurantifolia* Swingle, and *Citrus limon* Linn. The highest production is *Citrus sinensis* L. The citrus commodity achieved an average profit of IDR 16,037,449.17/year. Achievement of these advantages can be as an indicator of the abundance of citrus production in Indonesia (Bappenas 2000).

Recently, citrus production has decreased in many regions, but the production of citrus has declined more than 50%. The condition causes citrus growth failure due to the pest attack. One pest that attacks citrus crops is *Diaphorina citri* (Homoptera: Psyllidae). *Diaphorina citri* is the major insect pests of citrus, their role as a vector of Citrus Vein Phloem Degeneration (Wijaya et al. 2010).

The majority of agricultural systems in Indonesia still apply conventional farming systems. The use of chemical fertilizers and synthetic pesticides, also the application of non-organic farming systems in the short term is economically beneficial, but there are negative impacts on the surrounding environment. The conventional farming systems will lead to declining agricultural production. Conventional farming is usually contrasted to organic farming, as this responds to site-specific conditions by integrating cultural, biological, and mechanical practices that foster cycling of resources, promote ecological balance, and conserve biodiversity. It also causes land degradation with the loss of soil fertility, damage vegetation in the environment, and environmental pollution caused by hazardous substances from chemical pesticides (USDA 2005). Conventional agriculture is marked by the use of synthetic fertilizers and pesticides intensively. Conventional agriculture is marked by the use of synthetic fertilizers and pesticides intensively. Conventional farming can provide a very detrimental impact such as environmental pollution, pesticide residues, human health impairment, reduced useful organisms, pests become resistant to pesticides, and resurgence. The use of synthetic fertilizers may increase some types of nutrients but interfere with absorption of other nutrients and nutrient balance in the soil. Synthetic fertilizers also suppress the growth of soil microbes that cause a reduction in soil humus (Sudana 2003).

3 Impact Using Various Chemical Pesticides Toward Diversity of Arthropods

3.1 Arthropod Diversity as Affected by Agricultural Managements (Organic and Conventional Farming), Plant Species, and Landscape Context

Biological diversity has emerged in the past decade as a key area of concern for sustainable development. It provides a source of significant economic, esthetic, health, and cultural benefits. It is assumed that the well-being and prosperity of earth's ecological balance as well as human society directly depend on the extent and status of biological diversity. Generally, it is assumed that higher biodiversity results in higher productivity for biomass. In the tropics, where the climate is warmer, wetter, and less seasonal, biodiversity is richer, compared to temperate and polar regions. Latin America, the Caribbean, Asia, and the Pacific together host 80% of the ecological mega-diversity of the world. Consequently, biodiversity is, to a large degree, influenced by man, as changes in agro-biological management will influence biodiversity in such countries overall. Threats to global biodiversity, including loss of animal or plant biodiversity, occur in many parts of the world, and this often occurs rapidly. It can be measured by loss of individual species, groups of species, or decreases in the numbers of individual organisms. In a given location, the loss will often reflect the degradation or destruction of a whole ecosystem. According to the Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA 2003), habitat loss is the greatest, most serious of all threats to biodiversity. The introduction of non-native species and genetic stock is a major threat to biodiversity.

Some researchers said that agricultural practices also influence terrestrial and aquatic biodiversity within and around agricultural fields (Tilman 1999; Tilman et al. 2002). Fertilizers, pest control chemicals, tillage, and even crop rotation still have an impact on the biodiversity of agricultural ecosystems (Beringer 2000; Ross et al. 2002). The study about correlation between arthropod diversity and agricultural management observed by Boutin et al. (2009) showed that beneficial and phytophagous arthropod abundance differed between organic and conventional sites (only with sweep net) but family richness did not. Beneficial arthropods were more abundant in woody hedgerows, while phytophagous arthropods were more abundant in crop fields. This study also demonstrated a strong relationship between plant and arthropod composition. Habitats (total old field cover, total hedgerow length, and Shannon diversity index, all within 250 m radius) in the surrounding landscape influenced arthropod composition but were not leading factors in explaining richness and abundance. It is therefore of prime importance to consider both local factors (management practices and local vegetation) and regional factors such as landscape features as explanatory variables when attempting to explain biodiversity.

3.2 Community Structure of Arthropods in the Citrus Conventional Systems: A Case Study of Citrus Farming at Selorejo Village, Malang

Recently, Malang city is one of the tourist destinations. There are many attractions including agro-picking oranges in the villages Selorejo, Dau, Malang. Citrus is a major commodity in the village Selorejo. Data agriculture department in 2009 showed that the national citrus production reached 2.5 million tons per year (Cahyana 2009). Commodity crops, horticulture, and livestock are something in deficit up to 2012. Export target was not achieved due to the implementation, and realization is very small compared with the potential of national (Ministry of Agriculture) in 2014. The government hopes that the crop can improve the public incomes. In addition, it is encouraging farmers to use pesticides to achieve the maximum harvest as they expected. There *was can be* seen in the citrus orchard at Selorejo Village. Citrus orchard management is quite easy because of good harvests depend on routine pesticide spraying (Taufiqurrohman 2015). There are more than 10 kinds of pests that can cause damage to trees or citrus fruits, for example, fruit flies, fleas scales, aphids, and caterpillars (Marpaung et al. 2014). Pesticides would be reducing the ecological functions of the area. The impact of these pesticides will lead to loss of functions ecology that is no longer a balance between flora and fauna surrounding citrus groves. Changes in plantation caused the loss of ecosystem biodiversity especially in the agricultural sector. The use of chemicals has a major impact on soil organisms. Agricultural activity contains a lot of negative effects because it causes changes in the structure of the soil, temperature, humidity, and soil organic matter content which led to a reduction in arthropods abundance.

Arthropods that live in soil have a very vital role in the food chain, especially as decomposers, because without this natural organisms will not be able to recycle organic materials. In addition, arthropods also serve as prey for other smaller predators, so it will sustain other arthropods. As a consequence of micro-arthropod community structure will reflect the environmental factors that affect the soil, including human activity (Lavelle et al. 2006).

One study already investigated in conventional farming of citrus at *Selorejo V*illage. The purpose of this study is to identify the structure of arthropod community and determine the stability of the environment in citrus orchards with conventional systems. Observations already conducted before the citrus harvest season (April to September 2015) at the Selorejo Village, Malang Regency. Arthropod diversity was observed by visual encounter and pan trap methods. Observation of arthropods was also carried out with pitfall traps methods. Repetition is done three times before harvest. The results of pitfall traps and yellow traps indicated that there are three classes of arthropods (Insecta, Myriapoda, and Diplura), 7 orders and 21 families were found prior to spraying. There are 3 classes, 7 orders and 20 families of arthropods after spraying. After spraying insecticides on citrus crops showed that there was a decrease in the abundance of insects around the plantation. Myriapoda and Diplura can be found before spraying but after spraying did not find anymore. Before spraying, the citrus crop obtained 5 orders, 11 families of arthropods and in the refugia found 8 orders, 19 families of arthropods while after spraying, there was decline. Actually, the result of observation only found 5 orders, 7 families of arthropods but on refugia increased to 9 orders, 20 families of arthropods. It can be assumed that before spraying, so many arthropods exist in citrus plants, but when citrus are sprayed with insecticides that some arthropods are moved and hidden to refugia to avoid odors and toxins from insecticides. The abundance of insects was found in conventional farming at Selorejo Village. Before spraying pesticides and after spraying pesticides are shown in Table 3.

Figure 1 showed that the diversity index of soil arthropod decreases after spraying pesticides, but this did not happen on terrestrial arthropods. This is because of soil arthropods trapped, and they cannot run after spraying; consequently, these arthropods die into the trap. As for arthropods that live on land, it is easier to fly to avoid spraying and after spraying will come again.

3.3 Relationship Between the Diversity of Arthropods and Excessive Use of Pesticides

It was long ago presented by Berry et al. (1996) that modern agriculture has often created conditions favorable for pest populations, but inimical to those of beneficial arthropods. Heavy reliance on synthetic insecticides and herbicides over the last 40 years has been a significant factor in the decline of some invertebrate natural enemy populations in agricultural systems. In contrast, organic farming involves production systems which avoid or largely exclude the use of synthetic fertilizers, pesticides, growth regulators, and livestock feed additives. It has been established

Table 3 The abundance of arthropods at the citrus orchard

Class	Ordo	Family	The average arthropods (indv.)	
			Before spraying	After spraying
Insects	Diptera	Drosophilidae	48.3	98.5
		Tipulidae	2.0	0.5
		Cecidomyiidae	0.7	0
		Culicidae	43.3	8.5
		Antomizae	1.0	0.5
		Tiphiidae	17.0	1
		Chironomidae	0.0	26.5
		Bibionidae	2.0	12.5
		Tephritidae	4.5	2
		Muscidae	2.0	1.5
	Coleoptera	Scarabidae	2.7	5.5
		Dermestidae	24.5	65.5
		Dytiscidae	0.0	2.5
		Coccinellidae	32.0	7
		Curculionidae	1.3	2.5
		Ichneumonidae	1.0	0
		Stapylinidae	4.0	0.5
		Chrysomelidae	13.0	3
	Orthoptera	Blattidae	1.3	0.5
	Hymenoptera	Formicidae	13.7	29
	Hemiptera	Delphacidae	1.5	0
		Gerridae	1.0	0.5
	Dermaptera		1.3	0.5
	Lepidoptera	Pyralidae	1.0	0
		Ceratomimidae	0.0	1.5
Myriapoda			0.3	0
Diplura			1.0	0

by some authors that “organic” farming methods can lead to higher populations and species diversity of beneficial arthropods.

The comparison between the abundance and diversity of ground beetles (Coleoptera: Carabidae) by using pitfall traps on four pairs of conventional and organic farms in the USA showed that all pairs of farms had similar soil types and cropping histories, but differed in that one farm in each pair was managed conventionally, the other organically. Eight hundred and twenty-five carabid individuals were collected over three sampling periods, although the bulk of the data was collected during one period only. Organic farms had significantly higher numbers of carabid beetles and also had about twice the number of carabid species compared with conventional farms, but the two farm types had approximately the same level of community diversity as measured by the Shannon-Wiener index. Kromp (1989)

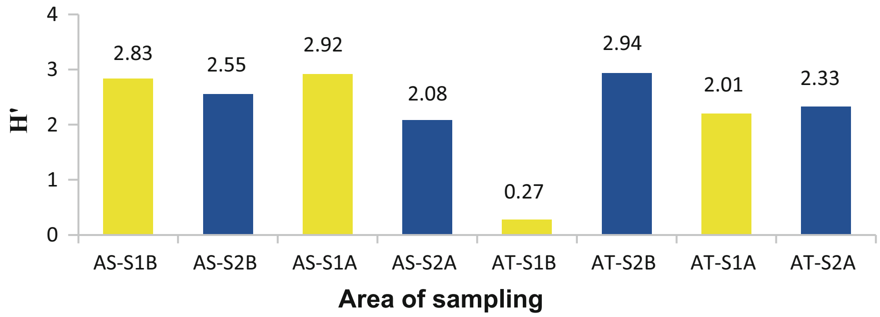

Fig. 1 Diversity index of arthropods at the citrus orchard (Gama et al. 2015). *Note* AS-S1B = the soil arthropods before spraying of insecticides (Plot 1), AS-S2B = the soil arthropods after spraying of insecticides (Plot 1), AS-S1A = the soil arthropods before spraying of insecticides (Plot 2), AS-S2A = the soil arthropods after spraying of insecticides (Plot 2), AT-S1B = the terrestrial arthropods before spraying of insecticides (Plot 1), AT-S2B = the terrestrial arthropods after spraying of insecticides (Plot 1), AT-S1A = the terrestrial arthropods before spraying of insecticides (Plot 2), AT-S2A = the terrestrial arthropods after spraying of insecticides (Plot 2)

also studied carabids in relation to organic/conventional agriculture and showed that the abundance and species number of this group of beetles, caught in pitfall traps, was considerably higher in “biological” (equivalent to organic) winter wheat than in conventional wheat. Some “farming systems” studies have also shown that populations of carabids and other beneficial arthropods are higher under some low-input (though not organic) regimes compared to high-input regimes (Booij and Noorlander 1992; Berry et al. 1996).

4 Conclusions

The majority of farmers in Indonesia are still applying conventional farming system because the farmers expect harvests quickly so that it can immediately reap the financial benefits. Some communities already knew the negative effects toward application of excessive pesticide on the surrounding environment, especially the effects on the diversity of arthropods. Organic farming systems are more effective than conventional systems because the system can minimize the use of pesticides, thereby reducing the expenditure of funds for the purchase of pesticides. In addition, conventional systems can lead to decreased diversity of arthropods from the use of pesticides that regardless of the dose.

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Part III
Community Development for Sustainable Society

Chapter 15
Management of Landscape Services for Improving Community Welfare in West Java, Indonesia

Regan Leonardus Kaswanto

Abstract A sustainable management of landscape services is needed to resolve ecological problems in rural and urban landscapes, particularly in developing countries, such as Indonesia. A specific management for particular area such as homegarden has to be developed in order to improve utilization of landscape services based on community activities. Four classic landscape services, i.e. biodiversity conservation, carbon stock and sequestration, water resources management, and landscape beautification are approached inside intensively managed homegarden. The landscape ecology approach was conducted through micro-, meso-, and macro-scales to figure out the potential ecology-economy-social benefit for urban-rural landscape inside homegarden as a small-scale agroforestry landscape or usually called as "*pekarangan*". A well planned and managed agroforestry landscape practices may suppress social, economical and ecological condition in rural marginal society and would improve the community welfare. Therefore, by managing *pekarangan* systems for landscape services, marginal communities would have the possibility to advance their asset of landscape services through plant biodiversity (H'), carbon stock (C), water resources utilization, and scenic beauty inside *pekarangan*. The aims of this research are to develop basic landscape service of plant biodiversity, carbon stock, water management and landscape beautification and to arrange recommendation for revitalizing *pekarangan*. The results show that *pekarangan* has diverse plant biodiversity (0.77–3.57) and diverse carbon stock (0.13–136.20 Mg/ha). *Pekarangan* also has the ability to utilize water effectively and at the same time contribute to provide amenity from its beautification for human well-being. Those landscape services provided by *pekarangan* could directly and indirectly improves the community welfare.

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1 Introduction

Revitalization of *pekarangan* towards a low carbon landscape (LCL) is a concept that answers to landscape management issues from a multidisciplinary. *Pekarangan* at the rural landscape provides various types of services that eventually improve community welfare. Arrangement of the *pekarangan* as a process of social and cultural landscape should be considered as sustainable ecological functions. Arrangement of the *pekarangan* can be investigated on a macro-scale, meso-scale and micro-scale. Macro-scale focused on two watersheds, meso-scale on the upstream, middle stream and downstream of the watershed and micro-scale on the *pekarangan* itself.

Pekarangan is one very representative for agroforestry landscape model. Agroforestry landscape is frequently defined as a combination of agriculture and forestry that are managed to create a balance between intensification of agriculture and forestry conservation. Agroforestry landscape also often developed in a complex land management, eventually able to optimize the sustainability advantages both ecological and social aspects arising from biological interactions when organisms therein contained grow effectively. *Pekarangan* can be interpreted as micro-scale agroforestry landscape, because in *pekarangan* annual and seasonal crops can be found, including livestock that are cultivated effectively. *Pekarangan* can provide various types of landscape services that are beneficial. In this article, four classic landscape services were observed, i.e. plant biodiversity, carbon stock, landscape beautification and water resources management.

Pekarangan can be assumed as a home garden, yard or open space that surrounds the house. *Pekarangan* also be defined as a complex agroforestry system which is rich with a blend of diverse species of annual and perennial plants with multi-storey vertical structure and often combined with livestock (Christanty 1990; Soemarwoto 1987). *Pekarangan* is a collection of plants, including trees, shrubs, bushes and vines, that exist on homegarden (Landauer and Brazil 1990). Various types of multipurpose products that can be produced from *pekarangan* with the needs of labour and other input costs are relatively low (Christanty 1990; Hochegger 1998; Soemarwoto and Conway 1992). Furthermore, *pekarangan* as also mentioned contributed significantly in the cycle of carbon stock and at the same time also improved the welfare of rural communities (Arifin and Nakagoshi 2011).

The benefits of *pekarangan* as mentioned above were not positively correlated with the utilization at present time. In the current situation, most of *pekarangan* are not managed properly, and even there is *pekarangan* which do not provide landscape services naturally (biodiversity and carbon stocks). Therefore, this article emphasizes how the links between biodiversity and carbon stocks on the landscape *pekarangan* can be managed in a sustainable manner.

This study has two objectives related to landscape services provided by *pekarangan* as one of agroforestry practice. These objectives are to develop classical landscape services from *pekarangan* by calculating the biodiversity index (H'), analyzing the carbon stock (*C*), measuring its beautification, observing the water management and to arrange recommendation of ideal management for sustainable *pekarangan*. Managing those landscape services both directly and indirectly is proving to improve community welfare.

2 Methods

2.1 Study Site

The study was conducted in four watersheds in West Java, namely Ci Liwung, Cisadane, Cimandiri and Cibuni Watershed (Fig. 1). These sites selection are based on the consideration of the following: (1) the same area of the upper watersheds so it can assume the same elevation, (2) the same orientation, i.e. towards the north and south which is used as a comparative analysis, and (3) the high effect of urbanization, because those four watershed areas are located at the greatest level of population growth and development in Indonesia.

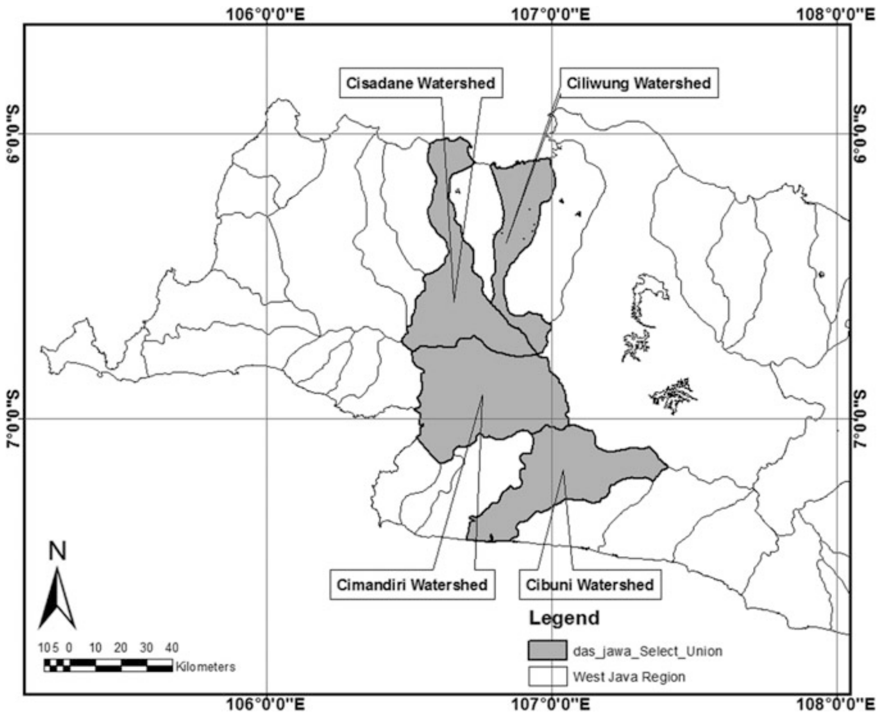


Fig. 1 Site study in two watersheds on West Java, Cisadane and Ci Liwung watersheds

Table 1 The general information of four watersheds of study areas

Name of watershed	Administrative location (district)	Total area (ha)	Perimeter (km)	Stream flow	Main river length (km)	Climate condition[a]
Cisadane (CS)	Bogor, Tangerang, Depok	153,485.47	273.50	Northern	112.7	A & B
Ci Liwung (CL)	Bogor, Jakarta, Bekasi, Depok	89,036.33	221.84	Northern	82.9	A & B
Cimandiri (CM)	Sukabumi, Cianjur	196,947.51	207.05	Southern	55.8	B
Cibuni (CB)	Sukabumi, Cianjur, Bandung	147,052.32	232.02	Southern	34.3	B

[a]Climate classifications are based on Schmidt and Ferguson (1951)

Cisadane watershed covers several districts and cities in West Java Province, DKI Jakarta, as well as Tangerang District and Tangerang City, Banten Province. Three subdistricts that were sampled were Ciampea Subdistrict on upstream, Ciseeng Subdistrict on middle and Karawaci Subdistrict on downstream. Ci Liwung watershed includes West Java Province and DKI Jakarta, the study sample was in Cisarua Subdistrict on upstream, Cibinong Subdistrict on middle and Tebet Subdistrict on downstream. In general, Ciliwung and Cisadane watersheds have humid climate with rainfall of 2000 mm/year (BMKG West Java in 2016), while Cimandiri dan Cibuni have B type climate condition (Table 1).

2.2 Sample Frame

In this study, the approach of landscape ecology was used to analyze the entire process of landscape agroforestry in *pekarangan* to assess the availability of landscape services relating to (1) plants biodiversity conservation, (2) carbon stock value, (3) landscape beautification and (4) water resources management on *pekarangan* (Fig. 2). The research process uses direct measurement methods and interview. The method was performed by landscape ecology perspective through a micro-scale of landscape agroforestry in *pekarangan*. The calculation of *pekarangan* sample starts with four watersheds, then in each watershed, there are three sub-watersheds, namely upstream, middle stream and downstream. In each sub-watershed, we selected two villages, and then in every village, we choose a hamlet. At each hamlet, we measured four *pekarangan* of G1, G2, G3 and G4. At the end, a total of 192 *pekarangan* samples have been measured directly and interviewed to figure out the potential diversity of landscape services inside (Table 2).

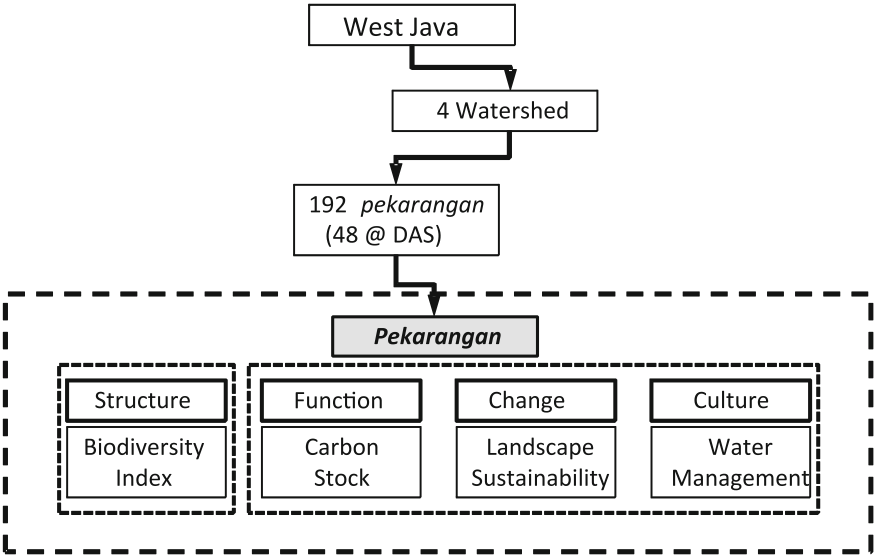


Fig. 2 Landscape ecology approach to analyze four aspects, (1) structure, (2) function, (3) change, and (4) culture on micro-scale agroforestry landscape (*pekarangan)*

Table 2 *Pekarangan* sample selection based on size and *other agricultural land* (OAL) ownership

Group	*Pekarangan* size (m^2)	Other agricultural land (OAL) ownership
G1	<120	Without OAL
G2	<120	With OAL < 1,000 m^2
G3	120–400	Without OAL
G4	120–400	With OAL < 1,000 m^2

2.3 Analysis of Plants Biodiversity Index

Vegetation analysis was conducted to calculate biodiversity index on plants that are found in *pekarangan*. Vegetation analysis procedure is as follows: (1) *pekarangan* selection as sample frame, (2) record and identify plant species, and (3) calculate important value index and Shannon–Wiener Index. Shannon–Wiener Index is a formula to calculate diversity, namely a combination number of species and number of individuals of each species in *pekarangan*, with formula as follows:

$$H' = -\left\{\sum \rho i \ln \rho i\right\}; \text{ with } \rho i = n_i/N$$

where:

H' = Shannon–Wiener Index
ρi = Relative abundance
n_i = Number of species (i)
N = Total number of individuals
Shannon–Wiener Index divided into three classes, i.e.
$H' < 1$ = Low diversity
$1 < H' < 3$ = Moderate diversity
$H' > 3$ = High diversity.

2.4 Carbon Stock Analysis

Carbon stock measurement analysis was approached by plant biomass analysis. Un-destructive method is used for biomass calculation using allometric equations based on the plant species found in *pekarangan*. Allometric is a mathematical function that shows the relationship between particular parts of the living creatures. The allometric equation which is used for estimating certain paramertes by using other parameters are more easily measured, in this study is prediction of tree biomass through measuring the diameter of the tree trunk (diameter breast height - DBH) (Hairiah and Rahayu 2007). Allometric formula for biomass estimation (Hairiah and Rahayu 2007) is as follows:

$$Y = a \cdot \mathrm{DBH}^b$$

where:

Y = Plant Biomass
DBH = *Diameter Breast Height* (1.35 m)
a = Conversion coefficient
b = Allometric coefficient.

Allometric formulas used in this study are tree allometric equations developed by Chave et al. (2005), while the bush is generalized using the equation by Ali et al. (2015). Estimation of carbon stock in herbaceous plants was done using the results of research by Roshetko et al. (2002, 2007) who has conducted sampling through harvesting (destructive sampling) in *pekarangan* area on Lampung with an average of 0.3 Mg/ha. Then estimate the carbon content of above ground in *pekarangan* using a formula according to Brown (1997), namely:

$$C = Y \times 0.5$$

where:

C = Carbon stock above ground (kg)
Y = Biomass value (kg)
0.5 = 50% carbon stock on biomass

2.5 Water Resources Management Analysis

Observation of water resources management in *pekarangan* was conducted through interview and questionnaire. We asked the flow of water utilization in each household, the utilization from water sources to the consumption and disposal activity. We mark every water pool and follow the distribution of water from each household member. We designed the *pekarangan* system inside and outside. The inside systems are house, pond, home yard (vegetation), waste (dump), animals (livestock) and for composting. While at the outside, we simulate the water that comes from spring, flows to river, to market and to the OAL.

2.6 Landscape Beautification Analysis

Measurement of landscape beautification was conducted by collecting the front side of each *pekarangan*. In total, 192 pictures of front yard *pekarangan* were displayed. The scenic beauty estimation (SBE) analysis was used to evaluate the quality of landscape of each *pekarangan*. The process of this analysis began with taking pictures of front side *pekarangan*. The views that had been taken were then presented to the respondents to get valuated. Every slide was played for ten seconds. The valuation score ranges from 1 to 10. Score one is the landscape with the worst aesthetic quality and ten is for landscape with the best aesthetic quality. Those scores were then used to get the SBE score, index estimation quantity of landscape beautification (Daniel and Boster 1976; Febriana and Kaswanto 2015), with this formula:

$$\mathrm{SBE}_x = \left(Z_{yx} - Z_{yo}\right) \times 100$$

where:

SBE_x = value estimation score of *x*th landscape beauty
z_{yx} = average value of *n*th landscape
z_{yo} = *z* average value of a landscape as a standard.

3 Results and Discussion

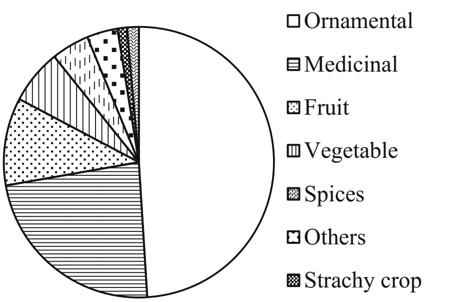
3.1 Plants Biodiversity Index in Pekarangan

There are 265 species of plants from 80 families that have been observed with eight functions classification, i.e. ornamental plants, industrial plants, starch crops, medicinal plants, herbs, vegetables, fruits and more. This is higher than a previous study conducted in four watersheds in West Java, namely 214 species (Kaswanto and Nakagoshi 2014). This is also higher when compared to some *pekarangan* researches in other tropical regions, courtyard Santa Rosa in the Peruvian Amazon with 168 species (Padoch and de Jong 1991) and in homegarden of northern Thailand with 230 species (Moreno-Black et al. 1996), as well as 253 species of western Kenya (Backes 2001). However, this result is smaller than other areas in West Java, namely Cianjur watershed of 440 species (Arifin et al. 2014), Zaire 272 species (Mpoyi et al. 1994) and Nicaragua 324 species (Méndez et al. 2001). Moreover, the highest number in West Java were reported by Karyono (1990), it reached 602 species. And our study nearly 40% of plants to number of Karyono (1990).

Horizontal structure on *pekarangan* with high biodiversity index related to the number and species of various ornamental plants. Plants in *pekarangan* are dominated by ornamental plants reached 50.03%. This shows that there are preference owners to utilize *pekarangan* as a purely aesthetic interest. As to meet the need for starch (carbohydrate), vegetables, herbs and industrial purposes (i.e. fuelwoods and housing board) is still relatively low (Fig. 3). Based on the functions of the plant, in *pekarangan* there are mangoes, *Pachystachys lutea* (lollipops) as hedgerow, as well as ornamental plants *Phalaenopsis* sp., and *Anthurium* sp.

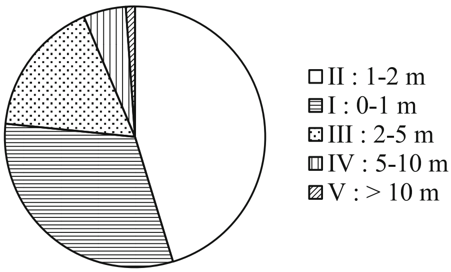
The vertical structure on *pekarangan* showed that most biodiversity is dominated by plants on Stratum II between 1 and 2 m (45.3%). However, plant with more than 2 meters high (Stratum III, IV and V) reached more than 20%, which means that the capacity of *pekarangan* space allows the plant to grow vertical optimally (Fig. 3). For example, *Crinum moorei* (daffodil) in stratum I, *Codiaeum* sp. (croton) in stratum II and *Mangifera indica* (mango) in stratum III. The ecological conditions of horizontal and vertical diversities showed that *pekarangan* has greatly contributed in maintaining sustainable environment (Kaswanto and Nakagoshi 2011). Hylander and Nemomissa (2009) also concluded that the species composition of *pekarangan* sometimes resembles plantation areas.

Plants biodiversity index indicated by the number of species and individual plants is found in 96 *pekarangan* samples. Most of *pekarangan* structures found almost have a same condition of forestry landscape, where the vertical and horizontal diversities are relatively high with a value of H' on a scale of moderate diversity (Fig. 4). The H' value ranges from 0.77 to 3.57, but the value of $H' > 1.00$ reaches 98.95% of total *pekarangan* samples. G1 and G3 are the pictures of *pekarangan* without ownership of OAL, while G2 and G4 *pekarangan* with ownership of OAL. The mean biodiversity index in *pekarangan* without OAL (G1 and G3) is higher than *pekarangan* with OAL (G2 and G4). This shows that the absence of the OAL will make homeowners take advantage of *pekarangan* intensively, thus making the biodiversity in *pekarangan* without OAL higher. Most of *pekarangan* without OAL have food crops and medicinal plants that can be used to fulfil the food needs of family members or increase income derived from *pekarangan* production. Karyono (1990) states *pekarangan* without a paddy field can be used as a carbohydrate-producing land with planting starchy crops such as cassava and sweet potatoes. Further, it is mentioned that some studies suggest the production of *pekarangan* also contributes to generate calories, protein, vitamins A and



Function	Presentase (%)
Ornamental	50.03
Medicinal	21.06
Fruit	12.42
Vegetables	7.01
Spices	5.18
Others	2.03
Strachy Crop	1.26
Industrial plant	1.01

Plant function as horizontal structure



Plant stratification	Presentase (%)
II : 1-2 m	48.21
I : 0-1 m	32.21
III : 2-5 m	12.62
IV : 5-10 m	5.7
V : > 10 m	1.26

Plants stratification as vertical structure

Fig. 3 Plant composition in *pekarangan* classified in eight use categories and five strata. Plants in *pekarangan* are dominated by ornamental plants (50.03%) and plant on second strata (1–2 m) up to 48.21%

C (Arifin et al. 2014; Christanty 1986; Christanty et al. 1986; Kaswanto and Nakagoshi 2014; Mulyoutami et al. 2009; Niñez 1987; Soemarwoto and Conway 1992). The income is derived from selling fruits and other plants from *pekarangan*.

Pekarangan with high biodiversity value tends to be maintained. Homeowners in addition to using land intensively yard also have habits or preferences (hobbies) associated with plants or gardening. Front *pekarangan* is often planted with ornamental plants, hedges and cherry trees as a shade, vegetables, herbs and spices at sides of *pekarangan*. This provides a positive impact on the management of *pekarangan*. Christanty et al. (1986) suggest ornamental plants usually placed in the front yard as well as economic value plants such as fruit trees so that the owner can see these plants, while medicinal plants, starchy crops and others are usually planted in back yard or front yard.

The diversity of plants is influenced by people's attention on *pekarangan*. Equipping *pekarangan* for families who lack land or cultivation area can help these families to get food supplies and fuel from the surrounding area. And finally,

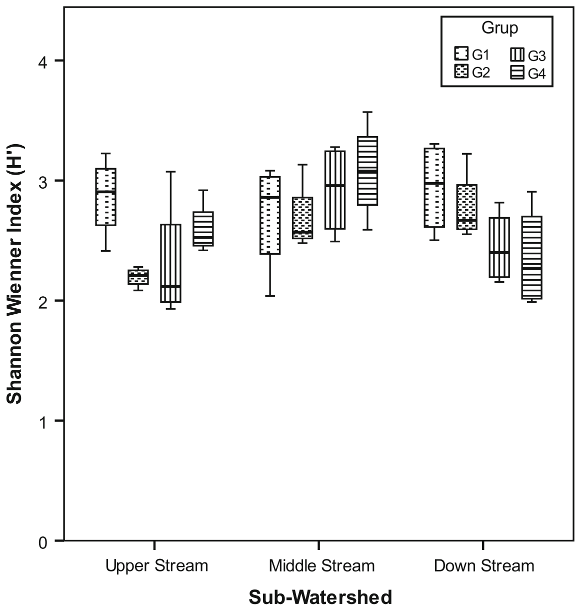


Fig. 4 Shannon–Wiener Index value on up-middle-downstream level and G1, G2, G3 and G4 groups

pekarangan always maintain diversity and at the same time preserve the surrounding forest (Mitchell and Hanstad 2004). This situation makes diversity of plant can continue to increase, indirectly. A high diversity can sustain carbon fluctuations in the environment (Henry et al. 2009), thus *pekarangan* can be one of the guard stabilities of the amount of CO_2 in the atmosphere.

3.2 Carbon Stock in Pekarangan

Carbon stock in *pekarangan* ranges from 0.13 to 90.80 Mg/ha in a small *pekarangan* (G1 and G2), while for medium-sized *pekarangan* (G3 and G4), it was higher ranging from 0.18 to 136.20 Mg/ha (Fig. 5). In total, the average carbon stock in *pekarangan* reached 22.26 Mg/ha. Results of the calculations also show that the carbon stock in *pekarangan* can reach up to 20% of the total carbon stock from carbon stock in natural forests. This means that the density and growth of plants in *pekarangan* have the ability to resemble (mimic) natural forest conditions. In the context of carbon stock, there is a real correlation between groups; however, there is no correlation between *pekarangan* with OAL and *pekarangan* without OAL. The average of carbon stock on *pekarangan* on middle stream of Cisadane watershed tends to be higher (26.11 Mg/ha), as well as the value of diversity index. Overall, *pekarangan* which have carbon stock >10:00 Mg/ha reaches 45.83% of the total samples. On average, in the upper stream is equal to 18.70 Mg/ha, and in the downstream equal to 21.96 Mg/ha.

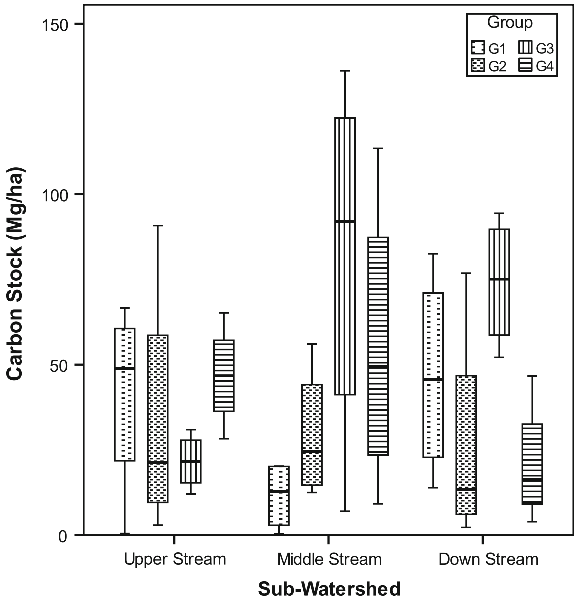


Fig. 5 Number of carbon stock on plants (Mg/ha) in *pekarangan* based on sub-watershed and group classification. Shows that small *pekarangan* also have capability to capture numerous carbon

The existence of large trees is causing carbon stock on middle stream of Cisadane watershed to be higher. One of *pekarangan* with a high value of carbon stock has several large trees with (DBH) more than 10–41 cm. Carbon stock above ground level mainly contained in plants, especially in permanent crops (Henry et al. 2009). Carbon stock is influenced by structure and composition of vegetation such as type, size, height and density of trees (Bajigo et al. 2015).

One of G3 *pekarangan* in middle stream of Cisadane watershed saves C up to 108.52 Mg/ha. Big trees of mango, *rambutan* and guava planted in this area accounted for nearly 95.32% 103.44 Mg/ha. Overall, carbon can be stored in above-ground parts of plants, litter, herbs, soil and roots. Above-ground biomass potential saves 32.9% of the total, while below ground can be reached 56.7% (Roshetko et al. 2002). Agroforestry practices will set the quantity of carbon that can be stored; it is associated with the species composition and ecological and environmental variations (Kumar 2011). Another thing is the speed of tree growth and the number of trees per unit of land (Henry et al. 2009).

In general, cultivation of tree on *pekarangan* will certainly store carbon much higher. It became one of the reasons the carbon stored in *pekarangan* without OAL higher than *pekarangan* with OAL. However, ownership of OAL significantly affects quantity of carbon stock in *pekarangan*, because *pekarangan* without OAL prefer to have ornamental plants that are profitable but have a low carbon content. On the other hand, it can be said that the small and medium *pekarangan* (<400 m^2) also have potential stored high carbon.

Wood of slower-growing species usually has higher density; therefore, the slow-growing species may accumulate more carbon in the long term

(Baker et al. 2004). Some examples of trees with high density which is more than 800 kg /m^3 are timber for furniture or other industries such as teak (*Tectona grandis*), *merbau* (*Intsia bijuga*) or *meranti* (*Shorea javanica*). Local trees are often planted in *pekarangan* and have medium density, namely cinnamon (*Cinnamomum burmanii*). People use this plant as a medicine and also herb. In general, community more often cultivated fruit trees like mango, *rambutan*, *durian* and jackfruit. Of course, densities of fruit trees are not high as timber. Even so homeowners can plant these two trees as needed, as fruits for consumption or timber for additional income. In addition there is also some kind of exotic plants, especially ornamental plants. Exotic plants will grow faster and also multiply by themselves, and will certainly contribute to carbon sequestration. However, the presence of exotic plants related carbon stock in the agroforestry landscape is still debated. Local plants are more adaptable than exotic plants (Nair et al. 2009), besides exotic plants will be more harmful especially if located near the conservation area (Bajigo et al. 2015; Kaswanto and Nakagoshi 2014).

3.3 Correlation Between Plants Biodiversity Index and Carbon Stock

Correlation analysis is conducted to see the linkages between biodiversity index and carbon stock in *pekarangan*. Management of landscape services such as biodiversity and carbon stock in *pekarangan* must be sustained for a long period, so that the study of relationship between these two things is important. The hypothesis is *pekarangan* with a lot of vegetation will be able to store much carbon.

As a result of linear regression, Shannon–Wiener Index and carbon stock are positively related. The relationship between Shannon–Wiener Index of trees with its carbon stock has a greater value of $R^2 = 0.234$. A variation of carbon stock does not affect plant biodiversity. These results are in line with the research of Mandal et al. (2013) and Karna et al. (2012). A comparative study in northern region of West Java showed that there is a possibility of positive correlation between Shannon–Winner Index and carbon stock inside *pekarangan* (Filqisthi and Kaswanto 2017).

The composition of tree species and agroforestry affects the quality and quantity of biomass on the ground and also carbon stored below ground (Nair et al. 2009). Water availability, quality and quantity of litter, root composition and distribution of carbon in the soil profile will influence both the quality and the quantity of the biomass returned to the soil. Recent research (Dayamba et al. 2016) found a positive relationship between species richness and underground carbon biomass in the West African region.

3.4 The Potential of Landscape Beautification Inside Pekarangan

The perspective of beauty from each *pekarangan* can be defined as social value, which means the highest value comes from the idea of productivity and the naturalness. The more beauty is implying to more natural. The landscape variables used for the analyses of the "society" value of the rural landscapes were defined on the scales for the "local" (human-natural) and for the "landscape" (not human-natural) perceptives (Franco et al. 2003).

The landscape beautification mainly came from the naturalness and the land use compatibility (Kaswanto 2015). Therefore, to increase the scenic beauty of each *pekarangan*, the natural arrangement of hardscapes and softscapes is a must. In addition, the beautification is also related to the experience of comfort, brightness and safety from a landscape (Febriana and Kaswanto 2015). It means to improve the landscape services from *pekarangan* can be reached by interfere the comfortability of microclimate inside *pekarangan* through planting functional plants such as oxygen provided plants, phytoremediation plants and high absorbed carbon dioxide plants. At the same time, the penetration of sunlight should reach the ground level (lawn area) to improve the brightness. Thus, increasing the maintenance of *pekarangan* to give the safety impression through well managed plants condition, routine pruning, standard thinning and well treated of old/broken plants (such as cavity treatment).

3.5 Water Resource Management in Pekarangan

As a lotic system, those four streams are particularly conditioned in a flow rate, turbidity and effects of temperature on the biota of rapids and pools. With a high flow rate over rocks or logs, the surface of a stream is broken and considerable water turbulence occurs and there is an increasing sedimentation process (Kaswanto et al. 2008). According to Seyhan's categories of watershed (1990), the characteristics of those four watersheds could be influenced by area, shape, slope, vegetation, land use, fishpond and lake number, drainage and pH permeability. In addition, those four watersheds can be dominantly categorized into perennial stream type with the presence of a defined channel. It means a defined channel was entrenched into the landscape or had an active water path that is noticeably scoured, sorted or settled materials. Those conditions proofed that rural landscapes have ability to absorb and clean the water contamination through natural process. However, the use of fertilizer and chemical pesticide should be monitored because some indicators of inorganic matters showed likely tendencies to polluted water (Kaswanto et al. 2012). Furthermore, the community is practicing local wisdom through landscape agroforestry management in restoring the value of water quality. The abilities to maintain the local wisdom knowledge to maintain the environmental quality are more likely the best options for achieving sustainable management in rural landscapes (Kaswanto et al. 2012).

Water management in each stream gradually changes the water cycling system, particularly in *pekarangan* system. Upper stream is almost free from house waste disposal. It is contrary to downstream that pollutes water streams with dump and waste pond water. But the most sustainable cycling system is located in middle stream where it is supported by a sustainable agroforestry system and has subsistence cycle in home activities and production. This situation has still in same typical condition which has been researched since almost ten years ago (Kaswanto et al. 2008). Figure 6 shows the investigation of the latest condition for water management inside and outside *pekarangan* system. A research in West Java shows that there are positive correlations between land use change and water quality (Karima and Kaswanto 2017).

Most households are connected to the water based on gravity utilization. Their concerns focused on water availability, demand, quality and management conflict on the watershed level (Kammerbauer et al. 2001). Anthropogenic activities can act on pristine wetland and change water quantity and water quality (Alvarez-Cobelas et al. 2001), and hydrological and ecological processes (Zalewski 2014). The different kinds of management conflicts can be observed as water fluxes in the creek were reduced during the dry season period (Kaswanto et al. 2008). In addition, the communities competed for irrigation water for their farming, as clear rules for the assignment of irrigation water were not established effectively. One of the water improvement practices is using water quality priority scenario that increases the agroforestry system production which is sustainable (Coiner et al. 2001) such as ecohydrology (Zalewski 2000). Degradation of freshwater ecosystems and those of water resources have two facets: pollution and the disruption of water and nutrient cycles, and pollution can be substantially eliminated by biotechnology. The optimization of ecotone (transition ecosystem) structure (Harashina et al. 2003) in whole watershed usually fights a lack of space for ecohydrologically relevant structure, and a lack of funding, although ecotones and other structural biotic elements provide basis for sustainable landscape management (Janauer 2000) and for ecological resilience (Ungaro et al. 2017).

3.6 Landscape Management of Pekarangan as Landscape Services Provider

In the context of productivity, G1 and G2 are significantly different from G3 and G4, which means a small *pekarangan* is more productive than a medium-sized *pekarangan*. This is because the management of small *pekarangan* is more intensive than a medium *pekarangan*. Small *pekarangan* (G1 and G2) are tending to develop an open space by growing more crops and raising more livestock/fish. This tendency is also because they have no other cultivated land they could manage, so that they are more focused on their own *pekarangan*. *Pekarangan* without OAL groups tend to have a higher income than *pekarangan* with OAL, because

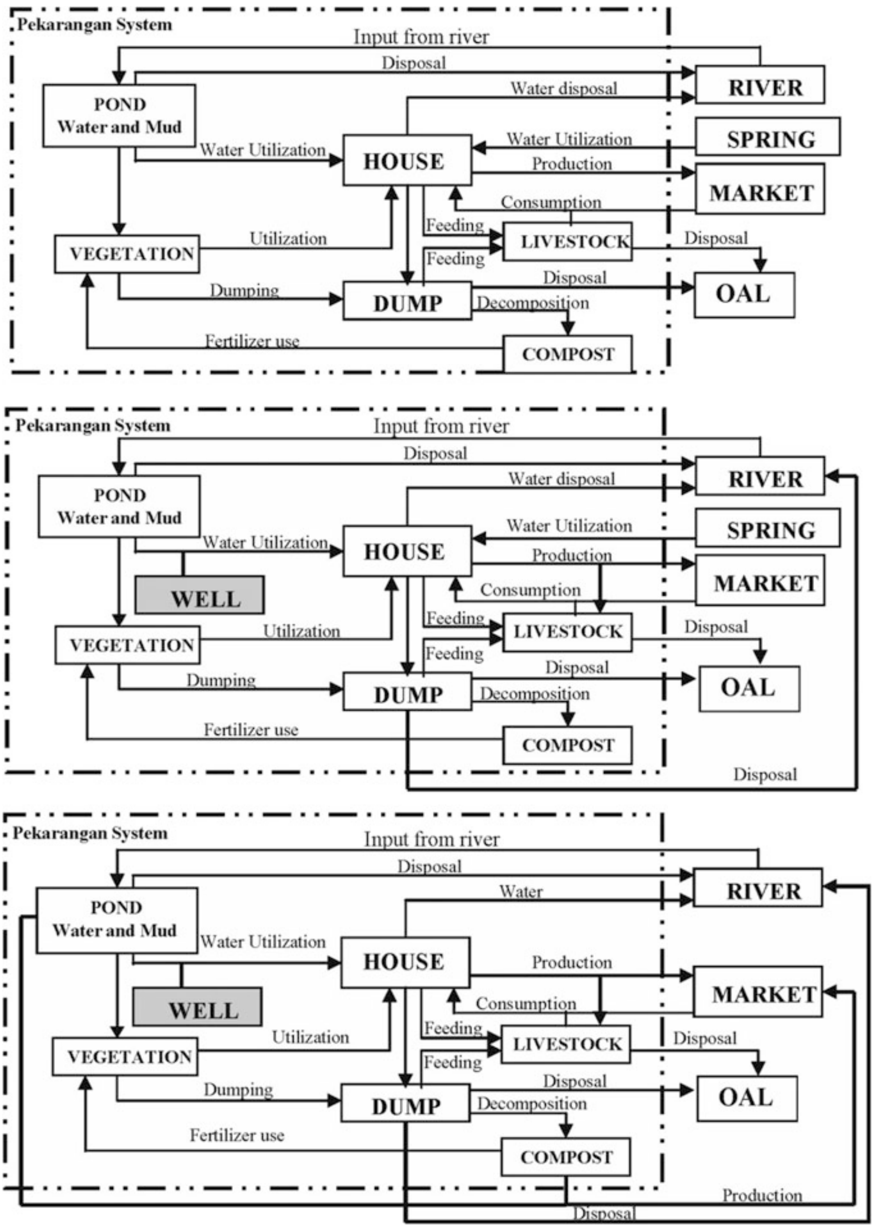


Fig. 6 Water management in the *pekarangan* system differentiates from upper stream (top), middle stream (middle) and downstream (bottom). The bold arrow and shading box indicate the differences. Modification from Kaswanto (2008)

pekarangan without OAL will always try to develop and increase *pekarangan* productivity, this is in line with the explanations at the beginning of this article.

Mitchell et al. (2004) also mention that *pekarangan* contribute significantly in many ways and significantly improve the financial status of the family. Furthermore, *pekarangan* not only play a role in ecology, but also social and cultural functions (Arifin et al. 2001). Small *pekarangan* should be considered as a model for the sustainable micro-scale agroforestry systems, integrated ecological and economic benefits that will improve community welfare for a better future, as proposed by Schultink (2000). *Pekarangan* can also contribute to improve household welfare, and it is in line with several previous studies (Albrecht and Kandji 2003; Harashina et al. 2003; Kabir and Webb 2008; Mulyoutami et al. 2009). In the end, *pekarangan* should be recommended as one strategy to aspire malnutrition and deficiency of micronutrients, especially for people in marginal areas. Some studies have also found that *pekarangan* significantly increase household consumption (Abdoellah et al. 2006; Marsh 1998; Mitchell and Hanstad 2004; Niñez 1985; Soemarwoto 1987; Wiersum 2006).

3.7 Management of Landscape Services for Improving Community Welfare

Managing landscape services, from classical types such as biodiversity, carbon stock, landscape beautification and water resources, would give a positive contribution for community welfare, particularly for those who have *pekarangan*. A community-based development to increase the community welfare could be as tourism activities and attractions (Qian et al. 2017), in particularly as agrotourism (Garrido et al. 2017; Kaswanto 2015; Lestrelin et al. 2017). Improved access to markets and social provision of education and health care have mostly improved the welfare of previously isolated groups (Cramb et al. 2009), particularly for *pekarangan* land use system.

4 Conclusion

Most of *pekarangan* structures have vertical and horizontal diversity relatively high with a value of H' ranged from 0.77 to 3.57, but the value of $H' > 1.00$ reaches 98.95% of the total samples of *pekarangan*. The average of H' in *pekarangan* without OAL (G1 and G3) is higher than *pekarangan* with OAL (G2 and G4). It shows that the absence of OAL will make homeowners take advantage of *pekarangan* more intensively, thus creating higher biodiversity index in *pekarangan* without OAL.

Similarly with carbon stock, especially if homeowners had decided to plant trees that have high density. OAL ownership affects the amount of carbon stock in *pekarangan*, because *pekarangan* without OAL prefer to have ornamental plants that are profitable but have a low carbon content. On the other hand, *pekarangan*

<400 m^2 also has potential for storing high carbon. Thus, it can be concluded that *pekarangan* will function both as a biodiversity conservation and as a carbon stock.

There are several recommendations which need to be concerned in *pekarangan* management. Those are (1) *pekarangan* should be maintained with multistrata composition and various type of plants, which create high biodiversity index, (2) *pekarangan* with high biodiversity index is necessarily to increase the carbon stock, which means that the existence of the tree becomes important because of its effectiveness in storing carbon and (3) *pekarangan* should be considered as a community capital not only as a tangible asset but also as an intangible asset (social value). On the other hand, related to the concept of low carbon landscape, there are three concepts that need to be implemented, namely optimizing the *pekarangan*, cultivating productive plant and planting local species to increase the value of landscape services.

Beautification should be considered for giving comfort, brightness and safety, while water utilization in three zones indicates optimal improvement of human activity and agricultural production. According to material balance cycling system, the middle stream of watershed has more sustainable water management pattern than the others.

As a conclusion, *pekarangan* as micro-scale agroforestry landscape can contribute significantly in providing landscape services. Landscape services are used to preserve the surrounding environment and at the same time could be as a community asset to improving household welfare. *Pekarangan* preservation from plant biodiversity and carbon stock aspects can provide added value for quality of the rural landscape. Therefore, the revitalization of *pekarangan* by improving landscape services as a rural communities asset needs to be empowered. Community should consider appropriate *pekarangan* agroforestry practices rather than relying only on cultivation of agricultural land. Community can also expect to revitalize the utilization of diverse local species in order to increase ecological, economic and social values. Furthermore, the well managed *pekarangan* system can be a way to achieve sustainable development goals (SDGs), particularly for developing countries.

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Chapter 16
Using Vegetation Greenness as a Criterion in Multi-criteria Analysis of Recreational Land Suitability in Protected Area: A Case Study of Krau Wildlife Reserve, Peninsular Malaysia

Saiful Arif Abdullah and Nur Hairunnisa Rafaai

Abstract Vegetation greenness usually used to interpret condition of ecological processes which are vital for sustaining biodiversity and integrity of natural ecosystems. Hence, vegetation greenness seems feasible as a criterion in multi-criteria analysis of recreational land suitability for sustainable land use planning in protected area. But, how feasible it is? Based on land suitability, analyzed using a multi-criteria analysis, two scenarios of recreational land suitability were developed using Krau Wildlife Reserve in Peninsular Malaysia as a case study. Scenario 1, does not use vegetation greenness as one of the criteria, and Scenario 2, uses vegetation greenness as one of the criteria. In this study, the proportion of recreational land suitability classes, "less suitable," "moderate suitable," and "most suitable," was measured under both scenarios. Then, the feasibility of vegetation greenness was evaluated by comparing the proportion of each suitability class in Scenario 2 with Scenario 1. Results revealed that in Scenario 1, the proportion of "most suitable" was the highest. In Scenario 2, the proportion of "most suitable" reduced but "moderate suitable" increased when compared with Scenario 1. This shows that vegetation greenness can limit the proportion of land used for recreation. Thus, vegetation greenness is feasible to be considered as a criterion for identifying recreational land suitability for sustainable land use planning in protected area.

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1 Introduction

Planning and managing land use sustainably in protected area is currently a challenge for governments, land managers, and conservationists (Geneletti and van Duren 2008; Adhikari et al. 2015; Bailey et al. 2016). They face a difficult situation in developing land for conservation and socioeconomic purposes based on the sustainable development principles (van Lier 1998). Generally, forests represent the major component in protected area which provides a suitable place for recreation such as picnic, hiking, camping, and bird watching. In this regard, related infrastructures such as information center, chalet, camping site, and observation tower are built to support the recreational activities. Nevertheless, when the recreational land uses are not properly planned and managed, it is economically disadvantageous and, ecologically, may cause disturbance to the natural resources of the forest and the sustainability of the protected area as a conservation site (Pickering and Hill 2007; Pickering et al. 2010; Steven et al. 2011).

Identifying land suitability is one of the approaches for ensuring the balance between recreational land uses and the conservation of natural resources in protected area. Generally, land suitability emphasizes the need to conserve natural resources and to minimize conflicts in land use management (Cendrero et al. 1993). In addition, land suitability represents a mechanism for identifying strategies and achieving the management objectives of protected area (Thomas and Middleton 2003). Therefore, land suitability for specific purposes, such as recreation, is required to minimize the conflict between land use and management in protected area (Haas et al. 1987; Cendrero et al. 1993). If not, the forest in protected area could experience high level of fragmentation and deforestation (Gaveau et al. 2007, 2009), which could ultimately prevent achieving the objectives of the establishment of the system (Sabatini et al. 2007).

Generally, identifying land suitability for specific purposes involves several criteria in which land attributes are mainly used. For example, Hsiaofei et al. (2006) identified land suitability for ecological service zones of a forest ecosystem in Hui-Sun, Taiwan, based on land attributes such as elevation, slope, forest condition, road network, and rivers. Liu and Li (2008) employed not only land attributes but also human disturbance factors, such as the distance from farmland, tourist sites, and construction sites, in identifying land suitability for protected area zoning in China. Land attributes such as geology, vegetation cover, and land use also used by Geneletti and van Duren (2008) in identifying land suitability for a protected area zoning in Italy. Even though ecological processes have been recognized important for sustaining, protecting, and conserving natural resources (Dunning et al. 1992; Bennet et al. 2009), they have not previously been considered as criterion for identifying land suitability for sustainable land use planning in protected area.

At the landscape scale, vegetation greenness usually used to interpret the condition of ecological processes (Burgan and Hartford 1993; Zhang et al. 1997; Ikeda et al. 1999). Intervention such as uncontrolled clearance of trees for land use development affecting the vegetation greenness which eventually disturb the ecosystem function and structure, which are vital for protecting the biological diversity and ecological integrity of ecosystem (Debinsky and Holt 2000; Weibull et al. 2003). This is contrary to land attributes that do not convey any information about ecological processes (Louisa and Antonio 2002). Thus, sustaining the vegetation greenness means sustaining natural and aesthetic values of a particular land. And, greenness can attract or encourage people for recreational activity (Thompson and Aspinall 2011; Almanza et al. 2012) which also has a positive association with health and quality of life (de Vries et al. 2003; Sugiyama et al. 2008; Pereira et al. 2012). In this context, vegetation greenness seems feasible as a criterion in multi-criteria analysis of recreational land suitability for sustainable land use planning in protected area. But, how feasible it is? To address this question, the suitability land for recreation in a protected area of Peninsular Malaysia was first analyzed. Second, the distribution and proportion of suitable land for recreation where the vegetation greenness is not used as a criterion were compared with analysis where the vegetation greenness is taken into account. The objective is to determine the feasibility of vegetation greenness in identifying land suitability with a case study of protected area in Peninsular Malaysia.

2 Case Study Site: Krau Wildlife Reserve

Krau Wildlife Reserve (latitude between 3° 35′N and 3° 52′N; longitude between 102° 5′E and 102° 17′E) is located in the state of Pahang on the west coast of Peninsular Malaysia (Fig. 1). The total area of this reserve is approximately 60,338 ha, and the altitude ranges from 45 to 2108 m above sea level (Yusof and Sorensen 2000). The largest part of this reserve is lowland, which extends from the central to the southern part of the reserve and is mainly covered by lowland dipterocarp forest. At the western part, the topography is rough terrain with steep slopes. The mountainous area with the highest peak is located in the northwestern part, while isolated small hills can be found in the southern part of the reserve.

The climate of this reserve is hot and humid. The mean daily minimum and maximum temperatures are approximately 23 and 33 °C, respectively, and the mean annual rainfall is approximately 2000 mm. This reserve harbors diverse species of flora and fauna as well as diverse ecosystem types. Five floristic altitudinal forest zones have been identified in the reserve: lowland dipterocarp, hill dipterocarp, upper dipterocarp, montane oak-laurel, and montane ericaceous forests (DWNP/DANCED 2001). This reserve falls under the Wildlife Reserve IV (Managed Nature Reserve) and Forest Reserve VIII (Multiple-use Management Area) categories of the International Union for Conservation of Nature (IUCN).

At present, there is no area being identified for recreation in the reserve, but the Department of Wildlife and National Parks Peninsular Malaysia has designated recreational area that potential and/or suitable to be set up in the Krau Wildlife Reserve (DWNP/DANCED 1999). The department defines recreational area as

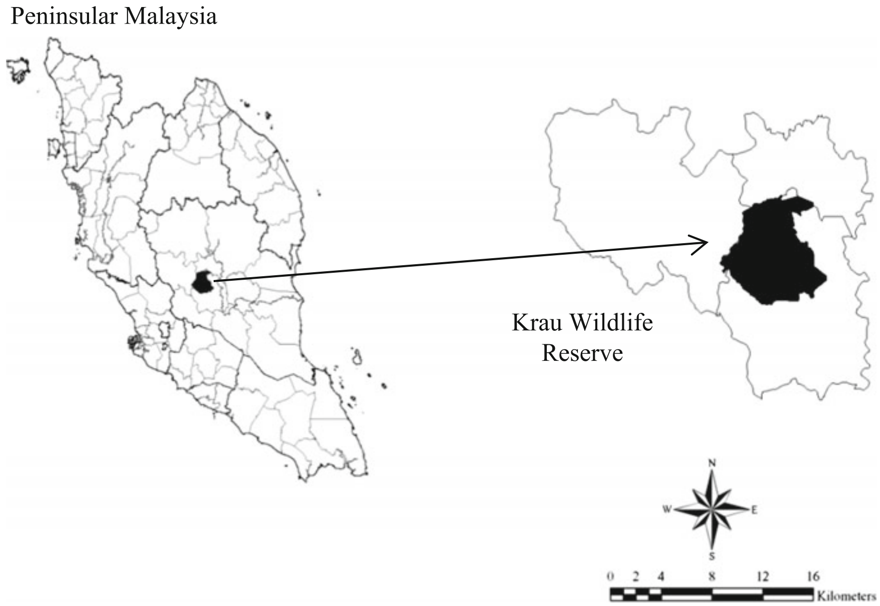

Fig. 1 Location of Krau Wildlife Reserve in the State of Pahang, Peninsular Malaysia

"area with recreational, tourism and educational value, where sustainable eco-tourism, recreation, conservation education and public awareness activities can be conducted" (DWNP/DANCED 1999).

3 Land Suitability for Recreational: Criterion Selection

Identifying land suitability is a process for determining a unit of land for a specific use (Geneletti and van Duren 2008). In the process, land unit assessment is the most appropriate because it is the basis for rational land use planning and management (FAO 1993; Rossiter 1996). In this study, the analysis was conducted in two stages. First, the selected criteria include the elevations, slopes, land uses, and riparian areas of the study area. Land attributes of elevation and slope as well as land uses are considered to be the basic criteria for identifying land suitability (Geneletti and van Duren 2008). The riparian area is important because its health and condition depend on the surrounding land uses (Naiman et al. 1993). Furthermore, the riparian area becomes the main focus in conservation and natural landscape management (Naiman et al. 1993). This first stage is designated as Scenario 1.

Second, the same criteria (i.e., the land attributes) were used, but vegetation greenness was included. This second stage is designated as Scenario 2. In this analysis, the normalized difference vegetation index (NDVI) was used because apart commonly used to measure vegetation greenness (e.g., Hermann et al. 2005; Xu et al. 2011), it also exhibits a strong relationship with the leaf area index (LAI) (Ramsey and Jensen 1996; Green et al. 1997; Kovacs et al. 2004) which LAI is closely related to various ecological processes, such as the net primary production (Gholz 1982; Meyers and Paw 1987), the energy exchange between plants and the atmosphere (Gholz et al. 1991), the rate of photosynthesis (Pierce and Running 1988; Gamon et al. 1995), and various plant physiological processes (Glenn et al. 2008). These revealed a strong relationship of vegetation greenness with ecological processes. Therefore, it can be considered as a reliable indicator to represent the vegetation greenness in a particular area (Svoray et al. 2003).

4 Data Sources and Multi-criteria Analysis

This study used a land use map of the study area from the year 2007 developed by Rafaai (2011). This map was based on a SPOT 5 image (2.5 m resolution) analyzed using ERDAS Imagine 9.2 and ArcGIS 9.3. The overall accuracy of the map is 86.4%, and the value of the kappa statistic is 0.83 (Rafaai 2011). The other data sources used were a digital elevation model (DEM) (scale 1:50,000), to generate elevation and slope maps, and maps of the rivers and the border of the Krau Wildlife Reserve were obtained from the Department of Wildlife and National Parks Peninsular Malaysia. The vegetation greenness map which was based on NDVI was analyzed using the spectral enhancement menu of ERDAS Imagine 9.2. The NDVI values are between −1 (no vegetation) and +1 (highest vegetation greenness) (Tucker and Sellers 1986; Lillesand et al. 2004). The layer of each criterion used to develop suitability map for recreation in the protected area is shown in Fig. 2.

A multi-criteria analysis is developed to characterize a particular land unit to achieve certain specific objectives (Zeleny 1982). Many studies have applied multi-criteria analyses and described their usefulness for achieving sustainable planning and management of protected area (Villa et al. 2001; Bojórquez-Tapia et al. 2004; Hjortsø et al. 2006). This type of multi-criteria analysis includes three main steps: ranking, scoring, and pair-wise comparison to determine the weight for each criterion (Saaty 1997).

Each criterion used in this study was divided into either three, four, or five sub-criteria. As the recreational area in Krau Wildlife Reserve has its own definition, the level of suitability of all sub-criteria needs to be ranked. In this process, the first step is to establish a standard measurement system to rank the criteria/sub-criteria. Here, the suitability value was ranked in three classes: 1 = "less suitable"; 2 = "moderate suitable"; and 3 = "most suitable." The highest priority sub-criteria of each criterion were given the highest suitability ranking for recreation of 3, whereas 1 indicates the lowest priority. The rankings were based on the perceived significance of natural resource conservation and suitability for recreation, which were determined based on the expert knowledge and the existing

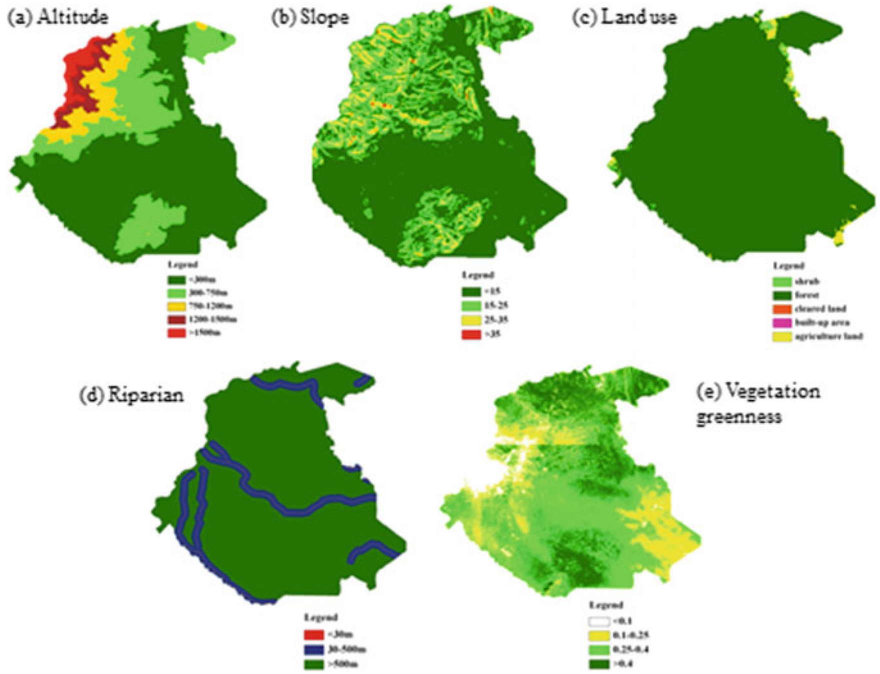

Fig. 2 Criteria used in Scenario 1 (**a**–**d**) and Scenario 2 (**a**–**e**)

literature. The ranking of the sub-criteria of each criterion for Scenario 1 is shown in Table 1. This ranking was also used in the second analysis (Scenario 2), with additional ranking of NDVI (vegetation greenness) sub-criterion (Table 1).

The process for determining the weight of each criterion is subjective. In a multi-criteria analysis, the process that widely used for achieving this goal is the analytical hierarchical process (AHP) developed by Saaty (1977). In the AHP, a weight value is obtained through pair-wise comparison analysis, and the relative importance is fixed based on the comparison of two criteria using the importance weight scoring scales (Saaty 1980). The weight values of each criterion for Scenario 1 and Scenario 2 are shown in Table 2. To determine whether the pair-wise comparison is consistent, an eigenvector method (Saaty 2000) was applied. Thus, the consistency ratio (CR) was used to assess the consistency of the pair-wise comparison. The steps for calculating the CR follow Saaty (1980). The pair-wise comparison is assumed to be consistent if the CR is less than 10% or 0.1, whereas if CR $\geq$ 0.1, the score given in the pair-wise comparison must be re-evaluated. The CR values for Scenario 1 and Scenario 2 are shown in Table 3.

Geographic information system and multi-criteria analysis are used to generate land suitability map for recreation via weight linear combination (Eastman et al. 1995). In weight linear combination (WLC), the weight of each criterion is combined to generate a land suitability map. The WLC model applied here is

Table 1 Ranking value for each sub-criterion of recreational zone used in the multi-criteria analysis

Criteria	Ranking
1. Elevation (m) (Whitmore 1986)	
0–300	3
300–750	3
750–1200	2
1200–1500	1
>1500	1
2. Slope (^{0}) (JPBD and LESTARI 2007)	
<15	3
15–25	3
25–35	1
>35	1
3. Land use (Rafaai 2011)	
Forest	3
Agriculture	2
Built-up area	1
Shrub	1
Cleared land	1
4. Distance from river (m) (Fisher and Fischenich 2000)	
<30	3
30–500	2
>500	1
5. [a]NDVI (vegetation greenness) (Byzedi and Saghafian 2009)	
<0.1	1
0.1–0.25	2
0.25–0.4	3
>0.4	1

Note: The first four criteria were used in Scenario 1 and Scenario 2 whereas [a]NDVI (vegetation greenness) was included only in Scenario 2

Table 2 Weight of each criterion under Scenario 1 and Scenario 2

Criterion	Scenario 1	Scenario 2
Elevation	0.401	0.343
Slope	0.282	0.258
Land use	0.092	0.071
Riparian	0.225	0.212
NDVI (vegetation greenness)	–	0.115

$S = \sum W_i X_i$, where S = suitability index; W_i = the weight of criteria i; and X_i = the score of criteria i. The higher the value of S, the higher the suitability of a particular land uses. In this study, this process was carried out using the model

Table 3 Consistency ratio (CR) for Scenario 1 and Scenario 2

	Consistency ratio (CR)
Scenario 1	0.069
Scenario 2	0.090

builder technique and weighted overlay method in ArcGIS ver 9.3 (ESRI 2000). GIS data were applied to the raster model because data analysis and operation are faster in raster format, especially for overlay analysis (Dangermond 1990).

5 Land Suitability Distribution and Proportion

The Scenarios 1 and 2 include three land suitability classes—"most suitable," "moderate suitable," and "less suitable"—for recreation as shown in Fig. 3. In the Scenario 1, the highest proportion of "most suitable" (81%) was observed (Fig. 4). The proportion of "moderate suitable" (17%) was approximately 60% lower than the "most suitable," whereas the lowest proportion was "less suitable" (2%).

In the Scenario 2, the proportions of "most suitable" (51%) and "moderate suitable" (47%) were not much different, whereas the proportion of "less suitable" was less than 10%. Compared with the Scenario 1, the proportion of the "moderate suitable" increased (Fig. 4) by about 64%. However, the proportion of the "most

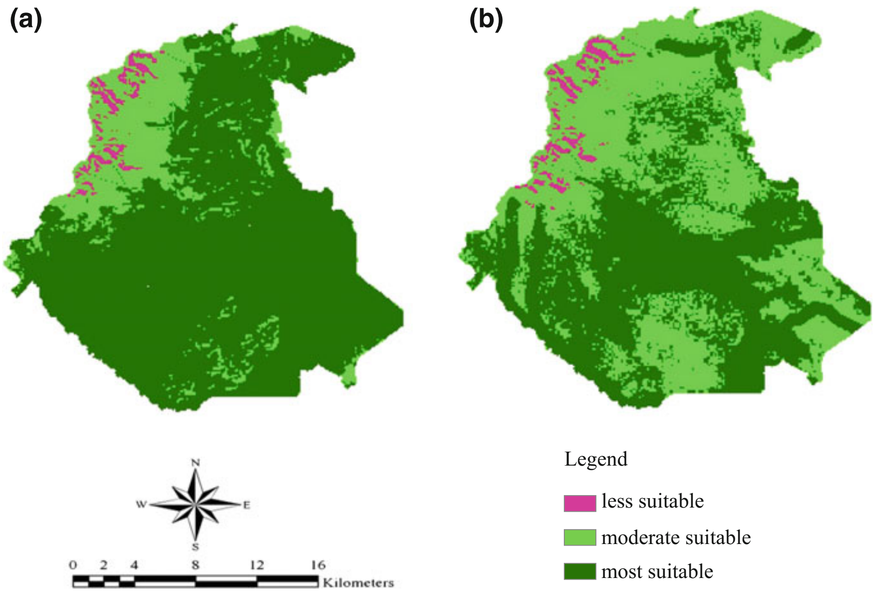

Fig. 3 Land suitability map for recreation **a** Scenario 1 and **b** Scenario 2 in the study area

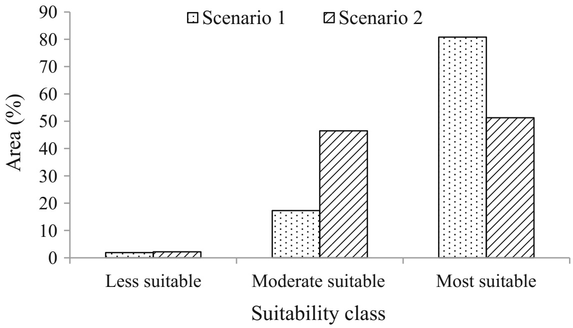

Fig. 4 Proportion of each land suitability class for recreation of Scenario 1 and Scenario 2 in the study area

suitable" decreased by about 37%. The proportion of "less suitable" remained the lowest and was not considerably different from that in Scenario 1 (Fig. 4).

6 Discussion and Conclusion

Sustainable land use and conservation planning are related to physical land planning with the purpose of optimizing the distribution and segregation of land in a limited spatial context (van Lier 1998; Leitáo and Ahern 2002). The assessment and selection of suitable areas for specific purposes based on multi-criteria analysis are important for land use and conservation planning in protected areas (Bibby 1998). In this context, application of land suitability is suggested, aimed to achieve sustainable development (Xu et al. 2006).

Land suitability analysis emphasizes permanent aspects, one of the most important of which is the land attributes of a particular area (Leitáo and Ahern 2002). On the Scenario 1, land attributes of elevation and slope exhibit the highest weight compared to the other criteria or factors determining the suitable land distribution and proportions for recreation. The highest weight is because in land use planning, the elevation and slope are considered to be the most important criteria for determining land suitability (Veldkamp and Lambin 2001; Butler et al. 2004), with elevation being more important compared to slope (Busing et al. 1993), as it exhibits a close relationship with the biological diversity in a particular region (Begon et al. 1996).

In the context of wildlife conservation, elevation influences the richness and diversity of species (Lee et al. 2004; Ellu and Obua 2005). The richness and diversity of many species decrease with increasing elevation (Körner 2000) due to the limited food sources and decreased ecosystem productivity at higher elevations compared to lowlands and flat areas (Singh et al. 2009). Furthermore, increasing elevation results in decreasing habitat size thus providing a limited area for many species to occupy (Körner 2000; Colwell et al. 2004). In land use and conservation planning, the forest areas in lowland are easier to access compared to that at higher elevations (Chomitz and Gray 1996; Nagendra et al. 2003; Fearnside 2006).

This study revealed that the most suitable land for recreation in Krau Wildlife Reserve was mostly distributed at the lowland. Therefore, control of recreational land use is needed at the lowlands, but it is less suitable at higher elevations (Scott et al. 2001). Land development for recreation at the lowland in particular may impose a threat to conservation efforts in this protected area because it may facilitate further encroachment of human activities.

On the Scenario 2 (with vegetation greenness included), the elevation and slope are still the main criteria for determining the suitable land distribution and proportion for recreation. When the vegetation greenness was included, the vegetation area of the reserve was divided into three classes based on NDVI values: high greenness (>0.4), moderate greenness (0.25–0.4), and lower greenness (0.1–0.25). These values provide different implications regarding the suitable land distribution and proportion for recreation. The "most suitable" for recreation decreased in proportion and might have changed to "moderate suitable," as the proportion of the latter increased noticeably.

A high vegetation greenness value is an indication of a healthy ecosystem and good primary productivity, which contribute to the existence of more species, particularly herbivorous species (Bourgarel et al. 2002). Therefore, there is a positive relationship between the spatial and temporal variations of the vegetation greenness and the species richness in a particular area (Gould 2000; Oindo and Skidmore 2002; Levin et al. 2007). In this study, areas with high vegetation greenness values have been allocated less for recreation. This finding shows that using the vegetation greenness as a criterion is feasible because it reflects ecosystem functions, such as the distribution, density, and diversity of animals and plants (Reed et al. 1994; Krishnaswamy et al. 2004; Feeley et al. 2005), as well as vegetation quality, where the greenness rate shows a relationship with food quality (Griffith et al. 2002) and can be used to measure the amount of energy that enters the ecosystem (Levin et al. 2007). Hence, the vegetation greenness supports ecosystem structure and function (Hsiofei et al. 2006; Pommerening and Stoyan 2006). Therefore, its application can have a significant influence on the conservation of natural resources and ecological integrity of a particular ecosystem.

This study revealed that the inclusion of vegetation greenness in identifying recreational land suitability is important for sustainable land use and conservation planning of the protected area. Its inclusion can limit or minimize the proportion of land suitable for recreation. This may enable many forested areas to be protected for natural resource conservation and also significant to support the conservation efforts of the protected area. This case study of Krau Wildlife Reserve can be served as a model that might also be applicable to the other protected areas in Peninsular Malaysia.

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Chapter 17
Green Open Space Demand and Community Place Attachment in Batu, East Java

Amin Setyo Leksono, Dina Poewoningsih and Nur Wiwit Puji Mahastiti Ika

Abstract Green open space (GOS) in the urban and rural landscape supports a lot of ecosystem service such as oxygen production, soil and water protection, microclimate control, carbon store, biodiversity conservation and provides landscape beauty as in addition to the production of agricultural commodities. This study aims to describe the GOS demand and community place attachment in Batu City, East Java, Indonesia. The GOS demand was estimated using oxygen requirement of resident and nonresident. Community place attachment was analyzed using people's perception. This study identified several treats for the existence of GOS, including population growth. Several strategies must be taken into account to sustain the GOS existence. Most people prefer several spots in Batu City must be planted with vegetation. Therefore, it is necessary to improve public participation in managing landscapes.

1 Introduction

Indonesia has considerable resource landscapes, both in urban and urban areas with a variety of characteristics. Rural landscape in tropical countries is seen as a source of biodiversity that play important roles to support the stability of the earth's ecosystem. These views attracted attention of the world community toward rural landscape preservation. Rural landscape in this study can be defined as a region with a countryside character different with urban character. Rural landscape also

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shows the relationships between nature and humans are characterized by land management activities as agricultural, horticultural, and forestry (Rogge et al. 2007).

Urban and rural landscape provide several ecosystem services such as value of the cultural amenities of the aesthetic of the rural landscape, wild habitat, green open space (GOS), and community cultural activities. Rural landscape can also be seen as a function of agricultural areas. In developing countries, including Indonesia, the value of rural landscape amenities is utilized to develop tourism activities such as agro-tourism and ecotourism. Rural landscape can thus be a driving force in the restructuring of sustainable rural areas (Sznajder and Przezbórska 2004; Domon 2011). GOS in rural landscape characterized by large areas of agricultural ecosystem supports a lot of landscape functions such as oxygen production, soil and water protection, microclimate control, carbon store, biodiversity conservation and provides landscape beauty as in addition to the production of agricultural commodities. Several studies have reported on the role of the GOS to reduce carbon (Nowak et al. 2007; Strohbach et al. 2012; Ardani et al. 2013).

The GOS along with other landscape components has attracted diverse landscape aesthetic potentials. This potential scenic beauty resource should be managed through landscape planning and design approach. That approach could be based on landscape as visual architectural resource or as a biophysical ecology resource. Some scholars and practitioners have suggested the idea of an “ecological aesthetic” to address issues relating to the protection of ecologically significant landscapes. Efforts to preserve and protect the rural landscape are generally associated with natural ecotourism activities. By experiencing how scenic landscapes in rural area are ecologically important and aesthetically interesting, people may have better understanding their value to human life and discover clues for appreciating ecologically significant landscapes that are “scenically challenged” (Saito 1998). The hotspot metaphor also suggests ways in which the model of human–environment interactions proposed by Gobster et al. (2007) might be implemented to communicate to public groups about the beauty of scenically challenged landscapes.

Study landscape has been recognized interdisciplinary dimension. Tress and Tress (2001) suggest the concept of transdisciplinary landscape which includes five dimensions: (1) the landscape as an entity spatially, (2) the landscape as mental entities, (3) landscape as a temporal dimension, (4) landscape as a nexus of nature and culture, and (5) as a complex system landscape. Landscape studies often focus on some but not all of these dimensions. To achieve its interdisciplinary and transdisciplinary goals, landscape ecology needs to appreciate and integrate the multifaceted perspectives on the culture–nature/people–place relationship which are offered by these diverse disciplines. Approach in assessing the aesthetic quality of the landscape has evolved into a debate between expert opinion and user perception-based approach. Experts generally dominate the approaches in environmental management practices while the perception-based approach has dominated in the study. Both approaches can generally accept the idea that the quality of the landscape comes from the interaction between the biophysical features of landscape and user perception.

Studies on the ecology of the landscape have been done, most of the studies conducted specifically in urban or rural. Study of landscape ecology in the agropolitan area still rarely performed. This study describes the landscape functions as an oxygen production and aesthetic functions performed in the agropolitan city. In this study, approach on assessing landscape quality was done using both expert and perception-based approach, while a study on the landscape function focused on oxygen demand.

2 Green Open Space: Structure and Function

Green open space is a term used by landscape planners and landscape architects for land areas that are intentionally left un-built as fields and forests while the land around them is developed into buildings and pavement (Ahern 1991). The GOS consists of the elongated or grouped area of the standing plants or vegetation, both of which grows naturally or planted. This open space is part of the space arrangement that serves as a protected area, which consists of the rural and urban landscape, forest, recreational green areas, green areas of sport center, green area of the yard, paddy field and garden. The intention of convening the GOS according to Minister Regulation No. 1 of 2007 was to preserve and balance the urban ecosystem that includes elements of environmental, social, and culture with an area that must be planned for approximately 40% of the area. The GOS has a primary function (intrinsic) as bio-ecological functions and additional functions (extrinsic) that is a function of architectural, social, and economic. The functioning of the natural ecology in the urban environment in a balanced and sustainable city will form a healthy and humane (Purnomohadi 2006).

In general, public open space in urban areas consists of green and non-GOSs. The non-GOS consists of hardened space (paved area) and blue open space that form the surface of rivers, lakes, and areas. These areas are designated for inundation or retention of the basin. Physically, green space can be divided into natural green space in the form of natural wildlife habitat, protected areas and national parks, as well as non-natural green space like parks, sports fields, and flower gardens.

The GOS has important functions with very wide spectrum, from the aspects of ecological function, social, cultural, architectural, and economics. Ecologically, GOS can improve the quality of groundwater, prevent flooding, reduce air pollution, and lower the temperature of a sweltering tropical city. The existence of green space aims to preserve, harmony and balance of the ecosystem, as well as recreational facilities for the residents of the city (Ståhle 2010). The functioning of ecological nature within the urban environment in a balanced form a healthy city.

The structure, shape, and composition of GOS consist of the ecological and planological configurations. Ecological configuration of GOS seen as natural landscapes such as protected areas, hills, riverbanks, lakes, and coastal borders. The planological configuration of GOS can be formed following the pattern of the structure housing the city as green space, urban or rural green space, green space districts, city green space and parks regional/national.

The GOS helps to provide plants and their use for community activities. Based on the layout, the GOS may exist the form of beach (coastal open space), river floodplains (river floodplain), green ways and open space along side of the airport runway. Based on the size, the GOS includes: (a) Macro areas, such as the area of agriculture, fisheries, forest, and airport green space, (b) Medium areas, such as city park, sports facilities, public cemetery, and (c) Micro areas, which is open land in any residential area that is provided in public facilities such as playgrounds (play ground), community park and a sports field.

The GOS is generally dominated by plants and herbs which have much effect on the air quality. Plants can create a microclimate, which is a decrease in ambient temperature, sufficient moisture, oxygen levels are increasing due to the process of assimilation and evapotranspiration from plants. Plants also absorb (reduce) the carbon dioxide in the air as the result of industrial activities and motor vehicles so that a good city should create a healthy city resident with the comfort and quality of its environment (Gunawan et al. 2017).

3 Oxygen Demand of People in Batu City

Batu City located in East Java, Indonesia. Geographically, it is located in 7.44° 55′ 11″ to 8.26° 35′ 45″ South Latitudes and 122.17° 10′ 90″ s/d 122.57° 00′ 00″ East Longitudes. The situation of topography in Batu City has two different characteristics, that is north and west side is hilly and surging height area, while east area and south area that is relatively flat though at 700 m height from sea level. Batu city has minimum temperature range from 24 to 18 °C and maximum temperature range from 32 to 28 °C. Its air humidity is 75–98% and the rainfall average is 875–3000 mm/year. Because of that condition, Batu city is suitable for subtropic plants of horticultural plants and cattle yard. Administratively, Batu City is divided into 3 districts and 23 villages/subdistricts. The districts are Batu district with 46,377 km^2 widths, Bumiaji district with 130,189 km^2 widths and Junrejo district with 26,234 km^2 widths. Total population in 2014 is 211,298 residents (Statistic Book of Batu City 2015).

In this study the presence of green space in Batu affected by the impact of the increasing number of population and political factors of urban development. The growth rate in Batu is categorized high with a rate of 5% annually (Statistic Book of Batu City 2015). The effect of growth rate can be seen from the development of the construction of housing, shops, public buildings, facilities, and infrastructure of the city that continues to increase. The treat from political factors of urban development can be seen from land use change began 2002–2008 and the suitability of land use with existing spatial plans (Batu City Report 2008). And undeveloped land covering an area of 1,906.40 ha or 9.57% of the area of Batu increased from the year 2002 which will possibly occur conversion on a steep and hilly location.

Regional development and opening of new land into prime factors have lead landscape changes and alter its function. The threat to the existence of the GOS in Batu city result of rapid development requires analysis of GOS demand (Ardani et al. 2013). The limited green space especially parks leads to the emergence of insecurity and social problems. In addition, the limited green space also affects the increase in microclimate, air pollution, flooding, and other adverse environmental impacts (Hartini 2008).

The amount of oxygen to be oxidized by humans from food around 3300 kcal per day and a man uses about 600 l of oxygen (27 mol) and produces 480 l of carbon dioxide per day, where it is known that the density of oxygen is 1.429 g/l (Septriana 2005).

The result of this study showed that a population of nearly 212,000 of resident and 3,192 nonresident (mostly tourist). Total oxygen demand was 183,901.2 kg/day, consisted of 181,164.5 kg/day for resident and 2,736.8 for nonresident (Table 1).

Result of this study indicates that the oxygen requirement must be fulfilled by its availability in the atmosphere. It is necessary to start vegetation planting effort in the residential areas (Setyowati 2008). Green plants catch about 150,000 million ton of CO_2 and 25,000 million ton of hydrogen to release 400,000 million ton of oxygen into the atmosphere, and to produce 450,000 million ton of organic substances. Every hour, 1 ha of green leaves absorb 8 kg of CO_2 equivalent to CO_2 exhaled by human breath about 200 people in the same time (Setyowati 2008). Role of tree plants is crucial in determining the comfort of the city environment, and it is appropriate to plant trees where serious attention in the implementation of urban greening as an element of urban forests (Krisdianto and Udiansyah 2012).

Table 1 Population and total oxygen demand in Batu city in 2014

District	Population		Oxygen demand		Total oxygen demand (kg/day)
	Resident	Nonresident	Resident	Nonresident	
Bumiaji	52,325	1803	44861.2	1545.8	46,407
Junrejo	60,764	487	52,101.4	417.6	52,519
Batu	98,209	902	84,201.9	773.4	84,975.3
Total	211,298	3192	181,164.5	2736.8	183,901.3

4 Green Open Space and Spatial Planning

Spatial planning is part of the development process that has three urgencies as follows: (a) optimizing the utilization of resources (principle of productivity and efficiency); (b) tool and a form of distribution of resources (the principle of equity, the balance and fairness); and (c) sustainability (sustainability principle). Many factors determine the success of spatial planning, such as spatial plan product quality and accurate, dynamic utilization of space refers to the product of spatial planning, and space utilization control process consistent and firm. So has the concept of spatial planning, orderly room a harmonious, balanced, and sustainable. Because of the space requirements increase as the population growth and the growth of economic activity, but the room has a limited carrying capacity is needed on spatial updated as developments with regard to the balance of the ecosystem.

Urban spatial planning starts with identifying areas that naturally must be saved (protected area) to ensure the preservation of the environment and regional functions that are naturally susceptible to disaster (Purnomohadi 2006). This area should be developed as a GOS and non-green to green space in spatial planning is very important because in spatial planning starting from which we can build. The rapid growth in urban areas leads to various social and environmental issues, so that the urban land use plan must establish the location of the area to be protected. The GOS is an instrument for the protection of natural and artificial resources in urban or rural landscape. Spatial Law No. 26 of 2007 has set 30% of the urban land must consist of GOS both private and public green space. In the urban land use plan, the GOS can be realized with strategic plans as follows: (a) set up a conservation area for the preservation of land and water; (b) develop of biodiversity area; (c) create the area of public recreation; (d) revitalize cemetery or burial place; (e) restrict excessive development and (f) protect natural, cultural, and historical resources.

5 The Green Open Space Shape Architectural Landscape

In socio-cultural perspective presence of green space can provide a function as a space of social interaction, recreation, and landmark of the city. The existence of GOS is important in controlling and maintaining the integrity and quality of the environment, because of the various functions associated with the presence of GOS (the function of ecological, social, economic, and architectural) and the aesthetic value of owning (object and environment) not only can improve the quality of the environment and continuity of urban life but also the identity of the city (Hakim and Utomo 2004; Haq 2011).

Green open space that is functional and aesthetic value in an urban system must meet the minimum width, pattern, and structure as well as the shape and distribution of the technical considerations in its management. While the ecological character, condition, city resident's desire, direction, and development objectives as well as the development of the city is a factor that determines the amount of GOS functional. This shows that green space an important component of urban ecosystems (Budiyono 2006).

Architecturally, GOS may increase the value of the beauty and comfort of the city through the existence of the city parks, flower gardens, and green lines on the streets of the city. Meanwhile GOS can also have an economic function, either directly as exploitation empty land into agricultural land or plantations (urban agriculture) and development of urban green tourism facilities that can bring tourists. In terms of ownership can be a green space green space owned by the general public and is open to the general public, or private green space (private) in the form of gardens located on private lands.

6 Landscape Aesthetic Ecology

There is an important role of the aesthetic ecology concept in participatory spatial planning (Poerwoningsih et al. 2015). This belief is supported by the sense of place concept in environmental behavior theory. Sense of place widely accepted as a concept to explore issues such as preferences, access control natural resources, and cultural significance in the use of resources, and the participation of local communities. The concept of sense of place characterizes the complex relationship of community to their environment. While the perception of the people on the surrounding environment refers to the use value of a space or environment, aesthetic ecology as a form of aesthetic perception as predicted Daniel (2001) had opportunities to be developed in a participatory spatial planning.

Approach to the concept of sense of place is often applied in tourism research, which aims to determine the motivation of people to visit a particular place in the urban and rural environment (Cheng and Wu 2009), environment, rural conventional suburban (Soini et al. 2012), traditional agricultural landscapes (Walker and Ryan 2008) until the scope of the road corridor space or open space for recreational activities (Blumentrath and Tveit 2014). Exploration of sense of place concept is made to relate the relationship between human and nature, also in terms of environmental conservation that ultimately contribute to the aesthetic quality of the environment. The contribution in management is often referred as a form of public participation in the environment.

There is a positive relationship between the sense of place and the behavior of certain environments. However, there is a relatively little research that has been done on the relationship between sense of place and community participation in rural areas as well as, the relationship between sense of place and a willingness to contribute to the management of rural space or landscape. In addition to the relationship between sense of place and environment character of the landscape, there is some empirical evidence that sense of place influences the actions of individuals and society in different mechanisms. Sense of place can be a good predictor of how people will react to changes in the environment. People who have a strong sense of place seemed more rooted, more caring and committed to solve the problem. (Walker and Ryan 2008; Lokocz et al. 2011; Soini et al. 2012).

Thus, the integration of the concept of ecological aesthetic in participatory spatial planning provides an opportunity to explore the processes of social and cultural influence environmental assessment and landscapes, including the opinions and judgments of society in landscape planning policies broadly (Soini et al. 2012).

7 Community's Perceptions and Preferences on Landscape Changes in Batu City

The addition of vegetation through simulation photomontage represents efforts to improve the aesthetic and ecological quality of Batu City landscape. The results of the analysis of visual preferences indicate that the general public can distinguish and respond to the landscape changes. Landscape changes in the corridor with *Tabebuya* or trumpet trees (*Tabebuia cassinoides*) vegetation addition more prefer than its landscape existing (86% of respondents). Landscape simulation with addition of *Angsana* or Narra (*Pterocarpus indicus*) vegetation more prefer than landscape existing or landscape with the addition of *Pucuk Merah* or Lilly Pilly (*Syzygium oleana*) vegetation. The other simulation performed on twenty-five viewpoint (VP) was conducted to determine people's preferences between *Angsana* vegetation and *Tabebuya* vegetation. Respondents preferred *Angsana* vegetation which serves as a shade ecologically more than vegetation *Tabebuya* which is more aesthetical functional. The results of this study indicate that the urban landscape type has an opportunity to improve the quality through the addition of vegetation which is supported by community who had understood about the presence of vegetation on the landscape.

Changes in the rural landscape type committed to the strategy of maintaining the landscape character that most have high-value landscape quality. The addition of vegetation carried out on the landscape corridor serves to reinforce the vista road with vegetation that vertically does not obstruct the view. The ideal choice is a type of evergreen pine vegetation *Cemara gunung* or Mountain Ru (*Casuarina junghuhniana*) which is the local vegetation. The results showed respondents prefer the landscape changes with the addition of Flamboyant vegetation than pine (VP 06). These results indicate that more people preferred the landscape change with characters shaded street corridors than a character transparency view to the sides.

The results showed that the respondents prefer the landscape changes with the addition of vegetation *Kemlandingan gunung* or Cape Wattle (*Albizia lophantha*) as seen in VP 07 that represent the landscape which has a high landscape quality. The addition of vegetation can improve the landscape on biodiversity aspects. The results of this study indicate that the public has understood and sensitive to this biodiversity aspect. The other results of visual preferences also strengthen an indication about people's understanding of the presence of building elements and physical on the landscape. Respondents responded less likely to buildings and other elements that are considered disturbing visual quality of the landscape as seen VP 03.

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Chapter 18
Perception of Citizens toward Implementation of Urban Forestry: Case of a Local City in the Philippines

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Abstract This study sought to understand how the constituents of Iligan City, a local city in Mindanao, Philippines, perceive the concept of urban forestry as necessary, beneficial and practical to be implemented. Specific objectives were to determine if there is any difference in the perception among the social types of respondents, to determine what demographic factors may have influenced their perception, to understand the reasons for such differences in perception, and to determine current constraints to urban forestry implementation. This study used a combination of qualitative and quantitative data gathering using validated structured questionnaire and visualization method. The respondents were 15 years old and above, coming from four social groups, namely students, professionals, policy makers, and other citizens. The results showed that the students, professionals, and the policy makers differ in perception of urban forestry and the general importance of trees, support the implementation of the program and the materialization of urban forestry from the other citizens (include sidewalk vendors, drivers, and unemployed citizens). With regards to gender, both male and female respondents are strongly aware of urban forestry and the general importance of trees, but their perception on the materialization of urban forestry and support in its implementation in the city differs. On the support of implementation and perception on the materialization of urban forestry, there are significant differences among age groups where 26–50 years old respondents perceived urban forestry weaker than those 15–25 years old, while 51 and above years old are uncertain. Both resident and transient respondents strongly agree on the awareness, support, and materialization of urban forestry in Iligan City.

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1 Introduction

The urbanization process has drastically changed the relationship between human society and the natural environment. Most obviously, the natural environment has been exploited to support economic growth (Konijnendijk 2000). As land surfaces are being modified by development such as concreting, asphalting, and improved infrastructure as a result of global trade industry (Shin et al. 2001; Blaschke 2006), waste heat generated by energy usage results in the increase in surface temperature and overall ambient temperature which have adverse effects on the environment as well as on the health of individuals (Santamouris et al. 1999; Mihalakakou et al. 2002). Adding the effects of climate change, urban areas become unpleasantly warm compared to the surrounding rural areas (Dimoudi et al. 2014). In addition, high volumes of traffic and noise, and increased built-up areas contribute to a lower quality of life, as well as the gradual weakening of the sense of human health and well-being due to intensification of heat stress episodes (European Environment Agency 2005) as a result of decreasing urban greeneries and tree covers.

Urban forestry refers to the cultivation and management of trees in the city for the purpose of improving the urban environment in terms of physiological, sociological, and economic well-being of urban society (Jorgensen 1974; McPherson 2003; Conway and Bang 2014). It advocates the role of trees as a critical part of the urban infrastructure. Urban forests are critical in cooling the urban heat island effects, maintaining moderate local climate, slowing wind and storm water, and shading homes and businesses to conserve energy (Grimmond et al. 1994; McPherson et al. 1997; Miller 1997). Urban forests play an important role in ecology of human habitats in many ways such as air quality regulation, water, and sunlight (Jo 2002; Wang et al. 2006; Chen 2006). It beautifies the city, serves as recreational area for people (Konijnendijk 2000), improves health (Velarde et al. 2007; Arnberger and Eder 2012), and plays a significant role in maintaining biodiversity (Alvey 2006; Konijnendijk et al. 2006; Pickett et al. 2011; Gaffin et al. 2012; Jones et al. 2012). Despite gaining attention in other countries, it is still unpopular and underdeveloped in the Philippines especially in local cities. Most of the studies conducted were done in mega cities and metropolitan areas.

Perception of the environment and programs to improve the environment may influence motives, attitudes, and preferences which could be translated into policies, planning, and management of the urban landscapes (Yuen and Hien 2005; Nasar 2008; Jim and Shan 2013). Perception on urban forestry may depend on the social and cultural values as well as the economic and educational background of the respondents (Acar et al. 2006; Thompson 2002). Understanding perception on urban forestry among social groups could add light on their possible participation, design, and management (Purcell 1992).

This study sought to understand social perception, awareness, and responsiveness on the concept of employing urban forestry in a local city. The main objective of this study was to determine how the constituents of Iligan City, a local city in Southern Philippines, perceive and respond to the concept of urban forestry as necessary, as well as beneficial and practical to be implemented. Specific objectives were to determine if there is any difference in the perception among the social types of respondents, to determine what demographic factors may have influenced their perception, to understand the reasons for such differences in perception, and to determine current constraints to urban forestry implementation.

2 Materials and Methods

2.1 The Study Site

Iligan City is a first class, highly urbanized city in northern Mindanao, Philippines. It is approximately 795 km southeast of Manila and has a total land area of 813.37 km^2, making it one of the 10 largest cities in the Philippines in terms of land area. According to the 2010 census, it has a population of 322,821 people (National Statistics Office, accessed July 2010). Iligan City falls within the third type of climate wherein the seasons are not very pronounced. Rain is more or less evenly distributed throughout the year. Because of its geographical location and being surrounded by mountains, the city experience less strong weather disturbances compared to areas in eastern Philippines facing the Pacific. Despite these facts, in the last three years, the city has declared four times the state of calamity due to typhoons and flooding.

Iligan City has increasingly grown in terms of its economy. This is evident in the development and improvement of infrastructures including the construction of new business establishments and its 14 major heavy industries located in it. However, environmental responsibilities have seemed to be neglected by both the city planners and investors despite these developments. In particular, cultivation of trees in the urban setting was not considered with the construction of new buildings and expansion of highways and city streets. Some of the city trees were even cut down to give way for road expansions and building constructions.

2.2 Data Gathering

This study used a combination of qualitative and quantitative data gathering using validated structured questionnaire with open- and close-ended questions and visualization method. The semi-structured questionnaire was used to assess the perception of the respondents on the concept of employing urban forestry in Iligan City. Each question has five possible answers, ranked from 1 (strongly agree) to 5 (strongly disagree) of which only one is to be selected that best fits the thought and perception of the respondent. The questionnaire contained demographic profile of the respondents including gender, age, marital status, allowance/income, residency, and occupation. The questions in the survey were grouped into the following themes:

- Awareness on the concept of urban forestry and general importance of trees
- Support for the implementation of urban forestry programs
- Perception on materialization of urban forestry in three settings
- Policy makers' support and prioritization of programs on urban forestry.

The groupings of the contents of the questionnaire into four themes are shown in Table 1. The questionnaire was also translated into the local dialect to help those who do not understand English very well.

The visualization method was also employed (Karjalainen and Tyrväinen 2002; Lewis and Sheppard 2006; Lange et al. 2008) in combination with the questionnaire. The visualizations were prepared using Adobe Photoshop software.

Table 1 Groupings of the contents of questionnaire into four themes

Theme 1: Awareness on the concept of urban forestry and general importance of trees • Concept of urban forestry • Trees are important to environment • Trees are important to human well-being • Absence of trees results in excessive heat • Absence of trees contribute to climate change • Trees cooldown environment • Trees add aesthetic value • Trees help reduce pollution
Theme 2: Support for the implementation of urban forestry programs • Planting, growing, and taking care of trees • Part of urban development plan • For climate change mitigation • Mandatory for commercial establishment • Urban forestry is feasible to be implemented • Support on the implementation • Willingness to participate
Theme 3: Perception on materialization of urban forestry in three settings • Prefer trees in commercial environment • Enjoy shopping in commercial environment with trees • Trees in commercial environment contributes to ecotourism • Prefer trees in residential environment • Enjoy living in residential environment with trees • Trees in residential environment contributes to well-being • Prefer trees in open space • Enjoy visiting open space with trees • Trees in open spaces contribute to nature conservation and climate change mitigation
Theme 4: For Policy makers only • Support urban forestry • Prioritize implementation of urban forestry

Photos of the current scenarios in Iligan City were taken and were computer edited to depict the desired urban forestry scenario. The purpose of the visualization was to provide basis and scenarios from which to analyze how people (respondents) interpret and react to the visual experience of the landscape and to the characteristics of urban forestry (Lange et al. 2008). There were three scenarios used in this study. The first scenario is urban forestry in commercial area (Fig. 1a), the second scenario is urban forestry in residential area (Fig. 1b), and the third scenario is urban forestry in abandoned open space (Fig. 1c).

Fig. 1 Visualization of three urban forestry scenarios: **a** A scenario which depicts the projected urban forestry. On the left shows the present commercial setting of Iligan City while on the right is a picture if urban forestry is employed; **b** A scenario which depicts urban forestry in residential area. On the left shows the present housing project while on the right is a picture if urban forestry is employed in the area; **c** A scenario which depicts the projected urban forestry on abandoned open space. On the left is the current situation while on the right is a picture if urban forestry is employed in the area

This study employed a purposive sampling method. The respondents were identified into four groups, namely (1) policy makers (which include local government heads, members of the city council, and division chiefs; (2) professionals (composed of those who are working in the academe and those in the business sector); (3) students (students from 15 years old and above who do not earn income and only receive monthly allowances); and (4) other constituents (include market and street vendors, public utility vehicle drivers, and unemployed citizen). The respondents' personal profile such as gender, age group, profession, and residency was examined if these are factors that influence their perception on the concept of urban forestry and its implementation in Iligan City. The monthly income was not included since 25% of the respondents are students who are yet dependent for support. Questionnaires were randomly distributed in the different parts of the city making sure that each group of the respondents would have a total of 50 completed questionnaires.

Open- and close-ended questions were prepared for five groups of respondents from each social type. Data gathering was conducted from November 2010 to February 2011. It is worth noting that the survey was conducted with the help of graduate students trained as research assistants. They were coached in the procedures and ethics of research survey.

2.3 Statistical Treatment

Chi-square test was used to determine if there are any significant differences in the answers among the four groups of respondents based on the three themes of the survey and to determine if demographic profiles of the respondents, such as their profession, gender, age group, and residency, are factors that influence their perception on the concept of urban forestry in Iligan City. All tests were run using Paleontological Statistics (PAST) software.

3 Results

The profile of the respondents ($N = 200$) is shown in Table 2. It was made sure that each of the categories (students, professionals, policy makers, and other constituents) has 50 respondents. The summary of the answers of the respondents on the four themes of the survey is shown in Table 3. The results show that the students, professionals, and the policy makers strongly agree on the awareness of the concept of urban forestry and general importance of trees, whereas the other constituents only agree. The results are the same with regard to the support for the implementation of urban forestry programs and the perception on materialization of urban forestry. Results of the chi-square test showed significant differences among the four groups of respondents on the three themes of the survey (Table 3).

The results also showed that, overall, there are significant differences between the other constituents and the rest of the groups of respondents on all three themes.

Descriptive statistics was applied to determine if the demographic characteristics of the respondents are factors influencing the way they perceive the concept of urban forestry. For the analysis of gender, results in Table 4 show that both male and female respondents have high awareness on the concept of urban forestry and general importance of trees. But with regards to their perception on the materialization of urban forestry and support for the implementation of the program in the city, females strongly agree, whereas males only agree. Chi-square test (Table 4) indicates that gender is not a factor that influences the respondents' awareness of urban forestry and general importance of trees. However, with regard to the support for the implementation of urban forestry and on the materialization of urban forestry, there are significant differences on the perception between males and females.

Variations in the perception among age groups were also observed. In Table 5, all age groups strongly agree on the awareness of urban forestry and general importance of trees. As to the support for the implementation, 15–20 years old and 51 and above age groups strongly agree, whereas 21–25, 26–30, and 31–50 years old only agree. For the perception on the materialization of urban forestry, all age groups, except 51 and above which is uncertain, strongly agree. The chi-square test (Table 5) showed that when it comes to the age groups, regardless of the social group of respondents, there are no significant differences on the respondents' awareness of the concept of urban forestry and general importance of trees. However, on the support on the implementation of the program and the perception on the materialization of urban forestry, there are significant differences among age groups.

Table 2 Demographic and socioeconomic characteristics of the respondents (N = 200)

	N		*N*
Gender		Occupation	
Male	86	Student	50
Female	114	Professional	50
		Policy maker	50
		Others	50
Age		Civil status	
15–20 years	31	Single	82
21–25 years	35	Married	92
26–30 years	30	Widow/widower	11
31–50 years	53	Separated	15
51 and above	51		
Income: (PhP/month)		Residence	
below 5000	78	Transient	41
5001–10,000	30	0–10 years	20
10,001–20,000	38	11–20 years	34
20,001–30,000	22	21–30 years	33
30,001–40,000	13	31–40 years	29
40,001–50,000	11	41–50 years	18
50,000 above	8	50 above years	25

Table 3 Summary of the answers of the respondents and chi-square test on the different themes of the survey. Values in parentheses are the general weighted averages (GWA) of the total scores of their answer to each question

Themes	Students	Professionals	Policy makers	Others	X^2	Sig.
Awareness on the concept of urban forestry and general importance of trees	Strongly agree (1.26)	Strongly agree (1.33)	Strongly agree (1.38)	Agree (2.06)	37.51	0.000**
Support for the implementation of urban forestry programs	Strongly agree (1.70)	Strongly agree (1.84)	Strongly agree (1.74)	Agree (2.46)	49.54	0.000**
Perceptions on the materialization of urban forestry in three settings	Strongly agree (1.20)	Strongly agree (1.21)	Strongly agree (1.46)	Agree (2.17)	46.14	0.000**
Policy makers' support on urban forestry	–	–	Strongly agree (1.47)	–		
Policy makers' prioritization of urban forestry	–	–	Strongly agree (1.71)	–		

**highly significant

Table 4 Summary of the answers of male and female respondents and the chi-square test for significant differences on the three themes of the survey. Values in parentheses are the general weighted averages (GWA) of the total scores of their answer to each question

Themes	Female	Male	X^2	Sig.
Awareness on the concept of urban forestry and general importance of trees	Strongly agree (1.41)	Strongly agree (1.64)	4.89	0.429^{ns}
Support for the implementation of urban forestry programs	Strongly agree (1.91)	Agree (2.26)	15.57	0.008**
Perceptions on the materialization of urban forestry	Strongly agree (1.38)	Agree (2.01)	13.25	0.021*

*significant; **highly significant; ^{ns}not significant

Table 5 Summary of the answers of the respondents based on age groups and the chi-square test for significant differences on the three themes of the survey. Values in parentheses are the general weighted averages (GWA) of the total scores of their answer to each question

Themes	A	B	C	D	E	X^2	Sig.
Awareness on the concept of urban forestry and general importance of trees	Strongly agree (1.25)	Strongly agree (1.64)	Strongly agree (1.52)	Strongly agree (1.69)	Strongly agree (1.50)	12.59	0.702 [ns]
Support for the implementation of urban forestry programs	Strongly agree (1.89)	Agree (2.13)	Agree (2.0)	Agree (2.27)	Strongly agree (1.87)	96.13	0.047*
Perceptions on the materialization of urban forestry	Strongly Agree (1.20)	Strongly Agree (1.78)	Strongly Agree (1.65)	Strongly agree (1.87)	Uncertain (3.75)	118.95	0.000**

A 15–20 years; *B* 21–25 years; *C* 26–30 years; *D* 31–50 years; *E* 51 and above
**highly significant; *significant; [ns]not significant

Table 6 Summary of the answers of resident and transient respondents and the chi-square test on the three themes of the survey. Values in parentheses are the general weighted averages (GWA) of the total scores of their answer to each question

Theme	Residents	Transients	X^2	Sig.
Awareness on the concept of urban forestry and general importance of trees	Strongly agree (1.58)	Strongly agree (1.38)	1.829	0.872 [ns]
Support for the implementation of urban forestry programs	Strongly agree (1.89)	Strongly agree (1.97)	3.477	0.626 [ns]
Perceptions on the materialization of urban forestry	Strongly agree (1.66)	Strongly agree (1.32)	5.460	0.362 [ns]

[ns]not significant

A test was also conducted to determine if there are significant differences between residents of Iligan City and transient respondents on their perception on the concept of urban forestry. Table 6 shows that residency (or being transient) in the city are not factors that influence their perception on the concept of urban forestry in Iligan City.

4 Discussion

The perception on the concept of urban forestry depends on the structure and composition, and the socioeconomic and demographic backgrounds of the respondents (Acar et al. 2006; Zube et al. 1982). The students, professionals, and policy makers all showed strong perception on the three themes of this study. According to Chung and Poon (1999), the young and the highly educated people have higher environmental awareness. The positive relationship between attitude toward environment and education reflected in this study is in line with other studies (Yabiku et al. 2008; Zhou et al. 2009; Larson et al. 2011). Also, these three groups of respondents may have had more experience with nature during childhood which made them disposed to positive attitude toward urban forestry and the desire to have it implemented around them (Bell et al. 2003; Sebba 1991). When asked of their reason why they support urban forestry, the most common answer was because they learned from school and perfectly understand the importance and functions of trees in all environmental settings. On the other hand, the lower perception of other constituents on three themes of this study reflects important information. Generally, these people have not received higher education compared to the rest of the respondents that makes them less appreciative of the importance of trees in the urban setting. In addition, compared with the professionals and policy makers, they receive very little income that would only make their ends meet in a day. Based on the open- and close-ended questions conducted during the survey, some respondents stated that they would only practically think of how to earn a living rather than thinking about things that do not concern their daily survival. According to them, they do not have extra time to participate in other activities. Furthermore, other respondents stated that they fear the implementation of urban forestry because it might take away their means of livelihood such as the street vendors and public vehicle drivers.

The policy makers of the Iligan City showed strong support and prioritization of urban forestry. They initiated the creation of the “The Iligan City Environment Code of 2010” which covers development plans and protection measures of forest resources, has the governing principles for water resources, waste management, pollution management, ecotourism, environmental impact assessment, etc. According to them, urban forestry would add aesthetic value to the city and would encourage more tourists to come, both local and foreign which in turn would boost the local economy.

Gender was not a factor that influenced the respondents’ awareness of urban forestry and general importance of trees in Iligan City. However, with regards to the support for the implementation and on the perception on materialization of urban forestry, females strongly agree, whereas males only agree. A study that was conducted in Turkey on women’s participation in forestry showed that the most important factors affecting women’s participation are perception related to forest dependence, quality of cooperatives, quality of forest organization, and forest quality (Atmis et al. 2007). Also, Chinese women usually take charge of the household affairs and typically more dependent on the immediate environment (Jim and Shan 2013) making them more willing to help improve their surroundings may it be through urban forestry. Women in the Philippines are quite similar to Turkish and Chinese women. Despite the increase in women's education and completion rates in the Philippines, they continue to participate in areas where women are traditionally occupied and still follow the gender stereotyping in their chosen career (World Bank 2012). These facts were proven to be true among women in Iligan City. Female respondents who were interviewed stated that they want more trees near where they live because it would help cooldown temperature at home to save energy thereby saving money. It would also give better place for their children to play so they do not have to go far. In addition, they said they know it could help minimize pollution and the green view would help relieve stress. Males, on the other hand, showed lower support on implementation and materialization of urban forestry. In the Philippines, men are usually the provider of the family. According to the Philippine Labor and Employment Plan 2011–2016, men continued to dominate the workforce as they accounted for more than 60% of the total employed over the past ten years. Relative to the labor force, their participation rate, at an annual average of 80.4%, exceeded that of the women by 30.1% points (National Statistics Office Labor Force Survey). According to some of the respondents, support on the implementation and materialization of urban forestry can be a threat to their working hours thereby reducing their income. In addition, men have more indoor and outdoor recreations compared to women (Culp 1998; Johnson et al. 2001) that could be sacrificed when they participate in urban forestry. Twenty-seven percent of the male and 16% of the female policy makers and professionals interviewed have recreational activities after work or on weekends.

Age groups were proven to affect perception of urban forestry. The highest positive perception on the three themes of the study was found in ages 15–25. The 15–20 and 21–25 age groups are mostly composed of students studying in high school and college. In the Philippines, the largest group of unemployed are the young people between 15 and 24 years old corresponding to 50% of the national unemployment (Weber 2012). When they are not working, they would have more time to participate in other activities. In addition, they are still energetic, idealistic, and more imaginative of bright future making them more participative in urban forestry. They have not lost trust in the authorities and tend to believe everything is possible. When interviewed, some students even related that they yearly participate in tree planting in the vicinity of the city, such as the mangrove area. Some of them are members of campus organizations which are advocating clean and green environment. On the other hand, the weaker support on the implementation of ages 26–50 could be attributed to the fact that they are the workforce of the society (National Statistics Office). They tend to think that supporting this activity would mean extra load or possibly leaving their jobs to do dirty outdoor works. According to some respondents, they even have to do 2–3 jobs just to support the family's need. On the perception of materialization, the 51 and above age group is uncertain. This group of people is mostly about to retire or retired from their jobs and had much frustrations from the society. Form talking to them, it was found out that many of them are more skeptical of the governments' promises and have lost trust in authorities based on past experiences. These results are similar to the findings of age effects on the perception of urban green spaces in China (Jim and Shan 2013).

Both permanent residents and transient respondents strongly agree on the three themes of the survey. This result implies that regardless of length of stay in Iligan City, people have the highest preference for high-quality naturalness and deep ecology of urban landscape for better well-being (Shin et al. 2001; Blaschke 2006). According to transients in Iligan City, it does not matter if they are staying in the city temporarily. They would support urban forestry because it could give overall national impact and that what could be applied in this place can be applied in other parts of the Philippines for the benefit of the majority.

5 Conclusions

Overall, the perceptions of the citizens of Iligan City toward urban forestry were affected by demographic factors such as profession, gender, and age. Being transient or permanent resident of the city did not cause variation in the perception. But looking into the result, the general responses of the respondents were all positive and none were negative. All of the respondents want Iligan City to have improved urban green spaces to be home for local biodiversity, source of livelihood for local people, add value to ecotourism, contribute more to health/well-being, efficient carbon sink, and biomass resource. It is hoped that local people would understand and support more of the urban forestry initiatives.

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Chapter 19
Forest Ownership Patterns Impacting on Landscape Structure of Vegetation in a Mountainous Farm Village, Western Japan

Atsushi Yamaba, Sonoko Watanabe and Shuji Wada

Abstract Forest management is defined mainly by the pattern of forest ownership. Thus, it is important to examine the relationships between the landscape structure of forest vegetation and the forest ownership patterns in order to understand the realities of "human impact" on cultural landscapes and ecosystems. Our study area was the mountain farm village of Hiroshima Prefecture, western Japan. These forests are owned and managed by the public, communal, or private sectors. The data set was prepared by overlapping the vegetation map data and the cadastral map data using GIS. The vegetation map was created by using ortho-rectified aerial digital photographs, and the types of vegetation were classified based on physiognomy. The cadastral map data were classified according to the ownership patterns. In the overlapping of the vegetation and cadastral maps, the boundaries between vegetation and ownership frequently conformed in the case of pine or artificial coniferous forests. Characteristic combinations of vegetation type and ownership patterns, such as pine forest and foundation or PFC and artificial coniferous forest, were also verified in terms of the proportion of vegetation type in each ownership pattern. The results suggest that the landscape patterns of strongly disturbed or commercial forests tend to be influenced by forest ownership patterns at the physiognomy level.

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1 Introduction

A forest landscape, one of the most important landscape elements of a mountainous farm village, is composed of patches that vary in size, shape, and arrangement, and influenced by not only natural site factors but also human activities (Naveh and Lieberman 1994; Turner et al. 1996; Kamada and Nakagoshi 1996, 1997). These human activities, or “management,” are explained mainly by ownership patterns (Ohmann et al. 2007) of the forests.

By recent studies, for example, relationships between ownership patterns and structure of forest landscape or vegetation have been confirmed or suggested as follows: differences of rare-species richness by public ownership of natural areas compared to private ownership in southern Ontario, Canada (Lovett-Doust et al. 2003); influence by individual landowners to littoral coarse wood density within northern Wisconsin lakes, USA (Marburg et al. 2006); differences in terms of land cover dynamics and landscape spatial pattern between community, government, and private ownership in Nepal (Nagendra et al. 2008); current patterns of vegetation cover types (Ohmann et al. 2007).

Thus, it is important to examine the relationships between the landscape structure of forest vegetation and the forest ownership patterns in order to understand the realities of “human impact” on cultural landscapes and ecosystems; moreover, this examination is also important for planning rural landscape management.

2 Study Area and Methods

2.1 Study Site

Our study area was the mountain farm village of “Yawata” in Kita-Hiroshima-cho town, Hiroshima Prefecture, western Japan (Fig. 1). Yawata is located at 650–1,200 m above sea level, and many types of vegetation such as beech climax forest, secondary forest (oak or pine), and artificial forest (cypress) are found in this region. These forests (total area of 3,500 ha) are owned and managed by the public, communal, or private sectors.

2.2 Data and Methods

The data set was prepared by overlapping the vegetation map data and the cadastral map data using the Arc GIS software (ESRI Inc.). The vegetation map data were created by using a grid cell (a total of 86,491 cells) with a size of 20 m × 20 m. The map was created by using ortho-rectified aerial digital photographs taken by Hiroshima Prefecture in 2000 (Fig. 2), and the types of vegetation were classified

Fig. 1 Study site

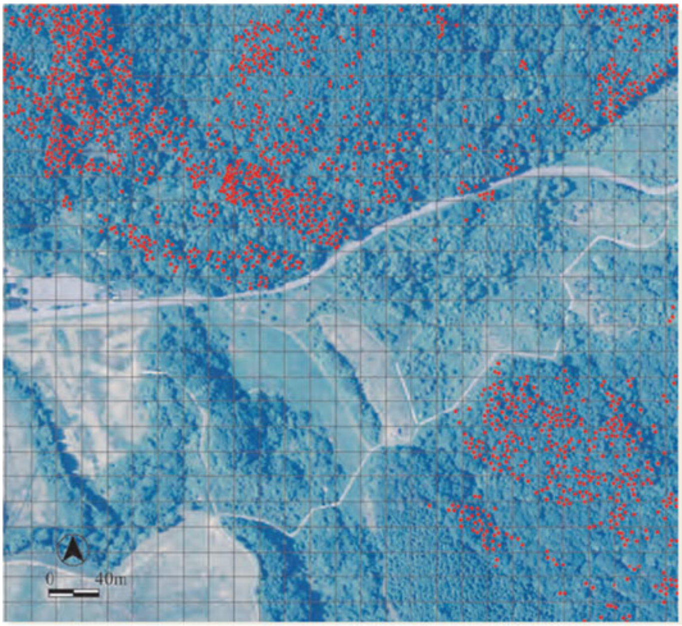


Fig. 2 Sample of ortho-rectified aerial digital photograph plotted points of trees in each grids (Watanabe et al. 2003)

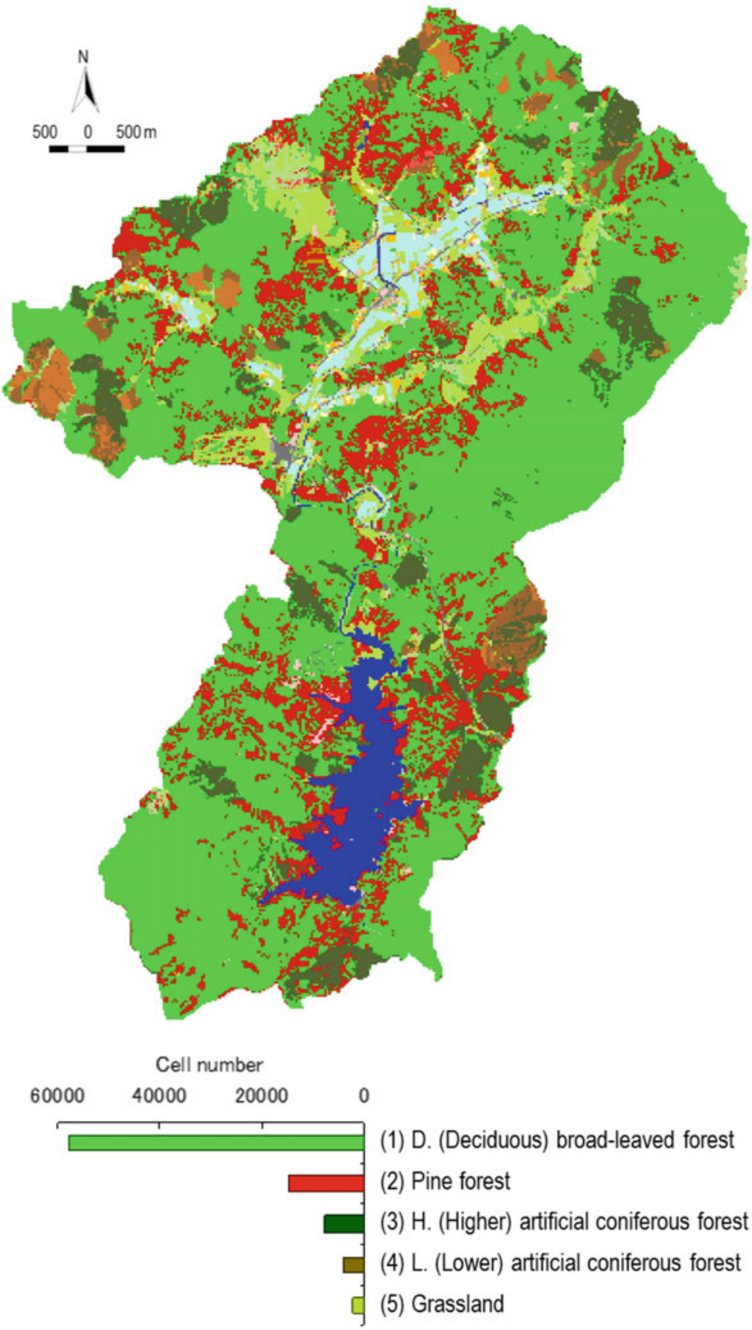


Fig. 3 Vegetation classified map of Yamawa village (Watanabe et al. 2003)

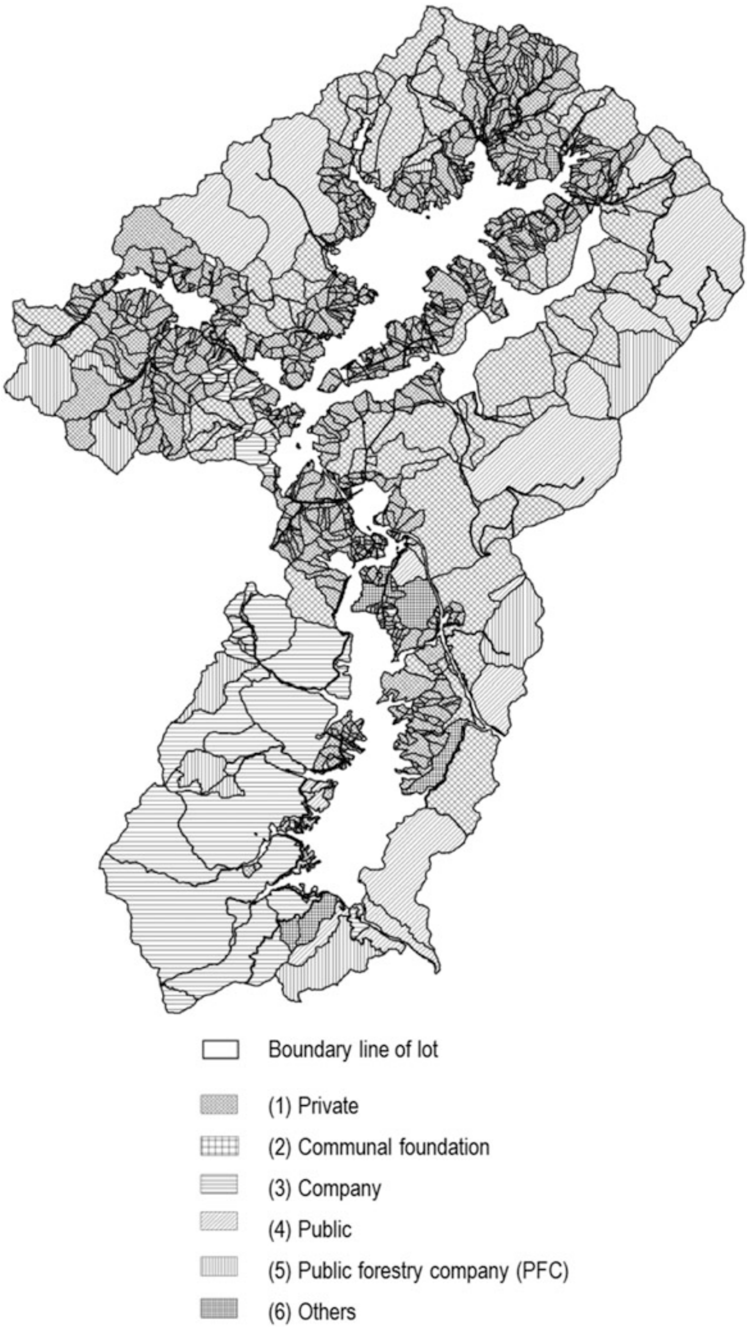
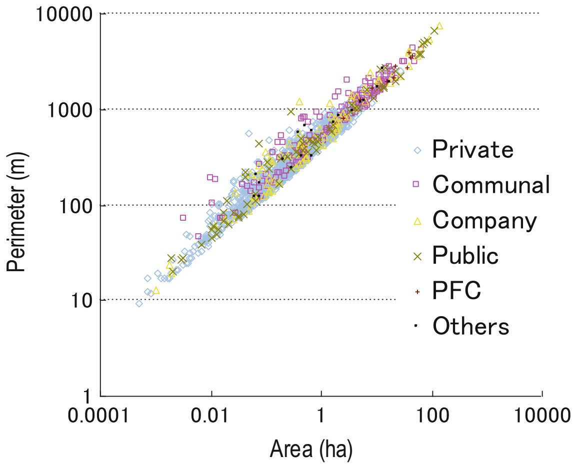


Fig. 4 Cadastral map of Yawata village

Fig. 5 Relationships between area and perimeter among each ownership type



based on physiognomy using a grid cell: (1) deciduous broad-leaved forest (56.6%), (2) pine forest (15.4%), (3) higher artificial coniferous forest (7.5%), (4) lower artificial coniferous forest (2.5%), (5) coppice and grassland (1.5%), and others (16.5%) (Watanabe et al. 2003) (Fig. 3).

The cadastral map (Fig. 4) data were converted from national land survey data (the National Land Agency format) to polygon line data by Hiroshima prefectural government, referred to as a "shape file" (a total of 1579 lots), and classified according to the ownership patterns: (1) private, (2) communal foundation, (3) company, (4) public, (5) public forestry corporation (PFC), and (6) other sectors. The total tendency of relationship between area and perimeter among each ownership type is linear, but some of the type (2) communal foundation appears to be relatively complicated shapes (Fig. 5).

3 Results and Discussion

In the overlapping of the vegetation and cadastral maps (Fig. 6), the boundaries between vegetation and ownership frequently conformed in the case of pine or artificial coniferous forests.

Characteristic combinations of vegetation type and ownership type, such as pine forest and communal foundation or artificial coniferous forest and PFC, were verified (Fig. 7). The pine forest overlapped with the communal foundation was considered as originally shared meadows under strong disturbance in the age of forest resource-dependent. The combinations of the artificial coniferous forest and the PFC were attributed to the original purpose to own and manage as the commercial forests.

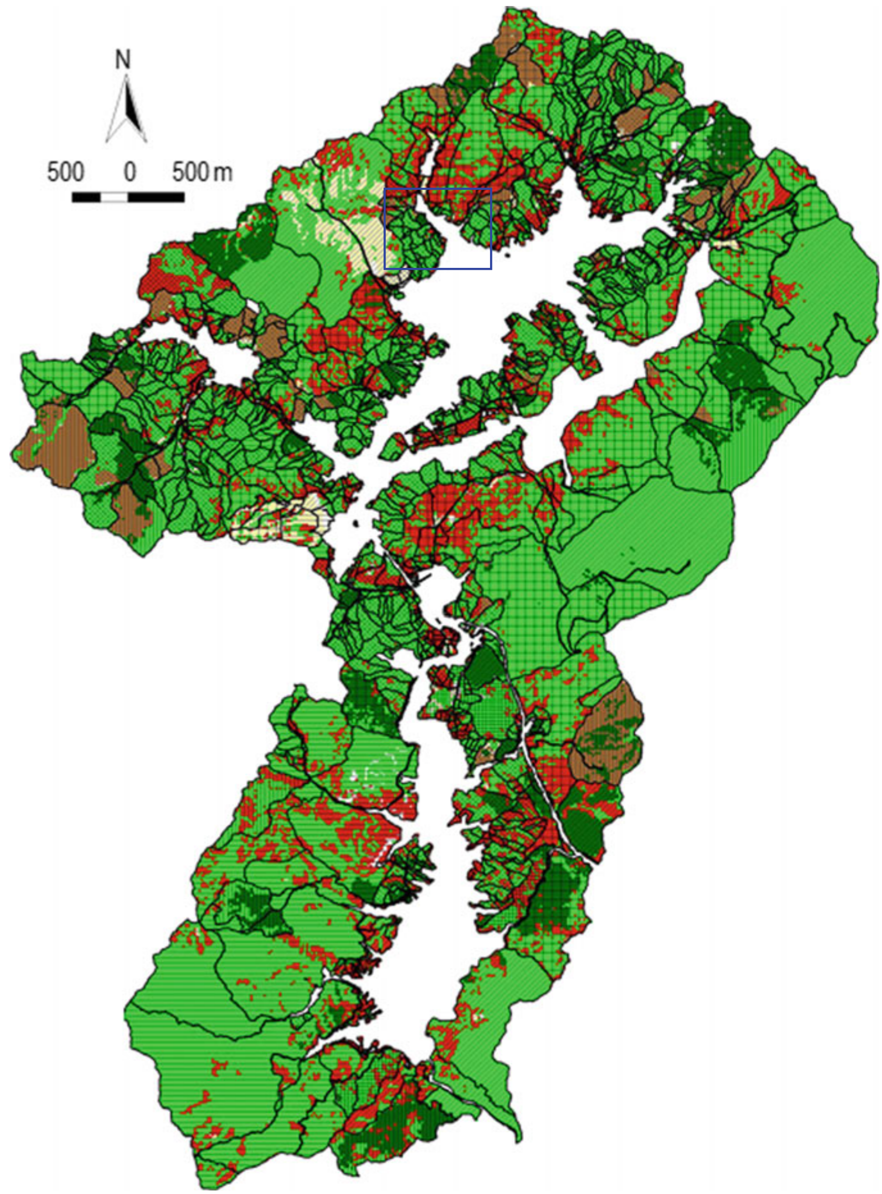


Fig. 6 Consolidated database of the vegetation and the cadastral map of Yawata village

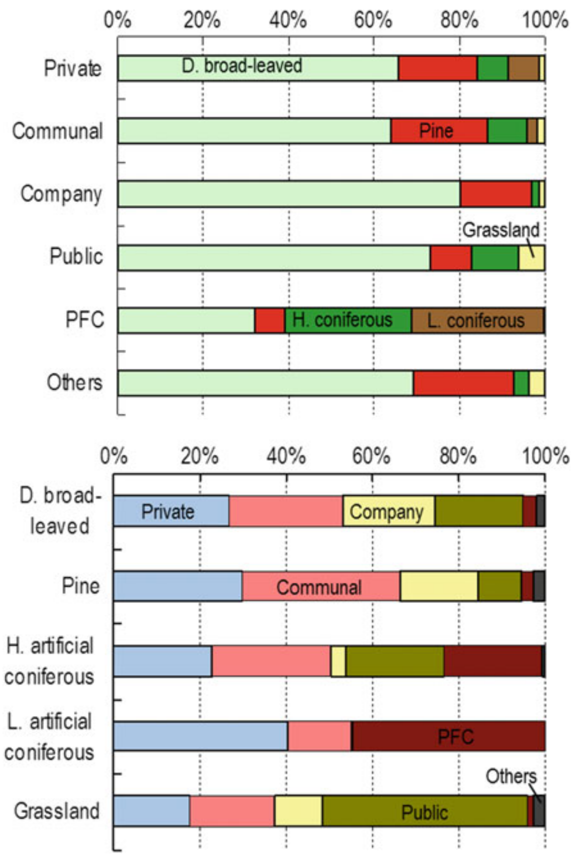


Fig. 7 Combinations between ownership type and vegetation type in terms of area proportion in each type

Using a ortho-rectified aerial digital black and white photograph taken by US military in 1947 as the scenography (the area of blue box shape in Fig. 6), the small vegetation patches (almost seemed to be deciduous broad-leaved, pine forests, and grassland) clearly match to the ownership boundary lines of almost private (Fig. 8). In those days that inhabitants depended on forest resources for daily life and agriculture, it was considered that continuous disturbance in each private forest impacted on diversity of forest landscape and stand structure.

In the limited forest areas that seemed to be complicated in combinations between the ownership types and the vegetation types such as called "Satoyama" (Duraiappah et al. 2012) based on 500 m radius from the residence areas for descriptive purpose (Table 1), most areas of the private ownerships were selected as opposed to the communal foundation, public, or PFC. The characteristic vegetation types were pine forest or grassland, but typical combinations between ownership types and vegetation types were not confirmed clearly.

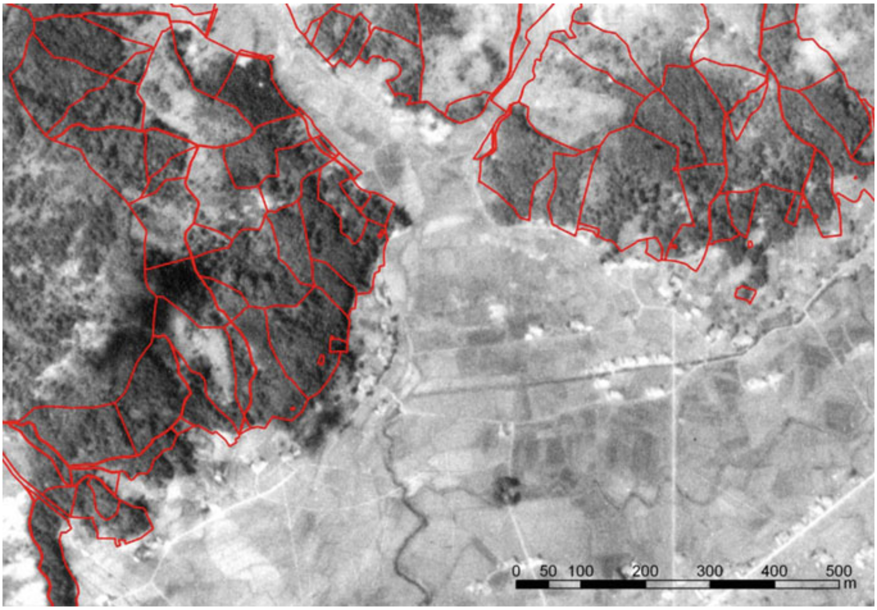


Fig. 8 Matching small vegetation patches to private ownership boundary lines in 1947

4 Conclusions

The results suggest that the landscape patterns of strongly disturbed or commercial forests tend to be influenced by forest ownership patterns at the physiognomy level. These results support the theory of the ownership structure plays an important role in relation to forest management practices (Bentsen et al. 2009). Distribution of ecological communities and patterns of land ownership and use are important considerations in conservation planning for ecologically sustainable forest management (Ohmann et al. 2007).

On the other hand, there is the potential for contribution to "SATOYAMA" forest conservation by the framework methodology of community-based management (Yamaba and Nakagoshi 2000), one of commons (Ostrom 1990). Commitment to moderate utilization of secondary forests or grasslands from the community organization is often underestimated as a good case of sustainable maintenance of a rural landscape.

Table 1 Combinations between ownership types and vegetation types within 500 m radius from residence areas. *Unit* cell number

Ownership	Vegetation							
	Deciduous broad-leaved	Pine	Higher artificial coniferous	Lower artificial coniferous	Grassland	Total in buffered area	Total	%
Private	14,366	4230	1003	1193	380	21,172	23,824	**88.9**
Communal	549	143	62	5	243	1002	23,633	4.2
Company	3291	2643	103	68	420	6525	15,554	42.0
Public	402	159	212	6	254	1033	15,923	6.5
PFC	9			66	10	85	5949	1.4
Other	308	65			60	433	1608	26.9
Total in buffered	18,925	7240	1380	1338	1367	30,250		
Total	57,892	14,733	7721	4122	2023		86,491	
%	32.7	**49.1**	17.9	32.5	**67.6**			

The numbers indicated by boldface show distinctive combinations

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Chapter 20
Spatial and Temporal Patterns of Groundwater Quality in Selangor, Malaysia

Shazwin Mat Taib, Mohd Nur Farhan Bin Abdul Wahab, Shahabaldin Rezania and Mohd Fadhil Md Din

Abstract The groundwater quality varies in short periods affected by the natural and anthropogenic factors. This study examines the spatial and temporal variations of groundwater quality at Selangor, Malaysia aimed to determine the availability of groundwater resources. Providing information and data for a holistic and comprehensive management, sustainable development of groundwater can be implemented based on the quantity and quality monitoring. The temporal variations of these major water quality data were cross-checked against the hydrologic variations. The mapping and graph of water parameters were plotted and analysed using geographic information system (GIS). Analysis was based on a short-term data collected from three prominent groundwater wells supplying raw water. A total of 22 water parameters were used for quality analysis and then compared to the previous results conducted by Japan International Cooperation Agency (JICA) in 2002. Results showed that the availability of groundwater in Selangor State quantity was adequate and the quality meets the requirement standard. Considering the fact that groundwater is part of the hydrologic cycle, proper water management procedures, planning and policies can be achieved only through an integrated approach involving both surface water and groundwater.

1 Introduction

Groundwater is water that is found beneath the ground surface in soil, sand and rocks spaces and in fractures of rock formations. The depth at which soil pore spaces or cracks and voids in rocks become completely saturated with water is

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called water table (Ramakrishnalah et al. 2009). Groundwater can be found almost everywhere and the water table may be as deep as tenth of metres and as shallow as one metre. It can be brought to the surface naturally through a spring or extracted through a well drilled into the aquifer. In rural areas, groundwater is taken out through shallow dug wells or comparatively deep tube well. While in urban areas, groundwater is pumped to the surface.

Generally, the term groundwater would be defined as water that is found underground the Earth surface. Hydrologists use the term groundwater to highlight water in the zone of saturation in which the entire void of space is filled with water (Heath 1983). However, Sato and Iwase (2006) have defined groundwater as all water below ground. Groundwater is water that is found underground in cracks and spaces in soil, sand and rocks and can be found almost everywhere. Groundwater occurs in two different zones which are as follows: saturated zone where all interconnected openings are full with water and the second zone is unsaturated zone where it occurs immediately below the land surface and contains water and air.

The area where groundwater fills these spaces is called the saturated zone of a geologic formation. The top of this zone is called the water table which may be only a metre below the ground's surface or it may be hundreds of metres down. Groundwater is stored and moves slowly through aquifers or sometimes known as the reservoirs of porous media such as sand, gravel and limestone, thus the speed at which groundwater flows depends on the size of the aquifers and the connection of the spaces. Groundwater is brought to the surface naturally through a spring or can

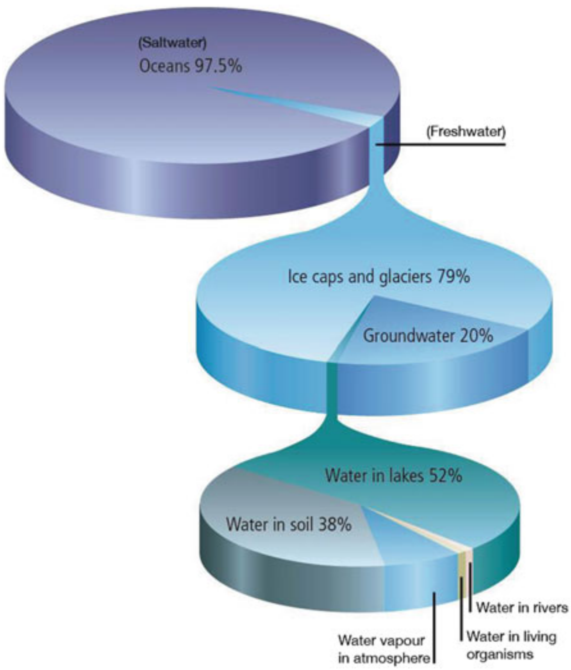

Fig. 1 Water distribution. *Source* World Water Distribution Year (2010)

be discharged into lakes and streams. This water can also be extracted through a well drilled into the aquifer, refer Fig. 1.

For the fact that supply of clean water is a major component of survival, solely dependency on the surface water sources needs to be diverted. Moreover, surface water resource supply is getting affected due to various factors such as deteriorated water quality, exposure to pollution and increasing water demand (Horton 1965). Therefore, a detailed study on groundwater resources is very much essential to ensure raw water reserves of Selangor State is enough to meet the quantity and quality water supply (Rahim et al. 2009).

Major threats to groundwater quality may come from point source which is urbanization industrial wastewaters for instance, septic tanks, sewer and detergents. Other than that, non-point (diffuse) sources might also be a threat to groundwater quality. Agricultural chemical such as fertilizers and pesticides are an example of non-point sources. If the groundwater is polluted, it can move from the original source of contamination over a wide area or even a very deep underground. It is usually difficult to know where the contamination has gone (Ramachandra 2006). The risks to health will depend on the concentration and type of contaminants in the groundwater and also for how long, how often and in what ways people are exposed to the water directly by drinking and inhalation or indirectly through skin contact.

As case study, this research examined the spatial and temporal variations of groundwater quality at Selangor, Malaysia aimed to determine the availability of groundwater resources. The Availability of Groundwater Resources Studies of Selangor States in year 2008 is referred for proposed water resources development by using the groundwater resources, particularly during the water crisis period in the future. It is consistent with the proposed groundwater resources development as a new water supply sources to supplement 30% amount to the State of Selangor in 2030 (Lin et al. 2008).

1.1 Groundwater Recharge and Discharge

Groundwater recharge and discharge define the relationship among groundwater storage, precipitation, vapour transpiration and surface water. Thus, groundwater recharge and discharge are the hydrologic processes by which water is exchanged between the saturated zone, unsaturated zone, land surface and atmosphere.

Recharge can be determined as a process by which groundwater is replenished. From the groundwater section view, recharge area is where water from precipitation is transmitted downward to an aquifer. Nearly, all areas, except composed of solid rock or covered by development, allow a certain percentage of total precipitation to reach the water table. But in several areas, more precipitation will infiltrate than in others. Areas which transmit the most precipitation are regularly referred to as critical recharge areas. Natural vegetation cover, flat topography, permeable soil, a deep water table and the absence of confining beds act as a promoter or factor for recharge process. Therefore, how water infiltrates depends on these factors.

Discharge areas are the antonym of recharge areas. They are the locations at which groundwater leaves the aquifer and flows to the surface and normally occurs where the water table intersects the land surface. When this happens, springs or seeps are found and may flow into freshwater bodies, such as lakes or streams, or they may flow into saltwater bodies.

By referring to the force of gravity, groundwater commonly flows from high areas to low areas. So, high areas such as hills are naturally where aquifers are recharged and low areas such as river valleys are where they discharge. Nevertheless, in many instances, aquifers occur under the river valleys, thus river valleys can also be important recharge areas (Yusoff et al. 2013).

1.2 Groundwater Development in Malaysia

Malaysia water demand is likely to grow significantly by approximately 17,000 million litres per day (MLD) when the country's population reaches more than 30 million according to 2009 press released by Sime Darby (Bahagian Hidrologi dan Sumber Air 2009). At present, surface water accounts for more than 98% of water consumed in Malaysia. This level of dependence is unsustainable and needs immediately to be addressed, especially since surface water is easily exaggerated by extreme weather conditions, as Malaysians know only too well. This is a matter of serious concern for the whole country and all responsible organizations should be looking into addressing this imbalance in our national water supply. Groundwater offers a more consistent and sustainable source of water as long as it is abstracted properly, utilizing right methods and technology (Mohamed et al. 2009).

For the records, groundwater in Malaysia stores for more than 90% of the freshwater resources. The whole water available for use could be approximated as the sum of 10% of the surface run-off and the volume of groundwater recharge. But, not all groundwater can be abstracted as some of these aquifers fall on developed land or land where detailed groundwater assessment is difficult. Several aquifers may not be suitable for further development, as the water quality may be poor and difficult to treat while others are already intruded by saline water.

Even though water supply for domestic, agricultural and industrial use in the country is drawn primarily from surface water sources such as rivers and streams, groundwater has also played an important role in supplying the needs in several places, particularly in rural areas and in areas where piped water supply is inadequate or non-existent. Rural populations rely on groundwater obtained from wells for their daily needs and activities such as drinking and irrigation. Groundwater is also being used by various factories, estates and farms to suit their individual water needs including the commercial production of mineral water. During the dry spell, groundwater has provided relief for people in Selangor and Sarawak. Groundwater is certainly capable of supplementing water requirements for the country as a few states had utilized the groundwater resources for public water supply like in

Table 1 Water resource summary in Malaysia (Minerals & Geoscience Department Malaysia)

Water resources	Quantity (billion m^3)
Annual rainfall	990
Surface run-off	566
Evapotranspiration	360
Groundwater recharge	120
Surface artificial storage	25
Groundwater storage	5000

Kelantan, Perlis, Pahang, Sabah and Terengganu. Table 1 shows the summary of water resources in Malaysia.

1.3 Groundwater Supply in Selangor, Malaysia

Selangor is very well-developed state and public water supply services provide potable water to almost 95% of populated areas. As such, groundwater is mainly used for non-portable purposes. Selangor Water Management Authority (LUAS) started the groundwater registration programme in 2005 whereby groundwater abstractors are required to obtain a license and submit details of the abstraction method and volume abstracted (Suratman 2005). Groundwater in Selangor occurs in both alluvial and hard-rock aquifers. The groundwater output recorded for 8 years duration from year 2005 to 2013 indicates a rapid rise (80%) in groundwater abstraction from 1.8 million cubic metres in year 2005 to 21.6 million cubic metres in year 2009 mostly to meet the industrial demand (source: LUAS).

The exploitation of groundwater for both irrigation and portable use is not common due to abundance of surface water in Malaysia's river system. Except in the state of Kelantan and some parts of Sabah and Sarawak where portable water supply is extracted from groundwater aquifers (Hossain 1989). Most of the industrial and domestic water supplies as well as the irrigation water supply in the country come directly from the rivers. The National Water Resource Study (NWRS) for Peninsular Malaysia (2000–2050) has recognized the groundwater resource is an important supplementary resource for those isolated rural areas not served by the water supply networks.

Groundwater is also the main source for agricultural irrigation activities. It is a major contributor that flows in streams and rivers and has a strong influence on surface water and wetland habitats for fauna and flora. Based on the number of licences issued by Selangor Water Management Authority (LUAS), there were premises in Selangor which used groundwater as their water supply, such as factories, hydroponics, fish farming, and landscaping to ensure the cooling of industrial plants for domestic supply.

In study conducted by JICA in 2002 was to formulate a sustainable groundwater resources and environmental management plan for the Langat Basin using Geographic Information System (GIS). GIS is utilized in this study in input and managing basic topographic maps, land use maps and other relevant data such as wetland, mining, forest reserves and so on (Manap et al. 2013). From the topography, the Langat Basin can be broadly divided into three, namely mountainous areas, hilly areas and flat lowlands, from the upstream to the downstream (JICA 2002). In the low flatlands, thick quaternary layers are deposited on the bedrock. The aquifer of the present study is the Simpang Formation consist sand and gravel. This aquifer distributes continuously around 15–20 m below the ground with the thickness of 20 to more than 100 m. It is generally considered that groundwater can be developed economically in this area. The average annual rainfall ranges from approximately 2200 to 2700 mm. The groundwater recharge is 108 mm a year which is 4.8% of the annual rainfall (Aller et al. 1987).

Groundwater quality for the highly acidic surface water significantly reduces the pH values of the groundwater to the range of 4.5–4.7. Total iron mostly exceeds the iron values specified in the Malaysian National Drinking Water Guidelines (0.3 mg/l). The higher concentration of arsenic values found in the shallower wells. Na_2SO_4 or NaCl type and intermediate type of water are dominant for the groundwater in this basin. The main activity of agriculture is dominated by palm oil plantation, followed by rubber, piggery, poultry, aquaculture, cattle and orchards. There are many types of pesticides being used mainly to control weeds, insects, rats and other pests. These pesticides and the fertilizer used in the palm oil are the potential source of groundwater pollution. Other potential sources include mines, solid waste landfill site, wastewater treatment plants and petroleum storage tanks of the petrol station (JICA 2002).

Land subsidence was the elevations of 20 shallow benchmarks that were measured in July and November 2000, and March and August 2001 to monitor the land subsidence. Three benchmarks were located near the Langat River indicate that have sunk around 11–16 mm since July 2000. These benchmarks are located in the area where much groundwater is extracted. The study concludes that consolidation by draining of peat/peat clay layer and clayey soil layer that are widely spread over the Basin may result in the subsidence around the area. Groundwater modelling was done to estimate the groundwater resources potential and also to predict groundwater abstraction impacts on the environment. The groundwater modelling software used was MODFLOW, MODPATH, Zone Budget, MT3D/RT3D and PEST. The geological layer was divided into seven layers for modelling purpose (JICA 2002).

In 2005, a study for sustainability on groundwater resources and environmental management for the Langat Basin was conducted by Suratman (2005). The geology of the study area is made up of Quaternary alluvium emplaced on top of sandstone and shale of the Kenny Hill Formation bedrock and Kajang Formation at the eastern fringe. Four units of Quaternary alluvium are recognized, namely the Beruas Formation, Gula Formation, Kempadang Formation and Simpang Formation. The groundwater recharge takes place mainly from upstream mountain and hilly areas. The groundwater can be classified as Na_2SO_4 or NaCl type. The chloride water indicates the influence of the seawater and marine origin sediments. Arsenic is widely detected although almost all are below the drinking standard of 0.05 mg/l and the highest concentration of arsenic is found in shallower wells. The potential sources of groundwater pollution are from a total of 30 industrial estates in the Basin, agricultural activities dominated by palm oil and rubber plantation, mines, solid waste landfill site, wastewater treatment plants and petroleum storage tanks. The results of groundwater flow model developed using Visual MODFLOW indicate that groundwater abstraction from the main aquifer will cause only negligible drawdown in the wetlands and shallow peat layer. The shallow layer is affected more by lowering of surface recharge through rainfall.

1.4 Aquifers Conditions in Klang Valley

The two most important aquifers in the Klang Valley are the Kuala Lumpur Limestone and Kenny Hill Formation (Binnie and Rakan 1979). A third aquifer comprising river and coastal alluvium could be developed as a low yield groundwater source. The coastal alluvial aquifer shows high sodium and chloride contents as results of saline intrusion, the river alluvial aquifer has high contents of nitrates, sulphate and coliform counts, whereas the limestone aquifers show high nitrates and coliform counts (Peng 2012). Data collected from wells tapping the different aquifer types in the Klang Valley have been summarized and shown in Table 2 (Suratman 1990).

1.5 Klang Valley River System

Selangor State lies approximately between 312,017–44,3151 m Easting and 285,818–430,281 m Northing. The map of study area is shown in Fig. 2. There are

Table 2 Well hydraulics of aquifer in Klang Valley (Hydrogeology of Klang Valley 1990)

Aquifer		Alluvium		Kenny Hill	Kuala Lumpur	Schist
		River	Coastal	Formation	Limestone	
Discharge (m^3/d)	Min	327	46.4	78.45	108	108
	Max		193.32	1308.00	1113.60	360
	Ave		148.88	499.25	580.75	201.13
Transmissivity (m^2/d)	Min	242.1	9.86	1.66	1.22	6.09
	Max		84.66	671.33	1189.49	95.56
	Ave		52.1	40.83	198.29	53.27
Storativity	Min			1.43E−07		1.43E−
	Max			2.27E−04		1.08E−
	Ave			8.12E−05		6.31E−
Permeability (m/d)	Min	56.94	0.65	0.02	0.03	0.07
	Max		3.38	11.59	86.73	2.29
	Ave		2.31	0.86	36.16	1.04

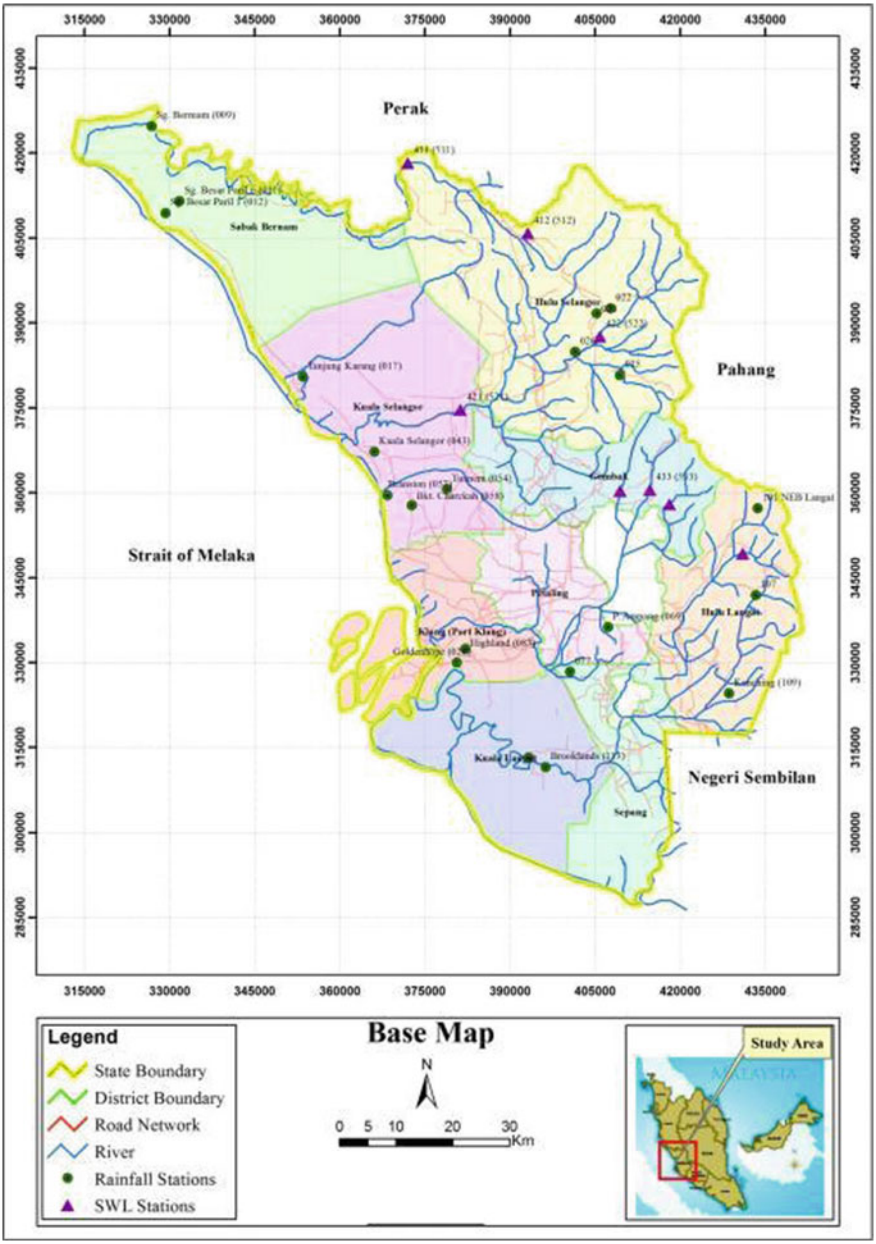

Fig. 2 Base map of the study area

four main river basins in the Selangor State, namely Bernam River, Selangor River, Klang River and Langat River. All the four river systems flow in the west direction and ultimately discharge into the Straits of Melaka as shown in Fig. 3.

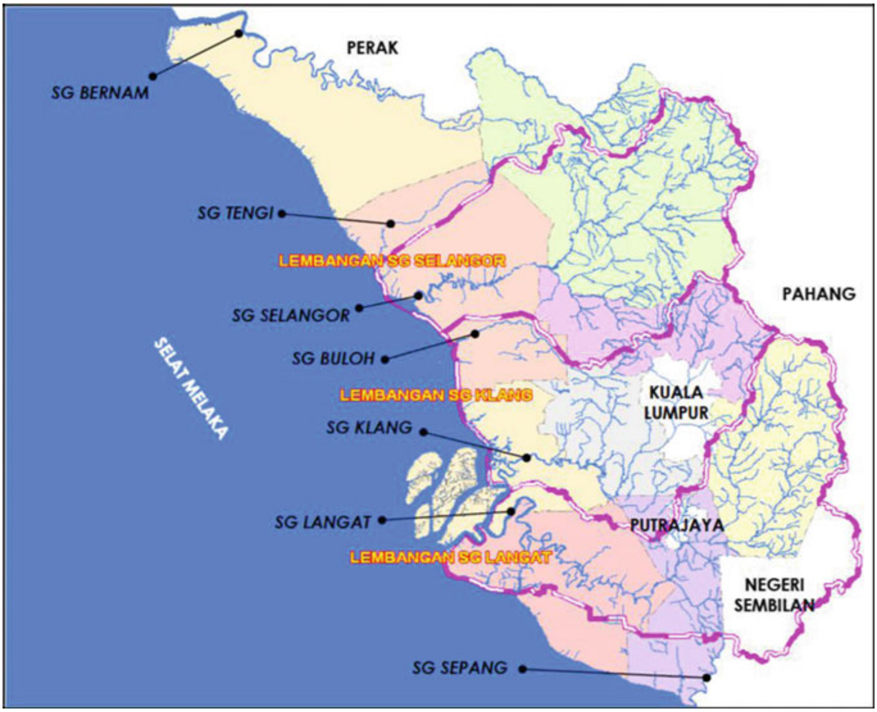

Fig. 3 Major river system of Selangor State

1.5.1 Bernam River Basin

Bernam River Basin is an interstate river which drains the southern part of Perak State and northern part of Selangor State. It has a length of about 200 km and a total basin area of 3335 km^2 (including the Tengi River system in Selangor State and the coastal flats as in EPU 2000 Study).

The main tributaries of Bernam River are Slim River, Dharoi River, Erong River and Trolak River. Bernam River and the main tributaries originate from the main range in the east. The upper part of the basin is mountainous and covered with virgin jungle while the middle part of the basin is mostly agro-forest consisting of rubber trees and oil palms. The river meanders through mostly peat swamp forest at the lower reaches before entering the Straits of Melaka near Sabak Bernam.

1.5.2 Selangor River Basin

Selangor River Basin with a catchment area of approximately 2200 km^2 emerges from the foothill of Fraser's Hill and traverses the north-east region of Selangor for 110 km until the coast. The main tributaries are Sembah River, Kanching River, Kerling River, Rawang River and Tinggi River. The headwaters region of the basin consists of forested foothills and rugged mountains. The middle region is predominantly undulating with vegetative cover comprising rubber trees and oil palms. At the low-lying coastal regions, the river meanders along the peat swamp forest and finally discharges into the Melaka Straits near Kuala Selangor.

There are two water supply dams in Selangor River Basin, namely Selangor River Dam and Tinggi River Dam. The Selangor River Dam has a catchment area of 197 km^2 and is located in the upper catchment of Selangor River Basin near Kuala Kubu Baru. The dam was completed in mid of year 2003. Under Selangor River Phase 3 Scheme, Selangor River Dam was constructed to provide additional 1100 mld (12.7 m^3/s) and enabling the abstraction capacity from Selangor River to be increased from 1900 mld (22 m^3/s) to 3000 mld (34.7 m^3/s) (Suratman 2003).

Tinggi River Dam has a catchment area of 40 km2 and is located in the upper reaches of Buloh River, the first order tributary of Selangor River near Ladang. This dam was designed as part of Selangor River Phase 2 Scheme to regulate the flow at the existing Batang Berjuntai water supply intake about 30 km downstream. There is a pumping station of 150 mld capacity to refill the Tinggi River Reservoir from the main stem of Selangor River during the high flow season (Rockwater 1997).

1.5.3 Klang River Basin

Klang River Basin has a total catchment area of about 1280 km^2 and a length of 120 km. It originates from the main range about 25 km north-east of Kuala Lumpur at an altitude of about 1330 m. As is typical of rivers on the west side of the main range, the rivers flow westerly to eventually enter the Straits of Melaka. The upper catchment is mainly forest on steep lands. At the middle reaches where Kuala Lumpur is located, Klang River captures two major tributaries, namely Batu River and Gombak River. The other major tributaries of Klang River include Ampang River, Kerayong River, Kuyoh River, Penchala River, Rasau River, Damansara River and Rasah River. Klang River Basin is the most heavily built-up area among the four major basins in the state. Urban centres have been sprouting within the basin rapidly for the past ten years. The rubber and oil palm estates as well as ex-mining lands are being converted into suburban centres with high population densities. About 50% of the basin area is currently developed for residential, commercial, industrial and institutional use.

There are at present two dams in the upper catchment: Klang Gates Dam on the main stem of Klang River and Batu Dam on Batu River. Both dams are for flood mitigation and to a lesser extent water supply purposes. The Klang Gates Dam has a catchment area of 77 km^2. It is located 15 km north-east of FT Kuala Lumpur. Water from this reservoir flows by gravity to the Bukit Nanas Treatment Plant via two steel mains. Klang Gates Dam was raised by 3 m in year 1979 and its total reservoir capacity is 32 MCM. Batu Dam has a catchment of 50 km^2, and it is a multi-purpose flood control and water supply dam. It is located about 16 km north of FT Kuala Lumpur. The dam has a reservoir capacity of 33.6 MCM for potable water supply to Klang Valley. Another dam, Subang Lake or Meru Dam is located at the lower catchment of Klang River, about 30 km west of FT Kuala Lumpur. It serves as direct water sources for areas surrounding the Klang area.

1.5.4 Langat River Basin

Langat River Basin has a total catchment area of approximately 2395 km^2. It comprises three major tributaries, namely Semenyih River, Beranang River and Labu River. Langat River Basin occupies the southernmost region of the state with part of the catchment intrudes into the neighbouring State of Negeri Sembilan in the south-east corner. Langat River headwater starts from the north-east of the basin, flows southwesterly and joined with Semenyih River after Bangi town. After the confluence with Semenyih River, the river changes its course to a westerly direction to meander towards the coast and discharges into the sea via the north and south estuaries. The north estuary flows into the straits known as Selat Lumut which is the waterway between the mainland and Pulau Indah (formerly Pulau Lumut). The south estuary flows directly into the open sea of the Straits of Melaka. The upper catchment is generally rugged mountain terrain with multiple land use covers. The lower catchment of the river is generally low-lying swampy land with some defunct mining lands.

There are two dams, namely Langat Dam and Semenyih Dam, located at the upper reaches of the river system. Langat Dam is located at the upstream of Langat River with a catchment area of 41.1 km^2 while Semenyih Dam at the upstream of Semenyih River has a catchment area of 56.7 km^2. Both dams have been constructed primarily for water supply purposes. Both dams serve as regulating reservoir scheme where controlled releases are made from an impounding reservoir to supplement the river flows during periods where the river flows are deficient.

2 Data Analysis

An integrated approach has been taken incorporating the land and water ecosystem, interaction between the surface and groundwater of the area to assess the groundwater resources.

2.1 Groundwater Availability

Basically, there are no sources of drinking water on Earth that are not polluted. Rainfall cleanses the atmosphere as it forms and falls. As a result, rainfall contains organic compounds, dissolve acids and also heavy metals such as mercury and selenium in many areas. Groundwater which is somewhat filtered and generally contains fewer quantities of pollutants than surface water may itself be polluted by ground releases of toxicants and by pollutants produced by chemical reactions in the water and soil as well.

2.2 Borelog Location

Existing geological features and lithological data of the study area have been collected from the Selangor Water Management Authority (LUAS), Minerals & Geoscience Department Malaysia (JMG) and other available sources and processed. A total of 320 nos. of borelog data have been collected during this study. The quality of borelog data has been checked, and finally 141 nos. of data have been selected to identify the geology of the study area. Borelog location map of the study area is shown in Fig. 4.

2.3 Groundwater Quality Data

The groundwater monitoring wells located in the study area, which are not uniformly distributed and inadequate for the study. The frequency of data collections form this well was once a year which is not sufficient for modelling purposes. Under Japan International Cooperation Agency JICA was study (2002), 15 nos. of monitoring well was installed in the part of the Langat basin area and collected data in 2002. Considering the urgency of data in model development an attempt was made to collect data from existing monitoring well. As a consequence, 15 nos. of monitoring well was selected, and primary data were collected for 3 months. The locations of the wells for primary data collections are given in Fig. 5.

After necessary quality checking, these data have been used in groundwater quality in compare to Ministry of Health Malaysia Standard (MOH STD) for drinking water of groundwater of the area. In order to assess the suitability of groundwater for different uses, a hydro-geochemical study has been carried out. Groundwater quality data for 15 stations have been collected by Japan International Cooperation Agency (JICA) and 3 sample wells have been used for the analysis based on 22 parameters water quality for this study. The 3 sample wells were selected in Fig. 6.

This study was to compare on Japan International Cooperation Agency (JICA) data and our recent data sampling with 22 parameters. Figure 6 shows that 3 points of monitoring well stations have been selected for this study.

The results of groundwater quality data show that, iron contents have exceeded the value given by Ministry of Health (MOH) Standard for drinking water which is less than 1.0 milligrams per litre (mg/l). Nevertheless, based on the iron for the all

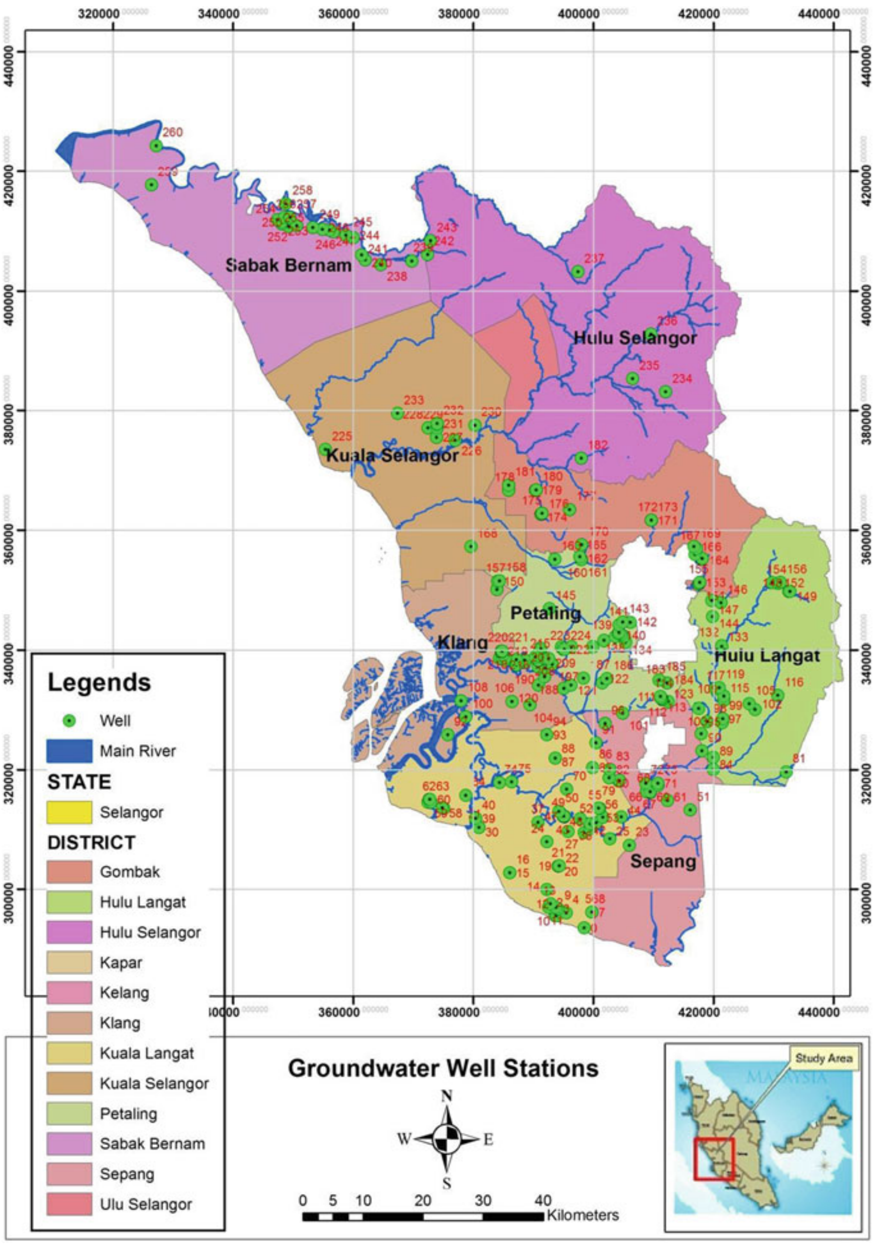

Fig. 4 Locations of borelog data in 2010

areas, respectively, Kapar, Dengkil and Rantau Panjang were high compared to the permitted level. The iron level in groundwater at Rantau Panjang was 7.78 mg/l followed by Dengkil with 4.05 mg/l and the lowest was Kapar with 1.2 mg/l.

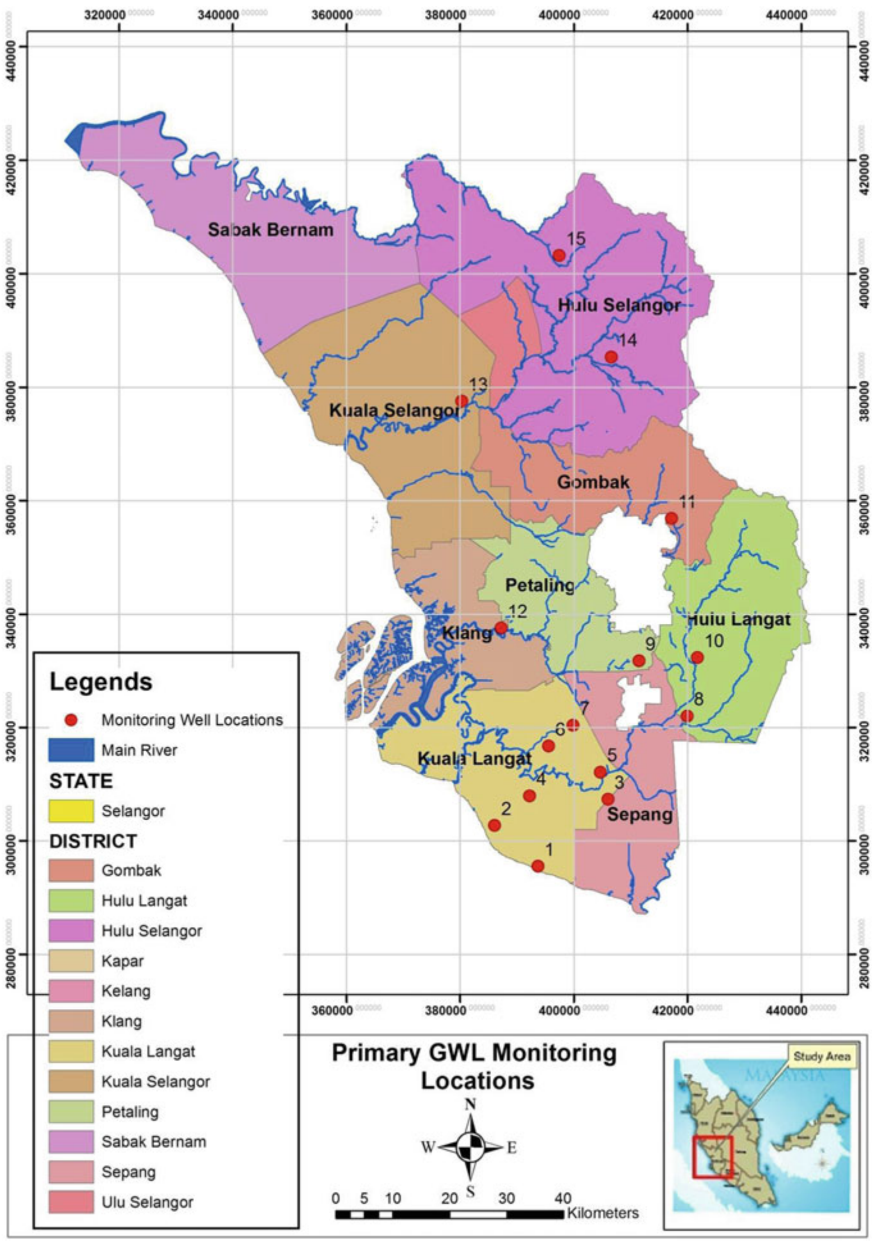

Fig. 5 Primary groundwater level monitoring station

At concentrations found in most natural water and at concentrations below aesthetic objective, iron is not considered a health risk. Water with high concentration of iron may cause staining of plumbing fixtures or laundry. Furthermore,

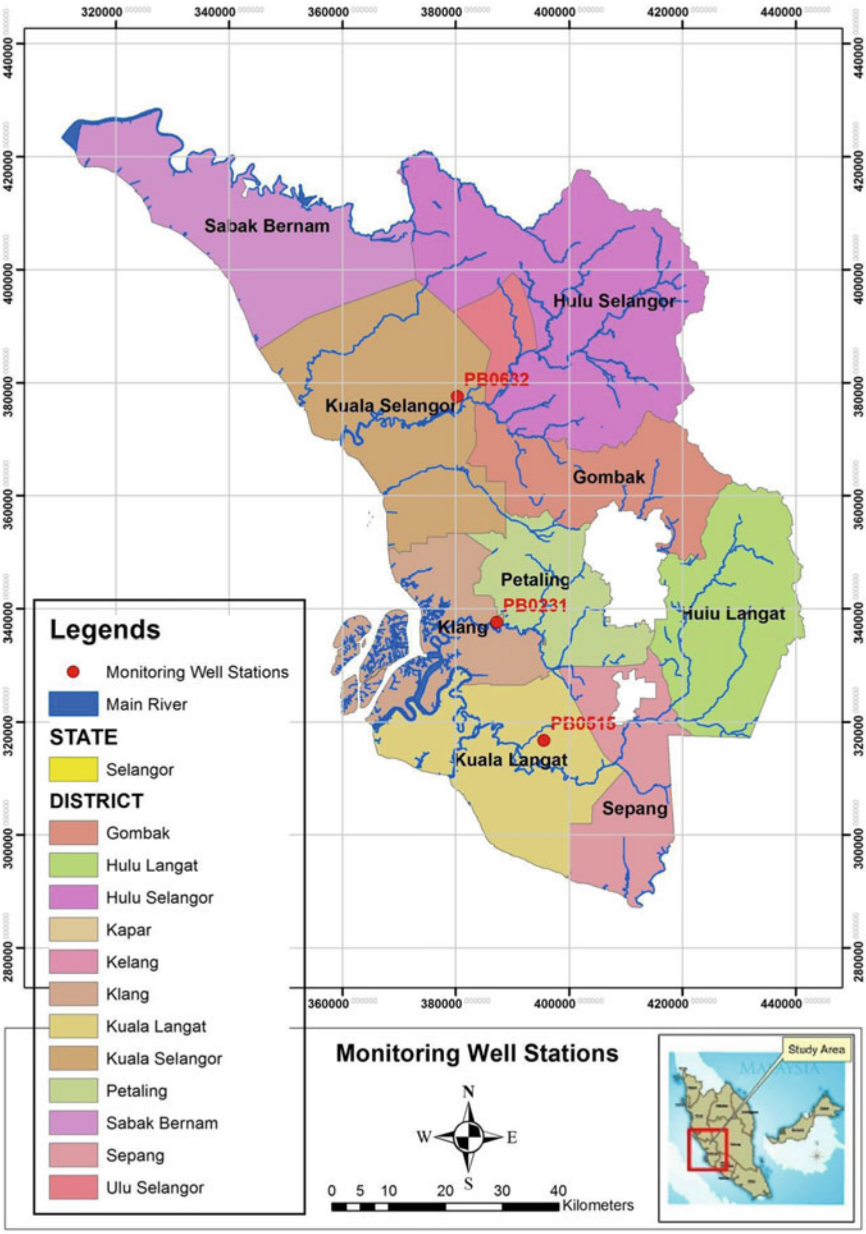

Fig. 6 Monitoring well stations

iron can collect and block pipes or fixtures and produce colour, taste and rust flakes in water. The most common sources of iron in groundwater are naturally occurring such as from weathering of iron bearing minerals and rocks. Industrial effluent, acid mine drainage, sewage and landfill leachate may also supply iron to local groundwater. The level of iron at Rantau Panjang was recorded as the highest resulted from the rapid development of the area and the activities from the nearby industrial zone.

Tables 3, 4 and 5 shows the results of groundwater quality in Kapar, Dengkil and Rantau Panjang, respectively. We can conclude that all 3 points of monitoring well stations that we choose have high potential to produce clean water supply. The results show that all analysed parameters have lower value compared to Ministry of Health (MOH) Standard for drinking water. However, some filtration or ultraviolet lamp treatment for the groundwater might require.

Table 3 Results of groundwater quality data at station PB 231 (Kapar)

No.	Test parameters	Units	MOB STD	NWQS STD	ID Well	
					PB 231	
					Nov 2002	Nov 2015
1	Sulphate	mg/1	250	250	0.8	10.3
2	Total hardness	mg/1	500	250	6.2	54.4
3	Bicarbonate as $CaCO_3$	mg/1	–	–	ND (<1)	48
4	Nitrate	mg/1	10	7	4.17	4.99
5	Coliform	cfu/ 100 ml	–	5000	950	1460
6	Manganese	mg/1	0.1	0.5	0.041	0.08
7	Chromium	mg/1	0.05	–	ND (<0.001)	ND (<0.001)
8	Zinc	mg/1	3	5	0.04	0.1
9	Arsenic	mg/1	0.01	0.05	ND (<0.001)	ND (<0.001)
10	Cadmium	mg/1	0.003	0.01	ND (<0.001)	ND (<0.001)
11	Calcium	mg/1	–	–	2	2.1
12	Mercury	mg/1	0.001	0.001	ND (<0.001)	ND (<0.001)
13	Magnesium	mg/1	–	–	0.3	1.3
14	Sodium	mg/1	200	–	2.1	4.6
15	Potassium	mg/1	–	–	0.9	1
16	Selenium	mg/1	0.01	0.01	ND (<0.01)	ND (<0.01)
17	Chloride	mg/1	250	200	3.4	10.2
I8	Phenols (total)	mg/1	0.002	10	ND (<0.002)	ND (<0.002)
19	Total dissolved solids	mg/1	1500	1000	18	41
20	Iron	mg/1	1	1	0.3	1.2
21	Copper	mg/1	1	0.02	0.12	0.18
22	Lead	mg/1	0.05	–	0.013	0.064

Table 4 Results of groundwater quality data at station PB 515 (Dengkil)

No.	Test parameters	Units	MOH STD	NWQS STD	ID Well	
					PB 515	
					Nov 2002	Nov 2015
1	Sulphate	mg/1	250	250	0.3	1.4
2	Total hardness	mg/1	500	250	314	386
3	Bicarbonate as $CaCO_3$	mg/1	–	–	536	582
4	Nitrate	mg/1	10	7	0.86	2.6
5	Coliform	cfu/ 100 ml	–	5000	444	675
6	Manganese	mg/1	0.1	0.5	0.67	0.52
7	Chromium	mg/1	0.05	–	ND (<0.001)	ND (<0.001)
8	Zinc	mg/1	3	5	ND (<0.01)	0.1
9	Arsenic	mg/1	0.01	0.05	ND (<0.001)	ND (<0.001)
10	Cadmium	mg/1	0.003	0.01	ND (<0.001)	ND (<0.001)
11	Calcium	mg/1	–	–	30.2	41.6
12	Mercury	mg/1	0.001	0.001	ND (<0 001)	ND (<0.001)
13	Magnesium	mg/1	–	–	58	71
14	Sodium	mg/1	200	–	163	187
15	Potassium	mg/1	–	–	42	53
16	Selenium	mg/1	0.01	0.01	ND (<0.01)	ND (<0.01)
17	Chloride	mg/1	250	200	150	210
18	Phenols (total)	mg/1	0.002	10	ND (<0.002)	ND (<0.002)
19	Total dissolved solids	mg/1	1500	1000	960	1264
20	Iron	mg/1	1	1	3.38	4.05
21	Copper	mg/1	1	0.02	ND (<0.001)	ND (<0.001)
22	Lead	mg/1	0.05	–	ND (<0.001)	ND (<0.001)

Table 5 Results of groundwater quality data at station PB 632 (Rantau Panjang)

No.	Test parameters	Units	MOH STD	NWQS STD	ID Well	
					PB 632	
					Nov 2002	Nov 2015
1	Sulphate	mg/1	250	250	7.5	10.2
2	Total hardness	mg/1	500	250	5.5	6.2
3	Bicarbonate as $CaCO_3$	mg/1	–	–	3	7
4	Nitrate	mg/1	10	7	0.04	0.28
5	Coliform	cfu/ 100 ml	–	5000	40	64
6	Manganese	mg/1	0.1	0.5	0.06	0.08

(continued)

Table 5 (continued)

No.	Test parameters	Units	MOH STD	NWQS STD	ID Well	
					PB 632	
					Nov 2002	Nov 2015
7	Chromium	mg/1	0.05	–	ND (<0.001)	ND (<0.001)
8	Zinc	mg/1	3	5	0.1	0.1
9	Arsenic	mg/1	0.01	0.05	0.01	0.04
10	Cadmium	mg/1	0.003	0.01	ND (<0.001)	ND (<0.001)
11	Calcium	mg/1	–	–	2	2
12	Mercury	mg/1	0.001	0.001	ND (<0.001)	ND (<0.001)
13	Magnesium	mg/1	–	–	0.7	1.9
14	Sodium	mg/1	200	–	4.3	6.6
15	Potassium	mg/1	–	–	3.1	3.4
16	Selenium	mg/1	0.01	0.01	ND (<0.01)	ND (<0.01)
17	Chloride	mg/1	250	200	2.2	3.4
18	Phenols (total)	mg/1	0.002	10	ND (<0.002)	ND (<0.002)
19	Total dissolved solids	mg/1	1500	1000	29	41
20	Iron	mg/1	1	1	6.1	7.78
21	Copper	mg/1	1	0.02	ND (<0.001)	ND (<0.001)
22	Lead	mg/1	0.05	–	0.005	0.014

3 Conclusion

Groundwater, a valuable natural resource, has become an important source of water to meet the increasing requirement for domestic, industrial and agricultural needs. Surface water, such as rivers, lakes and drainage areas, in several places becomes inadequate or even unavailable due to several factors which is rapid increase in demand due to population growth, industrial or agricultural expansion, deteriorating quality of surface sources and low flow of surface source during prolonged droughts.

As a result of these factors, a limitation on the availability and capacity of the surface water supply is being experienced. Groundwater is thus considered the only logical alternative to supplement the supply. In areas where there is a total lack of surface source, groundwater may be the only source of supply.

Considering the fact that groundwater is part of the hydrologic cycle, proper water management procedures, planning and policies can be achieved only through an integrated approach involving both surface water and groundwater. The study was thus aimed to determine the availability of groundwater resources of Selangor. Information and data for a holistic and comprehensive management of groundwater resources for sustainable development were collected using GIS that can be implemented and integrated based on the quantity and quality monitoring

(Mohamad 2011). Impact assessment of groundwater abstraction and land use change for future studies was also considered. From the analysis, we can conclude that the level of water quality data for all wells that was selected for monitoring remains good and suitable for drinking water supply. However, due to rapid development and industrialization as well as agricultural development, there is an increasing threat of pollution to groundwater. Groundwater degradation occurs over a long term which is a potential matter for argument.

4 Recommendations

Potential adverse impacts which arising from groundwater extraction on the environment in this area would primarily involve land subsidence and migration of brackish water to the fresh deep aquifer layer. These effects will occur in the long term if the development of groundwater resources in the areas is not managed in the sustainable manner. Therefore, we can minimize or control the impacts with the sustainable management.

Data accessibility on water wells drilling company which is actively involved in groundwater utilization, usually not being publish or release to the public. The related agencies or state water authorities need to make an effort to compile and legitimate the data. The distribution and numbers of groundwater sampling locations are not sufficient to derive the baseline status of water quality. An attempt has been made under this study to get preliminary idea about the water quality index (WQI).

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Chapter 21
Cultural Landscape Preservation and Ecotourism Development in Blambangan Biosphere Reserve, East Java

Luchman Hakim

Abstract Cultural landscapes in the Blambangan Biosphere Reserve, East Java, represent important resources for sustainable development. The reserve has rich bio-cultural resources, including wildlife, flora, landscapes, and human ethnicity and traditions. For years, tourism has been implemented in the core areas of the reserve, namely Alas Purwo National Park, Baluran National Park, Meru Betiri National Park, and the Ijen crater (Ijen Nature Reserve). So far, tourism has not been encouraged in the cultural landscape areas, but there is strong evidence that tourist interest in visiting these sites will increase significantly. Within the biosphere reserve, paddy terraces, agroforestry farming systems, and local settlements comprise the cultural landscapes with potential for development as tourist attractions within a model of local sustainable development; however, plans to exploit these opportunities should be guided by proper management to ensure the sustainability of the cultural landscapes. Plans to meet tourist needs often involve tourism product availability. The effectiveness of the management of cultural landscapes as a tourism destination is related to the availability of comprehensive environmental management planning documents. For tourism product construction and development to be attractive, scientific information on local knowledge, biodiversity level, and physical characteristic of cultural landscapes are essential.

1 Introduction

Cultural landscape is home and habitat for millions of people. Throughout the Indonesia archipelago, cultural landscapes provide valuable social, economic, and environmental resources; however, in many areas and for many complex reasons, they are at high risk of degradation. With increased development and unsustainable

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usage of natural resources, cultural landscape disturbances have arisen, indicating the urgent need for a proper and creative approach to managing them (Whitten et al. 1996; Hakim 2011; Nagaoka 2016).

Attention to cultural landscape conservation is growing rapidly; it is, therefore, important to identify and assess the value of these types of natural–cultural resources, especially in the context of tourism (Farina 2000; Agnoletti 2006; Aplin 2007). Involving cultural resources in tourism requires the comprehensive assessment of the physical, spiritual, and cultural value of the object; assessment of the cultural landscape cannot be performed from a single perspective (McKercher and Du Cros 2002; Agnoletti 2006).

Ecotourism provides an essential alternative to the empowering of local economic growth. Ecotourism promotes local community development and environmental conservation (Wood 2002; Beeton 2006). In Indonesia, a number of cultures and nature-based tourism destination have grown over the years, and many cultural landscapes have become famous tourism destination (Nagaoka 2016). Indonesian cultural landscape has a number of feature and characteristics that pose challenges to tourism planners as tourism attractions. There is numerous example of the use of cultural landscape in the tourism industry. In Indonesia, it includes Tana Toraja (South Sulawesi) (Crystal 1989), Borobudur (Central Java) (Nagaoka 2016), Tengger Highland (East Java) (Hakim 2011), and Ubud (Bali) (Picard 1995). Bali Island, one of the hot spot of cultural landscapes, is a successful international tourism destination. The value of cultural landscape, however, has been less received attentions. Little emphasis has been discussed on exploring and studying cultural landscapes in relation to tourism development. In many areas with the potential cultural landscape as a tourist attraction, people still largely rely on subsistence agriculture.

This study was conducted at Blambangan Biosphere Reserve, East Java Indonesia, with the main objectives of (1) describing the cultural landscapes within the biosphere reserve area and evaluating their importance for tourism development and (2) establishing and providing recommendations for cultural landscape management to achieve sustainable tourism. It is expected that this discussion will contribute to the sustainable development of the biosphere reserve.

2 The Cultural Landscape in East Java with Special Reference to the Blambangan Biosphere Reserve

2.1 Blambangan Biosphere Reserve

The Blambangan Biosphere Reserve (BBR) lies on the eastern part of Java Island and was officially listed as a biosphere reserve by UNESCO in 2016 to protect the biodiversity and cultural resources of East Java. The reserve was created to promote sustainable development and to encourage the use of sustainable resources to

Table 1 Zonation of Blambangan Biosphere Reserve

Reserve zoning	Terrestrial (ha)	Marine (ha)	Total (ha)	Notes
Core area	127,855.62	–	127,855.62	Encompasses Alas Purwo NP, Meru Betiri NP, Baluran NP, Ijen NR
Buffer zone	84,079.89	146,197.54	230,277.43	Plantation and state forest area
Transition area	320,814.34	–	320,814.34	Banyuwangi Regency
Total	532,453.85	146,197.54	778,647.39	

benefit local inhabitants. The reserve has an area of about 778,647.39 ha. The core zones of the reserve cover four conservation areas, namely Alas Purwo National Park, Meru Betiri National Park, Baluran National Park, and the Ijen Nature Reserve. The buffer zones mainly consist of protected forest under state-owned enterprises (PERHUTANI), state plantations (PTPN), and private plantations. The transition zone covers the entire Banyuwangi Regency (Table 1) (Indonesia MAB Program 2015).

Alas Purwo National Park, a lowland tropical forest in southeast BBR, is an area of high biodiversity. Alas Purwo forest was named as *Natuurmonumenten Poerwo en Djatie Ikan* in 1920 and declared by the Indonesian government as a national park in 1992 with a total area of 43,420 ha. The park is an important habitat for a number of endangered species, including *Bos javanicus*, *Cuon alpinus*, *Panthera pardus*, *Trachypithecus auratus*, *Manis javanica*, *Macaca fascicularis*, *Muntiacus muntjak*, *Melogale orientalis*, *Tupaia javanica,* and *Tragulus javanicus*. About 285 species of birds have been identified in the park. Culturally, Alas Purwo has spiritual significance to Javanese and Balinese Hindus; there are sacred sites within the park, including a sacred cave and a Hindu temple (Whitten et al. 1996; Alas Purwo National Park 2014).

Ijen Nature Reserve (2650 ha) in the northwest of the BBR system is a volcanic highland, with the Ijen crater as the main nature-based tourism attraction. The reserve was created in 1920 to preserve mountain biodiversity. The vegetation of the reserve consists of a lower to upper mountain tropical forest. The mountain rain forest of the reserve is home to 107 bird species, 21 of which are endemic to Indonesia and Java Island, including *Ptilinopus porphyreus*, *Halcyon cyanoventris*, *Pericrocotus miniatus*, *Rhipidura euryura*, *Pycnonotus bimaculatus*, *Nisaetus bartelsi,* and *Gallus various* (Whitten et al. 1996).

Baluran National Park, encompassing an area of 25,000 ha of semiarid forest, lies in the northern part of the BBR. The Baluran area was declared a nature reserve by the Dutch colonial government in 1937 and a national park in 1997. In the past, Baluran was known as “Africa van Java”, representing the richness and spectacular wildlife in the Baluran savanna ecosystem. About 234 species of birds have been identified in Baluran National Park; the principal species are *Bos javanicus*, *Bubalus* sp., *Sus scrofa*, *Panthera pardus*, *Trachypithecus auratus*, *Macaca fascicularis,* and *Rusa timorensis*. Baluran National Park is home to 158 butterflies (Whitten et al. 1996; Baluran National Park 2014).

Meru Betiri National Park, established in 1997, is a famous wildlife habitat. The park covers an area of about 58,000 ha of lowland and moist deciduous forest. The principal wildlife species are *Bos javanicus*, *Prionailurus bengalensis*, *Prionailurus viverrinus*, *Manis javanica*, *Tragulus javanicus*, *Trachypithecus auratus*, *Macaca fascicularis,* and *Muntiacus muntjak*. About 166 birds have been identified in Meru Betiri forest. Sukamade beach, in the southern part of the park, is major landing and nesting beach for protected sea turtles such as *Chelonia mydas* (endangered), *Dermochelys coriacea* (vulnerable), *Eretmochelys imbricata* (critically endangered), and *Lepidochelys olivacea* (vulnerable). The endemic plant species includes *Gigantochloa manggong* and *Bambusa cornuta*. Within the park, illegal logging is carried out and is most intensive in its western part (Whitten et al. 1996; Meru Betiri National Park 2014).

In the past, the area of Banyuwangi was known as Blambangan. Banyuwangi Regency has a land area of 5,782.50 km^2. Administratively, this regency consists of 24 districts (*kecamatan*), namely Pesanggaran, Siliragung, Bangorejo, Purwoharjo, Tegaldlimo, Muncar, Cluring, Gambiran, Tegalsari, Glenmore, Kalibaru, Genteng, Srono, Rogojampi, Kabat, Singojuruh, Sempu, Songgon, Glagah, Licin, Banyuwangi, Giri, Kalipuro, and Wongsorejo. The topography of the west to the southwest is mostly hilly with altitude ranging from 600 to 3,282 m asl in Mt. Raung. The south to southeast and eastern area is dominated by flat area. The length of the coastal area is 175.8 km. The monthly rainfall and a temperature range are between 24.8–195.5 mm and 26–29 °C. Humidity is ranging from 78 to 85%. A major part of the regency is covered by forest area (180,937.78 ha) (Banyuwangi Regency 2015).

The human population in Banyuwangi Regency has increased from 1,531,026 in 2003 to 1,627,130 in 2013. Human population density is 265 inhabitants/km^2 in 2003 and increases about 271 inhabitants/km^2 in 2013. Most of the population lives in the village. Local community inhabiting the Banyuwangi Regency area belongs to four ethnic groups: Javanese, Balinese, Madurese, and Osingnese. The indigenous community of Banyuwangi area, the Osingnese, lives in the urban and rural area of the regency's western side. Javanese mostly inhabited in the urban and rural area in the southern area. A small number of Balinese inhabited in the southeast area of regency, in which geographically it is close to Bali Islands, the home of Hindus community. In the northern area, Madurese is the dominant group. The main agricultural products were rice, vegetables, and fruit (Banyuwangi Regency 2015).

In the perspectives of BBR management plan, Banyuwangi Regency contributes significantly to biosphere reserve objective, especially as a model of local sustainable development. The abundance fertile lands in this region make it an important agricultural area for production of numerous crops, plantation, and forest product. Recently, Banyuwangi has been identified as one of the new attractive tourism destination. Banyuwangi Regency provides a variety of culture and nature-based tourism attractions and tourism growing faster than another sector in the regency. The development of tourism provides opportunities to meet the objectives of biosphere (Banyuwangi Regency 2015; Indonesia MAB Program 2015).

2.2 Cultural Landscapes in the Blambangan Biosphere Reserve

Over the years, indigenous populations in East Java have developed a wide variety of approaches and techniques for managing lands and natural resources. There are three important cultural landscapes in the BBR which are sites for potential development as tourism attractions, namely paddy terraces, agroforestry farming systems, and local settlements.

2.2.1 Paddy Terraces

Many paddy terrace ecosystems have been designated as UNESCO World Heritage sites, including the Jatiluwih and Tegalalang rice terraces (Bali), the Honghe Hani rice terraces (China), and the Ifugao and Banaue rice terraces (the Philippines). A paddy terrace is representative of harmonious living cultures; one of its key features is that it demonstrates sustainable land use by local people living in sloping lands. The terrace system contributes to landslide prevention, and there are sophisticated water management systems that have been developed by the local community to enhance crop productivity (Jiao and Li 2011; Chen et al. 2012; Roth 2014; Qiu et al. 2014).

In Banyuwangi, rice is a culturally important crop that is cultivated in paddy fields. The paddy field area is about 66,152 ha or 11.44% of the total area of Banyuwangi territory (Banyuwangi Regency 2015). Following the topography, paddy fields can be classified into flat and terraced fields. Most of the flat paddy fields are located in the southern part of the regency. In the hilly and mountainous area in the west of Banyuwangi, paddy terraces were established to adapt the sloping land topography. Recently, paddy terraces are geographically concentrated in the Kalibaru, Glenmore, Songgon, Giri, Licin, and Glagah districts.

Most of the paddy terraces are situated in the mountainous area. Physical characteristics of lands, climate, and water availability are important in determining paddy terrace existence. Water springs are abundance in the west area and have been channeled into traditional canals to irrigate the rice terrace. With the aid of proper irrigation, paddy field can produce 6 ton/ha each year (Banyuwangi Regency 2015). Among Osingnese, rice and crop rotation have long been used as a strategy to increase food security. The general combination pattern of plant species that illustrate the rotation includes rice—legumes, corn or rice—other crops species.

Cultivation of rice was followed by a leguminous crop able to improve the fertility of soil (Watson et al. 2002).

In BBR, there are threats to the future of paddy terrace sustainability. First, many paddy terraces are being altered because of rapid land use change. The increase of population in the rural area has led to a decrease of paddy field area and an increase of settlement area. Second, the paddy terrace recently threatened intensive chemical fertilizer and pesticides which decrease soil fertility and rice grain productivity. Scholar points out that massive chemical fertilizer and pesticides application have a major impact on soil biodiversity. Intensive rice cultivation is a universal problem and able to damage soil quality (Giller et al. 1997; Gomiero et al. 2011). Third, there is a potential problem caused by *Albizia chinensis* (sengon wood) introduction in paddy terrace system. The introduced sengon tree may also damage the irrigation system. Sengon is fast-growing woody trees species and, as many fast-growing tree species, it has been recognized to affect groundwater, changes in nutrient cycling, and changes in ecosystem biodiversity. Sengon is now a major wood sourced timber and is an important source of medium-term income for many farmers in Banyuwangi. Recently, sengon plantation is wide spreading on paddy terrace. There are, however, potential ecological costs from the establishment of sengon plantation (Otsamo 2002). Fourth, the young generation is no longer interested and involved in farming, especially young generation with a high education level. Farming is strenuous and does not provide high income. Therefore, many young people leave the villages and seek employment in other. There is a trend that young generation seeks other sources of income in urbanized area. The decrease of farmer potentially leads to the change in the social and economic condition in many rural areas in Banyuwangi. Fifth, recent phenomena of climate changes influence the crop yield and productivity, plant phenology, and potentially spread pest and pathogens. These factors contribute to the future sustainability of paddy terrace are a loss of traditional and cultural value, especially in the farming system.

The preservation and maintenance of paddy terraces are important for future tourism development. In such a case, promoting traditional ecological knowledge becomes one of the important aspects of paddy terrace conservation. This knowledge links ecological and sociocultural aspect and provides a value for paddy terrace as a sustainable land management system. It is also important to enhance the authenticity of landscapes as a tourism attraction (Fig. 1).

2.2.2 Agroforestry Farming System

An agroforestry garden is a form of cultural landscape that represents the "combined works of nature and man" (Article I, Operational Guidelines for the Implementation of the World Heritage Convention—ICOMOS 2007). Agroforestry is often considered to be a form of sustainable farming (Jose 2009); its contribution to biodiversity conservation and the provision of sustainable economic income to rural dwellers distinguishes it from other farming systems. In Banyuwangi, the link

Fig. 1 Paddy terrace landscape of Banyuwangi

between local people, culture, tradition, and biophysical characteristics is explicit in the agroforestry garden of Osingnese.

In Banyuwangi, the agroforestry system is practiced more extensively in dry land, or land with little water irrigation input. Dry land farming now covers 230,094.78 ha, and coffee is the main commodity. There are two important cultivated coffee species, namely *Coffea canephora* (robusta coffee) and *Coffea liberica* var. dewevrei (excelsa coffee), both grown under the shade of trees which have economic value. The most common tree species used for shade in agroforestry gardens are *Swietenia mahagoni*, *Garcinia mangostana*, *Durio zibethinus*, *Cocos nucifera,* and various bamboo species. Tree spices include *Myristica fragrans*, *Cinnamomum burmanni*, and *Syzygium aromaticum*. The agroforestry system can be considered as a complex biosystem. Incorporating woody tree species and coffee into an agroforestry farming system has the potential to increase the economic value and profitability of local gardens. Recent centers of coffee plantations within an agroforestry system include the Glenmore, Kalibaru, Sempu, Songgon, Glagah, Licin, Giri, and Kalipuro districts.

In agroforestry farming system, there is an intimate connection between farmer household's tradition, economic perception, culture, and local belief. Local culture often prescribes rituals and ceremony that require the use of specific plans, including *Musa paradisiaca*, *Cocos nucifera*, *Magnolia champaca*, and *Cananga odorata*. Local belief involves the decision of planting tree species. In such a case, the moment of planting differs per species, per crop, and per month. Some plant has been viewed medically important and has special meaning, including *Alpinia galanga*, *Sauropus androgynus,* and *Morinda citrifolia*. Planting numerous trees has been viewed as a good practice. These aspects contribute to the variety of agroforestry models.

In Banyuwangi, factors threat to agroforestry farming system has been identified numerous. As the number of population in rural area increases, the need for space and wood for house contractions increases. Recently, intensive contact with the outside and increase of consumerism among the young generation in villages have transformed agroforestry techniques into monoculture plantation. The decrease and disappearance of agroforestry are caused by the erosion of local farming culture appreciation and disappearance of the associated culture. It is shown by the rapid increase of sengon plantation area. An important of climate changes in the agroforestry farming system is likely to be changed in coffee and fruit productivity. The long drought in 2015 led some mangosteen trees died, while the long rainy season in 2016 lead durians and mangosteen fail to produce flower and fruit.

The cost of reducing the agroforestry farming system will vary considerably; the impact could include ecological, economic, and sociocultural aspects. A decrease in agroforestry could alter the microclimates of the Banyuwangi Regency and potentially affect the sustainability of the paddy fields. The key to the design of sustainable agroforestry farming systems is maintaining biodiversity. Scholars point out that enhancing the diversity of plant species is one of the crucial strategies for protecting a sustainable agroforestry system. The introduction of new species into the agroecosystem may allow, but consideration should be implemented comprehensively (Schroth 2004; McNeely and Schroth 2006).

2.2.3 Settlements and Home Gardens

The Osingnese, traditionally farmers, are considered to be indigenous inhabitants of the Banyuwangi area. One of their additional sources of employment is laboring in coffee plantations. There are also a small number of Osingnese sulfur miners in the Ijen crater. Local settlements with traditional houses lie around the village of Osingnese in the slope of Mt. Ijen; most settlements are concentrated along the main road and rural roads. Local settlements in the villages' area are scattered and are often surrounded by home gardens. In many settlement areas, houses built using the traditional architectural style and materials are easily found. There are three architectural types of Osingnese house: *crocokan*, *tikel,* or *baresan*, *tikel balung,* and *serangan*. These traditional architecture buildings provide unique cultural landscapes for tourists.

Home gardens are a component of the traditional settlement system. Home gardens plant species hold economic, ornamental, medical value and culturally significant for the local community. The staple food cultivated in home garden area is yams, cassava, and banana. Home garden trees are mostly fruit trees (*Nephelium lappaceum*, *Lansium domesticum*, *Persea Americana*, *Annona muricata*, and *Chrysophyllum cainito*). Ornamental plant species includes *Bougainvillea spectabilis*, *Duranta repens*, *Codiaeum variegatum*, and *Cordyline fruticosa*.

Ecologically, abundant and diverse plant species in a home garden ecosystem has a beneficial effect on runoff, infiltration and reduced erosion rate.

Associated with the preservation of local settlement and home gardens is the issue of modernization. The use of block stone, ceramics, and metal fences is an indication of local house modernization in Osingnese settlements. Changes in house architecture are strongly influenced by people's access to various information regarding modern building design and technology.

3 Recent Tourism Development

3.1 National Policy in Tourism

Governments of Indonesia recognize the power of tourism to generate both local and national economic growth. According to statistical data, annual international tourist arrival increased from 9.4 million in 2014 to 10.4 million in 2015. In 2015, the tourism sector generated Rp. 461.36 trillion, contributing to 4.23% of GDP. Tourism is estimated to employ 12.16 million people. Tourism also contributes to nature conservation and community development. According to the National Tourism Master Plan, the number of international tourists in 2019 is expected to reach 20 million. Recently, ten sites beyond Bali Island—the most famous tourism destination in the world—have been developed intensively, including Toba Lake (North Sumatra), Tanjung Lesung (Banten), Tanjung Kelayang (Bangka-Belitung), Borobudur Temple (Central Java), Kepulauan Seribu (Jakarta), Bromo Tengger Semeru (East Java), Mandalika (Lombok), Komodo-Labuan Bajo (East Nusa Tenggara), Wakatobi Island, and Morotai Island. Nature-based tourism is expected to contribute 19% and cultural tourism 7% to the total national tourism growth. By 2019, these areas are expected to be the most popular destinations (Ratman 2016).

The interest to tourism sector has been implemented in National Tourism Development Plan. Recent tourism policy focuses the development and promotion of nature-based tourism and cultural tourism. The challenges of such tourism development are often greater for an area with natural and cultural richness. It is also relevant to the recent tourist demand. Many tourists are interested in the natural object and cultural heritage. Recent tourist is also interested in interacting with the local community (Theobald 2005; Balmford et al. 2009).

3.2 Tourism Development in Banyuwangi Regency

Intensive and systematic tourism planning and development in Banyuwangi began in early 2011. The richness of its cultural–natural resources and geographic position influenced the decision to develop Banyuwangi as a tourism destination.

Banyuwangi's spectacular beach and coastal scenery, diverse flora, underwater life, the wildlife in its national park, mountain area, plantation and rural areas, and its traditional culture are important attractions for tourists. The Ijen crater and blue fire phenomena in Mt. Ijen are also important tourist destinations. In 2016, the number of visitors to Banyuwangi was calculated at about 3 million, with 75,000 international tourists.

In Banyuwangi, both the local government and the community are aware of tourism development. Local government encourages tourism because it creates jobs, generates numerous economic activities, and is able to support environmental conservation. Local communities in some areas in Banyuwangi are well aware of the possibilities of the tourism sector in providing new earning opportunities. Direct benefits to the local community will result from the demand for accommodation, transportation, and qualified guides. Within the villages are numerous potential places for tourism activities, including traditional settlements, home gardens, paddy fields, rivers, waterfalls, and plantations.

The rural area in Banyuwangi is blessed with an abundance of biodiversity and natural resources. The local government of Banyuwangi promotes rural tourism at Osingnese village in Kemiren and the villages surrounding the conservation area (i.e. Rajegwesi). In the Kemiren villages, cultural and natural resources are important elements of the tourism product. Tourists in Kemiren experience local culture and traditions, culinary and village life. Osingnese living in these villages still continue their traditional lifestyle and practice and numerous local wisdom (Indiarti and Munir 2016).

Osingnese in Kemiren Village are actively involved in tourism activity (Indiarti and Munir 2016). In 2000–2015, a series of the program took place in the local government, local community, and organization. The result of this program was the creation of rural tourism and community development. Technical and funds support was increased, and many tourism facilities in a rural area were created. Recently, a number of villages experienced an increase in visitor arrivals, and villages become popular destinations. The government of Banyuwangi has established document for tourism development, but there are few guidelines for tourism resources management. Policy on the state of the cultural landscape resources preservation and management is not available. Globally, recent tourism policy stressing the sustainability practices is an important pillar in tourism development. Sustainable tourism is based on the aspect that maintains economic growth; conserving environment and biodiversity and enhancing the social aspect of local people are both essential and should be integrated into planning and development (Hardy et al. 2002; Buckley 2012).

This implies that the tourism development in Banyuwangi should be developed at the integrative pillars of natural richness, cultural uniqueness, and local economic development. This issue is especially critical in Banyuwangi.

4 Cultural Landscape and Sustainable Tourism in Blambangan Biosphere Reserve

4.1 Trends in Ecotourism

Tourism attractions in the BBR include the biodiversity of the national parks, the Ijen crater, and the Osingnese culture. In the Alas Purwo National Park, the number of visiting tourists grew from 53,135 in 2010 to 121,818 in 2013. In 2015, the Meru Betiri National Park received 57,940 domestic tourists and 2152 international tourists. The main tourist attractions in Meru Betiri are Rajegwesi beach, Green Bay, and Sukamade beach. Visitor numbers at the Ijen crater increased from 16,428 in 2011 to 25,894 in 2013, and to over 35,390 in 2014. The wildlife in Baluran attracted more than 58,000 visitors in 2014. Wildlife tourism is very popular and forms a significant part of nature-based tourism in Baluran, Alas Purwo, and the Meru Betiri National Park. Recent tourist generations are willing to pay high prices to view the luxurious tropical forest, flora-fauna, and coral reefs. There is also interest in exploring the cultural diversity of the indigenous people and visiting cultural landscapes.

Globally, there has been increasing tourist interest in the use of local settlements and their cultural attributes (Ringer 2013); opportunities have arisen for many villages in Banyuwangi to develop their cultural landscape assets to become tourist attractions. Cultural landscapes, such as paddy terraces and agroforestry, create impressive landscapes and provide spectacular man-made ecosystems that are able to attract tourist interest. The potential tourist activity in cultural landscape sites includes seeing natural environments of the rural landscape that are distinct from urban environments, encountering cultural landscapes and biodiversity, enjoying rural agriculture, meeting friends to appreciate the beauty of the cultural landscape, learning about rural life, photography, interacting with farmers, and bird watching. Consequently, issues related to enhancing the quality of resources become crucial for planners and decision makers in the highly competitive situation of generating income through tourism. Promoting biodiversity conservation in cultural landscape is vital (Strang 1997; Farina 2000; Hakim 2011).

Cultural landscapes appear to be attractive tourism resources for three reasons. First, the unique vegetation structure and composition could play as an interesting object in the development of high-quality tourism product. Second, the outstanding physical feature could provide uniqueness of landscape. The terracing technique applied on the steeper slope is visually spectacular tourism object. Third, especially from a tourism product perspective, is the existence of cultural attributes which is generally required for the culture-based visitor attraction development. The potential cultural attraction includes traditional lifestyle, local customs, festival, and art.

4.2 Resources Management

In the BBR area, tourism in cultural landscapes sites is growing, but the scientific bio-cultural resources of most cultural landscape sites are poorly managed. Managing these assets is perhaps relevant to the overall objectives of managing biosphere reserves. While Banyuwangi Regency offers a number of beautiful cultural landscapes, the landscape management fails to realize and transform its value into a tourism attraction. Scholars point out that managing cultural landscape is a complex activity; this complexity is a function of both cultural and natural aspects (Aplin 2007; Plieninger and Bieling 2012). To improve the attractiveness of a cultural landscape, it is crucial to have a conservation and rural tourism management plan. The challenge lies in managing, promoting, and evaluating systematically the successful integration of the cultural landscape with sustainable tourism.

The future prospects for tourism in Banyuwangi's cultural landscape sites are enormous, but the industry is facing problems of environmental management. The management of visitors in cultural landscape sites requires supporting technical tools; however, there are no technical tools documents available. Tourism activity in a cultural landscape site is risky; large numbers of tourists could create cultural-environmental degradation and loss of biodiversity. The success of tourism in these sites will, therefore, depend on whether the authorities are able to manage tourist visits. This requires careful integration of strategies concerning cultural, environmental, and natural resources conservation, and visitor management (Swarbrooke and Page 2012). Techniques designed to minimize visitor impact include limiting group sizes and length of stay and promoting visitors' codes of conduct. Cultural landscapes are especially at risk when they are visited and exploited intensively. In such a case, applying carrying capacity becomes the significant tools (McKercher and Du Cros 2002).

Mapping cultural landscape distribution is important; these maps provide basic information for management and conservation, especially in a spatial context. Land use change is probably the vital determinant of cultural landscape disturbance and needs to be examined within a spatial context in the effort to protect and sustain landscape existence. Mapping can contribute to the database from which their carrying capacities as attractions can be formulated. In the spatial context, the paddy terrace distribution pattern is mostly related to factors such as topography and water availability, as well as culture, which is part of the cultural landscape construction. In Banyuwangi, areas that are dominated by paddy terraces, mostly found in the western part of the Regency, may be the most appropriate area for further cultural landscape-based tourism development.

In the perspective of sustainable and competitive destination, attraction is the core of the tourism success. Sources of attraction may include plants, animals, and landscapes (Swarbrooke and Page 2012). Identifying and understanding the biological and ecological setting of resources are important. The important data include species diversity, population structure, population interaction, species interaction, community dynamic, ecosystem process, and behavioral ecology. As far as the use of such data and information in attrition management was absent, the attractiveness of cultural landscapes object, however, is subjective. People have numerous perceptions about attractiveness. In such case, research regarding human perspectives in scenic beauty is, therefore, crucial.

The evaluation of resources is crucial. The use of paddy terrace and agroforestry garden for tourism purposes must be critically assessed and evaluated because of its negative impact on the cultural landscape. Tourism activity can cause a negative impact on the biophysical environment through an increase in vandalism, litter, and pollution. In a social context, tourism activity contributes sociocultural changes in the local community. Globally, the effect of tourism in local cultural changes has been well documented (Picard 1995; McKercher and Du Cros 2002; Ringer 2013).

Cultural landscape management and integration into tourism are relying on the capability of farmer managing soil biodiversity. Scholars note that farmer's knowledge and understanding of vegetation, soil, and soil-related process in traditional agroecosystem contributes significantly to agroecosystem health and is able to reduce soil erosions. In the recent increase of tourism activity in cultural landscape sites, knowledge on bio-cultural resources management becomes important.

4.3 Tourism Product Development

From the perspective of tourism product development, the bio-cultural attributes of cultural landscapes that can be appreciated include their uniqueness and naturalness (O'Hare 1997; Ringer 2013; Kikuchi et al. 2014). Seeing the uniqueness of a cultural landscape is an authentic experience. Biophysically, the uniqueness of the paddy terraces in Banyuwangi is affected by land contour, soil character, water supply, site elevation, crops, and vegetation. Rotational cropping systems in terraced lands, one of the unique features of a paddy terrace ecosystem, are often associated with social, economic, and cultural aspects. Their naturalness depends primarily on the abundance of green areas and few numbers of modern man-made buildings.

From the perspective of the tourism market, the unique and outstanding cultural landscape is not an attraction unless its potential value is transformed into a product that can be consumed by tourists. Tourism products in cultural landscape sites are numerous, ranging from farm trips to local culinary products. Recreational activity in cultural landscape sites is especially close to the attractions, in which it is the core and magnet of the destination. The spectrum of farm tours in agroforestry gardens can be numerous, including garden trekking and bird watching. In Tlemung (Kalipuro District), some households sell family produce and offer kopi luwak, or civet coffee, to foreign visitors, providing an additional source of household income.

Creating tourism product in cultural landscape sites is difficult unless the scientific information regarding object available. Scientific approach supports tourism manager to define the tourism product. It includes numerous scientific issues. The most important issues are following:

- Farmer knowledge, perception, and sustainable live principles. Understanding how farmers use natural resources sustainably is essential to determine the story behind the cultural landscape.
- Biodiversity richness, understanding biodiversity, and vegetation seasonality in cultural landscape tourism object area will facilitate diverse tourism product development such as fruit harvesting time, festival, and culinary based on specific plant. It is also important to promote mapping and exploring biodiversity and providing comprehensible explanations for tourists.
- Investigating and compiling data on lands physical characters, indigenous fruits and vegetables, outlining differences and providing comprehensible explanations. This could become a basis for better observation by tourists, valuing nature and appreciation of harvest experience, and enjoying local food.

Ensuring a healthy agroecosystem is also an essential factor for tourism program development. Osingnese agroforestry system presents variation in plant species, plant community arrangement and structure, and canopy structure. Agroforestry system provides habitat for a wide range of species (McNeely and Schroth 2006). Numerous tropical fruit trees species offer many opportunities for the sustainable use of agroforestry gardens, especially through agrotourism development. Designing for tourism product in agroforestry farming system sites may require an understanding of the diversity, characters, and phenology of plant species. According to scholars, the improvement of human resources to handle tourism program planning must be accompanied by local people education. This can be achieved through the increasing capacity of a local planner, community, and tourist guide (Weiermair 2004; Walder et al. 2006).

The tourism destination manager should have a clear and comprehensive understanding of the products of cultural landscapes (Walder et al. 2006; Ringer 2013). Regarding cultural landscape preservation, tourism products not only must be created to secure the visitors but should also be established to provide visitor experiences and knowledge. This is especially important because tourism managers often focus their attention on income and visitor satisfaction, but are rarely concerned with the educational aspects of tourism in cultural landscape sites. The future challenge lies not only in increasing tourist visits to cultural landscapes sites but also in offering interpretations and delivering scientific and preservation messages to the visitors. Simply, destination managers should develop a comprehensive understanding of what cultural landscapes are and how they work.

The form and value of cultural landscapes should be considered when establishing attractiveness in tourism products. Each cultural landscape has tangible and intangible value. Scholars point out that a cultural landscape is more than a physical object; it also represents the symbiosis between human culture and natural resources management (O'Hare 1997; Strang 1997; Farina 2000; Agnoletti 2006; Nagaoka

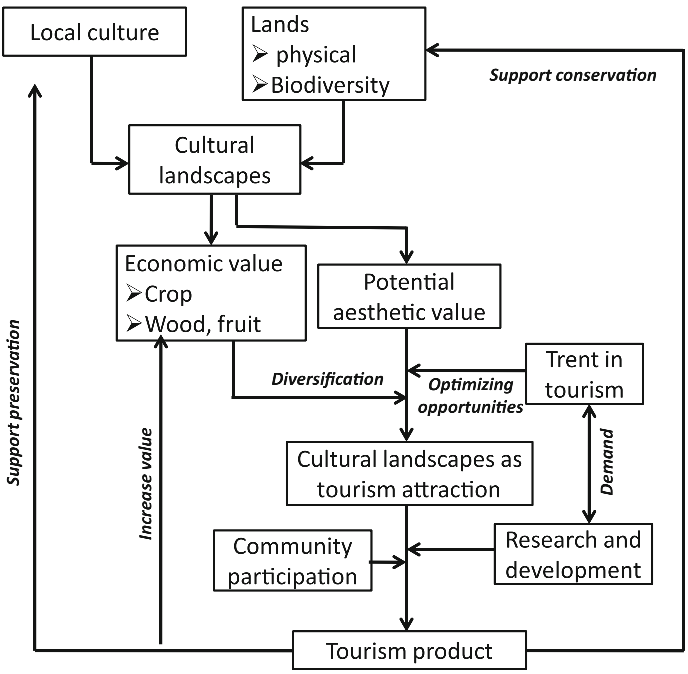

Fig. 2 Framework for cultural landscape management

2016). From the perspective of tourism product development, we propose that cultural landscape resources in the BBR can be managed and integrated into tourism, as shown in Fig. 2.

4.4 The Role of Community

Management philosophies should involve and incorporate the community, encouraging their involvement and participation in biodiversity conservation, cultural preservation, and sustainable economic opportunities (Moscardo 2008). Numerous reports state that the preservation of cultural landscapes depends on the support of the local community; when local people receive positive benefits from cultural landscapes, they will support the preservation programs. Some researchers point out that the benefits are not merely economic, but also sociocultural and environmental (Shadreck and Gilbert 2008; Stenseke 2009).

Working with local people is a crucial part of tourism development, especially in cultural landscape sites. In the effort to preserve these sites and promote sustainable tourism, the significant role of the local community includes the following: (1) maintaining the local cultural tradition in land management, (2) keeping and preserving certain aspects of the norms, values, and cultural identity, (3) providing and sharing local knowledge to support programs and actions, and (4) monitoring and evaluating program implementation. Effective management of cultural landscapes as tourism attractions in the future will, therefore, depend on the degree of community involvement and participation (Moscardo 2008). Managing cultural landscapes for the tourism industry requires an understanding of the interaction between human, culture, tradition, and environment. Part of the approach involves a fundamental recognition and appreciation of local human rights; this is crucial because every relationship between humans, nature, and culture is unique.

Community empowerment is a further agenda of development, and it is especially critical for the local community within cultural landscapes area in Banyuwangi regency. Local community education is the starting point for involving community into planning, monitoring, and evaluating tourism activity in cultural landscapes. In the perspectives of destination and attraction management, education becomes especially important in times of high competition. Economic and income generating issues of local people must be considered when designing cultural landscape as tourism attractions.

5 Conclusions

The Blambangan Biosphere Reserve contains many forms of cultural landscapes, comprising paddy terraces, agroforestry gardens, and local settlements. Cultural landscapes and tourism in this area can coexist when the principles of tourism destination management are implemented. Although cultural landscapes are recognized as important elements in tourism destinations, not all of their assets have been considered in tourism planning. Their use in tourism must be critically considered because of the possible negative impacts. In Banyuwangi, a lack of methodology and technical aspects to protect cultural landscapes has resulted in rapid losses in the paddy field and agroforestry systems. These contribute to the future tourism development. A key to devising and maintaining successful tourism programs in cultural landscape areas is the development of management plans. Tourism product design requires a comprehensive understanding of the farmers, biodiversity structure and extent, and physical characteristics of the cultural landscapes.

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Part IV
Remarks

Chapter 22
Bridge and Islandscape: Questions for Sustainability and Resilience of Island Societies in Korea and Japan

Sun-Kee Hong

Abstract Recently, as the urbanization index of the Korean islands has increased due to the construction of the bridge, it has become a different situation from the island environment. These situations are very diverse, including but not limited to the frequent occurrences of the livestock, and human life accidents due to the increase of the motor vehicles, the increase of the thefts of agricultural and fisheries products, environmental damages (including the landscape damages) due to the development of the lodges, the increase of side effects due to the attraction of the tourists who exceed the environmental accommodation capability of the island (the insufficiency of water and the increase of the wastes and contaminating substances), the inflow of the exotic plans by the motor vehicles, etc. The thing that is more important than anything else is that the human relationships between the island residents have been breaking and the community consciousness has been disappearing. Also, with the exchanges getting more frequent between the people living on the land and tourists, the cultural homogeneity of the island and the land and the uniformity of the island culture have been proceeded with. Although it can be said that the land-connecting bridge project is a long-cherished desired project of the island residents, the political background cannot be ignored as well, including the creation of the profits through the virtuous mind policies of the local government and the large-scale civil engineering projects and others of similar nature.

1 Introduction

Korea is an island country which possesses 3,358 islands. According to the Ministry of Land, Transport, and Maritime Affairs in 2010, there were 2,876 unmanned islands, which captured 85.65% of all the islands. Excluding the five big

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islands, which include Jeju-do, Geoje-do, Jin-do, Wan-do, and Namhae-do, most of the island areas of Korea are very small. Jeollanam-do makes up 62% of the islands of Korea. Shinan-gun is the only administrative district of Korea that is organized with the islands, possessing approximately 1,000 islands. In the recent decade on the islands of Shinan-gun, there have been very big changes (Park 2016). Through the bridges projects, connect the inlands and the islands (Fig. 1). The connections that link the islands, such as between an island and an island, between an island and an inland area, are through the projects of the bridges that connect the land and the island (Kim and Hong 2007). The reason the government has given for these projects has been in an effort to solve the inconveniences of the residents and the development of the tourism resources and similar issues (Hong 2008).

The central government as well as Jeollanam-do has been betting vigorously on the projects as if it is a matter of life or death. The bridges that connect the land and the islands, and the projects that connect the islands to each other which connect the islands of this region are all the focus of these projects. In the Jeollanam-do region, plans are scheduled to construct 103 land-connecting bridges and island-connecting bridges by investing 12.1451 trillion won from the present until the year 2020. Among these, as of March 2014, 44 projects have been completed, and 25 are under progress (Fig. 2). The land-connecting bridges are lifelong, cherished wishes of the island residents as well. It is the desire and initiation of the island residents and the regional administration for these projects, articulating that the land-connecting bridges are needed for solving the transportation challenges of the residents, from expanding the market of the agricultural and fisheries products that are produced on the islands, as well as for attracting the tourists to support and sustain economies. Although the land-connecting bridges and the island-connecting bridges have already been installed in many island areas and have been showing positive effects regarding the attraction, transportation, and facilitation of the tourists and residents, the reality is that there have been negative influences appearing slowly as well (Hong and Kim 2011). Because of the construction of the land-connecting bridges, more tourists have been traveling to the islands, and thus, the incomes of the residents have been increasing, and negatives such as increased traveler numbers have been slowly decreasing the more time passes. Ever since the biggest attraction, or, in other words, the isolation, that plagued the islands was resolved with the land-connecting bridges.

The value evaluations surrounding the mysteriousness and the rarity have been getting worse. In the case in which a visit was made by ship, enduring the inconvenience of the transportation, the difficulties regarding lodging and boarding gave tourists challenges in regard to visiting and staying on the island. However, despite the inconvenient conditions, the top attractiveness of being able to make the trip was a memorable experience. In the case of Jeungdo in Shinan-gun though, previously, there had been plenty of time for activities such as eating the small octopus caught at a mid-flat nearby while waiting for the ship on a pier of Saok-do, which made the experience more holistic. Ever since the bridge connection, the trip has become a light trip island travel which everything became easily traveled through a one-day visit.

Fig. 1 New Millennium Bridge. Constructing one of biggest island-connecting bridge connecting Amtaedo Island and Aphaedo Island, Shinan-gun, Korea. Aphaedo Island already connected to Mokpo City

The problem is that if such a land-connecting bridge gets installed, the budget that has been currently supported by the Ministry of Security and Public Administration (MOSPA) will be severed within 10 years, according to the Island Development Promotion Act (Kim 2013). According to the Island Development Promotion Act, an ‘island’ means an area of which the 4 sides are surrounded by the sea when there is full tide.[1] As an island that is connected to the land by a breakwater or a bridge, an island that has passed 10 years is not seen as ‘The islands of the sea’ according to the regulation in Article 2 (the range of the islands). Because of this, the residents do not know well that it can become a situation which is very unsuitable to the criteria for being a ‘designated island’ for which the budgetary support by the central government is possible. Because many of the land-connecting bridges and island-connecting bridges of Jeollanam-do, which has the archipelago, have been already started being constructed and construction has been scheduled in the future, the diverse problems will take place in the future in many ways that cannot be predicted and anticipated in advance (Kim 2016).

[1]Article 2. The scope of an island. (1) In Article 2 of The Island Development Promotion Act (hereafter, to be called ‘the law’), ‘The Island of the sea’ refers to the area of which the 4 sides are surrounded by the sea at full tide. <Amended on December 27, 1997 and on November 17, 2008>.

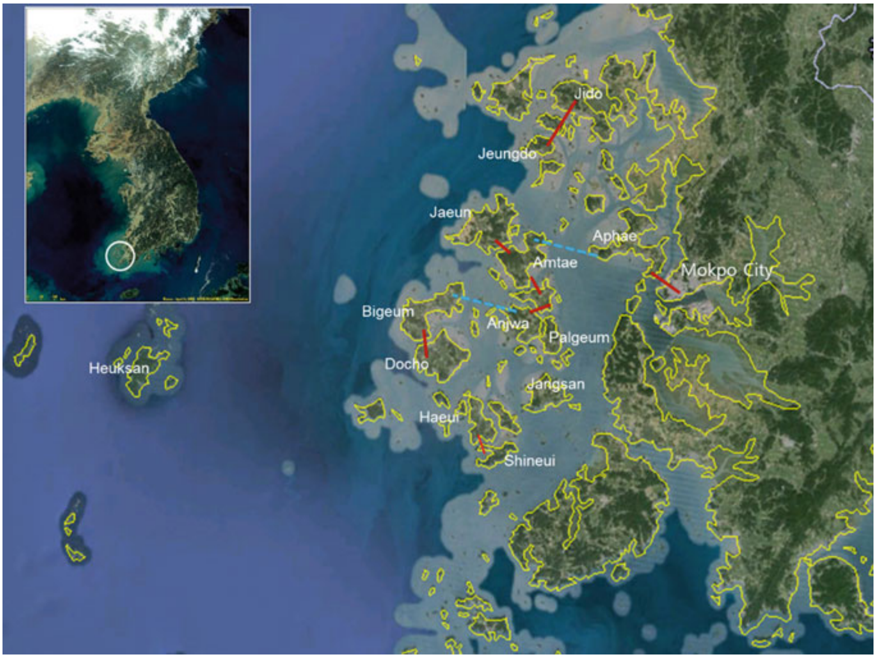

Fig. 2 Bridges connecting island and cities in Shina-gun, Jeollanamdo Province, Korea. Bridges connecting Jido and Jeungdo, bridges connecting Jaeun-Amtae-Anjwa-Palgeum, bridge connecting Bigeum and Docho, and bridge connecting Haeui and Shineui were completed. New Millennium Bridge connecting Aphae and Amtae are under constructing by 2018. Moreover, Bridge connecting Anjwa and Bigeum is planning in future

I believe that, if we closely examine the situations of the island regions both before and after the constructions of the land-connecting bridges and the island-connecting bridges on the main islands in Japan, which have already been built forty years ago, then perhaps these structures can be utilized as information providing the data and the materials by those professionals who detailed the realistic information of the negative aspects for the development of the connecting bridge over the archipelago in Jeollanam-do. It is intended that this data and material will be understood and organized by centering focus on the contents that were jointly planned and covered by the KBS Gwangju Headquarters and the Institution for Marine and Island Cultures, Mokpo National University. While comparing the before and the after construction of a land-connecting bridge in the island region of the Seto Inland Sea of Japan and, in order to confirm its influences on the islands, I visited several islands within the Seto Inland Sea and conducted interviews with the residents. I also discussed, in depth, the details regarding the land-connecting bridge with the experts from the Hiroshima University, the experts from The Center for Research and Promotion of Japanese Center, etc.

2 The Present Situation of the Islands of Japan

Japan, which is an island country, is organized with 6,852 islands. Here, if the four islands, including Hokkaido, Honshu, Shikoku and Kyushu, that are included in the mainland, are excluded, the total number of islands becomes 6,847 islands. Among these, there are 418 manned islands and 6,429 unmanned islands (Kim 2013). According to an international investigation by the Japanese Ministry of Internal Affairs and Communications, when taking a look at the trends of the population of Japan from 1955 until 2010, it appeared that, compared to the fact that the population of the country had increased by 40%, the population of the island regions had decreased by 50%. In other words, the rate of the decrease of the population of the island regions was very high compared to the other regions. Also, between 2002 and 2006, the moving population of the islands had decreased by 11%. The situation that is even more surprising is that 40% of all the inhabited islands did not have any doctor and that there were merely 10 islands that had obstetrics. The actual circumstance is that, on 185 islands, which is 70%, there are no health centers. In such a poor environment of the island regions, the educational facilities cannot be established or maintained. As a result, the closing down of the schools has been continuously occurring. Perhaps, we are seeing one aspect of Japan which has already become urbanized. However, the overall situation of the Japanese islands does not have a big difference when compared with that of Korea. In order to overcome such a situation, the Japanese government enacted the Ritou (a term 'Ritou' means 'isolated island' in Japanese) Promotion Act for the promotion of the islands nationwide in 1953. As a law for improving the many kinds of handicaps possessed by the islands, this law can be said to be a basic law that sorts out the islands of which the lives and the industrial bases are weak, selects the Ritou promotion countermeasure implementation regions, and not only maintains the social overhead capital facilities, including the electricity, the waterworks, the ports, the fishing ports, the roads, the airports, and the bases of the industries as the national subsidy programs but also improves the environment, as well as medical treatments, along with education, and other areas (Kim 2013). Among the inhabited islands, 305 islands have been receiving the management and the support according to the many kinds of legal systems. The 254 inhabited islands, excluding the islands of Okinawa, Amami, Ogasawara, etc., and the annexed islands are the Ritou promotion countermeasure implementation regions according to the Ritou Promotion Act.[2]

[2]The purpose of the Ritou Promotion Act: the preservations of the territories of Japan and the exclusive economic zones (EEZs), the uses of the marine resources, the preservation of the natural environment, the maintenances of the industrial bases, the improvement of life environment and regional economy. In order to seek for the promotion that has brought alive the special, geographical characteristics or the special, natural characteristics of Ritou, the original ideas of the region are brought alive. The countermeasures regarding the improvement of the basic conditions, the promotion of the industry, etc., are formulated. The businesses based on such conditions are carried out speedily and powerfully. And, by conceiving a special measure for the promotion of

3 Policy for the Islands of Japan

The national territory of Japan is comprised of the islands by itself. If I were to understand the recognition of the Japanese regarding an 'island' found by searching 'Japan', mainly, the recognition of the island with regard to the geography, the residential landscape, the power, the historical space, and life has been appearing well (Hong 2011).

While amending the Ritou Promotion Act for nearly 60 years, since 1953, Japan has been considerably maintaining the industries and the life bases of the islands.[3] Meanwhile, ever since the ratification of the United Nations Convention on the Law of the Sea (UNCLOS), Japan has been providing many-sided support regarding the preservation, the use, and the management of the marine territories or, in other words, the exclusive economic zones (EEZs). It has been providing the enormous support both nationally and in terms of the citizens particularly regarding the inhabited islands. In the case of the islands, however, where the decrease of the population and the aging of the population have been coming to the fore, the reality is different. According to the National Institute of Population and Social Security Research,[4] which has been dealing with the population statistics research on Japan, the prediction is that the population will decrease in the islands of the whole region of Japan in the future. Among these islands, it is predicted that in Ritou, which is designated by the Ritou Promotion Act, the population which was 3.46 million in the year 2005 will decrease by around 79% in the year 2025. Once the population decreases in this way, the structure that can perform the economic and social functions of the island will collapse. In Japan, such a reality has been recognized, and, based on the Ritou Promotion Act, a plan for improved maintenance, the special characteristics of the island and the value of the native culture have been sought after (https://ja.wikipedia.org/wiki/%E9%9B%A2%E5%B3%B6%E6%8C%AF%E8%88%88%E6%B3%95).

The special, natural geographical characteristics of an island can be said to be the ocean type, the isolation, and the narrowness[5] (MacArthur and Wilson 1967; Hong 2008; Whittaker and Fernandez-Palacios 2007). Such special characteristics have

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Ritou, the independent development of Ritou will be promoted, and the life stability of the island residents and the improvement of the welfare shall be sought after. And, furthermore, the contributions shall be made to the development of the citizens' economy and the promotion of the citizens' profits. (https://ja.wikipedia.org/wiki/%E9%9B%A2%E5%B3%B6%E6%8C%AF%E8%88%88%E6%B3%95)

[3]Ritou: In Japan, which is an island country, the Japanese have been expressing the 'islands' as 'Ritou' as a general term. In the case of the habited islands, they have been using the term 'inhabited island.' And in the case of the uninhabited islands, they have been using the term 'uninhabited island.' This is similar to the term 'island' of Korea, which generally manages the islands by distinguishing them into the inhabited islands and the uninhabited islands.

[4]National Social Security Japan Population Research Institute (http://www.ipss.go.jp/syoushika/tohkei/Mainmenu.asp)

[5]Excerpted from the Island Encyclopedia (from Hong 2008)

developed along with the changes of civilized society and with the changes of the socioeconomic environment, which have been surrounding the island, and both which determine rise and fall of the island region. From Meiji Era (late 19th C), Japan has been developing focused on the light industry which is based on mass production. By joining the free trade systems like the USA, the international trade in the international market is geared toward developing. After the WWII, one of the resulting effects was as a result, urbanization along the coastal areas at the same time as the pivotal, provincial, and urban axes[6] took place, and the industrial areas took charge of the comprehensive role involving productions, processing, and distributions. Though most of the heavy industries had been the exceptional situation in the island regions, excluding the ship-building industry, however, this changed in 1953 with the Ritou Promotion Act becoming enacted along with large-scale finances being established, and the maintenance of industries and life foundations was pursued.

The fishermen during the non-fishing time were recruited and employed for the public projects, including port constructions, road constructions, and others of the like. With a lot of the fishermen being solicited into industries, and becoming employed by such public projects, the industrial structures and the lifestyles of the island regions changed. The changes of the labor structure and the employment opportunities established a change for the public projects, not only for the island regions but also for the urban regions which were expanded. The standard of life became enhanced, thereby increasing the education opportunities as well. This also changed the awareness, regarding the islands, and therefore, induced the increases of urban inflows to the island populations. The awareness of island nation (‘Shimaguni’ in Japanese) has also been becoming rarefied. With developments becoming centered on the cities without any relation to the developments of the island regions, the interest and the awareness in the islands has been getting gradually distant.

The population of the world has been continuing to climb close to nearly to seven billion people. The problems of preservation, uses, and management of territorial waters, exclusive economic zones (EEZs), etc., have been getting acutely in danger along with the securing of the food sources, the securing of the economic blocs, the global environment problem, as well as other pressing issues. Since the effectuation of the United Nations Convention on the Law of the Sea (UNCLOS), the disputes with surrounding countries have been getting more frequent because of national profits related to the territorial waters and the EEZs. Between Japan and China, the territorial dispute surrounding the Senkaku Islands (Chinese name—Diaoyudao) is unusual. Before the enactment of the Basic Ocean law, in The Ritou Promotion Act the roles of the country and the citizens, including the demarcations, the management, the territories of Japan, and the EEZs are clearly stated. With the

[6]Pivotal urban axis: The axes of the marine cities that link the large-sized industrial cities of the Pacific Coasts, including Tokyo and Yokohama, and the industrial cities in the Seto Inland Sea, including Osaka, Kobe, and Kitakyushu have been called the pivotal urban axes.

enforcement of the Basic Ocean Law in 2008, the policies related to the preservation and management of Ritou and the promotion of Ritou were clearly stated. In the year 2010, The Law on the Low Water Lines Preservation and the Base Facilities Maintenance was enacted. Okinotorishima and Minamitorishima were designated as the specially decided Ritou.[7] The port constructions, as well as others like it, that can manage specializations have been proceeded with.

4 The Comparison Between the Before and the After of the Construction of the Land-Connecting Bridge on an Island in the Seto Inland Sea in Japan

4.1 The Construction of the Bridge

In the 1970s and the 1980s, according to the economic development of Japan, most of the population of the island regions moved to the cities. The island region residents, who had relied on the first level industries, proved that the economic development of Japan was an important opportunity for deciding the new direction for the employment. Many of the young people moved to the cities and were incorporated into the economic activities of Japan. The construction of a land-connecting bridge in Japan has the personality of a national territory remodeling that has innovatively improved the industry and the distribution while at the same time, linked the island regions that have been cut off with the mainland, by connecting Honshu and Shikoku (Fig. 3).

In actuality, the Seto Long-Bridge (13.1 km), which was constructed from 1978 until 1988, is the bridge that was completed while constructing the island-connecting bridges on five islands in the Seto Inland Sea, and it is the very first land-connecting bridge that is connected by a railroad. The purpose was to connect Honshu and Shikoku, and to diffuse the economic, ripple effects by making the logistics of economics and the human exchanges vigorously connected.

[7]The specially decided Ritou: The island that needs the expedition of the preservations and the uses of the exclusive, economic zones (EEZs) in the surroundings was designated as the specially decided Ritou by considering the geographical conditions, the social situation, the situation of the maintenance of the facilities, etc. In the specially decided Ritou, the port facilities that are needed for the projects and the work of the country can be constructed and managed by the Minister of Land, Infrastructure, Transport, and Tourism. And the certain waters in the surroundings of the concerned facilities can be occupied (http://law.e-gov.go.jp/htmldata/H22/H22HO041.html).

Fig. 3 Seto Long-Bridge, Japan (http://upload.wikimedia.org/wikipedia/commons/thumb/f/fc/Seto-Ohashi_Bridge.jpg/1280px-Seto-Ohashi_Bridge.jpg)

4.2 The Changes of the Island Ever Since the Construction of the Bridge

4.2.1 The Opinions of the Experts

After the large-scale bridge was constructed in the Seto Inland Sea, in order to confirm several kinds of changes, I visited islands expert Professor Nobukazu Nakagoshi (Co-editor of this book) in The Graduate School IDEC of Hiroshima University and we discussed the present situation of islands of the Seto Inland Sea in Japan and the problem of the land-connecting bridges (Fig. 4). The main points of the discussion with Prof. Nakagoshi are the following: The land-connecting bridges are desperately needed to solve the ongoing problem of needed emergency medical treatments regarding initially, the elderly on the islands as well as the other island residents in the situation in where they need such care. However, the opinion that negative problems, too, accompany the bridges, including the safety of the island, the inflow of the foreign invasive species, the destruction of the environment, the increased noise levels, the occurrence of waste, along with other similar issues. For example, when a land-connection has not been made, the people get to the island by ship, and thus the identities of the people visiting the island could be identified, but presently, because passage is possible 24 h a day, it is said that protecting the safety of the island (especially, theft acts and similar detrimental issues) became urgent.

Fig. 4 Interview with Prof. Nobukazu Nakagoshi at Hiroshima University, Japan (photo from KBS Kwangju)

Prof. Nakagoshi also pointed out other negative aspects, including the inflow of the foreign and invasive species by automobiles, the increase of pollution, the occurrence of increased wastes from tourists.

Because most of the large-sized bridges had been constructed from the 1970s until the 1980s, according to the economic and social atmosphere of the time, the idea was to improve the poor environments of the islands by connecting the islands with land. However, if we were to judge construction at the time point in the twenty-first century, it was a very mistaken decision in hindsight. Although there are the problems of the poor emergency medical treatments and the poor education of the islands, the situation had been such that they could be solved by the islands themselves. The social atmosphere, along with the opinions of the island residents, is such that they must be solved by coming to the land. Without fail, this ideology became an impetus for pursuing the construction of the land-connecting bridges. However, vastly different from the expectation, the environment conditions of the islands became worsened after the construction. Though it had been anticipated that after construction occurred and residents being connected with the islands, many of the inland people would settle down after entering the islands, increased tourists would visit, and the industries would rise. Instead, the populations of the islands have been increasingly reduced, the aging of the population has been rapid, the tourists have been visiting only temporarily, and the industries have been deteriorating further. The small-scale ship-building industry, despite the fact that it has the

Fig. 5 Lecturing of Prof. Nobukazu Nakagoshi about necessity of sustainable society and greenness at island stakeholder's meeting at Mukaijima, Onomichi City, Hiroshima Prefecture (September 12, 2015)

strong point that it can be located in the island area, the labor force was lost due to the decrease of the population (Fig. 5).

Despite such negative matters, Prof. Nakagoshi gave the opinion that regarding the identity of the island, the culture, and the development of the unique social system of the island, must be protected by the residents of the island themselves. The islands in the Seto Inland Sea still possess and maintain their respective culture and identity. In other words, even if there are islands that are near to each other, they have individual personalities that are unique from each other. He points out that, with the islands being connected with the inlands through the land-connecting bridges, such uniqueness and identity of the islands have become greatly damaged and that it must not be overlooked that this has been acting as a new factor of frustration among the island residents. The viewpoints of Prof. Nakagoshi, as an ecologist, on the land-connecting bridges get largely divided into two categories. First, there are the changes of the unique environments of the islands due to the inflows of the foreign environments, and then secondly, the changes of the unique identities of the islands.

Fig. 6 Shimokamagari, Kamikamagari, and Toyoshima in Hiroshima Prefecture, the Seto Inland Sea, Japan. The 'Akinada Tobishima Sea Road' (http://akinada4island.blog86fc2.com/) was created by connected island group (photo from http://tobishima7.com/en/forcyclist/)

4.2.2 The Opinions of the Island Residents

In order to understand in detail the strong and weak points of the land-connecting bridges and the island-connecting bridges by listening to the residents, I explored the islands (Shimokamagari, Kamikamagari, and Toyoshima) in the Seto Inland Sea, which belong to Kure City in the Hiroshima Prefecture. I arrived at Shimokamagari Island, after passing over the Akinada Bridge (Opened in 2000 with the length of 1,175 m) in Kure City. It is well-known in Korea as an island in the Seto Inland Sea where a Joseon Dynasty correspondence delegation stayed. It has been having a magnificent commemoration event every year. The museum, the event, and other activities related to the correspondence delegation of Joseon Dynasty are continued events that invigorate the economy of Shimokamagari Island (Fig. 6).

Shimokamagari and Kamikamagari are connected by the Kamagari Bridge, which opened in 1979 with the length of 480 m. The remaining islands are also connected by the island-connecting bridges. I was able to listen in detail, regarding the current situations of the islands before and after the opening of the land-connecting bridges and the island-connecting bridges by contacting the tour guides and the resident representatives (Chief monks, principals, lodging business, restaurants, etc.) of each island. It was said that, when the island-connecting bridges was installed for the very first time, it was in preparation for integration of the education system, the joint responses by the industrial system, and the invigoration of tourism to assist the situation in which the population had been decreasing. In order to smoothly send the products such as tangerines produced on the islands to the inlands, a land-connecting bridge was constructed based on The Farming and Fisheries Villages Support Act (Although, as a result of a B/C analysis, there is no economic feasibility, and in the case of the farming and fisheries villages, there is a plan for the special support). Although it was decided that the central government and the local government would pay the constructions costs, the situation is that in some areas, a told was needed to fund such costs. The price of this toll is an unexpected and expensive cost to the island residents. As a result, the residents submitted a petition expressing that the toll should be inexpensive. Recently, it was devised so that a kind of a ticket (token) is bought inexpensively and used. However, the present condition is that there is nearly no special support for the island residents. In Japan, too, once an island gets connected to the land, it is excluded from The Island Support Act. With the construction of the Akinada Bridge, a lot of the island population moved to Kure City nearby, or another nearby city.

The reduction of the population and the collapse of the educational system, the cases of Kamikamagari and Toyoshima are even more serious situations, both of which are connected by the island-connecting bridges. With the islands becoming connected by the bridges and with the frequent commuting to and from school between Kure and Shimokamagari. Previously, the elementary schools and the junior high schools in Kamikamagari and Toyoshima had been temporarily closed. According to the opposition by local residents, the school districts had been adjusted by having a junior high school in Kamikamagari and an elementary school in Toyoshima so that they could cooperate with each other and the students could commute to and from school. Presently, the decrease of the population and the aging of the population are in a very precarious situation, since it is anticipated that the education system will become nearly extinct as a result of these two factors. The construction of the land-connecting bridges was begun to reduce the gap with the main territory in terms of the quality of life and in order to promote the economies of the islands. Particularly through the invigoration of tourism, it had been intended to create economic profits for the island residents, but in reality the situation has become very different. Between three to four years, ever since the construction of the Akinada Bridge, the number of the tourists has explosively increased. Especially, through the diverse showcased events that are related to the Joseon mission to Japan, it became an opportunity for publicizing the brand of the island to the whole nation as well as internationally for Shimokamagari (Fig. 7).

Currently in the Kamagari Archipelago, all of the seven islands are presently connected with the island-connecting bridges. Although 60,000–70,000 tourists per year have been coming to these islands, most have been concentrating on Shimokamagari, which is connected via the Akinada Bridge. In the case of Toyoshima, around 2,000–3,000 people visit per year. However, there are nearly no accommodations, and the reality has been that the tourists leave after touring for only two to three hours. Before the construction of the bridges, including the land-connecting bridges and the island-connecting bridges, the main means of for all of these islands had been by way of ship. However, at present, all of the transportation travel commutes use automobiles. The small islands of the archipelago in the Seto Inland Sea have long relied on has been the traditional, marine industries that the islands can manage and operate, however these have been becoming extinct along with the related culture.

Prior to the construction of the big bridge, the things that could be solved between the islands in the Seto Inland Sea, by themselves, could be self-provided by, and could be shared among, the islands, including, for example, the supplies of the agricultural and fisheries products and the food materials. However, ever since

Fig. 7 Mitarai fisherman's village in Toyoshima, Japan. This historically traditional landscape had designated as an important landscape area by Japanese Government. This area is well presenting traditional architecture and street planning in Edo Era (seventeenth–nineteenth century)

the construction of this big bridge, the small-sized stores, restaurants, and bed and breakfasts within the islands were closed. The shopping issues that challenged the island residents have been solved in Kure City, which is a large city that is nearby. Although there have been temporary effects regarding the emergency medical service for the island residents, the sales of the products of the islands, and the increase of the tourists, not only has there been a population decrease, there has also been the move to the cities by the young bracket, the destruction of the communities, the decrease of the identities of the islands and also, the commerce of the islands, themselves has been becoming reduced. The situation is such that there are no uses of ships, the space, the time, and the platform for the exchanges that traditionally occurred between the residents have since disappeared. One local tourism commentator voiced that although the number of the tourists had increased (Shimokamagari), it was not to the extent of developing into the tourism industry. There was success in publicizing the formerly uninhabited islands in the Seto Inland Sea, to the whole country, the part that has been missed by the tourists have missed having access to things to see, places for eating, and places for resting once they have arrived. Additionally, transferring administration districts from the islands that are different from each other into one administrative district, as occurred with one administrative district being transferred into Kure City, as an administrative-convenient judgment, poses problems.

Historically and traditionally, the islands in the Seto Inland Sea have possessed their respective, individual self-government, cultural areas, and sphere of influence. Even if there is a modern, administrative integration, there is nearly no cooperation among the island residents. Making an island residents consultative body is a very difficult thing. In Kure City, a tourism consultative body called the 'Akinada Tobishima Sea Road' (http://akinada4island.blog86fc2.com/) was created by gathering the seven islands in the Seto Inland Sea which are connected by the land-connecting bridges and the island-connecting bridges. However, this was formed according to the administration of Kure City. In reality there has been very little actual cooperation among the island residents. Although the Save the Islands Movement has been unfolded by the islands, themselves, a lot of the difficulties have occurred including but not limited to: the insufficiency of the resources, the insufficiency of network, the insufficiency of awareness, have been experienced.

4.2.3 The Administrative Opinion

By visiting The Center for Research and Promotion of Japanese Center, the present situation of the islands of Japan as well as the present situation of the pursuit regarding the land-connecting bridges was discussed. It is the opinion of the experts and the administrators that, before the construction of a land-connecting bridge or an island-connecting bridge, the residents must thoroughly consider and understand clearly the problems brought forth both before and after the construction of the bridge and that the feasibility must be understood well. Once an island is connected by a bridge, the special characteristic of being an island disappears. In Japan, the island-developing funds are provided according to The Ritou Promotion Act. Once a bridge is connected, this fund is then severed. As a result, before the construction of a land-connecting bridge, raising the island's capability to become independent on the part of the island, itself, is very important. The land-connection projects and the island-connecting road projects have been becoming greatly reduced starting in the 1980s. Of course, although there have been some places that have been under construction presently, this has not reached the level of the 1980s and the 1990s. The awareness about the land-connecting bridges, the island-connecting bridges, and the awareness about the islands themselves has changed a lot. The result of the economic feasibility aspect situation is considered to be the highest outcome aspect.

5 Conclusion

Recently, we can see the reality in which the identities of the islands have been disappearing with the islands becoming land-connected with the bridges. Although, to the island residents, the land-connecting bridges that connect the islands with the lands can be a lifelong wish, along with the bridges getting connected is the financial support by the government being cut off and with foreign factors like invasive arriving and transported in, the exclusiveness and the specialness that the islands originally possessed, have been changing. This situation is one which has been prominently appearing in Korea, too, together with the socioeconomic phenomenon with the reduction of the overall populations of the islands and the aging of the populations of the islands. In Japan in the 1970s and the 1980s, the construction of the land-connecting bridges between the main islands and the surrounding islands had been hurried in accordance to the economic revival stance at the time. By installing the island-connecting bridges between the islands, the convenience of the island residents had been increased. Presently, after 30 years, it is evident that the populations of the islands have become rapidly became reduced. The industry has also been showing the result of deteriorating. Through exploration, it was intended to try projecting the situations Japanese islands experienced onto the islands of Korea at present.

Through the coverage and the investigations of the islands and bridges in the Seto Inland Sea, we must worry about the vision for the archipelago of Korea by fitting it to the global paradigm of the twenty-first century. An island is an island. It is judged that, with the residents of the islands, which have already been connected with the bridges, in the Seto Inland Sea benchmarking the efforts at making the island become independent, internationalized, and networked, now has become a time for re-examining, in depth, the overall matters related to the islands and the bridges.

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