Socio-ecological production landscapes in Asia

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Executive Summary

Socio-ecological production landscapes (SEPLs) have been developed by interactions between humans and nature, through activities such as agriculture, forestry and fishery. Biodiversity and ecosystem services have been maintained in SEPLs through building on local knowledge, techniques, rules and norms regarding wise use of natural resources as well as the sharing of benefits and burdens within the communities. Diverse human-nature interactions in SEPLs have been observed in the literature reviewed on selected SEPLs in Asia. This literature encompasses aspects of physical and institutional structures, management techniques, contemporary challenges, and some of the ways in which these have been addressed.

Under dry and alpine climates such as in Mongolia, Oman, Kyrgyzstan, China (Liangshan Yi Autonomous Prefecture, Sichuan Province) and Nepal, SEPLs are primarily characterized by pastoralism. This controls herds' load on vegetation by translocation of animals to overcome and adapt to the seasonal (or irregular) patterns of precipitation and temperature. In such regions, institutional systems for pastures and livestock management have been developed to adjust the locations where and the timeframes during which grazing takes place. Such systems, however, have been affected by changes in political and economic regimes such as the nationalization of land and livestock or privatization and the transition to a market economy, which caused grazing patterns to shift and led to both overuse and abandonment of pasture land.

Apart from these areas, rice cultivation dominates the majority of agricultural systems in Asia. In the temperate region including portions of countries like Japan, Korea and China (Shanxi Province), a mosaic pattern of land use is observed, which matches the suitability (adaptability) of each land use type with spatially variant topographic conditions. This land use includes paddy field, farmland, woodland, grassland, settlements, ponds and irrigation canals. In Japan and Korea, a decreasing and aging population is resulting in the degradation of SEPLs through abandonment of farmland and woodland.

Complexity of land use and mixed livelihoods characterize SEPLs in tropical areas such as those in India, Sri Lanka, Indonesia, the Philippines, Thailand, and Vietnam. Homegardens – multi-layered woodland composed of a variety of trees, vines and herbs, which provide farmers with foods, medicines, etc – use sunlight and nutrients in an effective manner. To benefit from high temperatures throughout the year, irrigation systems to overcome water scarcity for rice cultivation during the dry season have been developed and managed by local communities. In mountainous areas such as in the Philippines, Thailand and Vietnam, SEPLs entail a relatively extensive system including shifting cultivation and the extraction of wild plants near settlements and farmlands. While increasing demand for food and resources induced by population growth and the development of market economies is leading to intensification and expansion of farmland, especially toward monoculture cropping, abandonment of terraced paddy fields and irrigation systems that require intense management is being caused by population flows feeding into urban areas and other industries.

In SEPLs located in lowlands near wetland areas such as in Cambodia, Myanmar and Iraq, the gradient of water condition and micro-topography affects the spatial arrangement of production systems and/or crop varieties. Rice cultivation is accompanied by fishery activities. Population increase and market economy development is also the major cause of degradation of SEPLs through conversion of land use and extraction of wetland vegetation.

The SEPLs described provide evidence of some practices that enable adaption to spatial and temporal variation in environmental conditions. These include

fallow systems, combined use of different production systems or of different species/ varieties of crops and livestock, and land use according to topographic conditions. Local institutional systems that adjust and coordinate resource use were also observed in many of the targeted SEPLs.

Overall, population change (both increase and decrease) and development of market economies were observed to be common factors causing changes to SEPLs resulting in degradation of ecosystems and biodiversity. Measures have been taken to tackle these challenges in SEPLs including policy development and implementation of land tenure and resource management such as community forestry. Various projects on community development, awareness raising, restoration of ecosystems and abandoned agricultural facilities are also under way supported by NGOs, private sector organizations, governmental bodies and international organizations.

Introduction

Humans have always depended on the surrounding environment for the cultivation of food and the gathering of usable resources including clothing, shelter, medicine and so forth. Over generations of interactions between humans and nature, knowledge regarding wise use of natural resources has been accumulated locally and has helped to sustain ecosystems and biodiversity in their surroundings. Rules and norms regarding the management of natural resources as well as the sharing of benefits and burdens within the communities were reinforced, which led to a further strengthening of the mechanisms for sustainable management of natural resources. Building on such knowledge and practices, land use systems and institutional systems have co-evolved to match changes in natural and socio-economic conditions, forming unique landscapes –socio-ecological production landscapes (SEPLs) – in each respective region.

There has been growing understanding of the sustainability of such landscapes and the multiple benefits they provide, as people have increasingly recognized the negative environmental impacts of modern economic development, which has been achieved through extensive use of fossil fuels and at the cost of ecosystem degradation. Today these landscapes are under significant pressures stemming among other things from rapid population change, globalisation, urbanisation, climate change. The *Satoyama* Initiative was initiated by Ministry of the Environment, Japan and United Nations University Institute of Advanced Studies to tackle these issues, and to maintain and revitalize SEPLs toward its vision of "realizing societies in harmony with nature." The term "socio-ecological production landscapes" has been applied as a target area of the *Satoyama* Initiative referring the definition of Japanese traditional rural landscapes called satoyama and satoumi: "a dynamic mosaic of managed socio-ecological systems producing a bundle of ecosystem services for human well-being" (JSSA, 2010).

Although socio-ecological production landscapes can be found all around the world, there is need for more detailed examination and explanation to promote wider understanding of the importance of such landscapes for biodiversity and ecosystem conservation as well as for human populations. This document introduces the diversity of human-nature interactions in SEPLs in Asia. The document highlights various physical and institutional structures and management techniques, which characterise these landscapes. It also focuses on contemporary challenges and some of the ways in which these have been addressed. The cases were selected with consideration for geographical balance, as well as diversity of natural and social conditions. Asia, occupying the eastern and middle Eurasian Continent and its adjacent islands, dominates 23% of the world's landmass and is home to 60% of the world's population. The region contains both the highest and the lowest points on the surface of the Earth and is subject to a wide range of climate conditions - from tropical to boreal, from humid to desert - which have given rise to a diversity of fauna and flora. People have adapted their lifestyles in step with these diverse environments to enjoy the benefits of nature. This has entailed a wide variety of different ways of farming, fishing, grazing, and the extraction of timber and other materials from forests and grasslands. Such practices and systems build on long-term experiences of the people and should serve as important clues for efforts aimed at the establishment of sustainable societies.

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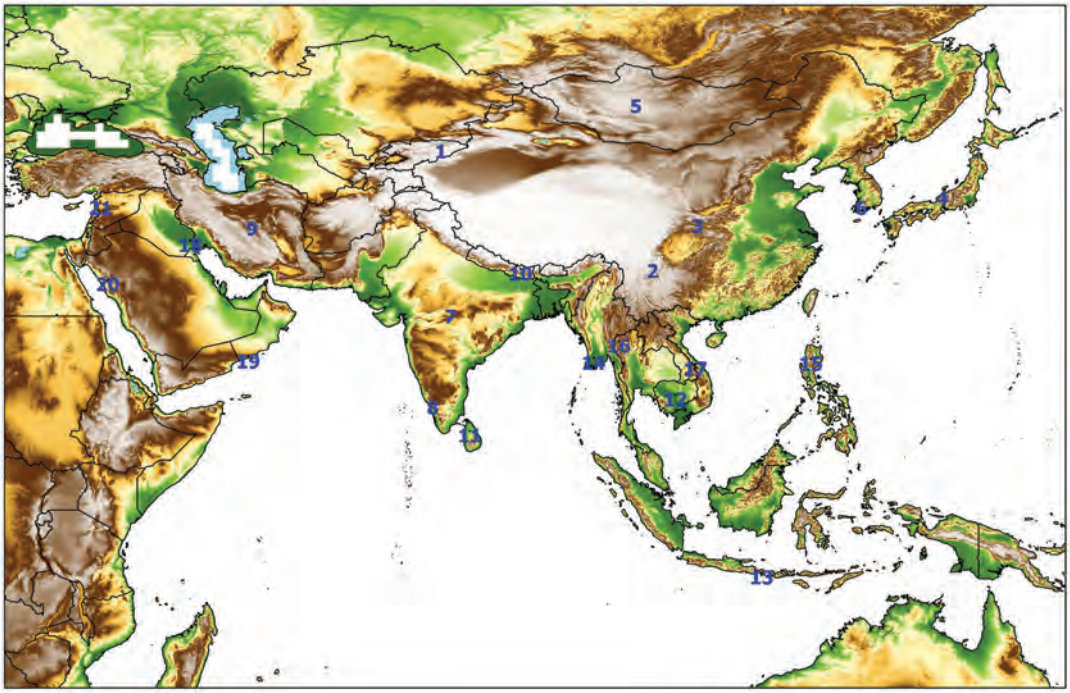

Map of Asia and the location of the socio-ecological production landscape in each chapter

1. Kyrgyz Republic: Transhumance in the Northern Mountainous Areas

1.1 Natural and Social Background

The Kyrgyz Republic is a mountainous state with arable land accounting for only 7.1% of the national land (the figure as of 2008 quoted from FAOSTAT). Pastures, however, are abundant as the high mountain range is largely covered with natural steppe grasslands, leading to the livestock industry accounting for nearly half of the gross agricultural product (JICA, 2007). In particular, Issyk-Kul and Naryn provinces in the north have an active livestock industry with large mountainous areas. The lowest altitude within the province is 2,040 m for Naryn province, which is the highest among all the provinces in Kyrgyz, followed by 1,600 m for Issyk-Kul province (Kajiura, 2009). The country has an climate in which the precipitation gradually increases from winter to spring in the lowlands, while the rainy season is in the summer in the highlands. The north, more mountainous than the south, experiences high rainfall and a cool climate in the summer, which is suited to grazing (Kajiura, 2009). A small proportion of the population is full-time livestock farmers, while the majority is agriculture-cum-livestock farmers, who keep livestock and, at the same time, practice farming on the limited area of arable land (JICA, 2007). Those in Issyk-Kul and Naryn provinces in the north cultivate agricultural products adapted to the highlands, including wheat, barley and potatoes, but the number of product items is less than in other provinces (Kajiura, 2009).

The Kyrgyz Republic became independent in August, 1991, just before the USSR collapsed in December of the same year. Since independence, the country has pursued a market economy and its economy has been gradually rising since 1995, with a major contribution from the agricultural sector. Its agro-pastoralism system has drastically changed since independence. When Kyrgyz was annexed by the USSR in the 1920s, all the arable land and livestock became state-owned property to serve the collective production system set up under the Soviet production regime composed of the *kolkhoz* (collective farms organized as cooperatives) and the *sovkhoz* (state-owned farms). In the post-independence era, the collective farm system was dissolved and a large portion of the arable land was distributed to the residents, leading to the generation of a number of small independent farmers. Livestock also became privately-owned, while the pastures remain state-owned even at present (Kajiura 2009; Esengulova et al., 2008).

In the pastures and their vicinity in the mountainous areas, there are many larger wild animals. The pastures are an important ecosystem that sustains the survival not only of the livestock, but of such wild herbivores as the Marco Polo Sheep (*Ovis ammon polii)* and the Siberian Ibex (*Capra sibirica*), and hence for the carnivores that eat such herbivores, including wolves and the Snow Leopard (*Uncia uncia),* which faces the threat of extinction (Watanabe et al., 2008; Arase et al., 2011; UNESCO, 2002).

1.2 Characteristics of Transhumance

The livestock grazed in Kyrgyz include five species: sheep, goats, cattle, yaks, and horses. Among others, sheep and goats occur in high numbers as greater efforts have been made towards the production of wool since the Soviet era (Kajiura, 2010). In the

post-independence era, livestock became privately-owned and its management also shifted from an organization-based system to an individual-based system, when the inappropriate transfer of management skills to individuals contributed to a sharp decline in the number of livestock, combined with the closure of wool processing plants and forced sales of livestock due to the hyperinflation during 1992-1993. From 1998 onwards, however, there had been no major changes in the number of livestock, which continued to show a stable trend. In recent years, the number of livestock has been growing steadily (Figure 1) (JICA, 2003; Esengulova et al., 2008).

The number of livestock per household varies according to the region and the ownership pattern of the livestock. According to a study conducted in the Naryn district, Naryn province, the average number of livestock per household was 15.3 head of sheep or goats, 2.5 of cattle and 2.8 of horses (JICA, 2007). Another study on 34 families in the Tong district, Issyk-Kul province found out that for 26 out of 34 families the grazing of livestock was contracted out to them by their acquaintances or relatives who were absent from the pastures. The average number of livestock owned by each of the 34 families was 56.1 head of sheep or goats, 9.3 of cattle and 5.4 of horses, while the average number contracted out to the 34 families by their counterparts was 202.9, 14.2 and 3.3 head, respectively. Thus, the number of grazed livestock was far larger for the contracted-out livestock than for the livestock owned by them (Kajiura, 2010).

In terms of the location of the pastures, the traditional pattern of Kyrgyzstan transhumance consists of the highlands in summer and the lowlands in winter. Such seasonal movement of livestock is made possible through livestock production by the subsistence economy of the people living in areas like Kyrgyz where the topography and climatic conditions are not suited to food crop production and is practiced based on the least amount of plant production. Livestock directly provide the people with food such as meat and milk and they generate cash income by selling some wool and the fattened livestock. In summer, it is important for fattening the livestock to take them to the alpine grasslands with lush pastures due to the high rainfall, which are located above the limit for crop agriculture. The grasses on the pastures are used as forage, or the livestock are directly fed by grazing them on the pastures. In Kyrgyzstan, depending on the season of use and the distance from the village, these pastures can be largely categorized into three types: the Spring-Autumn (*Jazdoo - Kuzdoo*), the Summer (*Jailoo*) and the Winter pastures (*Kyshtoo*). The use of state-owned pastures takes the form of leasing out arrangements to livestock farms or owners.

The three types of pastures were separately managed by different administrative units: the Winter pastures, which are located

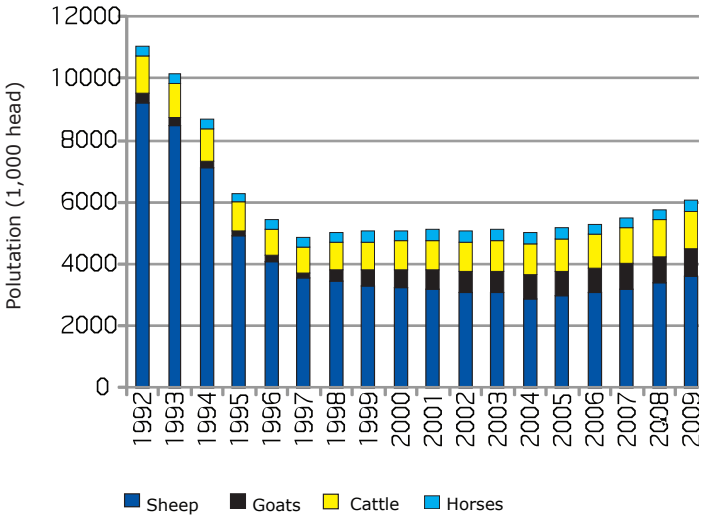

Figure 1. Trends in the Livestock Population in Kyrgyz from 1992 to 2009 (FAOSTAT)

closest to the villages, were managed by a local government at the village level known as the "*Aiyl Okumotu*"; the Spring-Autumn pastures were managed by a district government known as the "*Raion*"; and the Summer pastures, which are located farthest from the villages, were managed by a provincial government known as the "*Oblast*" (USAID, 2007). In 2009, the Kyrgyzstan government adopted a new law, the 2009 Law on Pastures, which transferred the responsibility for pasture management of all three types of pastures to the local government (*Aiyl Okumotu*) through the establishment of an Association of Pasture Users (APU) in each *aiyl okmotu*. A Pasture Committee, which consists of representatives of the pasture users and executive officers, was established as the executive body of the APU, which develops a plan for pasture use and implements the monitoring of the pastures and so on. The 2009 Law on Pastures also stipulates provisions for the distribution of pastures to the users. The areas of pasture for transhumance and fees for the use of the pastures are determined according to the number and type of livestock by the Pasture Committee. Users who pay the fee can obtain a ticket that certifies their right of access to the pastures and their use. Several documents are attached to the ticket, such as a map of the pastures, a receipt for the payment, the terms of pasture use, etc., and the users graze livestock based on information in the documents.

This sort of transhumance between high and low altitude areas is commonly practiced in mountainous areas unfit for agriculture in the adjacent countries of Central Asia, including Kazakhstan, Tajikistan and Afghanistan, as well as in Nepal. Much further away, seasonal transhumance is practiced in areas along the Alps and along the Mediterranean coast.

The three types of pastures are described below in terms of their characteristics and the specific cycle of transhumance.

1) Spring-Autumn pastures (*Jazdoo - Kuzdoo*)

The Spring-Autumn pastures are largely situated in the hilly areas at the foot of mountains below 2,500 m above sea level (Photo 1). Grazing starts in early spring, when the pastures sprout. They are also used as the venues for shearing and dipping. A number of herders own their huts to provide a base for livestock rearing and prepare to move up to the summer camp sites. In autumn, they return from the Summer pastures to this type of pasture for grazing (Esengulova et al., 2008; Fitzherbert et al., 2000). In the typical Spring-Autumn pastures, fescue, a member of the *Compositae* family, and *Artemisia* grow sparsely. Leguminous plants, including *Medicago*, *Trifolium* and *Astragalus* are lusher than in the Summer pastures, making a greater contribution to the grazing. However, overgrazing poses a major problem for the Spring-Autumn pastures. For example, the land surface vegetation cover in areas along the Tian Shan range rarely exceeds 40%. This also leads to the invasion of some plants unfit for grazing, including *Ranunculus alberti* , and *Inula* (Fitzherbert et al., 2000).

Photo 1. Pasture of the early summer in northeastern Kyrgyz (Near the Kazakhstan border, about 2,000m above sea level) (Photo: Koichi Tokugawa)

2) Summer pastures *(Jailoo)*

Summer pastures in general are the alpine grasslands on the slopes of moderately undulating mountains at over 2,500 m above sea level, which take one to six days on foot or by horse to reach from the villages (Photo 2). The total area of Summer pastures is the largest among the

three types of pastures (as shown in Table 1) and the high rainfall and cool climate during the summer season generates high biological productivity, altogether being taken advantage of by the grazing livestock. Sixty to one hundred percent of typical Summer pastures are accounted for by plants 5-15 cm high, including *Festuca valesiaca* (*Poaceae*), *Carex* and *Cyperus*, and the rest of them by broad-leaved perennial herbs, legumes and *Leontopodium ochroleucum*. Around 10% of the Summer pastures have been invaded by prostrate plants, including *Potentilla* and *Alchemilla* (Fitzherbert et al., 2000).

3) Winter pastures (*Kyshtoo*)

There is no clear-cut benchmark for the altitude of the Winter pastures, but most likely they are located at a lower altitude and are closer to the villages than the Spring-Autumn pastures. As the pastures are to be fitted out for wintering camp sites, they are semi-arid steppes with less snowfall, where *Artemisia* and *Stipa* plants grow in general. In Naryn province with its lowest altitude of 2,040 m within the province, for instance, the Winter pastures in Kara-Kujur valley are located at 2,700 m above sea level and can produce abundant forage with little snowfall. As is often the case, the pastures, which are situated close to the villages, adjoin agricultural lands, fields for hay, orchards and forests. Most of the agriculture-cum-livestock farmers thus also cultivate wheat, barley, vegetables and so on.

Photo 2. Sheep grazing of summer in the northern part of Issyk-Kul Lake (Oruktu, about 2,500–3,000m above sea level)(Photo: Koichi Tokugawa)

Since the Winter pastures are closer to the villages, land degradation due to overgrazing is more severe than for the Spring-Autumn pastures (World Bank, 2007; Fitzherbert et al., 2000).

Table 1. Area of the Three Types of Pastures in Kyrgyz

Type of Pasture	Km^2	%
Summer pastures, from 2,500 to 3,500 meters above sea level	38,890	44
Spring-Autumn pastures – 1,500-2,500 meters above sea level	26,970	30
Winter pastures	22,850	26
Total Pasture Area	88,710	100

Source: Fitzherbert et al. (2000)

A case study on the herders in the Tong district, Issyk-Kul province will be discussed below from the point of view of the annual cycle of grazing. In the Tong district, located near the Issyk-Kul Lake, the traditional pattern of grazing took the form of the winter camp sites on the lake coast along the Teskei range, where, aside from grazing, agricultural practice was the cultivation of grains such as wheat and barley, as well as pomiculture, including grapes, apricots, apples, peaches and pears, and the summer camp sites for grazing were set up on the mountainside at higher altitudes (Sawada, 1999). According to Kajiura (2010), the current grazing pattern of full-time herders in the Tong district can be summarized as shown below. Around April, they leave the winter camp sites and take their livestock to the huts around the villages. In May or soon afterwards, they choose a warm day to start shearing. Subsequently, they prepare for grazing, which begins in June and, in summer, transfer their livestock to the pastures at higher altitudes, where they set up the traditional assembled mobile houses known as "*boz-üy*" to provide a base for grazing. In September, when the temperatures decline sharply, the descent from the highland pastures commences and is completed no later than mid-October, when it snows. In their huts,

they prepare for wintering and take their fattened livestock with them, as traders, to the livestock bazaars in nearby towns. During December, they practice breeding and wait for the calving season around March before they resume the livestock migration the following spring (Kajiura, 2010).

1.3 Challenges and Responses

Kyrgyzstan pastoralism has significantly changed its form in the context of Soviet history from the founding to the collapse. Prior to the founding of the Soviet Union, Kyrgyz recognized that the pastures were common property. With no administrative organization in charge, they were managed by the kin or tribal groups actually practicing the grazing, the chiefs of which met together to discuss the grazing. The pastures were divided up on a kin or tribal group basis according to the natural topographic conditions such as rivers and valleys, and were used through shifting the sites for grazing subject to the condition of the pastures (rotational use) (Esengulova et al., 2008). In the Soviet era, all the livestock and pastures became state-owned and operated under the Soviet production regime composed of the *kolkhoz* and the *sovkhoz*, as mentioned above. Though the rotational use of pastures was encouraged under the control of the state, the maximization of livestock production under the collective production system led to a major problem of the intensive use of all the pastures.

In the post-Soviet era, as mentioned in section (2) above, the pastures, which remain state-owned, were separately managed by different organizations and were leased out to livestock farms or owners until a new law was adopted in 2009. However, they had not been appropriately distributed due to the blurred boundaries, as well as to a lack of management capability, as exemplified by the fact that many of the organizations responsible for management even have no maps of the pastures. In the context of this situation, a number of the herders did not follow the traditional pattern of transhumance and have overused, for their convenience, the Winter and Spring-Autumn pastures, which are located closer to their villages. As a result, these pastures have become degraded and this has allowed the invasion of species unfit for grazing. In contrast, it was often the case that the Summer pastures, which are located further away from the villages, were underutilized. Although some have recovered from the degraded situation attributed to their intensive use during the Soviet era, many more underutilized pastures have declined in economic value due to the progress of plant succession with the invasion of secondary plants unfit for grazing (USAID, 2007; Esengulova et al., 2008). According to the Gosregister, the situation of grassland coverage in 2005-2006 was categorized into the lush growth of non-edible weeds (27%), soil erosion (19%) and substantial degradation (33%). Other problems that have been pointed out include the low profits from leasing out the pastures (US$ 0.35/ha on average), the lack of any role played by the local communities in the pasture management and the underdevelopment of the infrastructure (USAID, 2007).

In order to improve the situation concerning the pastures, a new law which was adopted in 2009 completely changed the pasturage system of Kyrgyz. It is expected that by managing all pastures at the local level, and clarifying the pasture areas and the payment, the state of pastures will be improved and also qualified pastures will increase the productivity of the livestock.

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2 China: Agricultural and Pastoral Landscapes in the Mountainous Districts of the Upper Watershed of the Yangtze River

2.1 Background

Anning River, a tributary of Yangtze River, runs through the central part of the Liangshan Yi Autonomous Prefecture in Sichuan Province from north to south, and its valley is surrounded by steep mountains. Xichang, the capital of the prefecture, is located about 360 km southwest of Chengdu, and its altitude is a little less than 1,600 m above sea level. The city has an average annual temperature of 17.0°C, and there is a clear distinction between the rainy and dry seasons with 92% of the city's average annual precipitation of 1,033 mm concentrated in the rainy season from May to October. According to Köppen's climatic classification, the prefecture has a steppe climate. The climate in the valley of the Anning is characterized by its remarkable vertical variation due to the substantial difference in altitude. The altitude of Miyi County, located downstream from Xichang, is at the 1,100 meter level, and its climate is close to sub-tropical with an average annual temperature of around 20°C. In this county, it becomes considerably dry not only in the dry season, but also in the period up to early summer as is typified by the fact that the amount of evaporation exceeds the precipitation. In contrast, the mountainous district, which is above 3,000 m, has a cool-temperature climate with an average temperature at less than 8°C. These changes in temperature due to altitude can be observed in the vertical distribution of the vegetation (see Table 1). The timberline runs at a height of around 3,400 m above sea level, and declines to 3,200 m in areas where the wind is strong. The vegetation consists of prostrate Yunnan pines (*Pinus yunnanensis*), oaks (*Quercus monimotricha*), which grows as a shrub, and bamboo grass (*Fargesia pauciflora*). In the cool temperature zone, where the altitude ranges from 2,600 m to 3,400 m, it comprises a mixture of needle-leaved trees such as fir trees (*Abies* spp.) and spruce (*Picea* spp.) and broad-leaved ones such as Chinese red birch (*Betula albo-sinensis*) and *Rhododendron* spp. At heights of 2,600 m or lower, it is composed of trees of the warm-temperature zone with the 2,000-2,600 m zone dominated by a mixture of deciduous broad-leaved and needle-leaved trees, the 1,600-2,000 m zone by deciduous broad-leaved trees, and the zone below 1,600 m by evergreen broad-leaved trees (JICA, 2002). Particularly on the southern slopes lower than 1,600 m, trees cannot grow properly because it is too dry. Mammals that live in this area include wild boars, sambars, Chinese pangolins, and jungle cats. In addition, the highlands in Liangshan Prefecture are home to pandas and lesser pandas, both of which are designated as endangered species (Category IB).

Table 1. Major Components of the Vegetation and Tree Species in Liangshan Prefecture by Altitude

Height above sea level (m)	Major components of the vegetation	Major tree species
Above 3,400 (3,200) m	Shrubs and grasslands	Alpine grasslands
2,600-3,400 m	Mixture of cool- temperature zone deciduous broad-leaved and needle-leaved trees	Yunnan pine, oaks, Chinese red birch, fir trees, spruce, rhododendron, bamboo grass
2,000-2,600 m	Mixture of warm- temperature zone deciduous broad-leaved and needle-leaved trees	Yunnan pine, oaks, poplar, star annis,
1,600-2,000 m	Warm-temperature zone deciduous broad-leaved trees	Yunnan pine, alder, cypress
Below 1,600 m	Warm-temperature zone evergreen broad-leaved trees	Lead tree, jatropha curcas, bombax ceiba (This zone is dry from spring to early summer, and in particular, its southern slopes are extremely dry.)

Source: Revised JICA, 2002

In 2010, Liangshan Prefecture, which occupies an area of 60,000 km^2, had a population of 4.78 million (population density: 79 persons/km^2). Originally, the Yi were dominant in this region, but the number of Chinese who have migrated to this region since the 1950s has continued to increase. Ethnically, they account for the majority of the population at 54%, with the remaining 43% accounted for by Yi, 1% by Tibetans, and 2% by other minorities. Historically, since the Three Kingdoms period in the third century, the Yi have come to live in mountainous districts and on highlands due to the pressure of the Chinese from the lowlands. Liangshan Prefecture can be divided into two major spheres of life with Xichang City forming their boundary. While the lowlands and flatland in the valley of the Anning are inhabited by Chinese farmers, the mountainous districts and highlands, which are located in the upstream reaches of the river and are largely 2,000 m above sea level, are populated by the Yi. The population density of villages 2,000-2,700 m above sea level is 43 persons/km^2, and that of villages at 2,700 m above sea level or higher is 26 persons/km^2. Villages exist at altitudes of up to 3,500 m above sea level.

From the 1950s to 1980s, the Chinese government took the initiative in promoting forest development. It considered the logging and development of national forests as one of the financial resources for building China as a new socialist country and developed natural forests on an extensive scale (Yorimitsu, 2003). As a result, forests in the upstream and middle reaches of the Yangtze and the Huang were destroyed, causing flood disasters in the downstream regions. A disastrous flood in 1998 led the government to adopt a policy of prohibiting the logging of natural forests in the same year, marking a major shift in its forest policy. Today, afforestation is being promoted through government policies in various parts of the country. Government policies include the "Returning Farmland to Forests" policy, which aims to turn cultivated land into forest land as a measure to prevent agricultural land from being developed by farmers on steep slopes, and the "Closing Hills for Afforestation" policy, which aims to control pasturage and develop the forests.

2.2 Agricultural and grazing system in the high-elevation zones

The Yi have developed an agricultural and grazing system that combines grazing and cold-hardy crops suitable for high-elevation zones and have maintained agricultural and grazing landscapes even in steep mountains while preventing landslides. Yi agricultural and grazing landscapes, which combine cold-hardy crops and pasturage, are scattered in various places on land above 2,000 m with an area of approximately 40,000 km^2 (Photo 1). The following descriptions are based on the results of a socioeconomic survey conducted mainly in the valley of the Anning in 2001 (see Table 2). According to the statistics of municipal governments in five administrative units (Xichang City as well as Zhaojue, Xide, Dechang, and Miyi Counties) covered by the survey, 13% of the land (86,000 ha) in ten villages in these administrative units was used for agricultural land, 30% for grasslands, and 44% for forests, and 13% was accounted for by wasteland and land used for other purposes.

Photo 1. Zone at 2,000-2,700 m above sea level - Harvesting on Cultivated Land in Zhaojue Country (Photo: Japan Wildlife Reserch Center)

Table 2. Amount and Percentage of Average Cash Income by Altitude and Industry (Units: households, yuan, and %)

Zone of residence	Number of households by ethnic group		Average Cash Income (Yuan)					Percentage of average cash income (%)				
Altitude	Chinese	Yi	Total	Agri-culture	Forestry	Stock-raising	Other	Total	Agriculture	Forestry	Stock-raising	Other
Above 2,700 m	0	300	2,834	798	171	1,835	30	100	28	6	65	1
2,000-2,700 m	0	300	4,233	2,030	430	1,466	306	100	48	10	35	7
Below 2,000 m	387	13	6,038	3,766	3	972	1,297	100	62	0	16	22

Source: Revised JICA (2002)
Note: In this survey, interviews were conducted covering a total of 1,000 households (100 per village) in ten villages in five counties around Xichang City. Three Yi villages were located in each of the 2,000-2,700 m zone and the zone above 2,700 m, and villages consisting mostly of Chinese were located in the zone below 2,000 m. The table indicates the figures for villages in each elevation zone.

The grazing of sheep and cattle is suitable for cool mountainous districts with vast stretches of grassland. The Yi have a stable diet of crops that are cold resistant and resistant to unseasonable weather, examples of which include buckwheat, particularly a slightly bitter buckwheat, potatoes, and oats. The particularly important food crop is the potato (Matsushima, 2004; see Table 3). After the potatoes are harvested, turnips and grass are grown as an off-season crop, which is used as feed for sheep and other types of livestock, and this means that fields important as a means of food production are used for the cultivation of livestock feed for a certain period of the year. The Yi combine these crops with stock farming centered on sheep and pigs. Yi families living at 2,000 m or higher in the survey area raise two to three cattle, five pigs, 13-20 sheep, and 15 chickens on average and sell a little less than one head of cattle, three to five pigs, four to six sheep, and ten to 13 chickens annually. Domestic animals are an important source of income. In addition, income from forest products such as Japan pepper trees, walnuts, and pine resin has continued to rise in recent years.

Table 3. Ratio of Crops Cultivated and the Average Number of Domestic Animals Owned and Sold by Altitude and Crop (Units: households, %, and heads)

Zone of residence	Number of households by ethnic group		Ratio of crops cultivated (%)					Average number of domestic animals owned				Number of domestic animals sold in 2000			
Altitude	Chinese	Yi	Paddy rice	Buckwheat	Corn	Oats	Potatoes	Cattle	Pigs	Sheep	Chickens	Cattle	Pigs	Sheep	Chickens
Above 2,700 m	0	300	1	94	36	93	99	2.6	5.3	19.5	14.9	0.9	4.8	6.5	13.1
2,000-2,700 m	0	300	21	93	83	27	96	2.9	4.2	12.6	13.3	0.6	3.2	4.3	9.8
Below 2,000 m	387	13	100	3	44	2	2	0.9	3.0	1.7	7.7	0.3	3.0	0.4	7.5

Source: Revised JICA, 2002

Feed for sheep includes grass as well as *Pinus yunnanensis*, the leaves of shrubs, and bamboo grass. That for pigs consists of boiled agricultural products such as potatoes, corn, bitter buckwheat, oats, and turnips. The pigs are fed with boiled food once in the morning and then released into the mountains and fields. Pigs kept by the Yi also catch crabs in mountain streams and eat insects and wild herbs. They are highly rated for their firm body. Even if they are released, the pigs return to their keeper's house for the boiled food, but the grazing of sheep requires shepherd boys. As the Chinese economy grew, the price of pork has recently soared, prompting some wealthy Yi farmers to concentrate on raising pigs in their pigpens. These farmers mainly grow such crops as potatoes and turnips in large quantities to secure sufficient feed.

Another traditional technique to maintain the fertility of agricultural land in this cool climate is to leave the cultivated land fallow for some years after production (Photo 2). The Yi cultivate bitter buckwheat, oats, and other crops in their fields only once every two to four years, and by doing so they leave the cultivated land fallow for as long as possible in order to facilitate the recovery of its fertility. Since the cultivated land left fallow is used to graze sheep and cattle, the excrement of these animals is returned to the cultivated land, which is a reasonable way of keeping the land fertile. Moving to high-elevation land for grazing in summer, meanwhile, enables the Yi to avoid using land for both agriculture and stock farming at the same time. As one of the options needed in order to preserve grass resources, this is practiced in Zhaojue and Meigu Counties, particularly among the highland settlements that have a long winter. The Yi collect brushwood, grass, pine needles, and other materials for fuel, and some of them also use straw and other plant stems that are the byproducts of agricultural production.

2.3 Challenges and Responses

With the increasing elevation of the land, the demand for fuel materials grows. A comparison of the average annual amount of fuel materials consumed per household indicates that 0.7 tons of brushwood is collected and consumed for firewood in the warm zone below 2,000 m, 3.3 tons in the 2,000-2,700 m zone, and 6.6 tons in the zone above 2,700 m. Brushwood is used for cooking, boiling of food crops for pig feed, and heating. Large amounts of fuel materials such as brushwood are consumed by highland settlements, making the improvement of fuel efficiency an issue yet to be addressed. Efforts are being made to introduce improved kitchen stoves, but the Yi perceive their existing three-stone stoves as a tradition. Improved kitchen stoves also have such problems as being inferior as nighttime lighting or heating systems.

Photo 2. Zone above 2,700 m - Cultivated Land Left Fallow for Grazing in Xide County (Photo: Japan Wildlife Reserch Center)

As mentioned earlier, the Chinese government is pressing forward with its "Returning Farmland to the Forests" policy, which is particularly important to the Yi's sphere of life in the steep mountainous districts. This policy involves turning the slopes that have been excessively cultivated back into forests in order to accelerate the implementation of afforestation policy. It is producing steady results by providing low-income farmers with food and paid work. At first, planting nursery trees and agricultural crops at the same time was prohibited (Shang and Seki, 2003), but it came to be understood that such planting did not have adverse effects on the growth of nursery trees if it was not unbalanced, and today, the

"Returning Farmland to Forests" policy is being promoted by planting nursery trees and agricultural crops at the same time. In the Yi society, meanwhile, the number of elderly persons living in mountainous and outlying places is on the rise, and for these people it is becoming difficult to cultivate land on the steep slopes. For this reason, fruit trees have come to be chosen as tree species that should be planted under this policy. The forestry bureau of Liangshan Prefecture actively recommends the planting of fruit trees, and in particular the planting of walnuts in the cool highlands has been well received. The types of fruits in demand vary according to the regional conditions; while the planting of Japan pepper trees is being promoted in the colder highlands, that of oranges is being encouraged in the much warmer areas.

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3 China: Rural Communities in Cohabitation with the Crested Ibis in Yang County, Shaanxi Province

3.1 Natural and Social Background

Yang County is located in the Hanzhong Basin. The county has an area of 3,206 km^2 and altitudes between 3,071 m at the highest and 390 m at the lowest (The Book of Shaanxi Province Map, 2010). The Han River, which is the longest arm of the Chang Jiang River, runs from west to east through plains in the south part of the county and all drainage systems flow into the Han River. The average annual temperature is 12 to 14 degrees Celsius (Zhang et al., 2004) with the highest temperature at 38.7 degrees Celsius (Ou, 2010). The average annual precipitation is some 900 to 1,000 mm (Zhang et al., 2004). Thus, Yang County belongs to the temperate humid climate zone. There are 16 towns, 10 villages and 367 administrative *villages*. The county's population as of 2004 was 440,000. Of the total population, the non-farming population was 67,700, which means the majority of the inhabitants of the county are farmers (Cao, 2009). According to the county's statistics in 2004-2005, Yang County had an average annual income per farmer as low as RMB 1,400-1,800, far below the national average rural income per capita of RMB 2,622 in the same year, and hence has been designated as a State-level Poor County (Yueming et al., 2007). Around the center of the county, there are market places and employment opportunities in commerce and the tourism industry, while no such employment opportunities are found in the inter-mountain areas, where poverty is particularly severe (Su and Kawai, 2004).

In 2006, China prepared the "National Environmental Protection Plan in the Eleventh Five-Years" that sets forth its goals, including the development of ecological reserves, the establishment of integrated rural environmental protection and the building of eco-models. It specifically prioritizes the protection of wild birds, especially the Crested Ibis, as it is listed in the IUCN (the International Union for Conservation of Nature) Red List of Threatened Species and has been traditionally treasured by people as "a bird bringing happiness." The worldwide attention paid to the protection of the Crested Ibis lies behind the Chinese government's prioritization of this species in its policies (JICA, 2010).

Until the end of the 19th century, the Crested Ibis was widely distributed in Northeast Asia, including China, Russia, the Korean Peninsula and Japan. Due to the increase in the felling of the trees that were used by nesting colonies of these birds, the conversion of wetlands to agricultural land and hunting, the number of crested ibises had been dwindling to such an extent that the species had been considered extinct in the wild after the last five wild ibises were captured together in Japan in January 1981 (Xiaoping Yu et al., 2006; BirdLife, 2003). Although ibises had been considered extinct in China, seven individuals were found in a village in the interior of Yang County in May 1981 and measures to protect them were taken. Crested ibises have been protected as well as artificially bred, as a result the number of wild ibises in Yang County increased to over 800 as of 2011. The Nature Reserve was established in 2001, and currently the Shaanxi Hanzhong National Nature Reserve has an area as large as 37,549 ha, of which 33,715 ha (90%) is within Yang County (the remaining 10% belongs to Chenggu County, Shaanxi Province). Most of the area of the nature reserve is located in hilly areas at an altitude of 500-1,000 m.

The reserve has 13 towns/villages and 99 administrative villages with 77,612 people in 24,696 households as of 2003, of whom 95% are engaged in agriculture. As will be described in more detail below, this requires agricultural ecosystems, including wetland fields, that

play a significant role as the habitat of the Crested Ibis, and hence also requires the understanding and cooperation of the local residents who use the agricultural ecosystem (Su and Kawai, 2004). Thus, the nature reserve adopted a "community co-management" system promoted by *The State Forestry Administration of China*, in which it is jointly operated and managed with the local residents, and established a community co-management committee in Yang zhou zhen in 2003 (Su and Kawai, 2004).

3.2 Land Use in Yang County and Habitas of the Crested Ibis

The habitat for the Crested Ibis can be categorized into three areas according to its yearly activities: nesting areas, wide active areas and wintering areas. The nesting areas are located between low and middle mountain regions, at 700 to 1200 meters above sea level. More than 60% of these areas are made up of forests, and winter paddy fields are distributed in the valleys. The wide active areas are in the hills or plains at an altitude of between 450 and 750 meters. Some secondary forests as well as many rivers and reservoirs can be found in these hills. Paddy fields, fields and grassland account for a large proportion of these areas and they are the roosts and main feeding places for crested ibises during the wide active period. Agricultural land, small rivers and ditches are concentrated in the plains. Crested ibises often catch food around paddy fields and along the banks of rivers and reservoirs (Photo 1). The wintering areas are on low mountains and hilly areas between the nesting and wide active areas. These areas are stopover sites for resting ibises when moving from a wide active area to a nesting area (*Ding et al.*, 2004). Thus, a variety of environments is required to enable a crested ibis to inhabit. The environment of a mixture of secondary forests, wet fields, ditches and tanks in a mosaic pattern provides the habitat and nursery for various creatures, including endangered species. At the same time, such an environment also works as a venue for the life and livelihood of human beings (Su and Kawai, 2009).

Photo 1. Crested Ibis feeding in harvested paddy fields (Caoba village) (photo: Kojiro Mori)

In Yang County, a large proportion of rural land is used for agricultural purposes, including arable land for crop cultivation such as rice, wheat, corn and tubers, as well as orchards. The arable land of the county can be classified into three types: dry fields, wet fields, and rotational fields. A "dry field" refers to farmland in general, which is not submerged under water all year long, while a "wet field" is submerged under water all year long with wet rice being cultivated in summer and fallowing in water in the other seasons. The "rotational field" refers to arable land with double or multiple cropping, which is submerged under water in summer for wet rice cultivation and is dried out in winter for the upland crop cultivation, including wheat, corn and tubers. In Yang County, the wet fields are largely located in between mountainous areas, while the rotational fields with double cropping are in the plain areas (Su and Kawai, 2009).

The Crested Ibis needs for its subsistence wet fields that provide them with abundant weatherfish and aquatic insects. The wet fields submerged in winter, in particular, offer important feeding grounds for the crested ibises as they have their breeding season in winter. The area of wet fields in Yang County is 12,773 ha, accounting for 50.3% of the total arable land. There are also 80 reservoir dams and 2,232 tanks in the county. Such rich swamp resources thus enable the crested ibises to inhabit Yang County (Su and Kawai, 2009).

After the rediscovery of the Crested Ibis in the wild, the government of Yang County has promoted environmentally friendly

agriculture to ensure improvements in their habitat by submerging fields under water in winter and restricting the use of pesticides and chemical fertilizers. Additionally, the government of Yang County has taken measures such as banning the felling of trees around nesting places and roosts, ordering the closure or eviction of quartz mines and cement factories, etc. In Caoba village (Photo 2), Yang County, for instance, barren and sloping land had been tapped for pear orchards since the 1980s after the commencement of the Economic Reform and Open Door Policy. In the mid-1990s, when the Crested Ibises inhabited areas around the village, the government directive shifted towards ecological agriculture with less pesticide to ensure the protection of their habitat. Subsequently, less pesticide has been applied to the pear orchards, which were converted from wheat or corn cultivation. Many of the products cultivated in this way are certified as "Non-polluted food" by the Agriculture Department of the Shaanxi Province and are traded at higher prices in the market. In Caoba village, this shift toward the use of less pesticides in orchards not only led to an improvement in the habitat for wild birds, including the Crested Ibis, but to strengthening of the functions of sediment discharge control and an increase in income for the villagers. Moreover, the pruned pear branches are used as household fuel, reducing the stress on the forests for firewood and charcoal-making. In Caoba village, the pear orchards play a significant role in the village economy, as well as in the natural environment (Su and Kawai, 2004; JICA, 2010). The village is active in protecting the Crested Ibis through the signing of an agreement by the Village People's Committee, which the village people's autonomous body, with the nature reserve regarding its protection. This agreement was intended to protect the miscellaneous areas of forest where the Crested Ibis roosts by banning the grazing, logging and the gathering of wood for firewood and charcoal-making (Su and Kawai, 2004).

Photo 2. Full view of Caoba village (photo: Kojiro Mori)

Similar efforts toward reintroduction of the Crested Ibis have been made in Sado Island, Japan, and Changnyeong-gun, Gyeongsang, Republic of Korea by encouraging organic agriculture methods without the use of pesticides to create an environment suitable as a habitat for the species. In another part of China apart from Yang County, there is a steady population of wild crested ibises that has been brought to and released in Ningshan County, Shaanxi *Province. Artificial breeding of the Crested Ibis has been promoted in the* Dongzhai National Nature Reserve in Henan Province and *Deqing* County, Zhejiang *Province, with the aim of releasing them into the wild. The preservation and creation of an environment in which crested ibises can live is the immediate priority for each area.*

3.3 Challenges and Responses

Decrease in and Degradation of the Feeding Grounds

In winter, crested ibises mainly eat water creatures such as weatherfish, swamp eel (*Monopterus albus*), river crabs and pond snail (Viviparidae spp.). Winter paddy fields are therefore the main feeding places. However, the cultivation method has changed from a one-crop system to double-crop system since the 1980s. Since then, many farmers remove the water from the paddy fields after the harvest in autumn to cultivate wheat or vegetables. The feeding areas for crested ibises in winter has thus

dramatically declined and securing wet paddy fields submerged in winter is the priority issue (*Ding et al.*, 2004). Taking into account the increased number of the wild crested ibises, improvements in their feeding grounds are urgently required (Su and Kawai, 2009).

Decline in Agricultural Productivity and the Countermeasures

The decrease in rice yields due to regulations on the use of pesticides and fertilizers to protect the habitat of the Crested Ibis has had a significant impact on the incomes of the farmers. Incomes declined due to avoidance of the use of pesticides and chemical fertilizers, which amounted to the equivalent of approximately 150 kg per 1 mu (Chinese area unit, 1 mu is about 6.67 are) of paddy fields (Cao, 2009). Pear cultivation in Caoba village suffered from considerable damage due to pests and diseases in 1997 and in recent years (JICA, 2010). In response, the nature reserve has taken various measures to support the life of farmers. These measures include the development of roads, ditches and small hydroelectric power plants, support for the improvement of the lives of the inhabitants of the area such as support for the cultivation of fruit, herbal plants, etc., the signing of protection agreements with villages and individuals to protect the environment for nesting sites and roosts (including rewards for their successful protection), the employment of residents as patrol staff (temporary workers), etc. Experimental direct compensation for the farmers also started in 2008 and the decline in farm incomes due to the restrictions on the use of pesticides and fertilizers has been compensated for by a certain amount of payments. The compensation, however, faces major difficulties in terms of the inadequacy of the amount and the securing of the finance, resulting in arrears in payments in some areas. As the compensation payments do not necessarily provide a medium to long-term solution, it is necessary to establish stable production techniques and build mechanisms for economic self-reliance (JICA 2010; Su and Kawai, 2009).

China established three types of certification for organic agricultural products and products that were cultivated using less pesticide: (i) Non-polluted food; (ii) Green food; and (iii) Organic food (Zhao, 2009; Song 2008). A number of pear orchards in Caoba village have acquired the certificate of "Non-polluted food", leading to the expansion of market channels and sales at 50-60% higher prices in the market (Su and Kawai, 2004). In 2003-2004, the Green Rice Project was implemented in three villages, including Caoba village, with the assistance of WWF (World Wide Fund for Nature). In this project, based on a contract with the Crested Ibis Protection Center, the farmers cultivate wet rice without using pesticides and chemical fertilizers, and the harvested rice is designated as "Green Rice" after being certified as "Green Food" and is certainly sold at a price that is 15% higher. The decline in the farmers' income due to the application of organic farming techniques has been offset by the payment of compensation and the increase in the purchase price of Green Rice by being certified as Green Food (Su and Kawai, 2004).

For other approaches, the Yang County Society for the Protection of the Crested Ibis (the 13th out of 14 societies established for the protection of birds in China) works on the environmental education for children and the monitoring of crested ibises. These activities are supported by Yang County and Shaanxi Province (JICA, 2010). In addition, JICA commenced a five-year "Project for the Harmonization of the Local Community and the Crested Ibis" in 2010 that intended to show a balanced model between the protection of the habitat for the Crested Ibis and the improvements in the local people's livelihoods. Its activities include surveys and monitoring in their habitat, support for releasing crested ibises back into the wild, livelihood improvement activities through organic agriculture, eco-tourism, etc., and environmental education.

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4 Japan: Satoyama focusing on rice cultivation in Noto and Kaga Regions

4.1 Natural and Social Background

Ishikawa prefecture consists of the Noto Peninsula (Noto region), which is located almost at the center of Honshu island on the Sea of Japan coast, and the Kaga region that lies south of Noto. The prefecture is elongated from north to south. It has a varied natural environment from the coast to high mountains, which is like a miniature version of the Japanese Archipelago. The area of Ishikawa Prefecture is surrounded by the sea on three sides. It has a warm climate despite its high latitude due to the influence of the Tsushima Current (Ishikawa Prefecture, 2011). The mean precipitation in Kanazawa city is 2,399 mm and the region has more rainfall and snowfall than other regions in Japan (Japan Meteorological Agency). Ishikawa Prefecture is home to many plants including *Camellia japonica* subsp. *rusticana,* which is suited to the climate of the heavy-snow region along the Sea of Japan, and an alpine flower, *Fritillaria camtschatcensis*. Large-sized forest animals such as black bears (*Ursus thibetanus*) and *Capricornis crispus* can also be seen here. Reflecting the diverse habitat environment, 430 avian species have been identified so far. In the prefecture as a whole, secondary forests account for a large percentage of the land area (Ishikawa Prefecture, 2011). In the Noto region, a small area of *Fagus crenata* forest can be seen on mountain peaks. However, most of the area consists of agricultural land or secondary forest/ artificial forest of *Quercus serrata*, etc. In the Kaga region, lowlands are mainly used for agricultural purposes. Secondary forests of *Q. serrata* and *Pinus densiflora* stretch out in hilly areas and on low mountains. Large *Fagus crenata* forests can be seen in areas at altitudes of 800 meters and above. In hilly areas and on low mountains in the Noto and Kaga regions, the bottom parts of valleys along small rivers are used for rice paddies, and the slopes and ridges for coppice woodlands and plantation of *Cryptomeria japonica.* In Japan, areas that consist of agricultural land and settlements (which have been formed through agriculture and forestry), as well as secondary forests, grassland and the reservoirs surrounding them, are known as “Satoyama” (Photo 1 and 2).

Photo 1. Paddy fields, brush and settlements in Kaga Region (Kanazawa city) (photo: Japan Wildlife Research Center)

Photo 2. Paddy fields, brush and settlements in Noto Region (Noto-jima, Nanao city) (photo: Japan Wildlife Research Center)

The population of Ishikawa Prefecture is approximately 1.17 million (2011). Of the total, the population of the Noto region is approximately 210,000 and that of the Kaga region is approximately 960,000 (Population Labour Group, Statistical Information Office, Prefectural Exchange Division, Prefectural Culture Bureau, Ishikawa Prefectural Government, 2011). The population has been declining and aging. The productive population, aged between 15 and 65, has been declining since 1995, and the total population has been continuously declining since its peak (approximately 1.18 million) in 2000. In particular, the northern part of the Noto region is facing a serious situation, showing a continuous population decline for over 40 years (Ishikawa Prefecture, 2011).

4.2 Characteristics of satoyama landscapes in Ishikawa and changes in agriculture

Paddy rice cultivation using abundant water

Ishikawa Prefecture has a relatively warm climate and high precipitation and it is abundant in water, which is suitable for paddy rice cultivation. As the region is not suitable for cultivation in winter due to snow, rice is the main agricultural produce (Japan Satoyama Satoumi Assessment, Hokushinetsu Cluster, 2010). The rice acreage in Ishikawa Prefecture in 2010 was approximately 284km^2, which accounts for 6.8% of the total area of the prefecture, while 79% of the total crop cultivation area in the Noto region and 89% in the Kaga region were rice paddies (Statistical Information Office, Prefectural Exchange Division, Prefectural Culture Bureau, Ishikawa Prefectural Government, 2011).

Rice (*Oryza sativa*) is widely cultivated in warm regions (mainly Asia) of the world. It is one of the world's three leading cereal crops along with wheat (Triticum spp.) and corn (Zea mays) ("*Sekai yûyô shokubutsu jiten*" (Yamazaki et al., 1989). There are two types of rice: paddy rice which is cultivated in paddy fields and dry rice which is cultivated in dry fields. Mostly, only paddy rice is cultivated in Japan. Paddy rice cultivation is suitable for areas that are abundant in water and hot in summer. In paddy fields that are filled with water, soil quality is well maintained and there is no erosion. Paddy rice can be continuously cultivated because it is not damaged by continuous cropping (Yamazaki et al., 1989).

Rice paddies have been developed from long ago in Ishikawa Prefecture. During the early Edo Period (mid 17th century to early 18th century), new fields were actively developed in order to stabilize the finances of the Kaga Domain. The Tatsumi Water System, one of the four largest water systems in Japan, was developed in 1632 (Japan Satoyama Satoumi Assessment, Hokushinetsu Cluster, 2010). Water is essential to paddy rice cultivation. Securing (irrigation) and adjusting of water to be used is the most important issue in developing and maintaining agricultural land. Irrigation water for rice cultivation is taken from rivers, reservoirs or spring water through ditches. In this way, water is evenly spread throughout all paddy fields, and the depth of water in the fields can be adjusted. In Ishikawa Prefecture, irrigation water in many fields is taken from rivers due to the high precipitation in the region. However, reservoirs are used for irrigation in some areas. Reservoirs in Ishikawa Prefecture play an important role as the habitat for rare insects, amphibian and avian species. They are part of the essential environment for maintaining biodiversity in the prefecture (JWRC, 2004).

The outline of the paddy rice cultivation method employed in the Noto region is as follows: (JA Hakui, Hakui Municipal Farming Promotion Committee, 2011). Like other regions in Japan, paddy rice is cultivated by planting seedlings that are grown in a rice nursery. Koshihikari, the variety that is most cultivated in Ishikawa Prefecture is seeded in late March and planted in paddy fields in early May. Once seedlings that have around three leaves each are planted, they grow rapidly increasing their number of leaves and

stems. Rice ears emerge in early August and are harvested in mid September. The management of water in rice paddies is important for paddy rice cultivation. It is necessary to keep the water deep immediately after rice planting and make water shallower during the period between mid-May to mid-June during which the growth of the seedlings becomes active. In mid-June, when the number of stems per root exceeds 12, water in paddy fields is taken out to control the growth of stems, and fields are kept dry until early July. This process is known as "mid-summer drainage." The water level is increased around the time of ear emergence, and the water is removed again in early September to harvest in dry fields. Paddy fields are maintained almost dry during the winter time. Of around 17,700 agricultural management entities in Ishikawa Prefecture, the majority (around 17,200 entities) are family-run businesses (Statistical Information Office, Prefectural Exchange Division, Prefectural Culture Bureau, Ishikawa Prefectural Government, 2011).

Changes in agriculture

Along with the scale-down of the primary industries across the whole nation, those in Ishikawa Prefecture have dramatically been downsized. The factor causing the scale-down of agriculture in Japan is the change in people's dietary habits, including the decline in the consumption of rice and the increase in the consumption of animal products (meat, dairy products, etc.) and fat and oil, as well as the rice acreage reduction policy. The total area of agricultural land was 68,600 ha in 1965 (percentage of paddy fields: 82%). In 2006, it dropped to 44,300 ha (percentage of paddy fields: 84%), a decrease of approximately 40% over the previous 30 years (Ishikawa Prefecture, 2011).

The aging of farmers has also progressed. In 1950, the working population of the primary industries in Ishikawa Prefecture accounted for 52.6% of the total working population. However, it decreased to 6.4% by 1980 and 3.9% by 2005, showing continuous decline (Ishikawa Prefecture, 2011). Of the working population of the primary industries, the number of workers in the agriculture section decreased from approximately 230,000 (1960) to 94,900 (2006), down by nearly 40%. The number of core farmers who work full time in the farming industry has changed dramatically and totaled approximately 17,000 in 2006, which accounts for 12% of that in 1960 (approx. 140,000). Meanwhile, the percentage of core farmers aged 60 and over increased from 30.5% (1983) to 79.8% (2004), showing that the majority of farmers are the elderly (Japan Satoyama Satoumi Assessment, Hokusinetsu Cluster, 2010).

Use of woodland and its decline

Coppice woodland is an important element that makes up Satoyama, along with rice paddies. In the past, they were particularly essential for producing charcoal. The following description is based on the Nature Conservation Division, Environment and Safety Affairs Department, Ishikawa Prefectural Government (2004) and the Japan Wildlife Research Center (2004). Forests account for approximately 69% of the total land area of Ishikawa Prefecture (JWRC, 2001). In particular, *Q. serrata* comprises a large percentage of the area (24%) in the prefecture. *Q. serrata* is mainly used as the material of wood charcoal. *Q. acutissima* and *Q. variabilis* were once used in the Kaga region, and *Q.crispula* in the cooler Noto region. When these woods are cut down, tillers come out of the stumps. Timber can be produced continuously by thinning and growing the tillers. Demand for wood charcoal was previously high, and woods were cut down every 15 to 30 years.

The annual production volume of wood charcoal in the prefecture around 1950 exceeded 40,000 tons. However, as propane gas and petroleum oil became widely used after 1960, the production of wood charcoal dropped rapidly (Japan Satoyama Satoumi Assessment, Hokushinetsu Cluster, 2010). Although timber is still used for the bed logs of Shiitake mushroom (*Lentinula edodes),* one of the representative edible mushrooms, even it

is decreasing significantly in conjunction with the increase in Shiitake mushroom production using mushroom beds and the decrease in production using raw wood (Japan Satoyama Satoumi Assessment, Hokushinetsu Cluster, 2010). In the Noto region, some coppice woodlands are used for producing wood chips for paper making. However, coppice woodlands are not used as much as they were in the past.

When a high volume of wood charcoal was produced in the past, coppice woodlands were maintained by the regular trimming of trees, mowing and clearing of leaves. As a result, many *Lilium japonicum and Asarum spp.,* and *Luehdorfia japonica,* which eats these plants, could be seen as they prefer a light environment. These animals and plants adapt to a lighter environment that is moderately disturbed. Therefore, they will disappear if coppices woodlands are no longer maintained and bristle with bamboo grass and evergreen broad-leaved forests.

The maintenance of coppice woodlands (trimming of trees, mowing, etc.) in the Kaga region stopped as wood charcoal production decreased. Trees grew larger and the lighter deciduous forest has been replaced by the darker evergreen forest. As the import volume of bamboo shoots increase, bamboo forests *(Phyllostachys pubescens*) that were planted to produce bamboo shoots are less managed, and an increasing amount of bamboo is intruding in the surrounding woodlands in some places. As a result, the number of living organisms that choose a lighter environment decreased. It is pointed out that the level of biodiversity which has previously been well maintained is inclined to decrease (Ishikawa Prefecture, 2011).

4.3 Challenges and Responses

As a specific measure taken by the government for the improvement of Satoyama in Ishikawa Prefecture, the prefecture formulated the "Ishikawa Biodiversity Strategic Vision - toward an Ishikawa Where Ibis Fly" in March 2011. In this vision, the ibis (*Nipponia nippon*), which is closely associated with Ishikawa Prefecture, is used as the symbol of biodiversity. Setting the medium- to long-term goal to be achieved by 2050 - "passing down Satoyama-Satoumi with abundant life and ibises to the next generation" - the prefecture aims to utilize and preserve Satoyama and Satoumi (Ishikawa Prefecture, 2011). Of the seven priority targets to be achieved by 2020, the first is the "creation of a new value for Satoyama-Satoumi" and the second is the "development of a new form of Satoyama with the participation of various entities." The prefecture is encouraging many entities to participate in these activities by adding contemporary value to Satoyama-Satoumi. In April 2011, Ishikawa Prefecture established a Satoyama Creation Office in its Environment Department as a coordinating center for integrated measures for the utilization and preservation of Satoyama-Satoumi, and also to provide an actual operating force that could revitalize Satoyama-Satoumi by linking various entities such as companies, NPOs, education institutes and local organizations with the Satoyama landscape. Moreover, the prefecture established the "Ishikawa Satoyama Creation Fund" with a total capital of 5.3 billion yen funded by the prefecture itself and local financial institutions in May 2011, promoting the "Ishikawa Satoyama Creation Fund Project" that aims to create energetic Satoyama and Satoumi using the profits and contributions from companies (website of the Satoyama Creation Office, Environment Department, Ishikawa Prefectural Government). As a publicly-offered project, this includes support for the creation of works using the local resources of Satoyama and Satoumi (e.g. production of special local products, pre-production, model tours, etc.).

In addition, there are the efforts of higher education institutions such as those of Kanazawa University. One of the more notable activities is the Satoyama Meister Training Program (Nakamura and Kada, 2010; Noto Satoyama Meister Training Program Web site) which was established with the aim of fostering local leaders who will contribute to the revitalization

of Noto by creating environmentally-friendly agriculture, forestry and fisheries industries and to develop new Satoyama Satoumi businesses. Other objectives of the program include: 1) the creation of a natural environment in which various animals and plants can coexist by revitalizing and linking together Satoyama landscape and Satoumi, 2) the creation of environmentally-friendly agriculture, forestry and fisheries industries that are essential to achieve by combining intellectual properties of universities (modern science and technology) with traditional knowledge of the area (traditional technique and experience), and 3) a detailed proposition on technology and management that could provide business opportunities.

There is also an effort called, "Kanakura School," which is an activity conducted by an NPO in Kanakura District, Machino Town, Wajima City in the Noto region (Matsui et al., 2010; NPO Yasuragi no Sato Kanakura School Web site). The aim of their activity is to contribute to the development of the whole Noto region through seeking and transmitting true attractive aspects of Noto. The district has a history of over 500 years since the Muromachi Period, and a cluster of temples is spread in the region. The NPO is working on projects that study and put into practice the use of the unique resources of Noto, offering visits to historical places such as shrines, holding events to revitalize the Noto region, agriculture experiences, direct selling of agricultural products, management of a cafe using local produce, etc.

As stated above, the population that supports the agriculture of Ishikawa Prefecture is declining and aging. This is leading to the abandonment of management of agricultural land and woodlands, and as a result, the deterioration of biodiversity is progressing. Generally, these phenomena can be seen in many parts of Japan and an evaluation of Satoyama-Satoumi was conducted throughout the nation over four years from 2007. This is the result of applying the approach and framework of sub-global assessment that was developed in the Millennium Ecosystem Assessment (MA). Discussions have been held over these regions after many people from various organizations, including research and education institutions and municipalities, sent in information during the assessment of the Hokushinetsu region (Japan Satoyama Satoumi Assessment, Hokushinetsu Cluster, 2010) and it is expected that, through such activities, the current situation and issues regarding Satoyama-Satoumi will be summarized and utilized to determine future measures.

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5 Mongolia: Nomadic Pastoralism in the Mongolian Plateau

5.1 Natural and Social Backgrounds

Mongolia is among the countries with the highest altitude in the world, with the Altai Mountains (about 4,300 m above sea level) and the Hangayn Mountains (about 4,000 m) towering to the west, as well as the Mongolian Plateau at an altitude of 1,000-1,500 m stretching to the east. Precipitation amounts to less than 400 mm per year with a relatively higher amount in the north, where moisture from the Arctic Ocean passing over Siberia runs into the mountainous plateau. A varied vegetation pattern in the country is created by the precipitation distribution pattern ranging from higher amounts in the north to lower ones to the south. Its vegetation zones comprise the High mountain belt, Mountain taiga belt, Mountain forest steppe, Steppe zone, Semidesert zone and Desert zone. The Steppe zone accounts for about 34% of the total vegetation cover (Ministry of Nature, Environment and Tourism of Mongolia, 2009).

Mongolia's national land of some 1.56 million km^2 is mostly covered with pastureland, accounting for nearly 80%. As for the climate, its inland location leads to lower rainfall, while its high plateau location keeps the temperatures, and hence the moisture evaporation, lower. The seasonal fluctuations in precipitation are significant, concentrated in a period between mid-May and August, when the plants grow faster with the longer hours of solar radiation and rising temperatures due to the country's higher latitude location. The average temperature in July is 16-24 degrees Celsius as compared with minus 16-24 degrees Celsius or below in January. One could argue that Mongolia's geographical conditions characterized by its inland location, plateau topography and high latitude are well suited to pasture growth (Kamimura, 2004). The Mongolian plateau has more than 2,600 species of plants, of which over 600 comprise pasture species. The main pasture species include those from the *Poaceae, Typhaceae, Liliaceae, Compositae* and *Chenopodiaceae*. In the rangelands, the same kind of pasture grows in clumps, altogether forming a gigantic patchwork of different kinds of pasture. The use of a rangeland covered with a specific species of pasture is selected depending on the season, as well as on the physiological and biological characteristics of, and the tastes of, the livestock (Imaoka, 2005).

Since the Mongolian People's Republic was proclaimed in 1924, following the 1921 People's Revolution, the country maintained a socialist regime for a long time through which land was nationalized and modernization was pursued under a centrally-planned economy system. In 1955, it also introduced a system of agricultural collectivization by pastoral cooperatives known as *negdel*. Reforms were made to the political and economic regime from the late 1980s in the wake of the USSR's policy of *perestroika*. This led to regime transformation from a socialist system with a centrally-planned economy to a democratic system with a market economy. The country was renamed Mongolia with a democratic constitution taking effect in 1992 after the collapse of the USSR. Under the market economy system, the ownership of livestock was privatized to enable control by nomadic households, while privatization of the pastureland itself is not allowed under the new constitution, leaving it to remain as state-owned land (Kamimura, 2004; Johnson et al., 2006; Fernandez-Gimenez, 1999).

5.2 Pastoral System in Mongolia

Structure of Nomadic Pastoralism and the Use of Grasslands

The natural conditions of a dry area are heavily dependent on the availability of water; the biggest problem is that precipitation has large temporal and spatial deviations. Because husbandry at a fixed location would result in placing fatal stress on the vegetation, proper control of the herd's load on vegetation is required in accordance with the temporal and spatial deviations of precipitation. The husbandry system that manages this control by translocation is nomadic pastoralism (Konagaya, 2007).

Nomadic pastoralism in Mongolia has taken the form of changing the rangelands season by season within a certain areal range. Shifting the sites of livestock farms reduces the stress on vegetation so that the rangelands are used in a manner that allows the grazing pastures to re-grow sufficiently. In addition, grazing multiple livestock species allows pastureland in the area to be used evenly, which in turn prevents it from degrading due to over-grazing. One could argue that nomadic pastoralism is the most reasonable land use in the steppes under the harsh natural conditions, compared with those areas more suited to agriculture in warmer climates and with more abundant water.

1) Seasonal shifts in the use of rangelands

As pastoral life is organized according to the seasons, the location of camp sites shifts seasonally within a certain area (Photo 1). Rangelands, as state-owned lands, can be used by anyone in principle. As for sites on which fixed structures such as livestock pens and barns are built and used as winter or spring camp sites together with the surrounding pastureland, however, a priority right of use is given to households who have repeatedly used, maintained and managed them (Kazato, 2006).

Photo 1. Wintering sites (Photo: Tomoo Okayasu)

The location of grazing camp sites is set according to the topography and weather. For instance, southern foothills with blocked seasonal winds from the north and less snowfall in winter and upper tablelands that receive cool winds in summer. In Hairhan, Chuluut district, 630 km west of the capital Ulan Bator, as the seasons change the camp sites are shifted to: spring camps (khavarjaa) in February-March; summer camps (zuslan) in May-June; autumn camps (namarjaa) in August-September; and winter camps (o'voljoo) in October-November. The Chuluut district is located in highlands at 1,700-2,040 m above sea level in the Hangayn Mountains, and Hairhan shares the catchment of the Khanui River. The summer camp sites concentrate on the Khanui River plain, where the rangelands cover a wider area of plain that can be sighted from the camp for several kilometers, such as the river flood plain and the vicinity of any confluence with a tributary. Livestock can drink water freely as there are streams and swamps everywhere. On the other hand, winter camp sites use valleys in the upper reaches of tributaries where the north-west seasonal winds are blocked (Kazato, 2006). Most of them are set up in the same location every year, but this is not necessarily the case for spring, summer and autumn camp sites, which are determined flexibly taking into account the condition of the grasslands that year (Saina, 2007).

In shifting rangelands, the recovery of the pasture is also taken into consideration. In summer, the pasture grows better and becomes more nutritious, leading to active grazing in preparation for winter. However, camp sites may shift after only several days

in case a longer grazing period prevents the pasture from growing well and bearing seed. In autumn, the livestock are first fed with specific species of pasture that die down earlier, and then migrate to another rangeland where the pasture stays growing longer in order to avoid overgrazing all the pasture. Combined with such seasonal shifts in the use of rangelands, pastureland with degraded vegetation is left fallow for more than two years (Saina, 2007). Thus, the rangelands are being sustainably used in Mongolia.

2) Multiple use of pastureland by different livestock species

Mongolian people have traditionally kept five species of livestock: sheep, goats, horses, cattle (including yaks) and camels (Photo 2), counting around 10.76 million, 10.65 million, 1.97 million, 1.80 million and 0.26 million head, respectively, according to statistics on the livestock population in 2003 (Imaoka, 2005; Konagaya, 2007). These five species of livestock are suitable for nomadic pastoralism due to their gregariousness and the manageability of large herds or flocks in a vast pasture land. They are also suited to the natural conditions of the steppes owing to their resistance to these conditions and their physical capabilities, as well as to their high tolerance of poor feeding and hunger conditions. Each of them, however, has different dietary preferences in terms of the species and height of grass plants and the different rates at which they move when grazing. Thus, the grazing behavior of each species of livestock rarely overlaps with regard to pastureland. As it is difficult to find pastureland areas that fulfill all the requirements of the five species, the principle of "Right Species, Right Place" has been adopted to accomplish an appropriate mix of several species of livestock suited to the grazing pastures within reach of the migration routes of the nomads.

Traditional Production Organizations

In Mongolia, nomadic pastoralism, which is family-run in principle, is operated by an area-based community for increased efficiency comprising several families known as "*khot-ail*". The *khot-ail* is organized within two to three families among the parents and children as well as in-laws (Soyllkham, 2004; Fernandez-Gimenez, 1999). Grazing larger livestock including camels, cattle and horses requires the strong physical force of men, while milking and processing for all the herds is the labor of women and children. As the labor force of a single family is insufficient, several families organize themselves into a community in which there is a division of labor with regard to the grazing of several livestock species, milking, shearing, the setting up of winter camp sites, etc. The *khot-ail* system was established in the 14th-15th centuries and lasted until around 1960, when the pastoral cooperative (*negdel*) system had already become prevalent under the socialist regime (Imaoka, 2005).

Under the *negdel* system, the ownership of livestock was transferred to cooperatives, while each family took charge of and grazed 400-500 head of livestock and contributed their products to the *negdel*. Only a single species of livestock was assigned to each family, compared with multiple species grazed under the *khot-ail* system, which negatively affected the vegetation since acquiring the feeding pasture for a single species required extension of the total area required for grazing (Soyllkham, 2004).

In the post-socialist era, the *khot-ail* system was reappraised for its well-functioning utilization of grasslands and livestock resources in a collaborative and efficient manner, and hence has been revived to become the only form of production organization for nomads after the *negdel* system was dissolved in 1991 (Imaoka, 2005).

Photo 2. Sheep and goats in rangelands (Photo: Tomoo Okayasu)

Table 1. Livestock species and their characteristics

	Horses	Cattle	Sheep	Goats	Camels
Characteristics	Higher resistance to cold and excellent mobility	Greater capacity for endurance and greater ability to defend themselves against wolves	Higher resistance to cold and dry conditions, and docile nature	Higher fertility and agility	Higher resistance to cold and dry conditions
Suitable pastureland and pasture preferences for the species of livestock	Pastureland rich in weeds growing on the hills and tablelands (poaceous pastures)	Grasses growing on high moisture soils along rivers, mountain streams, etc.	Pasture in grasslands (Agropyron cristatum , etc.)	Intermountain shrubs (chenopodiaceous pastures)	Halophilous plants on flat plains

Source: Saina, 2007 (partly changed)

Benefits of Nomadic Pastoralism

Nomads procure most of the materials for food, clothing and shelter from their livestock by using the meat and milk for consumption, the fur or skins as they are for rugs or for tanning treatment to make leather, and the bones and horns are made into baby bottles and toys, as well as fortune-telling instruments (Saina, 2007). A portion of the raw milk harvested in summer is consumed as yogurt or fermented mare's milk during that season, while most of the rest of it is processed and preserved for consumption during the off-season for milk production in winter to spring. It is in November before winter starts that the livestock are best slaughtered, partly because they have the highest store of fat in their bodies and partly because the slaughtered meat can be naturally frozen and dried. During this time, the nomads slaughter several head of livestock together to provide food until the next spring (Kazato, 2006). Large livestock, including horses, cattle and camels, are used for transportation to carry people and the materials and objects they need to take with them. Thus, the livestock are utilized in a variety of ways.

Feeding pressure by livestock has the most significant impact on the grassland ecosystem. In the Mongolian traditional system of nomadic pastoralism, however, such feeding pressure is minimized due to the greater extent of temporal and spatial distribution of the grazing, resulting in moderate disturbance to a wide area of grasslands. The more often livestock eat the plants (grazing), the lower the height of the grass shoots in the grassland. In the Mongolian Plateau, the relationship between grass height and the average number of plant species per square meter is such that the number of species is small in both areas with tall and short grass, and peaks at around 30 species in the areas with medium-height grass. This implies that moderate feeding pressure has augmented the diversity of species in grasslands (Fujita et al., 2005). In contrast, where the pasture is far from the residence of the nomads or the livestock are prevented from eating the grass by being penned, the plants grow well and competition among them is intensified, leading to the dominance of only the winning species and resulting in a reduction in the species diversity (Fujita et al., 2005). Thus, human intervention has sustained a grassland ecosystem that has a high level of biodiversity in the Mongolian Plateau.

5.3 Challenges and Responses

One major factor that could significantly determine the existence of nomads is *dzud* or snow disaster. A *dzud* is caused by serious lack of fodder resulting from ice covering the grass, low temperatures, strong winds or the previous year's summer drought. Large numbers of animals die due to starvation and considerable damage is inflicted upon the nomads (Otani et al., 2004; Shinoda and Morinaga, 2005; Tachiiri et al., 2008). The 1999/2000 *dzud* was the severest in 50 years, killing 8.2 million head of livestock (Tachiiri et al., 2008). Global climate change could intensify droughts in Mongolia, and it is

feared that intensified droughts would lead to aggravation of *dzud* (Shinoda and Morinaga, 2005). Moreover, degradation of the pastureland ecosystem due to over-grazing is thought to expand damages (Otani et al., 2004). Coping with the problems of *dzud* is a major challenge that Mongolia needs to address.

There are also challenges that emerged after democratization. In 1991, Mongolia transformed itself from a socialist country to a democratic country with a market economy. In connection with these changes, the *negdel* system under the socialist regime was dissolved, and the public sales channel of livestock products was closed. Hence nomads were forced to conduct marketing by themselves and the geographical distance to markets became important. As a result, a regional divide emerged, and many nomads are attempting to narrow the divide by moving close to Ulan Bator and other big cities and performing sedentary grazing there (Konagaya, 2007; Kato, 2007). Such a concentration of livestock results in over-grazing and impacts the pastureland ecosystem (Fujita, 2005). The Law on Land enacted in 1994 (as amended in 2002) authorizes heads of local governments to regulate seasonal movements and the number of animals one is allowed to own, but little success has been achieved (Fernandez-Gimenez, 2006).

In addition, due to the high inflation rates up to the early 1990s, as well as the willingness not to reduce livestock, which represented a form of capital in the face of their concern about the future, the nomads refrained from selling their livestock. Only cashmere, with its relatively high price in the international market could provide a livelihood that gained a cash income, leading to an increase in the number of goats kept by the nomads. As a result, an increase in the proportion of goats in the total livestock population has changed the balance of the grazing pressure that had been maintained for a long time. To cope with this problem, greater dispersion of livestock has been promoted through the use of the tax system. Mongolian pastoralists are set to be charged a livestock tax. Amendments to the income tax law in 2002 required a change in the livelihood taxation method. The amount of tax is determined by converting the number of livestock owned by each household into the equivalent number of sheep with different conversion factors according to the species. In the amendment, one goat is converted into the equivalent of 1.5 sheep, raising the taxation level on goats (Komatsu, 2008). This measure is considered to be an attempt to reduce the number of sheep.

As wells supplying water to camp sites are indispensable for pastoralism, under the socialist regime it was the State that took the initiative in installing and maintaining them. In the post-socialist era, the decline in the number of available wells due to the inadequate level of construction as well as operation and maintenance problems has led to a reduction in the area available for grazing, which in turn is considered to have caused local overgrazing. As a measure to deal with this problem, Action Plan of the Government of Mongolia for 2004-2008 stipulated a closely related objective of repairing 1,900 units of mechanical wells and digging an additional 800 units. In connection with this, the 2005 Action Plan of the Ministry of Food and Agriculture laid out the conditions for the effective use of wells and water source areas in grasslands (Komatsu, 2008).

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6 South Korea: Traditional Rural Landscape "Maeul"

6.1 Natural and Social Background

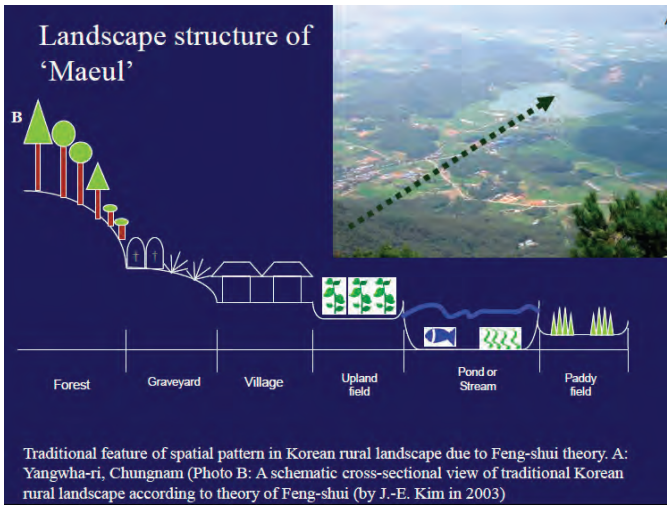
While the northern part of South Korea, which extends from north to south, has a cold climate with little rain, the southern part, situated in the temperate zone, is warm and has a high rainfall regime affected by the ocean. The country has two thirds of its land covered with forests. The characteristic forest vegetation of South Korea consists of *Pinus densiflora*, *Quercus spp*, and *Aceraceae*, and most of the forests close to settlements and agricultural land are dominated by *Pinus densiflora* . Since the entire country was devastated by the Korean War, which began in 1950, there are many secondary forests, which are 30 to 40 years old. Agricultural land accounts for about 18% of the national land, distributed mainly in the southwestern part of the country, and 60% of it is accounted for by paddy fields (Republic of Korea, 2009).

After the end of the Korean War, South Korea began to achieve rapid economic growth in the 1960s. The government formulated the first and second five-year economic development plans, which covered the period from 1962 to 1972, but since these plans focused on industrialization, physiocratic agricultural policies were abandoned one after another with spending on the agricultural sector remaining at only around 20% of total fiscal investments (Han, 1988). As a result, the proportion represented by the agricultural sector in the total working population, which stood at 60.6% in 1963, fell to 49.5% in 1970, and the percentage of the gross national product accounted for by agricultural production decreased from 39.4% to 25.2% during the same period. The ratio of the income of farmers to the income of workers in urban areas (non-farmer income) declined from 80.6% in 1966 to 67.1% in 1970, generating a regional imbalance in income (Han, 1988). In order to solve rural problems such as the regional imbalance in income that resulted from the advancement of industrialization and the influx of people into the cities and to achieve the balanced development of regional communities and the lives of their residents, the Sae-maeul movement was established as part of the priority measures taken to develop agricultural and fishing villages under the third economic development plan, which began in 1972 (Han, 1988).

After the declaration of democratization in 1987, the roles of local governments underwent major changes as local autonomy was restored. Up to that time, the central government had led regional development, but it shifted its policy from positioning local governments as organs that executed the central government's projects to allowing them to independently develop and implement administrative plans designed to revitalize rural areas. Since this shift, projects aimed at encouraging local residents to take the initiative in promoting and enlivening regional economies have replaced the previous rural policies that focused on infrastructure development (Son, 2008).

6.2 Characteristics of Agricultural Landscape "Maeul"

Rural Landscapes and Feng Shui



Traditional feature of spatial pattern in Korean rural landscape due to Feng-shui theory. A: Yangwha-ri, Chungnam (Photo B: A schematic cross-sectional view of traditional Korean rural landscape according to theory of Feng-shui (by J.-E. Kim in 2003)

Source: Hong, 2009. SATOYAMA Initiative International Workshop Realizing Sustainable Rural Society in Harmony with Nature Presentation materials.

In South Korean rural areas, land use is characterized by a mosaic of secondary forests, cultivated land, paddy fields, streams, irrigation ponds, and so forth, and such rural landscapes, including the settlements (Photo 1), are called "maeul" (Hong, 2009; Hong and Kim, 2011). The guardian deities of a village are considered to live in the mountains that rise behind these settlements, and given that there are examples of altars being built to pray for rain or hold mountain festivals, it is inferred that these deities are worshiped by the local residents. In addition, in each village, there are one or more *dangsan*, which is a place for the entire village to conduct religious rites (Photo 2). Many *dangsan*, whose structure varies from one settlement to another, consist of a combination of sacred trees, halls, piles of stones, rocks, stone statues, and other objects, and the sacred trees are often huge or old. *Dangsan*, which is jointly owned and used by the members of the village, signifies the local union of the members of the village and is an important element that constitutes the cultural landscape of villages (Shibuya, 1990).

The South Koreans have believed in feng shui since ancient times, and maeul is also strongly influenced by Feng-Shui theory (Hong et al., 2007; Hong and Kim, 2011). In olden times, kings and feudal lords used feng shui to select sites suitable for building capitals, castles, and temples. After the middle of the period of the Yi Dynasty (1392-1910), feng shui gradually spread to the general public and came to be considered important when determining sites suitable for the location of houses and graveyards (Nishigaki, 1993). "Feng" refers to the weather and climate, and "shui" relates to everything that is related to water. The South Koreans have believed that fertile land, fresh air, clean water, the fruits of the forest, and other natural blessings are brought by appropriate connections of wind and water (Nakagoshi and Hong, 2001; Hong et al., 2007). In the feng shui tradition, a landform with mountains behind it is considered auspicious. Therefore, a "maeul landscape" has small hills as part of the background and is structured so that it starts with secondary forests on the mountain side and after the forests come graveyards, settlements, agricultural land, ponds, and streams arranged down the slope in this order.

In addition, in South Korea, burial has generally been the practice since the period of the Yi Dynasty, when Confucianism prevailed. The South Koreans believed that their descendents would prosper if they construct graveyards for their ancestors at locations considered favorable in the feng shui tradition, and, based on this belief, they constructed many graveyards in the south-facing lands that lay between the secondary forests and the villages. Graveyards are built by felling the woods, piling up earth, and covering the earth with *Zoysia japonica*. These traditional landscapes in rural areas are maintained by removing shrubs and weeds that extend out from the neighboring forests and doing repairs to the graveyards once or twice a year. If the graveyards are abandoned due to a fall in the agricultural population and changes in the lifestyles of the villagers, however, the graveyards and their surroundings become wasteland, degrading the traditional landscape and affecting the dynamics of the vegetation (Kim et al., 2007; Hong et al., 1995).

Photo 1. Cultivated land and secondary forests (Photo: Japan Wildlife Research Center)

Photo 2. Dangsan (Photo: Japan Wildrlife Research Center)

The Cultural Heritage Administration of Korea designates the various types of village forest as *bangpungnim* (windbreak forests), *hoannim* (forests established along riverbanks or coast lines to prevent floods), *eoburim* (fish shelter forests) , *dangsup* (sacred forests), *yeoksarim* (forests to which historical stories and legends are attached) and the *seonghwannim* (forests under the tenets of "Feng-Shui" theory) (Hong et al., 2011). *Seonghwannim* are the secondary forests around the settlements which are developed to make up for the defects in the landforms or geographical features around the settlements, if they are regarded as unfavorable or deficient when seen from the viewpoint of Feng-Shui (Shibuya, 1990). One example is that if the mountains in a certain direction are too low, secondary forests are created in that direction to prevent the winds that disperse moisture from the soil. In this manner, the secondary forests behind or around settlements, which are jointly used as places to conduct religious rites, are important elements that constitute the rural cultural landscape of South Korea, in addition to fulfilling practical functions.(Hong and Kim, 2011).

Changes in the Rural Landscape

Located in South Chŏlla Province in southern South Korea, Teokseong-ri is an ordinary settlement that has paddy fields and secondary forests, two characteristics of rural areas in the country. According to the Statistical Year Book, the number of farming households in Teokseong-ri started to decline sharply in the 1980s, and at the same time, the area of paddy fields decreased. But rice production has continued to grow compared to the 1980s though it fluctuated from time to time. This is because the agricultural efficiency of the settlement improved due to mechanization and the introduction of chemical fertilizers (Kim et al., 2006).

Secondary forests have been used to provide timber, fuel for ondols (traditional underfloor residential heating systems in South Korea), firewood and charcoal, fertilizer, and for other purposes, as well as for the gathering of edible wild plants and mushrooms (Youn, 2009). Human interventions such as cutting off branches and collecting fallen branches and leaves to allow sufficient light to penetrate into the forests, thus promoting the growth of seeds, have contributed to the maintenance of these forest ecosystems (Kim et al., 2006). In the rapid economic growth in the 1960s, however, firewood was replaced by fossil fuels (Youn, 2009), and use of chemical fertilizers were increased, thus decreasing the use of secondary forests. The forest vegetation of Teokseong-ri is mainly composed of *Pinus densiflora* , *Q.*

mongolica, and a mixed of *Pinus densiflora* and *Quercus* spp. Some reports claim that without human intervention, *Pinus densiflora* forests change into a mixed type of *Pinus densiflora* and *Quercus* spp(Kim et al., 2006). At Teokseong-ri, too, the percentage of *Pinus densiflora* to the total area of forests fell from 47.9% to 30.6% while that of *Q. mongolica* and other oaks rose. The proportion of lots in which *Pinus densiflora* were dominant also fell, from 15.3% to 6.7%, while on the other hand, that of lots dominated by *Q. mongolica* and other oaks rose. As described above, the forest ecosystem in the villages has undergone changes (Kim et al., 2006).

6.3 Challenges and Responses

Due to the rise in demand for labor in the industrial sector during the period of economic growth that began in the 1960s, people moved from rural villages to urban areas, substantially reducing the agricultural population. In the 1990s, the market for agricultural products was increasingly opened to the rest of the world, and imports of low-priced agricultural products increased. Partly because of this, the rural economy shrank as rural communities lost their vitality. Even today, agricultural land in South Korea is continuing to decline mainly for such reasons as the conversion of agricultural land due to urbanization and industrialization and an increase in the area of cultivated land that is abandoned due to the ageing of the population caused by the drift of young people and those in their prime of life to the cities. The area of agricultural land declined from 2,298,000 ha in 1970 to 1,715,000 ha in 2010 (You and Iizawa, 2005; Statistics Korea, 2011). The "Sae-maeul" movement, which meant "creating new villages" in the spirit of self-help and cooperation, started on a nationwide scale in the 1970s. This was a movement to modernize farming villages and aimed to improve their economic, social, and cultural status using a maeul as the unit of the movement, thus raising the level of welfare of all rural areas in the country. In addition, a wide range of projects such as improving the living environment, developing the production infrastructure, and increasing agricultural incomes were carried out, and as a result, the income of farmers grew and their living standards improved. In these rural development projects, however, the characteristics of individual agricultural villages and their traditional customs were not taken into consideration as a result of the uniform government-led form of development, and many of the ecological functions of agricultural villages that maintained the natural environment as well as their function of handing down traditional culture to posterity were lost (Cho and Yamaji, 2005). As described above, traditional rural landscapes in South Korea are being lost due to industrialization, urbanization, government-led development, and other factors.

Since 2000, various related ministries have implemented rural area revitalization projects with villages as their units. The "Rural Traditional Theme Maeul" project, which was launched by the Rural Development Administration in 2002, aims to identify outstanding natural landscapes and traditional cultures unique to agricultural villages as well as the knowledge required to maintain these, and then to enliven the lives of farmers and promote urban-rural exchanges through experience, learning, stays with farmers, direct sales of agricultural products, and other initiatives with traditional rural culture as their theme. By 2009, 440 villages nationwide had been registered with the Rural Development Administration. This project is carried out through village meetings based on consultations and agreements made by the residents with the administrative support of provinces and municipalities and with the cooperation of experts (Kim and Ohashi, 2005; Kim and Mitsuhashi, 2009). In 2005, the Ministry of the Environment launched "Ecologically Excellent Village and Ecologically Well-Restored Village" project. This project certifies Ecologically Excellent Villages or Excellent Well-Restored Villages, and certified villages receive a budget from the project's fund for three years. This system aims to

educate local residents in the importance of protection of the natural environment and resource management and revitalize regional economies as agricultural tourism villages (JWRC, 2009). There are still issues to be addressed, however, as shown by the example of Gacheon Darangyi Village, which is located at the southernmost tip of South Kyŏngsang Province's Namhae County. The landscape consisting of mountains, terraced rice fields, private houses, terraced rice fields, and the sea arranged in this order was recognized as a rural landscape and traditional cultural resource. Since the landscape was designated as a "Rural Traditional Theme Maeul" site in 2002, the number of tourists visiting the village has increased, and the villagers as tourist home operators have economically benefited from the tourism boom, but the truth is that this has not yet contributed to a rise in income for the farmers (Kim and Mitsuhashi, 2009).

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7 India: Sacred Forests

7.1 Natural and Social Background

Indian society has a multiethnic makeup, including the Aryans, the Dravidians, the Mongoloids, as well as over 40,000 ethnic minority groups. The religious background in India is also diverse, composed of 80.5% Hindus, 13.4% Muslims, 2.3% Christians, 1.9% Sikhs, 0.8% Buddhists and 0.4% Jains. Regardless of the religious or cultural background, a number of ethnic groups have practiced nature worship and have conserved nature in general and specific animals through their own traditional methods from time immemorial.

In India, the forest coverage is about 68,289,000 ha as of 2009 (FAOSTAT's figure), accounting for some 20.8% of the land area. Despite the recent global trend towards a decline in the area of forests, Indian forest coverage is on the rise as is evidenced by the increase in the forest area of around 2,319,000 ha between 2000 and 2004 (FAO, 2010). This increase, however, has occurred in the open forest areas with a crown ratio of 10-40%, while the area of dense forests with a crown ratio of over 40% has declined (FAO, 2010). Thus, in India, high quality forests are considered to be on the decline. Major threats to the Indian forest ecosystem include the conversion of forests to agricultural land associated with the growth of the population, inappropriate patterns of shifting cultivation and illegal encroachment. The projections of an enlarging population for at least more than half a century will require India to address the recovery of natural resources, including the protection of the remaining forests and reforestation. Since the Indian Forest Act which was firstly enacted in 1878 under British rule and was last amended in 1927, Indian forests are owned by the government and those who have protected and used the forests over many generations have been deprived of ownership.

Photo 1. Dense overstory of the Ambuttilkavu sacred grove, Kannur, Kerala (Photo: Aneesh CR)

Photo 2. Natural regeneration in the Ambuttilkavu sacred grove, Kannur, Kerala (Photo: Aneesh CR)

7.2 Characteristics of Sacred Forests

Sacred Forest

"Sacred Forests" in India refers to the small patches of forest that indigenous peoples or ethnic minorities have protected and conserved to devote them to their own Gods /spirits or to their ancestral spirits (Photo 1 and 2). Sacred forests are found throughout the country. The number of reported ones totaled more than 13,720 (as shown in Table 1), which, with the number of unreported ones, adds up to an estimate of over

100,000 sacred forests (Malhotra et al., 2001). They are particularly concentrated in the Western Ghats, central India and northeastern India. In contrast, there have been no reports of sacred forests in the Andaman and Nicobar Islands, Jammu and Kashmir State, Lakshadweep Union Territory, National Capital Territory of Delhi, Goa State, Punjab State and Tripura State. Practices to protect small patches of forest, which are believed to be the abode of Gods in accordance with religious or traditional rules, have also been performed across the world, and such sacred forests are known to exist in Asia, Africa, Europe, Australia, North America and South America (Bhagwat and Rutte, 2006). There are also reports of sacred forests in Ghana, Nigeria, Syria, Turkey and Japan (Kahn et al., 2008).

In Kerala State where sacred forests are closely featured with serpent worship, most of those that are owned collectively by the villagers are dedicated to Lord Ayyappan (Vishnu, a Hindu God) or the Goddess Bhagavathi. On the other hand, sacred forests owned by the tribal communities are dedicated to one of the following; *vanadevatha*, the goddess of the forest, spirits, demons or ancestors. The Gods and ancestral spirits in the forests are thought to safeguard the local people against various calamities, as well as enable them to confront various taboos. These forests have been protected for many centuries and have played a significant role in conserving biodiversity as primary forests.

Structure, Use and Management of the Sacred Forests

A large proportion of sacred forests are remnants of primary forests that have remained almost intact. For example, most of the sacred forests in Kerala State, as well as those in Kodagu district, Karnataka state, are reported to be relics of lowland evergreen and semi-evergreen forests that were previously extensive and grew in clusters in the past (Chandrakanth et al., 2004; Kerala Forest and Wildlife Department, 2009). The composition of the vegetation of these sacred forests is generally a mixture of trees of different heights, including shrubs (low trees), herbs, climbing plants and stranglers (*Ficus aurea*), with a lush coverage of fungi and ferns over the humic ground (Kerala Forest and Wildlife Department, 2009). Native Tree species such as *Canarium stricum, Vateria indica, Magifera indica, Dalbergia latifolia, Artocarpus heterophylus, Santalum album, Ficus glomerata, Bamboosa arundinaceae* and other species are found in the sacred forests of Karnataka State (Chandrakanth et al., 2004).

Sacred forests are generally concentrated in areas at a lower altitude, and widely distributed from the lowlands to the foothills.(Chandrakanth et al., 2004; Kerala Forest and Wildlife Department, 2009). In Kodagu District, more than 1,200 sacred forests occur corresponding to one for every 300 ha of land, with the remaining portion covered by coffee plantations, which together constitute the landscape (Ormsby and Bhagwat, 2010). Most of the sacred forests are found in the vicinity of

Table 1 Number of Reported Sacred Forests by State in India

States	Reported Cases	States	Reported Cases
Andhra Pradesh	750	Maharashtra	1,600
Arunachal Pradesh	58	Manipur	365
Assam	40	Meghalaya	79
Chhattisgarh	600	Orissa	322
Gujarat	29	Rajasthan	9
Haryana	248	Sikkim	56
Himachal Pradesh	5,000	Tamil Nadu	448
Jharkhand	21	Uttaranchal	1
Karnataka	1,424	West Bengal	670
Kerala	2,000		
Total			**13,720**

Source: modified from Malhotra et al.(2001)

water sources (Chandrakanth et al., 2004; Kerala Forest and Wildlife Department, 2009). In old villages, temples and tanks are often located in contiguity with sacred forests, suggesting that they have a role in securing and distributing water resources used for irrigated agriculture and other uses (Swamy et al., 2003; Kerala Forest and Wildlife Department, 2009).

The management systems and methods in terms of the maintenance and protection of these sacred forests vary, including the implementation of rites and feasts related to the forests, the resolution of conflicts and disputes, and biomass harvesting. In India, sacred forests are generally classified into the following three categories (Malhotra et al., 2001):

1) Those under the management of the state forest department;
2) Those under the management of other administrative institutions (the revenue, district councils, etc.); and
3) Those managed by the local people, including families, clans or temple committees.

While the management bodies of the sacred forests often vary even within the same state and the same district, all the sacred forests in Meghalaya State, for example, are under the management of district councils (Malhotra et al., 2001), which are chaired by priests who execute the rituals in the forests (Ormsby and Bhagwat, 2010). Also, in Maharashtra State, the majority of them are managed by the state forest department. Those in Kerala State correspond to the third category above, where the management bodies are categorized into individual families, a group of several families or the statutory agency for temple management (Chandrashekara and Sankar, 1998). In Kodagu district in Karnataka State, sacred forests are either owned and managed by a family or managed by a temple committee consisting of several local families.

As for the use of the natural resources of the sacred forests, in some forests it is prohibited by religion and custom to harvest any biomass, while others allow extraction of a certain portion of the forest resources, which provides direct benefits to the local people. In the former case, encroachment and destruction of the forest are strictly banned and individual family members including children are not allowed to remove tree branches or any other products. There may be no direct benefits from the use of the resources, however, monetary or material benefits may accrue due to visits by tourists and pilgrims. In the latter case, timber may be extracted only for the purpose of temple construction and repair. The collection of minor forest products such as fallen leaves and branches as well as the picking of certain trees, fruits and plants (*Caryota urens* and *Mangifera indica*, etc.) may be performed for ritualistic uses (Chandrashekara and Sankar, 1998; Chandrakanth et al., 2004;). Examples of other sacred plant species include *Artocarpus heterophyllus* Lamk., *Blumea balsamifera* (Linn.)D.C, *Cudrenia nepalensis*, *Cynodon dactylon* Pers., *Dactyloctenium aegyptium* Beauv., *Erythrina indica* Lam. and *Plectranthus ternifolius* D. Don, that are used in rituals and/or considered to repel evil spirits (Khumbongmayum et al., 2004). Some medicinal plants unique to sacred groves are occasionally extracted only with the consent of the relevant communities (Chandrakanth et al., 2004). In some cases, this extraction of plant materials may be used for handicrafts and other purposes and may serve as a source of cash income for the local communities.

The compliance with the management and conservation of the forest and with the controlled use of these resources depends largely on the faith handed down through the generations as well as on the belief that the loss of forest resources will lead to misfortune (illness, a poor harvest of agricultural products, etc.) . Another example of such beliefs is that those who damage the forests will be turned into a hedgehog over the next millennium. To demonstrate the presence of the sacred land, the homegardens in Udaipur District, Rajasthan State in Northwestern India, for instance, use saffron water to demarcate the border between other areas by sprinkling it in the sacred forest (Ormsby and Bhagwat, 2010).

A variety of rites and feasts are performed in sacred forests. People expect material, moral and social benefits in return for their offerings to the Gods or the spirits of the forests. There is a belief, for example, that spirits inhabit such trees as the banyan, neem and tamarind tree, and a toy cradle for a wish to have a baby or a black cloth enclosing salt for a wish to be guarded from evil are tied to their branches. The annual village fiestas devoted to local Gods or spirits are also practiced in the sacred forests by making offerings, or cuisine cooked using the withered branches picked from the forests is devoted to them. At night, village people recount folk tales and perform epic poetry on a stage in the sacred forest. Such fiestas last for a week, and on the last day, animals such as chickens and goats are offered as a sacrifice to the Gods or the spirits (Swamy et al., 2003).

Functions and Benefits

Sacred forests provide various benefits. As mentioned above, in the sacred forests that have been protected on the basis of religious beliefs or traditional customs since time immemorial and have been handed over to successive generations, the local people have conserved a number of rare, endemic or endangered species, many of which have the potential to provide medical, agricultural or industrial benefits to humankind. Those in Tamil Nadu State, for instance, include such rare endemic species as *Antiaris toxicaria*, *Diospyros maalbarica, Diospyros ebenum*, *Feronia elephantum, Butea frondosa, Garcinia cambogia and Sterculia foetida.* Besides, over several tens of important herbs, including *Abutilon indicum*, *Andrographis paniculata* and *Evolvulus alsinoides*, are extensively used by the local people for the treatment of ulcers, bites by snakes and scorpions, gastrointestinal dysfunctions and fever (Swamy et al., 2003). These herbs are also applied in the treatment of livestock, including snakes bites.

According to a study on the biodiversity of sacred forests and the adjacent official forest reserves in Kodagu District, Karnataka State by Bhagwat and others (2005), the sacred forests still maintain populations of endangered species that were not found in the forest reserves, including *Actinodaphne lawsonii, Hopea ponga, Madhuca neriifoli* and *Syzygium zeylanicum*. Out of 163 species of larger fungi, 49 species were endemic to the sacred forests. Thus, sacred forests are considered to be complementary to forest reserves (Bhagwat et al., 2006; Kahn et al., 2008). In particular, those located in cultivated landscapes serve as habitats for various plant and animal species, and potentially provide corridors that secure the connectivity of the habitats. (Bhagwat et al., 2006).

Moreover, the sacred forests centered on human activities play a significant role in the conservation of water and soil by promoting the nutrient cycle (Malhotra et al., 2001). In general, swamps and streams in the vicinity of sacred forests rarely experience the drying up of their water supply, and hence the local people have installed wells and tanks there to secure and use the water resources. The trees in the forests also serve to avoid soil erosion (Swamy et al., 2003) and the decomposition of the fallen leaves and branches promotes the nutrient cycle of the soil, producing fertile humus. The forests accumulate such humus in abundance and the nutrients make a major contribution to the improvement of the productivity of the adjacent agro-ecosystems such as tapioca or rubber plantations (Malhotra et al., 2001).

7.3 Challenges and Responses

In recent years, sacred forests have been facing several social, cultural and economic challenges that directly or indirectly undermine their relevant traditional functions of resource management. These challenges include agricultural expansion and associated encroachment, religious, cultural and demographic transitions, and ambiguity in the current property rights system (Khumbongmayum et al., 2004; Bhagwat and Rutte, 2006).

In Karnataka, where earnings from coffee exportation account for about 70% of the value of total exports, illegal conversion of the sacred forests to coffee cultivation land has been taking place. An increase in the market price can be a factor accelerating such encroachment. Sacred forests have also been encroached on for the cultivation of other plantation crops like ginger and banana, as well as for illegal logging (Chandrakanth et al., 2004).

Cultural change over time associated with the advent of modernization and urbanization has led to a devaluation of the traditions, customs, and religious beliefs that serve as the foundations for the conservation of the sacred forests. Now, many consider the traditional belief system as superstitious and only a few older people know the rituals. The younger generations are losing interest. As such, the violation of cultural norms and taboos no longer carries heavy consequences, which is leading to degradation of the sacred groves (Swamy et al.,2003; Ormsby and Bhagwat, 2010).

In addition, increasing immigration over the years for the purpose of agricultural labor and timber harvesting has generated new demand for land cultivation, settlement and such. Forestlands, including some sacred groves, have been targeted by the immigrants who may not share or value the traditions and beliefs associated with the forests (Chandrakanth et al., 2004; Ormsby and Bhagwat, 2010).

One of the other issues concerns the legal status of the sacred forests. In Karnataka, for example, while many sacred forests are managed by the village communities, the legal ownership belongs to the state forest government, and because these two entities vary in their policies on and underlying motives for using the sacred forest, discrepancies occur. In some instances, the State Revenue Department mistakenly records some state-owned sacred forests under the name of private planters, which makes it difficult for the village committees to enforce their informal rules on the sacred forests. In other instances, the state government itself can encroach on the sacred groves designated as reserve forests, for example, by constructing homes for the homeless, making them no longer the intact forests protected only for religious purposes (Chandrakanth et al., 2004).

Owing to such issues, the traditional methods for the conservation and management of the sacred forests have been impaired, causing the loss, reduction, and fragmentation of these forests and in turn, the loss of biological and cultural diversity as well as of the benefits provided by them. In Kodagu district in Karnataka, about 50% of the area of sacred forests is said to be have been lost during the 1900s (Chandrakanth et al., 2004).

The importance of conserving sacred groves is recognized by the central government of India as some efforts are being made. In its Intensification of Forest Management Scheme which was operated during the national land policy of the 11th Five-Year Plan (2007-2012), the government set out the protection and conservation of sacred forests as one of the seven main components. Under this scheme, which requires the state forest governments to implement the majority of the work, the Kerala Forest Department has developed its own conservation program targeted at the selected sacred forests in the state .The program aims to bring accountability and the involvement of the general public to sacred forest conservation. The owner of the concerned forests shall develop and submit a management plan to the forest department, by which regular monitoring and maintenance of the forests at the community level are ensured and for which incentives are being provided (Karma Kerala, 2010). The central government of India has also paid attention to sacred forests from the viewpoint of biodiversity conservation. The National Biodiversity Action Plan (2008) sets out measures for the strengthened conservation management of sacred forests and the preparation of support policies for these forests, as well as for grasslands and pasture, as a priority issue toward the achievement of the 2010 Biodiversity Target of the Convention on Biological Diversity.

Scientists have pointed out the following required measures for the conservation of sacred forests (Chandrakanth et al., 2004; Bhagwat et al., 2005; Bhagwat and Rutte, 2006; Khan et al., 2008):

- Legal and institutional reforms including clarification of the customary and land use rights of the local people, legal protection of the sacred forests for their religious and cultural value in addition to biological value and the empowerment of village-level management committees through their legalization and perhaps through their incorporation in the ongoing process of the decentralization of forest management in India, such as under the JFM program;
- Granting incentives for the sustainable conservation management and alternative livelihood development for the local people;
- Incorporation of sacred forests into biodiversity action plans at the local level and the preparation and implementation of a comprehensive conservation strategy;
- Raising awareness among local people concerning the benefits from sacred forests (the provision of ecosystem services indispensable for the maintenance and improvements of their lives), as well as the need for sustainable conservation management;
- Intervention and support by third parties for their management and conservation;
- Conducting research to foster a better understanding of the socio-cultural systems and community institutions for the management of sacred forests, and their usefulness for the conservation of biodiversity.

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8 India: Homegardens in South India and the Andaman and Nicobar Islands

8.1 Natural and Social Background

The economy in India has been on the rise since India moved to a market-based system in the wake of the foreign exchange crisis in 1991 based on economic liberalization through economic reforms, including deregulation and the active use of foreign investment (Ministry of Foreign Affairs of Japan, n.d.) .According to the Ministry of Statistics and Programme Implementation, the GDP growth rate increased to 8.5% in FY2010 (8.0% in the previous year) from the prior level of around 3.5%. In FY2010, in particular, the agricultural sector broke the record in the yields of major grains, achieving 6.6% growth, a substantial increase from 0.4% in the previous year (JETRO, 2011). This sector accounts for about 18% of the nominal GDP (as of 2008 from the World Bank Data), and is estimated to sustain the livelihoods of around two-thirds of the total population. India has a population of some 1.21 billion (the provisional figure from the 2011 National Census), of which about 70% live in rural areas (FAO, 1996), with an annual rate of growth of 1.3% in 2010 (World Bank data).

Its agricultural land has an area of some 179,963,000 ha, accounting for about 55% of the total country area (as of 2009 from FAOSTAT), but is limited in terms of the area available per capita due to the large agricultural population and the decline in available land associated with the high population growth. In fact, the average land holding per household is as small as around 0.1 ha (as of 2008 from the World Bank Data). There are a substantial number of farmers who cannot own any agricultural land. The majority of the agricultural population practices small-scale subsistence agriculture, occupying about 32.4% of the agricultural land area.

One of the representative forms of subsistence agricultural systems in India is the homegarden. Homegardens are commonly found across the world: in South Asia, including India, Sri Lanka, Nepal and Bangladesh, and Southeast Asia such as Indonesia, Thailand, Vietnam and the Philippines, the Pacific islands, the Caribbean islands, Central and South America, and tropical Africa (FAO, 1996; Kumar and Nair, 2004;FAO, 2004). In India, in particular, they are found more often in the tropical rainy areas of south India, including the plains of Kerala State, Tamil Nadu State, Karunataka State and the Andaman and Nicobar Islands, which have been reported most frequently. A relatively large number of reports concern the ones in northeastern India including Assam State (Shrivastava and Heinen, 2005; Linthoingambi and Das, 2010; Tynsong and Tiwari, 2010). The following will describe various aspects of homegardens, with particular focus on those in peninsular India and the Andaman and Nicobar Islands.

8.2 Characteristics of the Homegardens

Surrounding Environment and Structure of Homegardens

Homegardening has been a way of life for centuries and is still critical to the local subsistence economies and food security, including in Kerala state in peninsular India, which has about 5.4 million small gardens (mostly less than 0.5 ha in area) (KSLUB, 1995). It is a system composed of a combination of the cultivation of crops, trees and shrubs, the raising of livestock and poultry, as well as fish culture (Photo 1). It is well known that these traditional land-use systems are influenced to a great extent by the biophysical and socio-cultural characteristics of the locales where they are practiced. The land use

of the Andaman and Nicobar Islands is mainly composed of forests (87%), homegardens (4.6%) and paddy fields (1.3%) (Pandey et al., 2006). In contrast, the Kerala State is composed of forests (28%) and cropped lands (69%) (as of 2009 from the Kerala State Planning Board), and the homegardens constitute about 50% of the cropped lands. Other land uses for cropped lands include paddy fields and plantations of coconuts or rubber. The homegardens size ranges from 0.05-2 ha in the Andaman Islands, 0.5 to 5 ha in the Nicobar Islands and 0.02 to 1 ha in Kerala State (Nair and Sreedharan, 1986; Pandey et al., 2007). Homegardens in tropical rainy areas in south India, in general, take advantage of the slopes of the hills, while paddy fields lie in the plains. In the Andaman Islands, some villages have homegardens sparsely distributed amidst stretches of paddy fields, while others are found clustered to some extent (Pandey et al., 2007).

Photo 1. A typical Kerala homegarden (Photo: B.M.Kumar)

Vegetation Structure of Homegardens

A typical homegarden is an integral part of the farmer's farming system and an adjunct to the house, where selected trees, shrubs and herbs are grown for edible products and cash income, as well as for a variety of outputs that have both production and service values including aesthetic and ecological benefits (Photo 2). This system has been operated and maintained for many years by the local people on a trial-and-error basis in terms of an area-specific combination of cultivated varieties and cultivation methods suited to the characteristics of the area concerned (climate, topography, etc.). Even within the same area, the diversity of cultivated varieties and the planting pattern vary according to the household characteristics since the cultivated crops and trees and their combination are affected by the household's needs (including nutritional ones) and tastes, as well as by ecological, social and economic factors.

Photo 2. Diversity of woody species in Kerala homegardens (Photo: B.M.Kumar)

The presence of a large number of species within the same land management unit, often seemingly not following any specific geometry, makes it difficult to define the temporal/spatial architecture of homegardens. The structural entities of homegardens are arranged in a complex micro-zonal pattern having well-defined vertical/horizontal stratification with each structural ensemble occupying a specific niche, such that they cannot be easily dissociated from one another (Nair and Sreedharan, 1986). In such multilayered structure, plants including the following are cultivated; coconut and areca nut trees, cacao, cashew nuts, fruit trees (bananas, mangoes, pineapples, etc.), root vegetables, spice crops (peppers, ginger, cloves, nutmeg, turmeric, cinnamon, etc.) and forest trees such as teak (*Tectona grandis*), jackfruit (*Artocarpus heterophyllus*), casuarina (*Casuarina equisetifolia*), silver oaks (*Grevillea robusta*) and bamboo (*Bambusa arundinaca*) (Nair and Sreedharan, 1986; Kumar, 2005; Pandey et al., 2006; Pandy et al., 2007; Santhoshkumar and Ichikawa, 2010). In the

Andaman Islands, for example, the three-layered homegarden is mainly covered with coconut and areca nut trees as the top storey at 12-16 m high; mangoes, jackfruit, neem trees (*Azadirachta indica*) and tamarind as the second storey at 4.5-9.5 m high; spice crops such as cinnamon and nutmeg and fruit trees such as lemons as the first storey; and pineapples as the ground cover. Fruit trees, in particular, are planted closer to the homes, which in turn tend to be built on the upper part of slopes to avoid constant raindrops from the vegetation (Pandey et al., 2007).

There are also a lot of farmers who practice rice cultivation and pastoralism in combination with their homegardens. Cows and buffaloes are not only used for milking, but for farm work, while chickens and ducks are raised for their eggs and for meat production. Some farmers also keep sheep, goats and hogs. Crop residues and household waste are fed to the livestock and poultry, whose manure, in turn, is applied to the crops as fertilizer, establishing a cyclical pattern of resource use. Since it is costly to raise livestock (especially cows and buffaloes), there is a tendency to buy them at the peak period of farm work (June and July) and then sell them as soon as the work is completed. In lowland and coastal areas, some homegardens use mangrove forests, ditches and paddy fields for fish or prawn culture.

Land Ownership and Management of Homegardens

Land ownership patterns, including homegardens, vary according to the region and the community. In the Western Ghats located in the southern part of the Indian peninsula mainland, for instance, land in general can be owned and managed by individuals (private ownership system) (Kumar and Takeuchi, 2009). Similarly, in the Andaman Islands, where families are a social unit, land is also subject to the private ownership system. In contrast, in the Nicobar Islands, where the social unit of the indigenous people is communities, land is owned by communities and distributed by the village representatives to individuals (Pandey et al., 2007).

Homegardens and paddy fields are operated and managed on a family basis (Nair and Sreedharan, 1986; Pandey et al., 2007). A typical family in south India is composed of 5-8 members, of which one or two are males aged 20-35 years. Traditionally, the farm work was practiced with a gender-based division of labor, in which the females worked on transplanting, harvesting and winnowing, while the males took the heavier work such as land tilling and the transportation of seedlings to the paddy fields. They rarely use machinery and largely depend on animals such as buffaloes for around 80% of their farm work. This situation, however, is gradually changing with the influx of farm machinery warranted by the shortage and high cost of labor. According to Torquebiau (1992) who summarized several case studies on homegarden labor requirements and flexibility, temporal complementarity in labor allocation is yet another advantage of homegardening. For example, labor demand for homegardens seldom shows sharp peaks and troughs and is more flexible and distributed throughout the year, in sharp contrast to that of seasonal agricultural operations such as wetland rice paddy cultivation.

Functions and Benefits

In south India, the crops cultivated and harvested in homegardens are used by the farmers for their own consumption and are traded in the local market only as a source of cash income. In the Andaman Islands, over 70% of the harvested coconuts and areca nuts are sold to vendors while the rest are consumed by the farmers themselves. The main commercial crops in the homegardens in south India include coconuts, areca nuts, pepper, cashew nuts, ginger, turmeric and cacao. In Kerala State, these crops are largely traded in the market.

Homegardens and similar types of agriculture involve the intercropping of various trees and crops depending on the seasons to bring a variety of benefits. Firstly, this type of agriculture avoids farmland degradation, which is often observed in intensive agriculture, and maintains and even improves the land

productivity through soil conservation and nutrient cycling. Another benefit is that there is no need to depend on the use of chemical fertilizers as the leaves from cultivated trees provide organic manure (Nair and Sreedharan, 1986; Peyre et al., 2006).

Secondly, unlike the seasonally-fluctuating crop agricultural practices often found in tropical regions, homegardens require a relatively even amount of labor inputs at any time of the year in their operation and maintenance, leading to the generation of employment opportunities, including assistance for seeding and harvesting and work in processing industries for the harvested crops (coir industry produced from the fiber of the husk of the coconut, cacao processing, cassava industry and canned fruit processing) (Nair and Sreedharan, 1986).

Also, the multi-layered vegetation structure of homegardens is similar to that of natural forests, and hence homegardens have become habitats for various wild flora and fauna. In areas where there are stretches of farmland with less biological or ecological diversity, among others, homegardens play an important role in terms of the conservation of biodiversity (Santhoshkumar and Ichikawa, 2010).

8.3 Challenges and Responses

Homegardens provide various benefits as mentioned above, but the market value of the products from them is relatively low, hence the cash income of the farmers is small (Pandey et al., 2007; Santhoshkumar et al., 2010). As they are situated on a limited area of land, the yield of each crop is relatively low despite the high cropping intensity. Thus, a number of farmers reduce the area of their homegarden and prioritize cash crops (coconuts, areca nuts, etc.) and multiple use species (white popinac, wild tamarind, etc.), and tend to shift to a monoculture.

Public policies related to homegardens such as those on land tenure, agriculture, and forestry have also contributed to the trend for homegardeners to shift to monocrop cultivation. For example, the Kerala Land Reforms Act of 1963 regulates the upper limit of per capita land allocation (8 ha maximum for a five-member family) to cope with land ownership polarization. However, certain types of land uses such as private forests and plantations for coffee, rubber, tea, cardamom, etc., were exempted from this act. Thus, again, many landowners began to grow cash crops such as rubber intensively to avoid the provisions of the act (Guillerne et al., 2011).

In the light of these situation the diversity of trees and shrubs have declined and the structure of homegardens has tended to become homogenized, using more chemical fertilizers, and hence leading to soil degradation and erosion (Peyer et al.,2006). In the Andaman and Nicobar Islands, where the soil is gravelly or sandy loamy with little cohesive strength, serious soil erosion is occurring in homegardens, which is estimated at around 12 tons of soil per hectare per year on coconut growing land (Pandey et al., 2006).

As such, the sustainability of the traditional, biologically diverse and ecologically sustainable homegarden itself is presently under threat. The declining biodiversity and landscape diversity due to the replacement of traditional land use systems will lead to threats to food security/diversity as well as to the reduced availability of fodder, fuel, green manure and other ecosystem services that have been provided by homegardens.

It has been pointed out that technological development for productivity improvements and capacity building for crop management are required for small-scale farmlands. To improve and sustain the productivity of homegardens in the Andaman and Nicobar Islands, for instance, Pandey and others recommended integrated farming with the efficient use of the high precipitation (Pandey et al., 2007). Specifically included were the double cropping of rice, fish culture using the tanks that take advantage of the rainfall and the cultivation of high-yield varieties. Furthermore legislative reform that recognizes and supports the multifunctional and socioeconomically adaptable traditional agroforestry systems may be necessary.

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9 Iran: Agriculture Using Underground Irrigation Canals in Inland Dry and Semi-dry Zones

9.1 Background

The term "qanat" refers to technology that has been developed to use groundwater for agriculture and the lives of people in dry zones (Jomehpour, 2009). The origin of qanats is not certain, but it is believed that they have a history of some 3,000 years since tradition says that some of them were built in 1200 BC (Balali et al., 2009). There is also a view that qanats were originally not facilities to supply water but technology to remove water at the time of mining (Hosseini et al., 2010), but it is said that this technology spread to various places from Iran along with the Islamic faith (Balali et al., 2009). Today, technology similar to Iranian qanats is found in more than 34 countries around the world, and has a local name in each country (Jomehpour, 2009; Hussain et al., 2008). For example, it is called "Kariz" in Afghanistan, Tajikistan, China and also in Iran, "Falaj" in Oman, "Foggara" in Libya, Tunisia, and Algeria, "Galeria" in Spain, "Khotara" in Morocco, and "Auon" in Saudi Arabia and Egypt. However, in recent years, qanats are being concentrated and the number of qanats is decreasing in most countries.

Iran faces the Caspian Sea to the north and the Persian Gulf to the south. While the Alborz mountains stretch from east to west, the Zagros mountains run from northwest to southeast. The inland area surrounded by these mountains consists of dry zones 500-1,000 meters above sea level. Dry and semi-dry zones account for about 75% of the country and have an average annual precipitation of about 242 mm. This is about one third of the world's average annual precipitation of 860 mm (Hosseini, 2010). There is relatively high rainfall from winter to early spring, but during the summer season, there is little rain, and large amounts of water evaporate because it is hot. The inland area has an average annual precipitation of 100-500 mm, but 500 mm or more falls on the mountains. Water brought by rivers that rise in the mountains flows toward the inland basin and disappears into vast stretches of alluvial or diluvial beds in the basin or into salt lakes located at the center of the basin. These alluvial and diluvial beds consist mainly of unconsolidated gravel, sand, and silt, all of which makes it easy for river water to permeate into the ground (Moritani, 1969).

In the dry zones in Iran, people have used qanats, the only source of water supply, to overcome the obstacle to development of water shortages for centuries, creating the characteristic Qanat Civilization (Jomehpour, 2009). It has unique cultural, socioeconomic, and politic characteristics, and in this civilization the Iranians developed the wisdom to think how to coexist with the deserts by using irrigation water, performing agricultural work jointly, and taking other measures (Jomehpour, 2009; Salih, 2006). Qanat water is used for agriculture and drinking water (Photo 1; Hussain et al., 2008) and today it is even supplied to urban areas (Jomehpour, 2009).

Photo 1. Drinking water tank (The water comes through the underwater canal) (Photo: Vafadarimehrizi Kazem)

9.2 Characteristics of Qanat System

Structure and Construction of Qanats

According to the Iranian Ministry of Jihad-e-Agriculture, there are 37,490 qanats nationwide with their tunnels extending for 30,000 km and the amount of water supplied by them totals 38,000,000 m^3 (Hosseini et al., 2010). There are two types of qanats: the mountain type and the plain type. While mountain-type qanats draw water from aquifers filled with rainwater and snowmelt and channel it from the mountains to settlements through canals (Figure 1), plain-type ones bring the water from rivers (Jomehpour, 2009; Hussain et al., 2008; Salih, 2006).

In general, a qanat is composed of gently sloping horizontal ducts 50-80 cm in width and 90-150 cm in depth, which continue from the headspring to the irrigated land, and wells perpendicular to the ducts, which are drilled for the construction of the qanat and the removal of the excavated earth. After the construction of the qanat, these wells are used for ventilation (Jomehpour, 2009). In addition, the structure of qanats is largely affected by the climate of the area where they are constructed (Jomehpour, 2009; Hussain et al., 2008). If much rain falls, the ducts of the qanats are short, and their wells are shallow. If precipitation is low, on the other hand, the ducts are long, and the wells are deep. Cultivated land and settlement sites are situated downslope from the point where the water surfaces, and the people use the water from the qanats.

Qanats are constructed by experts called "Muqanni (or Moghannis)" (Balali et al., 2009; Salih, 2006). Muqanni first install a winch and put the earth that is dug up when constructing the qanat into buckets and pull them up to the ground. Thus vertical holes about 90 cm in width are first dug. In this work, one worker uses a mattock (pickax), and others employ a short-handled spade (Balali et al., 2009). Muqanni are highly regarded in Iranian society (Jomehpour, 2009) and their techniques are handed down from father to son. Muqanni, who belong to a management organization of Qanat called Buneh (described below), are supplied with agricultural products for repairing qanats and making other contributions throughout the year even if they are not engaged in agricultural work (Balali et al., 2009).

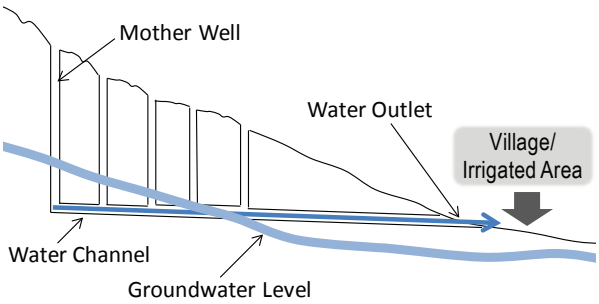

Figure 1. The structure of a typical qanat (mountain-type) (Source: Salih, 2006, modified)

Qanat Management Organization: Buneh

Qanats are constructed and maintained by an organization called a "Buneh" (Mohmmoud et al., 2009). The Buneh also manages the water use, as well as the production of agricultural products, the development of agricultural land, and related socioeconomic systems as described below (Jomehpour, 2009; Balali et al., 2009). Agricultural production by individuals is disadvantageous compared to a Buneh-based one due to the lack of capital and labor required for the construction and maintenance of qanats. In addition, Buneh play a role in efficiently developing agricultural land, and it can therefore be said that Buneh raise the socioeconomic position of tenant farmers compared to agricultural production by individuals (Balali et al., 2009).

In the Buneh-based collective system, the landowner stands at the top of the hierarchy and is mainly responsible for investments in qanats, irrigation, short-term loans to purchase seeds, and the provision of cash to tenants during the winter season (Jomehpour, 2009). A Buneh usually consists of 10-15 tenants (Jomehpour, 2009). From among these tenants, the landowner chooses the one

who has experience and technical skills in agriculture as the Buneh's leader called a "Sarbuneh" (or "Abyar"). The Sarbuneh then selects two assistants, called "Varbuneh," from among his or her friends and relatives. Other members comprise sharecroppers without any official position. A member's share of the agricultural products is determined by his or her position in the Buneh (Balali et al., 2009). As described above, the structure of a Buneh reflects the socioeconomic position of its members in the village (Jomehpour, 2009).

Distribution of Agricultural Land and Water Distribution

The distribution of agricultural land among Buneh organizations in a village is determined at a meeting convened by the village's Sarbuneh at the beginning of the agricultural season each year. Agricultural land is ranked in three grades (good, average, and bad) depending on its fertility, and when agricultural land is distributed, ingenuous plans are used to ensure that all grades of land are included in the package of land allotted to each Buneh. Each Buneh lets certain tracts of land lie fallow (Jomehpour, 2009). Once the distribution of land to each Buneh is determined, the Sarbuneh demarcates the lots in the Buneh, adjusts the types of cereals cultivated in each lot, the irrigation, and the periods of sowing, defines the roles of the members, concludes contracts with seasonal workers, mediates between the landowner and the tenants, and performs other duties (Balali et al., 2009). Qanat water is used according to each individual's water rights. Usually, depending on the hour, water rights are distributed at a rate of several minutes to several hours a year. In this way, the size of each tenant's agricultural land and the amount of cereals he/she grows are determined by his/her water rights (Photo 2). For this reason, in each Buneh, a balance has to constantly be made between water rights and agricultural land. These water rights have been handed down from generation to generation, and this balance has also been maintained (Jomehpour, 2009).

Photo 2. Qanat irrigation canal (Photo: Vafadarimehrizi Kazem)

Major Qanat-related Land Uses

As mentioned above, the agricultural land below the qanats and the water available from them are distributed among the tenants who work within the range of the land and water distributed. In this region, land can generally be cultivated twice a year, spring and autumn. In early spring, the tenants sow the seeds of tomatoes, eggplants, cucumbers, onions, watermelons, and other vegetables, and encourage them to sprout by moistening the earth moderately through qanat irrigation (Photo 3). Subsequently, they irrigate the fields roughly every three to four days, although the interval between irrigation varies slightly according to the crops, maintain a sufficient amount of water to stimulate the growth of crops, and harvest the crops around August. In autumn, the seeds of wheat, barley, and other cereals are planted from September to October. In winter, irrigation water is not used due to the relatively large amount of rainfall, but the fields are irrigated from early April to around early June. Tenants do not cultivate land in the same pattern in order to prevent it from becoming sterile. They use it for spring crop planting and autumn crop planting and then let it lie fallow, and repeat this pattern in a three-year cycle.

Photo 3. Agriculture on Qanat irrigation system in dry areas (Photo: Vafadarimehrizi Kazem)

Qanats also supply water to orchards. In particular, mountain-type qanats use underground snowmelt from the mountains as their water source, and the orchards are often scattered on the slopes near these water sources, with the qanat water first provided to the orchards (Centre for Sustainable Development, 2003).

Functions and Benefits

Qanats fulfill a wide range of functions. The following section discusses four of these functions.

(a) Multiple uses

Qanats can be used for multiple purposes such as irrigation water, drinking water, and systems to discharge groundwater at times of flooding (Jomehpour, 2009; Hussain et al., 2008). In particular, drinking water from qanats is supplied to both rural and urban areas. The groundwater discharge systems play the role of preventing the groundwater level from rising when flash floods occur, a phenomenon peculiar to dry zones (Jomehpour, 2009). An existing example is Hassanabad Qanat that provides drinking water for Yazd city. In Mehriz city located in south of Yazd city, people have been using a small fish in the qanat as an indicator of water quality and changes in the population of this fish can indicate possible problems with qanat water over time.

(b) Source of energy

One example is that hydroelectric power is generated using sloping water supply pipes and flour is milled using water wheels (Jomehpour, 2009; Hussain et al., 2008). In Iran, even today, there are cities where water wheels remain with high potential for tourism applications and potential for livelihood diversification in the local community (Hussein et al., 2008).

(c) Ecological Functions

Qanats prevent excessive water collection, ensuring sustainable water supplies, since they can only provide as much water as the aquifers can naturally replenish (Mohammad, 2009; Hussein et al., 2008). If precipitation decreases, the volume of water running through qanats also decreases. On the other hand, pump wells tend to constantly collect the required amount of water irrespective of the precipitation and the amount of water existing in the aquifers, and the water is therefore not supplied in a sustainable way (Jomehpour, 2009; Hussain et al., 2008).

In addition, since the ground is dug as deep as the solid subsoil when qanats are built, the qanats are less wet and prevent a rise in the groundwater level, inundation, evaporation, and other undesirable phenomena, reducing the concentration of salts in the water, which prevents agricultural land from being ruined by salination (Jomehpour, 2009).

(d) Social Functions

Qanats are closely related to the local communities. The management of qanats is decentralized and involves the local residents. This unites local residents and generates their allegiance to the local community (Hussain et al., 2008). The social status of people is determined by the extent of the water rights for qanats that they have (Jomehpour et al., 2009; Hussain et al., 2008). Muqanni, experts in qanat construction, have a high social status, and the social status of people living in urban areas is determined by whether their place of residence is located upstream or downstream from a qanat as well as the distance to it (Jomehpour, 2009).

Qanats are also closely related to the social and cultural traditions of the area where

they are located (Jomehpour, 2009). Qanat water is considered sacred, and a ceremony called a "Qanat wedding" is often held. In this ceremony, a woman purified with qanat water pours special soup into the qanat. It is believed that by holding such a ceremony, local people can continue to use qanat water in the following year (Foltz, 2002).

9.3 Challenges and Responses

Where the Problems Lie

In recent years, the proportion of qanat water to the total water supply has decreased. It was 70% before 1950 but fell to 50% in 1950 and to 10% in 2000 (Hosseini et al., 2010). The reasons for this decrease in the number of qanats include urbanization (Hosseini et al., 2010) and the introduction of modern pump wells (Balali et al., 2009; Jomehpour, 2009; Hussain et al., 2008). If, due to urbanization, a new city was planned to be built in an area where qanats were located, the qanats have been filled in with earth. Buildings were constructed on the vertical holes of qanats, and there are many cases in which it is no longer known where the qanats existed (Hosseini et al., 2010). In addition, agricultural reforms, which began in 1962, accelerated the introduction of modern pump wells. These agricultural reforms promoted the redistribution of land ownership rights from feudal landowners and absentee landlords to tenant farmers (Yokoyama et al., 2007). With these reforms, the relationship between the landowners and Buneh, both of whom had up to then been responsible for the management of the qanats, ceased to exist. Since it was difficult for individuals to manage qanats, modern pump wells came to be more favored. Another reason for these changes was that there were scholars who underestimated qanat technology and argued for a shift to modern pump systems (Balali et al., 2009).

The recent growth in the population is also cited as the reason for the shift to modern pump wells. Qanats have been replaced by pump wells because they could not meet the growing demand for water as the population grew (Hussain et al., 2008). It takes less time to dig a pump well than to construct a qanat. While it takes two to three years to expand the horizontal ducts of qanats when it becomes necessary to increase the amount of water discharged, pump wells are more convenient mainly because all that needs to be done is to replace the existing ducts with ones that have a larger diameter. For this reason, farmers have gradually come to favor pump wells (Balali et al., 2009).

Moreover, it is pointed out that there is a shortage of labor for qanat construction as people have changed their jobs from primary industries to other areas, and a lack of understanding of qanats affects policy making. The government overlooked the social functions of qanats such as efficient agricultural production by Buneh and as a result pushed forward with such policies as agricultural modernization using pump wells and industrialization (Hussain et al., 2008).

Responses

Today, however, qanats are attracting worldwide attention (Hussain et al., 2008). Up to now, when the world was faced with water shortages due to population growth, it has found solutions in technological innovation. But at the Second World Water Forum, which took place in the Dutch city of the Hague in 2000, participants pointed out that water crises had occurred due to failures in water management rather than water shortages (Balali et al., 2009). In this context, traditional water use and management systems like qanats have attracted attention as sustainable systems (Balali et al., 2009). Some experts point out the need to take such measures as establishing laws to protect qanats and integrating qanats into modern irrigation systems in the future (Hussain et al., 2008). Others urge the need to gather information on qanats, evaluate the cost benefits of pump wells compared to qanats, and ensure worldwide information sharing, for example. The Iranians position qanats as something that connects people to nature, creates ecological awareness, and prompts people to take ecologically conscious actions. For this reason, activities aimed at connecting people to nature are carried out at mosques and other facilities in connection with the Islamic religion in which water plays an important role (Balali et al., 2009).

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10 Nepal: Agro-Pastoralism by Sherpa Communities in the North-Eastern Mountains

10.1 Background

Nepal is a mountainous country in Central Asia situated between China to the North and India to the East, West and South. Geographically it extends between the latitudes of 26 and 30 degrees north. About 2,200 km of the Himalayan range lies along the northern border of Nepal. Of the 14,7181 km^2 land area of Nepal, 86% is mountainous and the remaining 14% consists of flatlands. About 39.6% of the national land is under forests, 12% under grasslands and 21% agricultural land (MoFSC, 2009). Due to its acute altitudinal variation (67–8,848 m asl) and unique geographical position, Nepal has wide-ranging climatic and environmental diversity within a north-south distance of only approximately 200 km. The lowland plain areas with a subtropical monsoon climate in the southern belt (< 300 m asl), mid-range mountains with a temperate climate in the hilly areas (300–2,500 m asl) and the high mountains with a cold temperate and boreal climate in the northern belt (above 2,500m asl). Such diverse conditions have provided Nepal with a rich complement of ecosystems and wide biological diversity.

The Himalayas can be largely divided into four geographical areas: the northwestern, western, central and eastern zones. The eastern zone is located in the part of the Himalayas that largely extends in an arc to the south, with high precipitation and the temperatures of a subtropical climate. The stronger influence of the monsoon in the eastern zone provides plants with a favorable environment in terms of water and temperature, which are important elements for their growth, leading to the substantial forest cover in that zone. The substantial difference in elevation in the mountainous areas creates a variety of vegetation at different elevations (Yamamoto and Tsuchiya, 2000). In the lowlands, it is possible to see *Shorea robusta*, a dominant tree found in Southeast Asian tropical forests. As the elevation increases, lucidophyllous trees such as *Castanopsis* and *Quercus* become dominant. The highlands at an altitude of 3,000-3,800 m at the alpine tree line are covered with *Abies* forests, while those at higher altitudes with forests of shrubs as high as around one meter, including *Juniperus recurua* and *Rhododendron anthopogon.* Even higher are the alpine grasslands stretching up to an altitude of almost 5,000 m, serving as natural rangelands in summer (Yamamoto and Tsuchiya, 2000).

Nepal is a multicultural and multilingual country with significant ethnic diversity. In Nepal a system of direct rule called the "Panchayat" system continued until 1990. However, after the pro-democracy movement became rampant across the country in 1990, a Multiparty Democracy was established and the Local Development Act came into effect in 1992. Accordingly, the local Panchayats (local level administrative units) were substituted for by Village Development Committees (VDC) and their higher level counterparts were termed District Development Committees (DDC) (Tatsumi, 2005). The monarchy came under the new constitution of Nepal. Due to the growing level of poverty, social discrimination, unemployment and political unrest, Nepal suffered a decade-long armed conflict. Finally, Nepal was declared a Federal Democratic Republic in 2008 after overthrowing the historical monarchy and is now in a political transition while building its new constitution. The VDCs and DDCs still continue as the governance units operating at the local and district levels, respectively. Nepal's total population in 2011 is estimated at about 26.6 million (CBS, 2011). Local level decision-making occurs at the community level, VDC level, municipality level and at the district level. Nepal is mainly an agrarian country with

considerable potential, among others, for tourism, hydroelectric power development, biological resources and high value medicinal and aromatic plants. Due to the prevalence of traditional farming systems, communities still have a rich store of traditional knowledge concerning the most effective management of local natural resources, such as agriculture, livestock and forestry.

10.2 Characteristics of the Agro-Pastoralism in the Mountain Areas

Junibesi Valley, Solu-Khumbu District

Photo 1. Junbesi (2,700 m asl) (Photo: Tetsuya Inamura)

The mountain farming system, which can be considered as one of the SEPLs in Nepal is characterized by being labor intensive, complex and subsistent on the natural environment. This section describes agro-pastoralism by Sherpa communities using an example from the Junibesi Valley of the Beni Village in the Solu-Khumbu district of Nepal (Photo 1). The Solu-Khumbu district, located in the northernmost part of the Sagarmatha zone in Nepal has an area of around 3,300 km^2 (Kano, 2000), and is inhabited mainly by Sherpa people. The Sherpa are mountain people who are said to have migrated from eastern Tibet passing over the Himalayas in the 16th century. Sherpa settlers have developed their current form of agriculture and pastoralism by adapting themselves to a topography with large differences in elevation, and have traded with the Tibetans for goods, including the fragrant wood used for their rituals (Yuki et al., 2000). In the 1970s, a rise in the popularity of tourism occurred and as the tourist industry progressed and its proportional contribution to the economy of the Solukhumbu Sherpas steadily rose (Yuki et al., 2000). Beni village in the Solu region is composed of around 22 settlements with about 260 households in total, largely populated by Sherpas (Inamura et al., 2000a). Junbesi is a valley with moderate slopes within the Beni village situated at an altitude of 2,500-3,000 m and is covered by extensive moraine and alluvial deposits that communities of shrubs and herbaceous species have colonized. In the upper reaches of the streams, glacial troughs with a U-shaped cross-section occur and behind these a table-like highland extends at an altitude of 4,500-5,000 m. The topography is very undulating with many glacial cirques surrounded by crags at around 5,000 m above sea level, and is largely covered with cliffs and boulders, leaving little area for rangelands (Inamura et al., 2000b).

The Junbesi Valley has a mild climate but high precipitation as it is situated on the southern side of Mt. Numbur, a vanguard mountain of the Himalayas, which the southern moist airstream encounters and then brings much rain during the monsoon season from June to September. In particular it rains all day long from mid-July to September. From December onwards, it becomes a full-fledged winter, and is covered with accumulated snow. In terms of the latitude, however, the valley belongs to the subtropical zone, and hence its climate is relatively mild, resulting in only several to 10 centimeters of snow accumulation at the foot of the mountains (Honma, 2000).

Farming and Transhumance

The Sherpa residents in the Junbesi Valley largely practice agriculture, and some of them are also engaged in keeping herds of "*naks*" (female yaks) and "*zoms*" (a single crossbreed between yaks and cows) (Photo 2). *Zoms,* which yield more milk than *naks*, are kept for milking after calving (Inamura and Hongo, 2000). The method of rearing *naks* and *zoms* takes the form of transhumance, in which the cattle move around the rangelands at different altitudes according to the natural climatic cycles. These livestock are grazed in such forests as

Castanopsis and *Quercus* species–located near agricultural lands in the vicinity of settlements during the winter season and are gradually transferred to the upper reaches of valley streams during the period between late March and early April. As the monsoon rain starting from mid-June stimulates the sprouting of grasses on the plateau, the livestock are grazed in summer camp site pastures set up at around 4,500 m above sea level from August to September. They are then brought back to the Sherpa settlements, while maintaining feeding in the form of glade grazing on their way back in October when the temperature declines sharply (Kumagai, 2005). During the migration of livestock from the settlements to the summer camp sites, they are fed such herbaceous species and shrubs as *Abies* that grow in the forests (Yamamoto et al., 2000). The transhumance in the Junbesi Valley is characterized by its vertical migration over a relatively short distance despite the significant difference in the elevation of migration from the settlements at an altitude of 2,500-3,000 m to the rangelands at nearly 4,500 m (Iwata, 2000).

Photo 2. Rangeland for yaks in summer (4,300m asl) (Photo: Tetsuya Inamura)

In the Junbesi Valley, agricultural land extends up to 3,000 m asl in the vicinity of the settlements with the main products including grains such as wheat, barley, corn and potatoes. Corn and potatoes are cultivated as summer crops, while wheat and barley are planted in winter, when crop cultivation is made possible by the lower elevation of the valley. In addition to these staple food crops and potatoes, beans and vegetables are also cultivated in the valley. In the 1970s, the pomiculture of apples and peaches started and the beginning of their commercialization was marked by the supply of these fruits to the periodic local markets that have recently been established, as well as to the lodges for trekkers (Kano, 2001).

Agricultural weeds are extensively used as forage in Junibesi. For example, the weeds are cut down together with the stalk, leaf and other residues of the corn plants left in the field after the harvest during the period between mid-September and October, and are then dried and stored as forage for the winter (Kano, 2001). The use of weeds for forage is partly due to the significant fluctuation in the availability of forage due to seasonal changes. During the seasons from spring to autumn, there are plenty of plants thriving due to the higher temperatures and abundant precipitation, while in winter, most of the grasses in the grasslands die down, when the shortage of this forage is compensated for by the use of weeds (after they are dried and stored) as a substitute (Hongo and Fujikura, 2000).

Rangeland Management

The Sherpas have patrilineal clans called *ru* and those in the Solu region, in principle, have organized themselves into a single clan for each settlement. In the Junbesi Valley, land along it was demarcated according to valleys and ridges and has been occupied by the clans in a mosaic pattern. The plots of land held by the clans are not in a single area, but in the form of multiple plots scattered from the lower areas to the higher areas. These lands have been used for transhumance using yaks and *zoms*. Access to them is restricted to members of the clan concerned, and hence the forests and grasslands to be used as rangelands have customarily been managed by the same clan as they are treated as commons with access restricted to their members (Inamura et al., 2000a). Access to each rangeland is subject to the clan's rules. The Lama clan, for instance, has an agreement that no one can enter the area beyond the rangeland in summer known as *basa* before a certain date during the period between late June and July (one day in *Shrawan* month in the Nepali Calendar). Thus, the rangeland is managed on a clan basis to ensure that pastures in

the rangeland upstream from the *basa* can grow well (Inamura et al., 2000b). As for non-members, they have to pay a certain fee to the clan chief called *Mizar* to get permission to use the rangeland, although forests around the settlements and fields are available to everyone in the community (Furukawa and Tsuchiya, 2000).

Transhumance in Other Areas

The Khumbu region in the Solu-Khumbu district is situated in a basin-like highland composed of various broad valleys between the vanguard and the border mountain ranges, where there are settlements at an altitude of 3,900-4,200 m, around 1,000-1,500 m higher than the Junbesi Valley. In the Khumbu region, a lower level of snow accumulation makes it possible to graze on the south-facing slopes in the highlands at an altitude of over 4,000 m, even in winter. Agricultural lands extend up to areas at an altitude of 4,300 m, which is the agricultural limit line. The Sherpas in this region practice a form of transhumance with multiple plots of arable land, rangelands and houses on sites at different altitudes in specific valleys, while, in the Junbesi Valley, farming is limited to areas around the settlements and their transhumance is separate from other cultivation practices (Kano, 2001). Based on the climatic cycle, the Khumbu Sherpas also practice transhumance by going up to the highland in summer and coming down to areas at a lower altitude in the autumn. Moreover, during the period between late autumn and early spring, they again practice transhumance in the highlands using the hay that was cut in the autumn and stored in highland houses in order to cope with the shortage of forage in winter. Transhumance in winter is also intended to enable fertilizer to be applied to the scattered arable land as barley and potatoes are cultivated up to areas at an altitude of 4,300 m, the agricultural limit line (Inamura et al., 2000b).

Unlike in the Junbesi Valley, a village in the Khumbu region is composed of multiple clans and there are no plots of land occupied by any particular clan. It is the keepers called *nawa*, assigned by each village, who make the decisions on the timing of livestock migration and take charge of the use and management of the forests. The *nawa* of the livestock protect the crops in the fields from the livestock by moving them out of the village during the cropping seasons, while they leave the pastures on the rangelands to grow well by moving them back to the village during non-cropping seasons (Furukawa et al., 2000; Uprety, 2008).

10.3 Challenges and Responses

All national forests were nationalized in 1957 and the Nepalese Forest Act of 1993 clearly mentions that the ownership of forests rests with the state. However, the lands under the control of those at the bottom of the state hierarchy were in effect beyond the control of the state. Thus, in the Junbesi Valley, the lands were managed by the clans. Under the Forest Act, the management of forests, which had hitherto been allocated to each of the clans, was transferred to Community Forestry Users Groups known as *saudaya* by designating them "community forests." Community Forests are demarcated by the s*amdaya* in a manner whereby the forests and grasslands around settlements are enclosed as communal lands. This system is in conflict with the Sherpa's existing land use pattern in which the rangelands along the migratory routes of the livestock, located far from their settlements, are also used for grazing, leading to friction among the users. In the Junbesi Valley, for example, a village where the majority of the population is a clan called *Salaka* established a s*amdaya* that acquired occupancy rights over a vast area of forests and grasslands around their settlements. The area covered by these occupancy rights includes many rangelands that have traditionally been used and occupied by the *Lama* clan. Some of the *Lama* clan, however, do not accept the legitimacy of the *samdaya* system and continue to practice grazing just as they have done in the past (Banjade et al., 2008; Furukawa et al., 2000).

There are a number of factors contributing to the recent decline in the number of herders. This is considered to be partly attributable to the reduction in the area available for rangelands due to the enforcement of the Forest Act. Other factors include the

changing preferences among the new generation and the availability of work in overseas labor markets (Banjade et al., 2008).

The shrinking access to pasture lands due to new legal institutional interventions leaves largely unexploited the natural resources of the grasslands, which is the main endowment of the mountainous areas. Aside from grazing, the herders have used handmade paper produced from the bark of the *Daphne bholua* plant growing wild in *Abies* forests (Furukawa and Tsuchiya, 2000). They also collect and trade in high value medicinal and aromatic plants, such as Indian nard or *Nardostachys grandiflora* and *Cordyceps sinensis,* for commercial trade and domestic consumption (Parajuli, 1998; Yamamoto et al., 2000). With the decline in grazing opportunities, a good deal of the knowledge about such herbal plants will be gradually lost (Banjade et al., 2008). Planning for new interventions in socio-ecological production landscapes (SEPL) should consider the interests of the indigenous and local communities and the richness of their traditional knowledge in relation to the ecosystem services that have been delivered to communities over the centuries.

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11 Sri Lanka: Tank Irrigation Farming in Dry Zones

11.1 Background

Sri Lanka is an island country in the Indian Ocean with an area of about 6,561,000 ha. The southern center of the island is dominated by highlands with about twelve high mountain peaks over 2,000 m (Imbulana et al., 2006). Sri Lanka has a tropical climate marked by high temperatures and high humidity, and the average annual temperature in the coastal and low-lying areas ranges from 27°C to 28°C, but the highlands enjoy a cool climate with the average temperature remaining at around 22°C throughout the year. Affected by seasonal winds twice a year, the southwest monsoon and the northeast monsoon, the annual precipitation varies according to the seasons. Using the annual precipitation of 1,875 mm as a guideline, the land is divided into two major parts: the dry zones, which account for approximately 70% of the country, and the wet zones (Editorial Department of Ninomiya Shoten Publishers, 2011). During the period of the northeast monsoon, which extends from December to February (Maha Season), rain falls mainly in the north, north central and eastern parts of the island. During the period of the southwest monsoon, which extends from May to September (Yala Season), large amounts of rain fall on the wet zones located in the southwestern part of the island (Imbulana et al., 2006). In the dry zones located in the northern and eastern parts of the country, on the other hand, 80% of the annual precipitation (about 1,100 mm) is concentrated in the Maha Season with the amount of precipitation during the Yala Season being only a little or almost none, depending on the year. Furthermore, due to the effects of the dry winds that blow during this season, the amount of water that exceeds the annual precipitation occasionally evaporates (annual evaporation; 1,700 mm to 1,900 mm), (Panabokke et al., 2002).

Photo 1. A small (village) tank
(Photo Credit: U.S. Imbulana)

In order for people to live on land in the dry zones, it is indispensable to secure water resources and use them efficiently. Thus tank (*weva*) irrigation systems have been developed throughout the dry zones since ancient times and are still used extensively (Photo1). These dry zones consist of flat peneplains, which were formed by the erosion of old mountain ranges, and are generally hilly with many small valleys scattered everywhere. The permeability of the underlying rock is low and is only covered with a thin layer of soil. It is believed that these geographical features, which are suitable for building tanks, are also one of the factors that contributed to the development of the irrigation systems (Panabokke et al., 2002).

The Sri Lankan economy has been supported mainly by agriculture, forestry, and fisheries, however, in line with economic growth, the manufacturing, wholesale and retailing industries have expanded and clothing has become one of the largest export items nowadays in Sri Lanka. Production from agriculture, forestry, and fisheries accounts for about 13% of the country's gross domestic product (GDP) with the agricultural population representing 44% of the workforce engaged in economic activities in 2010 (World Bank Data). Agricultural land occupies about 40% of the national land (FAOSTAT's figure in 2009), and agriculture is divided into two

major forms of management: plantations of black tea, natural rubber, coconuts, and other products, and small-scale individual farms centered on the cultivation of rice (Ministry of Agriculture, Forestry, and Fisheries, 2010). The latter form of agriculture prevails in the dry zones, which occupy the major portion of the country. While double cropping is possible using the biannual rainy seasons (Yala and Maha Seasons) in the wet zones where 30-40% of the total population of about 20,670,000 live (FAOSTAT's figure in 2009), agriculture using irrigation systems is practiced in the dry zones. Approximately 40% or more of Sri Lanka's annual rice production comes from the dry zones (FAO, n.d.).

11.2 Characteristics of Tank Irrigation System

Distribution and Structure of Tank Irrigation System

It is believed that the irrigation systems in Sri Lanka were built from after the time the Aryans colonized the island in the fifth century B.C. These irrigation systems are found in all the dry zones of Sri Lanka (Table 1). One characteristic of the systems is that many small tanks are located close to each other, although there are regional differences, and there is one tank per 12 km^2 area if the density of tanks is low and one per 1 km^2 area if it is high. The highest density of small tanks is found in the Kurunegala district in the southern part of the North Western Province and the Anuradhapura district in the central part of the North Central Province (Panabokke, 2002; FAO, n.d.). However, not all tanks are used even today, and many of them have already been abandoned and have ceased to fulfill their functions.

Under the Agrarian Services Act No.58 of 1979, the current systems are classified into two major categories: minor/village irrigation or small scale/village tank systems, which distribute water to an area of less than 80 ha, and major irrigation or large tank systems that provide water to an area of 80 ha or more (Panabokke et al., 2002; Imbulana et al., 2006). It is considered that originally, small tanks were built by villagers at the community level, and later, larger tanks came to be built through the intervention of the government (Somasiri, 2008).

Small tank systems in general are found in cascade along inland valleys or streams in the dry zone. With many of the small tanks interconnected, the system is designed so that water flows from the upstream tanks to the downstream ones. Some of the tanks in this series of small tanks are connected to larger tanks or feeder canals, forming a complicated, large scale irrigation system that covers a large area of land. Each small tank has a small area of reservation catchment around it, and paddy fields and villages are spread along the downstream reaches. The next small tank and its reservation catchment is located just downstream from the paddy fields (Kono and Somarathna, 2000; Somasiri, 2008).

In addition to rice growing using irrigation farming, during the Maha Season (November to March) when the rain falls, some farmers are engaged in a form of swidden agriculture called *chena*, which utilizes the highland slopes that cannot be irrigated. Furthermore, many farmers cultivate a wide range of fruits and crops (homegardens) and raise cattle around their houses in order to meet their own needs (Panabokke et al., 2002). Moreover, fish are

Table 1 Number of Small Tanks in Each Province in Sri Lanka Dry Zones

Provinces/Regions	Number of small tanks		Total
	In operation	Abandoned	
Northern Province	608	816	1,424
North Central Province	2,095	1,922	4,017
North Western Province	4,200	2,273	6,473
Southern Province*	653	757	1,410
Lower Uva Province*	16	543	559
Eastern Province south of the Mahaweli*	–	1,017	1,017
Eastern Province north of the Mahaweli*	48	425	473
Total	7,620	7,753	**15,373**

* Only the areas in the province that come under the category of dry zones (Panabokke et al., 2002)

caught in the small tanks and in addition to providing water for the paddy fields, these tanks are used for various purposes such as water supply for local residents and livestock husbandry (Panabokke et al., 2002) (Photo 2).

Photo 2. A small irrigation system managed by the farmers (Photo: U.S. Imbulana)

Management of Irrigation Systems

The ancient small-tank irrigation systems in Sri Lanka were built by local residents and have been managed by them over the years (Photo 3). In accordance with the customary *rajakariya* system, which governed land ownership, they have been managed by the local residents in a sustainable way on the instructions of cultivation and water distribution managers called *velvidane* (Somasiri, 2008). The residents are thus assured of a fair allocation of the resources and equal land ownership. Prior to the farming season, the residents hold meetings called *kanna* to discuss and decide on the dates when cultivation should begin, when the irrigation water should start to be channeled to the paddy fields, and when the irrigation canals should be closed, as well as the repair of the small-tank irrigation systems, the division of roles in such repair work, and other matters. In the years when there is little rain, a form of cultivation to conserve water called *bettma* is practiced in which only the paddy fields closest to the tanks are cultivated. Attention is also given to the equal use of water resources and soil by employing a system called *kattimaru*, which requires two to three farmers to take turns cultivating the paddy fields that are allocated to them (Somasiri, 2008).

With the colonial control of Sri Lanka by European countries such as Great Britain and the reform of political systems, however, the existing irrigation management systems run by local residents collapsed. The *rajakariya* system was abolished, and, as a result, the small-tank irrigation systems were left unmanaged, the land in the dry zones became devastated and the farmers were reduced to extreme poverty. In 1848, the residents rose in revolt in the Kandy region. In 1900, following this revolt, the British government established an Irrigation Department as part of its measures to cope with poverty and started to repair the devastated irrigation systems. The government took the main responsibility for their management, and the farmers were allowed to participate in discussions with administrative officials about the farm work and irrigation system management at meetings held before the farming season. However, since such meetings were held only twice a year and led by administrative officials, the opinions of farmers were not fully reflected in the management of the irrigation systems, and these meetings did not produce satisfactory results (Somasiri, 2008).

Photo 3. Livestock grazing in areas around a small tank (Photo: U.S. Imbulana)

With the introduction of the *Paddy Land Act of 1958*, the responsibility for the small-tank system was transferred to the Ministry of Agriculture and the present Department of Agrarian Development (DAD) was established. Since then, the DAD has been providing technical and institutional support to minor irrigation schemes as well as supporting repair work

for the small-tank systems. Even after management responsibility was transferred to the provincial council, the DAD still provides various forms for support to minor irrigation systems (Imbulana, US, personal communication). Although many issues still remain, minor irrigation is currently managed mainly by the farmers.

On the other hand, major irrigation had less farmer participation in its management until the 1980s. Subsequently, the Irrigation Department in charge of major irrigation systems started introducing and implementing various projects to promote participatory management of the large tank systems. One of these initiatives was a project to repair the Gal Oya Left Bank system in eastern Sri Lanka, and this project began in 1981. In this project, a committee consisting of farmers and administrative officials was organized to jointly repair the irrigation systems. In addition, representatives of the farmers participated in planning meetings held in each season. The farmers were thus given the opportunity to have their opinions reflected in the decisions on the areas to which irrigation water should be distributed according to the amount of water in the small tanks, how the operating and maintenance budgets should be allocated, and other matters (Amarasinghe et al., 1998).

Since the 1980s, meanwhile, new legal systems and organizations have been put in place to support participatory management. In 1984, a new Irrigation Management Division was established under the Ministry of Irrigation to officially introduce a process that involved local residents in major irrigation projects. In the second half of the 1980s, the practical management of part of the equipment (such as the water distribution canals) for major irrigation systems was transferred to farmer organizations. With the revision of the Agrarian Services Act in 1991, these farmer organizations were legally approved, and with the revision of the Irrigation Ordinance in 1994, they were granted the related rights and began to take responsibility for irrigation system management (Somasiri, 2008).

Functions and Benefits

The irrigation systems are designed to store rainwater brought during the short rainy seasons to secure the water resources that make it possible to cultivate rice (double cropping) and other crops (such as red pepper and onions) throughout the year even in the dry zones with unstable rainfall, and this ensures food security for the local residents (Kono and Somarathna, 2000).Water resources are used not only for the residents, but also for livestock for drinking and other purposes.

In addition to their direct use, tanks provide the functions of maintaining a cool and comfortable microclimate, groundwater recharging, soil conservation and such. In addition, besides contributing to sustaining agricultural biodiversity, the tanks, which are spread throughout areas covering 70% of Sri Lanka's land and have existed since days long past constitute part of the most varied wetland ecosystem in the country (FAO, n.d.). Furthermore, since early on, they have been used as a place for the social activities of local residents such as meetings, bathing and performing social and cultural functions (FAO, n.d.; Panabokke et al., 2002).

11.3 Challenges and Responses

In the past, a self-sufficient life was sustained in the dry zones of Sri Lanka by combining irrigation farming, rainfed *chena* farming, home gardens, as well as livestock raising, fishing and food gathering in nearby forests, with most of the irrigation water provided from the small tanks. However, starting with the abolition of *Rajakariya* system in the colonial period, subsequent changes in various socio-economic factors have made it difficult to maintain such agroecosystems even at present, where efforts including the rehabilitation of irrigation systems and promotion of participatory management are in place. One of the contributing and confounding factors in this situation is the

reduction in available land owing to the increase in population and other factors. Since the productivity of irrigation and *chena* farming in fragmented and limited areas of land is relatively low and thus the income of the farmers has declined, fewer farmers intend to invest in the management of minor irrigation systems (Panabokke et al., 2002).

With the aim of repairing the devastated irrigation systems and to manage them efficiently, the Sri Lankan government has implemented various projects. Minor irrigation projects such as the Village Irrigation Rehabilitation Project and the National Irrigation Rehabilitation Project were conducted in the 1990s with the support of the World Bank. As for major irrigation, the Integrated Management of Major Irrigation Schemes Programme has been in place since the late 1900s.

In order to cope with these problems and operate and maintain sustainable irrigation systems efficiently, it is indispensable to manage the systems by involving the local residents. In the 10-year Comprehensive National Development Programme called "Mahinda Chintana (2006-2016)" announced in November 2006, the Sri Lankan government formulated a strategy to achieve economic growth and eliminate poverty through agricultural development and cited as the priority issues in the agricultural sector: (1) improvements in the productivity of irrigation farming, water management, and facilities operation and maintenance, (2) the promotion of marketing and crop diversification, and (3) participation by resident organizations (FAO, 2011).

As described above, the Sri Lankan government has long established laws and systems for participatory management and has been implementing these initiatives on a project basis, but in the future, it will need to continue taking such measures as government financial support for farmers organizations, on-site implementation of the related policies, the granting of economic incentives to encourage participation by the local residents, and the establishment of cooperation between the government and the farmers (Somasiri, 2008).

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12 Cambodia: Paddy rice cultivation and freshwater fishing industry in the Mekong and Tonl Sap Rivers

12.1 Background

According to the Köppen climate classification, the largest part of Cambodia is classified as tropical savanna. The country has less precipitation than other countries in Southeast Asia. However, more water than the total amount of annual rainfall in the whole country is brought to Cambodia via the Mekong River. The water fills a wide plain in central Cambodia and then runs into the South China Sea. The change of water by season is a major climatic characteristic in Cambodia (Amakawa, 2004) The Mekong River is a large river whose source watershed is the Tibetan Plateau, which has an altitude of 5,200 meters. From there, the river flows nearly 4,000 km to reach Cambodia. Basins of the Mekong and Tonle Sap Rivers cover approximately 40% of the total land area of 180,000 km^2, and the Mekong River joins the Tonle Sap River, which is connected with Tonle Sap Lake around Phnom Penh.

The Tonle Sap Lake (with an altitude of five meters) is one of the largest tropical lakes in the world, spanning 1.4 million ha in the rainy season. In the dry season, water in the Tonle Sap Lake flows into the Tonle Sap River. In the rainy season, the risen water in the Mekong River goes upstream to the Tonle Sap River, and the lake expands (Table 1). The flood plain includes flooded forests, shrub forests and grassland. It is abundant in food for fishes such as zooplankton and phytoplankton, floating algae, water bugs that grow in the water, and sunken grass, leaves and insects (Nakahara et al, 1996). Therefore, Tonle Sap Lake is a freshwater fishing ground that boasts large catches. Tonle Sap Lake is like a huge pool that rapidly expands in the rainy season. The water areas, including paddy fields, have abundant ecological resources.

Table 1. Characteristics of Tonle Sap Lake in the dry and rainy seasons

Category	Dry season	Rainy season
Month	Mid-November - Mid-May	Mid-May - Mid-November
Monsoon	Northeast Monsoon	Southwest Monsoon
Flow of Tonle Sap River	Downstream	Upstream
Water area	300,000 ha	Over 1.4 million ha
Water depth	0.5 m	8.5 m
Water temperature	28 - 30°C	26 - 28°C

Source: derived from materials by Tsukawaki (2001) and Oyagi (2009)
Note 1: The current of Tonle Sap River stops at the end of both the dry season and rainy season and the water doesn't go downstream or upstream.

12.2 Characteristics of Landscape and Agriculture in the Basins of Mekong and Tonle Sap River

Rice Cultivation

The characteristics of the landscape around the Mekong and Tonle Sap river basins, which contain the flood plain of Tonle Sap Lake, the size of which contracts or expands in a vast, flat land, include the rain-fed paddy fields in which ordinary rice is cultivated, paddy fields around the outer border of the high water area, high water paddy fields for the cultivation of floating rice, and a floating village. The staple food is rice, and fish is one of the important foods in Cambodia. Local residents engage in paddy rice cultivation

and freshwater fishing according to the seasonal changes in the water levels. Paddy rice cultivation is characterized by cultivation systems that are adapted to the expansion and contraction of the flooded area. Ordinary rice is cultivated in the outer area and in rain-fed paddy fields with an increased water level of less than around one meter, and floating rice in the area with an increased water level of two meters or more (Kobayashi, 2004). Sugar palms (*Borassus flabellifer*) are scattered in rain-fed paddy fields (Photo 1), not in the high water area (Photo 2; Table 2). For example, in Sankor Distict, Kampong Svay County, Kampong Thom Province, floating rice is directly seeded in April and harvested at the end of December or in January (Table 3). Seedbeds of ordinary rice are prepared around the end of May, when the rainy season begins (Kobayashi, 2004), and harvesting starts in November. Varieties of ordinary rice can be chosen from early-season, medium-season and late-season. In general, the yield of late-season rice is higher than that of early-season rice but farm households prefer to cultivate multiple varieties. It is considered that this is to adjust the time of each farm work process according to the varietal characteristics of rice by intentionally delaying the time of planting and harvesting that require a large amount of labour, and to secure the period of having enough rice for personal consumption (Tanikawa, 1997).

Photo 1. Borassus flabellifer (Sugar palm) scattered within rain-fed paddy fields (Photo: Japan Wildlife Research Center)

Photo 2. High-water area in the dry season (Photo: Japan Wildlife Research Center)

Table 2. Landscape elements surrounding Tonle Sap Lake

Water depth in rainy season	Less than 1 m	2 - 4 m	- 8.5 m
Characteristic Elements of the landscape	Rain-fed paddy fields + the outer border of the flooded area	Paddy fields with a high water level due to flooding	Floating village
Paddy rice cultivation	Ordinary rice	Floating rice	No cultivation
Sugar palm	Scattered	No cultivation	No cultivation
Dwellings	Many settlements (stilt houses) of by-business farmers/fishermen along national routes in the outer area of the flood plain	Few or no dwellings (Seasonal huts, if any)	Stilt houses, boat houses, raft houses
Flooded forests	No	Yes	Yes (Fuel supply source of residents in floating villages)

Source derived from materials by Kobayashi 2004, and Kobayashi 2007

Table 3. Agricultural calendar around the north part of the Tonle Sap Lake

Agricultural produce	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
						Growing period						
Early-season rice							Rice nursery	Trans-plantation				Harvest
Medium-season rice						Rice nursery		Transplantation				Harvest
Late-season rice	Harvest				Rice nursery		Transplantation					
Floating rice	Harvest			Direct seeding								
Sugar palm	tapping sap											tapping
Rainy/ dry season	Dry season				Rainy season							Dry season

Source: Tanikawa (1997)

Freshwater Fishing

According to the survey (Tanikawa, 2001) conducted in a village near Siem Reap City (located in the north part of Tonle Sap Lake), the area has a large production volume of rice in rain-fed paddy fields but the production is unstable due to the change in precipitation. As a measure to cope with the shortage of rice, farmers are engaged in various works such as sugar production from sugar palms, breeding domestic livestock, including cattle, pigs, chickens, etc., making souvenirs for visitors, reparation and construction works in the Angkor ruins in the vicinity, etc.

For most farmers living around the flood plain, an important income source in the dry season is small-scale freshwater fishing. For example, in two villages (183 and 140 households respectively) in the Kampong Thom Province, fishery production is conducted around Tonle Sap Lake and the surrounding area of the villages (ponds, rivers, flooded forests, rice paddies). Fish catches are therefore higher in Tonle Sap Lake. Even in the fisheries industry around the villages that have small fish catches, the self-consumption rate is only 5 to 10% and most catches are for sale. Some farmers travel 25 km from their home village to a floating village to do fishing on Tonle Sap Lake as a side job for almost 9 months (from October to June) during the dry season (Hori et al., 2005).

People who are mainly engaged in fishery are the residents of floating villages (Photo 3). The size of floating villages varies and large ones have 1,000 to 2,000 households and a population of 5,000 to 10,000 or more. There are 170 floating villages in 23 communes in the whole Tonle Sap Lake area, where approximately 100,000 people live (Kasai, 2003). Houses in floating villages are stilt houses that can cope with drastic changes of water depth, and boat/raft houses that are built on top of boats. These houses are roofed with light materials such as corrugated iron, thatches or shingles. In a floating village, there are private houses, gas stations, fish processing factories, ice-making factories, a government office, school, restaurants for foreign tourists, a branch of the provincial fishery office, etc.

Photo 3. Floating village: Kampong Phluk
(Photo: Japan Wildlife Research Center)

12.3 Challenges and Responses

In Cambodia, when farming villages entered the market economy in the 1990s, the degradation of the resources rapidly accelerated. The society is now facing a significant increase in population. Abundant ecosystems around Tonle Sap Lake have long provided important resources to maintain the daily life of poor residents in villages in Cambodia. Today, however, residents are unable to find a solution to their own poverty problems by relying on the resources of the lake alone.

Some of the challenges concerning the management of natural resources around Tonle Sap Lake are the modernization of fishing techniques, the significant decrease of flood forests and the increase in population in the area. Flood forests are cut down to be used as fuel wood for residents. The deforested land is converted to farmland, and the area of flood forests has decreased to a quarter of its peak, which was as large as one million ha (Kasai, 2003). As a response, from around 2000, the Cambodian government has been promoting community fisheries as a measure to cope with issues including sustainable and fair management of fishery resources in Tonle Sap Lake, the improvement of life standards and poverty. Problems such as the decline in resources and deterioration of ecosystems are being recognized by local residents (JWRC, 2009).

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13 Indonesia: Rice Terrace Landscapes and Irrigation Associations (*Subak*) in Bali Island

13.1 Background

Bali is a volcanic island located in the tropics, to the east of Java, the main island of the Republic of Indonesia. It has an area of approximately 5,600 km^2 and a series of volcanoes at an altitude of the order of 2,000 m stretching from the east to the west nearly at its center. This backbone range creates a diversity of natural conditions on the island. Bali has clearly alternating rainy and dry seasons. The rainy season corresponds to the northwest monsoon season approximately from November to March, while the dry season corresponds to the southeast monsoon approximately from April to October. The precipitation along the north and south coasts is low at up to 1,500 mm, while thatin the central highland and mountainous area is as high as 2,000-3,000 mm (Shimmi, 1993).

The vegetation on Bali Island varies from monsoon forests in highlands to tropical rainforests in the lowlands through to savanna vegetation in between, as well as to mangrove forests in the coastal areas. The main animals include Bali cattle - a domesticated species of banteng (*Bos javanicus)*, Long-tailed Macaques (*Macaca fascicularis*) and marbled cats (*Pardofelis marmorata)*. Over 300 species of birds inhabit the area and Bali Starling *Leucopsar rothschildi*, designated as the provincial bird, is an endangered species endemic to Bali (Ministry of Forestry Indonesia, 2011).

Indonesia is a predominantly Muslim country, accounting for more than 90% of the population, with a minority of Hindus. Bali Island, however, was inhabited by an overwhelming majority of Hindus, accounting more than 90%. Although the number is slightly decreasing as those who believed in other religions increased partly due to migration from other islands, Hindus still remains a majority (Nagano, 2007). Bali Island, which is well known as "the last paradise," "island of the Gods" or "island of festivals and entertainment," attracts many tourists from all over the world due to its unique of Bali-Hindu culture (Shimmi, 1993). Balinese people's common values are based on the doctrine of "Tri Hita Karana." "Tri" means three, while "Hita" denotes happiness and harmony and "Karana" means 'cause of'. According to the doctrine ('three causes of happiness and harmony'), happiness can only be achieved if "the Creator", "human beings" and "nature" exist in harmony with one another. Thus, on Bali Island, local communities are closely tied to nature, culture and religion (Soehartono and Mardiastuti, 2009).

The number in the workforce in agriculture, forestry and fishery sector is decreasing. In 1971, the agriculture, forestry and fishery sector constituted two-thirds, or 66.7% of the total workforce (Maotani, 2000), while in 2004, it decreased to 35.3%. On the other hand, the number is increasing in the secondary and tertiary industries being 23.0% in commerce, restaurants and hotels, 14.2% in manufacturing, 13.4% in services and 7.2% in construction. (Nagano, 2007).

13.2 The subak system Supporting the Rice Terrace Landscape

Rice terrace landscape in Bali island

The paddy field (rice terrace) landscape is a typical landscape seen in Bali Island (Photo 1). In terms of topographical conditions, paddy fields on Bali Island can be largely categorized into those in the lowlands in the lower reaches of rivers; those in valley floor plains; rice terraces in areas of steep slopes; and those largely carved into slopes covered with pyroclastic flows in gently sloping areas (Shimmi, 1993). The paddy fields provide various benefits, including

sustainable watershed management, flood control due to the temporary reservation of rainfall in the paddy fields, groundwater recharging and the stabilization of river flows due to the delayed discharge of water. Moreover, other benefits include water quality management by absorbing nitrogen and phosphorus, the provision of habitats for wild animals and the mitigation of substantial changes in temperature due to evapotranspiration (Gany, 2010). In Bali, the perennial crops grown on the land around the rice terraces include bananas, oranges and mangoes, with bamboo groves and different kinds of palms growing well. In the north, due to the lower precipitation than in the central south, coffee and coconuts are cultivated and livestock farming is practiced. In the west, stretches of hilly areas are mostly covered with forests (Nagano, 2007).

Photo 1. Rice Terraces in Bali Island
(Photo: Japan Wildlife Resesarch Center)

The Irrigation Associations (*Subak*)

The paddy field landscape is founded on the *subak* system, a system of highly developed traditional irrigation associations. It is not known exactly when the *subak* system was established. Some ancient epigraphs, however, have indicated that it was introduced in Bali Island several hundred years ago from East Java (Gany, 2010). It was in 1071 that the existence of the *subak* system came to be more widely known. This traditional irrigation system was developed on Bali island and has been handed down from generation to generation up to the present (Windia, 2010).

Each *subak* is organized by independent farmers who own the paddy fields where the irrigation channel runs or the tenants who work on them. A single farmer can be a member of several *subak*. The *subak* is not only an association engaged in irrigation activities, but an organization performing religious services, including fertility rituals dedicated to the Dewi Sri (the Goddess of rice) or the Batara Wisnu (the God of support and sustain the Universe) (JWRC, 2009). Each *subak* has its own temple. The temples and stone altars are set up at intake weirs. The members of the *subak* maintain the temples and perform a variety of rituals according to the growth stage of the paddy rice.

Subak have customary law known as *awig-awig* that provides for the obligations to be met by its membership, which each member has to abide by. All these affairs are managed by the leader of the *subak*, called *pekaseh* (Nagano, 2007). Based on customary law, the *subak* establish the rules according to which the leader convenes meetings of the association, enforces the decisions and regulations made for irrigation channel maintenance and water allocation, and imposes fines against violators, if any (Nagano, 2007).

Rice planting in the paddy fields is subject to regulations known as *kertamasa* and *gadu*. In December during the rainy season, the *kertamasa* governs the paddies by allowing all the members to conduct rice planting, while in August during the dry season, the *gadu* require only half of the members to plant rice in their paddy fields, taking the shortage of water into account. Thus, *subak* members plant rice during the dry season under the *gadu* regulations every other year, or double cropping is performed biennially, resulting in three harvests in total every two years.

The *gadu* provides the most important regulations for the *subak*, and hence the relevant official documents are addressed to each household every year to inform them about their turn for *gadu* cultivation that year. Under the *gadu* system, rice is harvested in around 3-4 months, followed by the planting of soybeans. In the year when *gadu* is not applied, the paddy field

is fallowed after the harvest of soybeans in July. Therefore, the *gadu* system not only addresses the shortage of water, but maintains fertility by leaving the paddy fields fallow for a certain period. The lunar calendar is applied to determine the timing of rice planting and harvesting, which can be observed by the members through their section leaders. A penalty is imposed on those who do not follow them.

Seedlings planted earlier than the determined date will be uprooted or the premature rice stalks will be cut down before harvesting. The period for rice planting is set for 15 consecutive days, with the intention that concerted rice planting within a certain limited period will avoid the concentration of damage by birds or insects on a particular paddy field (Nagano, 2007).

Irrigation Facilities of the *Subak*

The total number of the *subak* is about 1,200, covering approximately 100,000 ha of irrigated fields. The area of paddy fields irrigated by a single *subak* varies from several hectares to hundreds of hectares, with an average area of some 80 ha (Shimmi, 1993). The *subak* irrigation system comprises such facilities as intake weirs, channels and tunnels (Photo 2). Since the river valleys on Bali Island are canyon-like, an open channel along a wall cannot convey water up to the slopes where the paddy fields are situated. Therefore, irrigation channels have been constructed to pass through unlined tunnels. The number of intake weirs on the island is over 1,600, of which 85% constitute the traditional type of masonry weirs and the remaining 15% are permanent structures made of concrete. In terms of the area of paddy fields, amounting to approximately 100,000 ha in total, each type of weir has an equal share of 50%, with the irrigated area per weir amounting to about 40 ha for the former type and some 220 ha for the latter type. The appropriate maintenance of these irrigation facilities, including reconstruction and repairs, has been indispensable to the establishment of paddy cultivation on Bali Island. Thus, renovation and construction projects for the *subak* irrigation system have been implemented proactively since Dutch rule (since early 17th century until 1945), which promoted labor intensive cultivation methods (Shimmi, 1993).

13.3 Challenges and Responses

Photo 2. Irrigation channel
(Photo: Japan Wildlife Research Center)

At present, rice cropping on Bali Island is under the threat of a decline in its practice for both technical and non-technical reasons. Serious problems include the competition for land and aquatic environments, the decline in the area of irrigation and the resultant decline in rice yields. The marked physical changes resulting from rapid economic development on the island is clearly reflected in the reduction in the irrigated area, which is being replaced by the accelerated development of tourism infrastructure, including amenities such as hotels and restaurants and amusement facilities. The strong demand for skilled workers in the tourism sector increasingly affects the shift of a substantial proportion of the workforce from agriculture to the tourism sector. Coupled with stagnant levels of wages for hired labor such as for rice harvesting, as well as rice prices, paddy cultivation has become unprofitable today. In this context, at least 5,000 ha of paddy fields have been converted to non-agricultural uses, including housing and industrial sites over the last seven years. According to recent records, the average rate of decline in the area of irrigated agriculture in Bali Province is 1.01% per year, or about 870 ha of irrigated land is lost

every year in this province (Gany, 2010). Tourism development on the island has influenced the *subak* system in a variety of ways. In the rapidly urbanizing West Denpasar District, in Denpasar city, for instance, five *subak* disappeared during the period from 1995 to 2000 (Nagano, 2007). Besides, the deteriorating living conditions pose problems, including polluted water discharged from souvenir factories such as batik dyeing factories and the encroachment of plastic garbage in paddy fields (Nagano, 2007).

Taking into account the fall in the yield and price of rice in Bali Island, the socio-cultural functions, one of the most important functions among the non-technical aspects of paddy agriculture are brought to attention and the approach that does not simply treat irrigated agriculture as a technical domain, but as an integrated cultural system is suggested as effective (Gany, 2010). In the midst of changes resulting from rapid development, it is worth noting that the "customary village contest", which evaluates how the local communities in Bali Island are under the guidance of the government, raises awareness among the local people about their own traditions and prevents the land they own, including paddy fields, from being converted to non-agricultural purposes (Nagano, 2007). On the other hand, the problems with regard to polluted water and garbage are attributed to the fact that those with different occupations, including those in the tourism sector, have migrated and settled in areas with paddy fields managed under the *subak* system (Nagano, 2007). The Mangrove Information Center,which was established in Denpasar city by the Ministry of Forestry with support of the Japan International Cooperation Agency (JICA), had implemented various activities to raise awareness about the massive amount of garbage drifting down to the mangrove forests from the upstream reaches of rivers or paddy fields by organizing workshops for representatives from each settlement and installing carts for garbage collection (Nagano, 2007).

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14 Myanmar: Mangrove Forests in the Ayeyarwady Delta

14.1 Natural and Social Background

A mangrove ecosystem is a community of forests that grow in the intertidal environment, which is the transition area between the land and the sea (Ono, 2007). In general, plants cannot grow in saline water conditions, but mangroves can grow in this intertidal environment since they can discharge salt using various methods such as accumulating salt in particular leaves and shedding them to discharge the salt if the amount of accumulated salt exceeds a certain limit, the filtering of salt by the roots, and allowing salt to be evaporated after passing through salt glands on the surface of the leaves (Sashida, 2006). It is confirmed that mangrove forests are distributed in 123 countries worldwide (Spalding et al., 2010). In particular, mangrove forests have developed in Asian regions such as India, Bangladesh, Myanmar, Thailand, Vietnam, Malaysia, Cambodia, the Philippines, and Indonesia, representing a little less than 46% of the total mangrove forest area of the world (Nay, 2004).

The Ayeyarwady delta has an area of 33,670 km^2 (JICA, 2005), and its coastline extends for about 469 km. The mangrove forests extending over the delta area constitute the largest of their kind in Myanmar, accounting for 46.4% of the total mangrove forests in the country (Khin, 2008). Twenty-nine species of mangrove trees have been confirmed to exist in the Ayeyarwady delta, forming the most complicated mangrove system in Asia (Nay, 2002). In particular, *Heritiera fomes* is widespread and dominant, and other species that exist here include *Excoecaria agallocha*, *Bruguiera gymnorrhiza*, *Cynometra ramiflora*, *Ceriops decandra*, and *Avicennia officinalis* (Ono, 2007). According to Köppen's climatic classification, the Ayeyarwady delta belongs to the tropical monsoon climate, in which three distinct seasons, the rainy season (mid-May to mid-October), the winter season (mid-October to mid-February) and the dry season (mid-February to mid-May), are recognized with a very large difference in precipitation between the rainy and the dry seasons (JICA, 2005; Ono, 2007). The delta has tidal water channels of many rivers, large and small, which branch off from the Ayeyarwady and is often flooded due to tidal effects and rainfall during the rainy season. The amount of sediment discharge in the Ayeyarwady is enormous compared to other large rivers in Southeast Asia. With this sediment, sand banks called beach ridges have formed at the end of the delta, which geographically characterizes the mangrove area in the coastal region (Ono, 2007).

The southern area of Myanmar, including the Ayeyarwady delta, started to be colonized by the British in 1852, and due to the declaration of land nationalization, the ownership of all land came to belong to the state with all forests and forest products considered to be owned by the state. Since then, there has been no change in the fundamental framework of this system, and even today no land is privately owned by individuals.

14.2 Use of Mangrove Forest Ecosystesm in Ayeyarwady Delta

Land use

Mangrove forests have been provided farmers with firewood, timber, medicinal herbs, and other forestry products, which are used for particular purposes. They have also served as the breeding area for fish and shellfish. Thus people in Ayerarwa dy Delta have depended on the mangrove ecosystems for many things besides fuel and food. The major occupation of the people living in the delta varies according

to the way they occupy or hold the land. Those who own land are engaged mainly in agriculture, and in particular, rice cultivation is flourishing. In general, farmers cultivate rice once a year using rain during the monsoon season. As another form of land use, home gardens play an important role. Home gardens are made up of useful trees that are the mixture of existing varieties and cashable tree crops, and are used mainly for self-sufficiency. They are managed extensively. Many large-scale farmers produce coconut palms and betel palms that are cashable tree crops. Home gardens provide a number of other plant resources for food and herbal medicines or for poisons.

On the other hand, small farmers who have only narrow tracts of land and seasonal workers who have no land work under large-scale farmers as migratory laborers during the busy seasons, earning a wage of 400-500 kyat a day (about $0.40-0.50 based on the exchange rate of 2005). In addition, they tend to depend on fisheries such as the catching of crabs and shrimps for a living, and rely on resources in the mangrove forests for many aspects such as fuel and food. Most of the small farmers and seasonal workers are poor because they have difficulty making a living. If the poverty line is 100,000 kyat per household per year as defined by the United Nations Development Programme (UNDP), the percentage of poor families in the Kadonkani and Pyindaye reserved forests in 2002 was extremely high at 59.6% and 54.5%, respectively (JICA, 2005).

Benefits of Mangrove Forests

In addition to the direct value of the resources, mangrove forests provide the habitat for macaques (genus *Macaca*), which are indigenous to mangroves, as well as for otters, crocodiles, many species of birds and insects, and so forth, contributing greatly to the preservation of biodiversity (JICA, 2005; JICA, 2006). The other many indirect benefits include erosion and flood control, mitigation of the effects of global warming, and functioning as a tree barrier to protect the shoreline from winds and tides. When the earthquake that occurred off Sumatra in December 2004 caused a massive tsunami, for example, damage from the tidal waves was mitigated in coastal areas where mangrove forests existed since they reduced the speed of the tsunami and prevented driftage from passing through them, thus weakening the destructive power of the tsunami (Sashida, 2006). According to the investigation conducted in Bogalay in the administrative division of Ayeyarwady, which received the most damage from Cyclone Nargis in 2008, in areas more than 10 km from the route of the cyclone the mortality rate of residents in settlements near mangrove forests and secondary forests was notably lower than that in settlements in the non-forest areas. A hearing investigation revealed that many residents who survived the cyclone avoided being swept away by the high waves by holding onto trees in the forests. This showed that mangrove forests have the effect of reducing damage from high waves (Ya, 2011).

Land Use in the Reserved Forests

Settlement areas in the Ayeyarwady delta are managed by the General Administration Department of the Ministry of Home Affairs. The resident's right to hold land has been established but is subject to state intervention. Land revenue is collected annually from residents who hold land in the settlement area (Ono, 2007). Forest areas are managed by the Forest Department. In Myanmar, land development is prohibited in the reserved forests stipulated by the forest act, but as a result of illegal development, there is housing land, paddy fields, home gardens, plantations, and other property even in the reserved forests. The plantation here is a local one managed by land owners who employ local seasonal laborers, etc and not typical large-scale plantation which depends on a cheap labor force that started under the colonial system. The Ayeyarwady delta has 13 reserved forests of which eleven include mangroves. The Meinmahla, Kyakankwin Pyauk, Kadonkani, Pyindaye, and Pyinalan reserved forests include approximately

97,000 hectares of paddy fields, which occupy 47% of the area of the five forests, larger than the area of mangrove forests, which occupy an area of 90,386 ha (44% share) (JICA, 2005).The occupants of these properties maintain their illegal ownership by paying a small penalty to the Forest Department each year (Ono, 2007). The "penalty" includes money that is collected without any legal basis by public officers from the illegal occupants of property. The fact that some residents are not unable to distinguish the penalty from land revenues in the settlement areas is spurring the illegal ownership of reserved forests, which is considered to be a problem for their management. Figure 1 shows the actual condition of the land use in the township of Bogalay in the administrative division of Ayeyarwady. In this area, development has progressed in the reserved forests, and there are villages built on privately occupied land. There are also community forests that have been developed according to the Community Forestry Instructions (as described later).

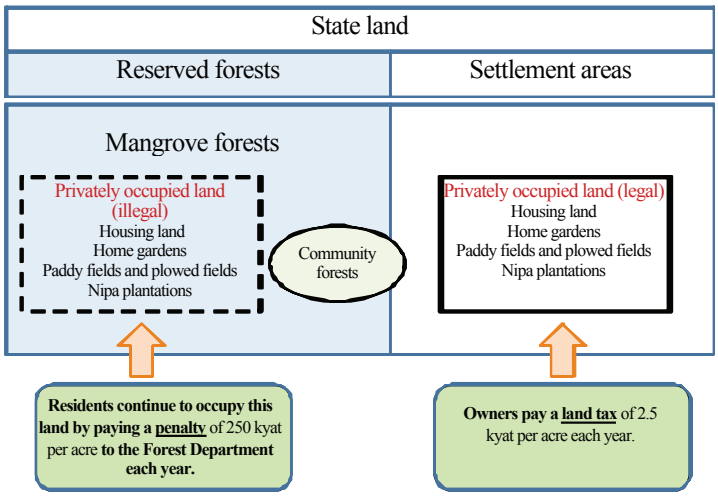

Figure 1. The Actual Condition of the Land Systems and Land Use in the Township of Bogalay in the Administrative Division of Ayeyarwady (Source: Ono, 2007 modified) (Amount of the penalty is as of 2007, investigation by Ono)

Community Forestry

In 1995, the Forest Department issued Community Forestry Instructions to allow local residents to control forests, promoting the implementation of community forestry.

User groups engaged in community forestry activities have acquired the right to use community forests for 30 years under the Forest Department's licensing system. They are allowed to collect products from their community forests, use them, and sell them in their community. Furthermore, since they also have the right to own produce incidental to community forests such as crabs and shrimps, they can make a profit by continuously producing them (JICA, 2005). Local residents are allowed to develop community forests in the reserved forests and other areas. User groups organized by local residents draw up plans to manage activities in their community forests and apply to the Forest Department for approval. Upon receipt of the applications, the Forest Department examines the applications, and based on the results of these examinations, it grants the user groups a 30-year lease and usufructuary rights over community forests. One characteristic of community forestry is that the Forest Department actively allows user groups to apply such plans not only to community forestry activities, but also to newly developed forests and to those remaining natural forests that local residents have historically used. The Forest Department's responsibility as it is related to community forestry activities is to support and manage such activities carried out by the user groups. User groups carry out community forestry activities in accordance with the management plans they work out on their own and that the Forest Department authorizes (JICA, 2005).

14.3 Challenges and Responses

Records from 1924 indicate that in the southern part of the Ayeyarwady delta, there were 506,000 ha of mangrove forests in the area that covered an area of 200 km by 60 km. The surveys conducted from 1998 to 1999 show, however, that these mangrove forests decreased to 87,000 ha. This means that 83% of the

mangrove forests disappeared in 75 years (Mochizuki, 2002). In 1962, a military dictatorship was established. After it adopted a national isolation policy, the economy stagnated in urban areas including the capital of Yangon, and electricity and oil fuel became scarce, causing the nation to depend more on firewood and charcoal for cooking fuel. In addition, the growth in the population further increased the demand for fuel, prompting the felling of mangrove forests that supplied the firewood for commercial purposes. From 1971 to 1993, the Ayeyarwady delta provided 85% of the charcoal consumed in the capital city of Yangon (JICA, 2005). Moreover, as the population grew, mangrove forests were turned into paddy fields as a food production center in accordance with the government's policy. As described above, the indiscriminate felling of mangrove forests and the development of paddy fields due to the rapid increase of the demand in urban areas from the 1970s to the 1980s devastated the forests throughout the Ayeyarwady delta. The deterioration in the remaining mangrove forests is also under way as typified by changes in the composition of species such as a decrease in the number of useful species of mangrove and the transition of mangrove forests into tangles of various kinds of trees, as well as by a decline in the size of the mangrove trees (Ono, 2007).

The destruction of mangrove forests in recent years is largely attributed to the construction of culture ponds for shrimp farming. After the government announced its open economic policy in 1990, many businesses constructed culture ponds in the delta to produce shrimp and fish for export to the world market. In 2004, according to materials provide by the Forest Department, 1,200 ha of mangrove forests in the Ayeyarwady delta were turned into shrimp culture ponds. The dams and embankments built around shrimp culture ponds prevent currents from flowing into and out of the delta, and as a result, the rise in the concentration of salt in the water affects the growth of many forms of life (Khin, 2008).

The sediment discharge of the Ayeyarwady has decreased due to human activities such as land development in inland areas outside the delta region, which has caused erosion around the forward edge of coastal areas in the delta. Moreover, Cyclone Nargis in 2008 which affected the Ayeyarwady and Yangon administrative divisions, caused the worst damage in the history of Myanmar. The number of deaths and missing people reached nearly 140,000 due to the high waves and the heavy storm (Ya, 2011) and approximately 94% of all buildings collapsed or were heavily damaged. It also destroyed about 14,000 ha of mangrove forests and many plantations (Woo, 2008). The destruction of mangrove forests brought a large amount of sand onto the tidal flats and changed various habitats in the coastal area, resulting in adverse effects on biodiversity. In addition, seawater flowed into paddy fields and tributaries of the Ayeyarwady were polluted with high-concentrations of bacteria in the delta lowlands (Woo, 2008).

In 1993, in order to cope with the depletion of the mangrove forests, the Peace and Development Committee of the administrative division of Ayeyarwady prohibited the felling of any of the species of mangrove in the administrative division except the felling of trees after afforestation and forest nurturing, the construction of charcoal kilns, and charcoal making. Even today, charcoal production is totally prohibited in the delta, but charcoal can be produced under license using wood generated by the felling of trees in afforested areas (JICA, 2005).

The restoration of mangrove forests became an issue to be addressed at the national level, and in early 1980, the Forest Department launched a directly managed afforestation project. In general, within the area of the activities of the villagers, the Department is promoting the restoration of mangrove forests by developing new forest areas through community forestry activities based on the Community Forestry Instructions mentioned in Section (2), and in areas distant from the villages, it is directly planting mangrove trees. The

directly managed afforestation began on a scale of 75 acres a year in the 1980s, and several years later, the scale was expanded to 750 acres a year. However, nearly half of the areas afforested by the Forest Department were destroyed by later invasions: the development of agricultural land, the construction of culture ponds, and the selection of unsuitable species that killed many of the mangroves, leaving the mangrove forests in the delta devastated (JICA, 2006). With financial support from the Action for Mangrove Reforestation (ACTMANG), an NGO engaged in mangrove reforestation in Japan based on financial support from Tokio Marine & Nichido Fire Insurance Co., Ltd., the Forest Resource and Environment Development and Conservation Association (FREDA), a local NGO, initiated a five-year mangrove afforestation project in the Pyindaye reserved forests in 1999. This project takes an integrated approach that encompasses mangrove afforestation based on the Community Forestry Instructions and poverty reduction aimed at improving the living standards of members of community forestry user groups (Photo 1; FREDA, n.d.).

In 2007, JICA launched a five-year project (after the impact of Cyclone Nargis in 2008, it was postponed one year to become a six-year project) to plan the comprehensive management of mangroves in the Ayeyarwady delta by involving local residents. The overall goal of the project is to ensure the sustainable management and use of mangrove forests and to reduce the poverty of local residents. Up to now, the project have provided the staffs of the Forest Department with a wide range of training programmes and formulated afforestation plans needed to systematize mangrove afforestation technology and conducted tests based on such plans. Since FY2011, they have worked to develop technical guidelines and manuals based on the knowledge they have accumulated in the past.

As stated above, efforts have been to ensure the recovery of the mangrove forests through plantation projects at various levels. However, policies concerning the development of mangrove forests are under a chaotic situation. Land-use plans and policies concerning reserved forests are not unified and shrimp farms have been developed continuously.

Photo 1. Community forest developed collaboratively by local residents and NGO (Photo: Kunio Suzuki)

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15 Philippines: A Combination of Rice Terraces, Swidden, and Muyong (Privately Owned Forests) in the Province of Ifugao

15.1 Background

The Province of Ifugao (2,517 km^2) consists of mountainous areas located on the eastern slopes of the Cordillera Central Mountains, which run through the northern part of Luzon Island in the Philippines from north to south with some of their peaks rising 2,000 m above sea level or higher. Together with the Province of Benguet (2,655 km^2), located in eastern Ifugao, it constitute part of the mountainous area called the Cordillera Administrative Region (comprising six provinces), which have many ethnic minorities. Ecological landscapes consisting of a basic combination of rice terraces, muyong, and swidden, are distributed throughout these two provinces. Banaue is situated about 380 km north of Manila, the capital of the country. This region has a tropical monsoon climate with its annual precipitation amounting to 2,500 to 3,000 mm due to the rains brought by semiannual monsoons (winter's northeastern monsoon and summer's southwestern monsoon) as well as typhoons. Located in the subtropical zone, Banaue, the center of rice terrace tourism, has an average annual temperature of 20.8°C, approximately 6.6°C lower than that for Manila, because it stands at about 1,100 m above sea level.

The Municipality of Banaue covers mountainous areas whose height ranges from 700 m to 2,000 m above sea level. Its forest vegetation is dominated by mountain rain forests, but in particular, mossy forests are distributed in cool areas that rise 1,800 m above sea level or higher. Major trees include *Quercus* spp. in the beech family (*Fagaceae*), *Cinnamomum* spp. in the laurel family (*Lauraceae*), and *Shorea astylosa* and *Shorea contorta* in the dipterocarp family (*Dipterocarpaceae*). Particularly abundant is *Pinus kesiya var. langbianensis*, which grows in a wide range of areas from 500 m above sea level to the province's highest peak of 2,700 m. This species forms pure stands or forests mixed with broadleaf species.

In the early 20th century, it is estimated that approximately 70% of the land in the Philippines was covered with forests. Since 1990, the percentage of forest areas has recovered from 21.9% to 25.6%, but from a long-term perspective, the country has seen its forests destroyed on a nationwide scale (see Table 1). The Province of Ifugao is an exception, on the other hand, in that the forest ratio remains relatively high partly because the province is located in a high mountainous area and therefore lacks forest resources that are subjected to commercial felling.

Table 1 Trends in the Percentage of Forest Area in the Philippines

Year	Percentage of forest area (%)	Forest area (10,000 km^2)	Source
1950	49.1	14.7	Kummer (1992, p.56)
1957	44.3	13.3	
1969	34.9	10.5	
1976	30.0	9.0	
1980	25.9	7.8	
1987	22.2	6.7	
1990	21.9	6.6	FAO (2010)
2000	23.7	7.1	
2005	24.6	7.4	
2010	25.6	7.7	

Source: Created based on Kummer (1992) and FAO (2010)

15.2 Mosaic Landscape of Ifugao

Combination of rice terraces, muyong (privately owned forests), and swidden field

The landscape of agricultural villages in Ifugao consists chiefly of common forests (Inalahan), privately owned forests (Muyon), fields to produce vegetables, swidden to produce beans, sugar cane, sweet potatoes, and other crops (Uma), rice terraces (Payo), shared tracts of land covered with cogon (*Imperata cylindrica*), and settlements (Figure 1). The spectacular landscape of innumerable rice terraces on the slopes of V-shaped steep valleys from the valley floor to the top of the mountain slopes was inscribed on the World Heritage List in 1995. Rice terraces and irrigation canals developed in mountainous areas with high annual precipitation require constant management and maintenance based on traditional wisdom and techniques. Ifugao's farmers have diligently performed management and maintenance work such as the repair of stone fences and weeding around rice terraces.

In Banaue's Poitan Village, common forests cover areas that range from 1,200 m above sea level to the 2,000-meter-high mountain summit. Those around the summit play an important role as watershed protection forests since about 90% of terraced paddy fields in this region are irrigated (JBIC, 2004). Muyong, meanwhile, are distributed in a mosaic-like way among the rice terraces and scattered settlements between 800 m and 1,200 m above sea level (Hayama, 2003). In Banaue's Bagaan Village, on the other hand, common forests are located in cone-shaped valleys surrounded by mountains into which brooks flow, and the rice terraces are distributed along the lower part of the valleys with the muyong and other forests along the upper parts (Photos 1 and 2; Figure 1).

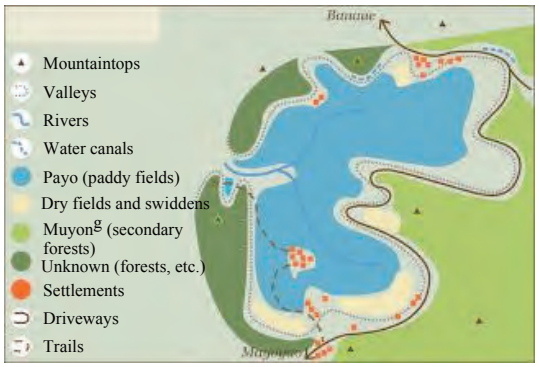

Figure 1. An Overview of Multiple Land Use in Bagaan Village

Photo 1. A Scene from Bagaan Village (Photo: Japan Wildlife Research Center)

Photo 2. Rice Terraces and Muyong in Bagaan Village (Photo: Japan Wildlife Research Center)

Since it is more difficult to cultivate rice in terraced paddy fields the higher the elevation, the upper limit to rice terraces in Ifugao generally tends to be at around 1,200 m above sea level except for some highlands that enjoy better sunshine. In rice terraces, a wide range of varieties are grown, including tinawon, which is cold-hardy and suitable for upland cultivation. Rice is planted in the dry season so that it grows in April and May when it is hottest and the plant enjoys full sunshine (JBIC, 2004). The average area of rice terraces owned per household ranges from 0.2 to 0.3 ha, and since the region's cool weather does not allow double cropping, annual rice self-sufficiency is even less than a half year, at around 5.0 months. Therefore, the Ifugao farmers fell some of the common forests on steep slopes in mountainous areas and develop swidden to cultivate sweet potatoes in order to support their diet. For the Ifugao, sweet potatoes are not only a vital food, but also an important feed for the pigs they raise. Some of the rice terraces are temporarily used as fields to cultivate taro, onions, and other vegetables. In addition, the Ifugao actively gather snails, bivalves, small fish, and tadpoles, all of which live in or around the rice terraces, as well as edible wild plants such as bracken and Japanese royal ferns and water grasses such as the Java water dropwort.

Useful plants in muyong

Many useful plants are found in muyong (see Table 2) and these plants have been used to support self-sufficiency mainly in food and firewood with some of them sold for construction, sculpture, and other purposes. In muyong, the Ifugao gather durians, longans, mangoes, and other fruits, as well as the leaves, stems, and roots of useful plants for food. They also collect medicinal herbs and *Calamus manilensis*, as well as bamboos, mahogany (*Swietenia mahagoni*), angsana (*Pterocarpus indicus*), and other trees for materials to construct houses and furniture. Areca palms (*Areca catechu*) and betel pepper (*Piper* spp.), both used for spices, are also important plants for the local farmers. Many of these useful plants have been actively transplanted to muyong and nurtured there.

Wood carvings produced by the Ifugao are extremely famous in the Philippines and constitute part of their livelihood, providing an important non-agricultural source of income. Wood carving is so prosperous that most of the materials have to be procured from outside Ifugao because sufficient amounts of *Alnus formosana*, khasya pines, angsana, and other trees, all raw materials for wood carving, cannot be supplied from within the province. The Hapuwan, a subgroup of the Ifugao, collect many fragrant herbs from muyong;

Table 2 Uses of Plants in Muyong

Uses	Number of families	Major families	Parts of the plants that are used
Food	36	*Myrtaceae, Palmae*	Fruits, leaves, stems, shoots, flowers, trunks, buds, and seeds
Fuel	43	*Moraceae, Euphorbiaceae*	Trunks, branches, and culms
Construction materials	36	*Euphorbiaceae*	Trunks, branches, and culms
Medicinal herbs (humans)	28	*Asteraceae*	Leaves, sap, trunks, bark, fruit, and flowers
Medicinal herbs (domestic animals)	12	*Musaceae*	Leaves, fruits, seeds, and sap
Woodworking	5	*Meliaceae*	Branches and trunks
Total	160		

Source: Rondolo (2001)

traditionally, they have used them as insect repellents in paddy fields as alternatives to agricultural chemicals. Coffee, lemongrass (*Cymbopogon citratus*), and citrus fruits are cultivated as cash crops (JWRC, 2009).

Development and management of muyong

Muyong forests have been developed by Ifugao farmers through the active promotion of natural regeneration and artificial regeneration. Farmers recognize well that daily management is important for muyong, and that the quality of muyong as forests is determined by whether they are managed properly on a daily basis. Promotion of natural regeneration means encouraging the regeneration of native tree species mainly through weeding and clear-cutting, thus actively protecting and developing them. In particular, at the sites where the trees are felled, the area within a radius of about one meter from each felled tree is weeded out to promote natural regeneration. Forestation involves planting pines, angsana, and other trees. Since the mid-1970s, seedlings of precocious tree species such as *Gmelina arborea*, khasya pines, and angsana, which are used for construction and wood carving, have been provided and widely planted mainly through forestation projects implemented by the Department of the Environment and Natural Resources (DENR) and the European Union (EU).

Depending on the conditions, muyong are carefully maintained mainly through afforestation, weeding, clear-cutting, and thinning. Furthermore, the priority is given to using low-quality trees, such as withered or curved trees and those that have stopped growing under pressure, for firewood and charcoal (Butic and Ngidlo, 2009). Felling trees in muyong for construction and wood carving materials requires the consent of the owner. Muyong, however, are open to their owner's relatives and neighboring residents, too, since minor uses of muyong such as the collection of firewood and fruits do not require the consent of the owner. Thus, the practice of using muyong is flexible enough to take the interests of the community into consideration as compared to rice terraces, which are always inherited as personal property, and swidden, which is managed by individuals as important food production sites even if they become common forests after the swidden farming is finished.

15.3 Challenges and Responses

Ifugao has an excellent system of land use including rice terraces, swidden, and muyong, which fits its natural conditions, but sustaining this system requires hard work because it involves repairing and weeding the stone fences around the rice terraces, maintaining long irrigation canals, and taking measures to keep wild birds and animals off the swidden. With the construction of a concrete-surfaced national road leading to Banaue in the mid-1970s, Ifugao was no longer a remote province in the mountains and started interaction with the external world. Specifically, less expensive lowland rice was brought to Ifugao in large quantities, and at the same time, tourism aimed at visiting the rice terraces and enjoying other attractions gradually became prosperous. It provides the local people with more opportunities to earn cash income such as the production of wood carvings and other souvenirs for visitors and the guiding and transportation of visitors. An increasing number of residents are leaving their villages and working away from home in order to seek further opportunities to earn cash income, causing a population drain. These developments are prompting villagers to gradually give up the cultivation of terraced paddy fields, which take a considerable amount of labor to manage, and the percentage of abandoned rice terraces is reaching around 25-30%. Sweet potatoes and other vegetables are cultivated in some of these abandoned fields. Swidden fields are also substantially reducing leading the increase of secondary forest. In 2001, UNESCO designated the rice terraces of the Philippine Cordilleras as an endangered heritage site, and as of June 2011, they remained among the world's 34 UNESCO heritage sites in danger. There is no hope of the rice terraces being excluded from the list of endangered heritage sites (UNESCO, 2011).

As part of its corporate social responsibility (CSR) programs, a Japanese electric power company has attempted small-scale hydroelectric power generation, which has small environmental impacts, in Ifugao's Municipality of Kiangan since 2010. Revenues from this project are used to protect the rice terraces and other landscapes, which are designated as a World Heritage Site (Tokyo Electric Power Company, 2008).

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16 Thailand: Traditional Land Use and Community Forestry by Hill People in Northern Thailand

16.1 Background

Northern Thailand is a mountainous area covered with forests. Most of Northern Thailand corresponds to the catchment area of the four tributaries of the Chaophraya River running from north to south of the country: the Ping, Wang, Yom and Nan Rivers. In other parts of the area, Mae hong son province and the western portion of Tak province constitute part of the catchment of the Salween River flowing into Myanmar while the northern portion of Chiang Rai province forms that of the Mekong River bordering Laos. These watersheds are aligned with ridges, including Mt. Doi Inthanon (2,565 m above sea level), the highest summit of the country. The climate of Northern Thailand is characterized by monsoons, which create three distinct seasons: the cool dry season (from November to February); the high-temperature dry season (March-May); and the warm rainy season (May-October). Annual precipitation amounts to 1,100-1,500 mm (Gardner etal., 2007).

Seasonal and topographical complexities, as well as the long-standing impacts of human activities, including rotational swidden cultivation, have created a complex and mosaic pattern of vegetation comprising evergreen and deciduous forests. In the humid areas at lower altitudes below 800 m, evergreen forests with gigantic trees as high as 40 m are formed with a species density of about 150 per hectare, including the genus *Acrocarpus* (the family Leguminosae), the genus *Hopea* (the family Dipterocarpaceae) and the genus *Toona* (the family Meliaceae). In the humid areas, even at the higher altitudes of over 1,200 m, there are extensive evergreen forests, including Lauraceae, Magnoliaceae, and Theaceae, with the number of species equivalent to that of the lower areas. The vegetation on the ridges and the arid land of sandy soil is characterized by pine trees, including *Pinus merkusii* and *P. kesiya* (Gardner etal., 2007). Thus, Northern Thailand is covered by a variety of plant habitats. Twelve "hill people", including the Karen, Mon, Yao, Aka, Lahu and Lisu, live in this area.

In Thailand, the State has the forest management rights. As for the forests that have been collectively managed and used historically to fulfill their basic needs by the local communities (community forests), however, the local people have demanded their rights to the management and use of such forests (community forestry) since the late 1980s. In response to this demand by local people, the Royal Forestry Department (RFD) has implemented a policy of allowing traditional forest management by the local communities as a means of promoting the protection of forest biodiversity by recognizing and registering the use of the forests outside forestry reserve areas, including national parks, as "community forestry." In addition, the Regional Community Forestry Training Center for Asia and the Pacific (RECOFTC), has a support system that underpins local activities by establishing training courses for those who assist in community forestry. This series of developments in the social environment for community forestry have brought about the establishment of management organizations at the local level, rules in written form, including penalties, maps made with the use of GPS and community forests with the borders clearly demarcated by posts and signs (Fujita, 2008; Inoue, 2000: Kurashima, 2010). There are now more than 10,000 community forests throughout the country, of which 7,000 that are located outside the reserved areas have been registered by the RFD (RECOFTC Website, 2011). The community forests recognized by the

current legislation are limited to those in the economic zones within conservation forests, as well as those on public lands. In fact, however, many community forests are located within such reserved areas as national parks and wildlife sanctuaries. A community forest bill to support all community forestry has been prepared, but, as of April 2009, the bill had still not been enacted into law, and hence there is still room for improvements in the legal regime for community forestry (Kurashima, 2010).

16.2 Community Forestry and Natural Resource Use in the Mae Laup Basin Network

Photo 1. A Kalen settlement and the surrounding land use (photo: Japan Wildlife Research Center)

The typical landscape of the mountainous area of Northern Thailand is composed of paddy fields in the valleys adjacent to settlements, rotational swidden fields on the slopes, and the surrounding forests of various kinds (Photo 1). In this area, a variety of wildlife in subtropical forests have been sustainably used to provide various types of resources. Aside from such forest products as forest trees, mushrooms, medicinal herbs and wild plants found in the communal lands of the settlements, much wildlife from the surrounding environment is exploited for food, including areas along waysides, field dikes, tanks and even irrigation channels. The yard of each house is used as a home garden, which looks just like a lush yard, but where almost all the variety of species planted are useful plants, including herbs and spices such as mint and ginger, as well as fruit trees such as banana. The communities have sustainably managed paddy and swidden fields and communal lands by establishing different rules and customs on their utilization, including those on water allocation for the paddy fields (JWRC, 2009). Such a pattern of natural resource use is also found in the mountainous areas of Vietnam and Laos. In Thailand, however, while the forest is owned by the state, it also recognize this traditional land use as "community forestry" and supports for it by public-private partnerships with NGOs.

The Mae Laup Basin Network is composed of five villages located along the upstream reaches of the Ping River in a mountainous area at an altitude of approximately 1,200 m that straddles Mae hong son and Chiang Mai provinces. This village network was launched following approval by the local government in 1998, with the support of an NGO called the Raks Thai Foundation. This represents official community forestry with forest management rules and a community forest management committee. The Karen, which is a hill people living in the mountainous areas of Thailand and Myanmar lives in these villages. Although they are Christians, their original faith in animism has not been completely lost. The total area of the network amounts to 7,970 ha, of which the residential area accounts for 3% (219 ha), the paddy and permanent fields for 6% (504 ha), the swidden fields and the related fallow land for 21% (1,697 ha), and the forests for 70% (5,898 ha) (Figure 1).

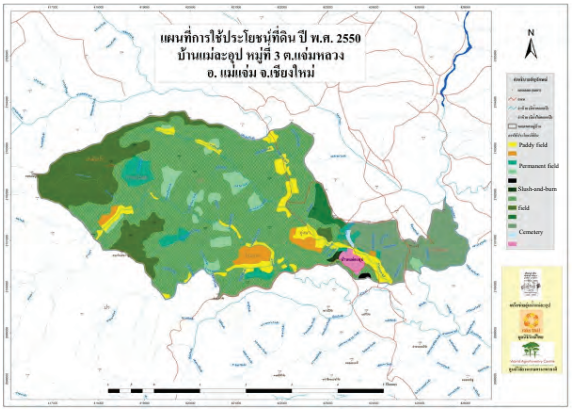

Figure 1. Land Use Map of the Mae Laup Basin Network (Five Villages)

The forests include a forest reserve, forest that is in use and "umbilical cord forest" (described below). Rotational swidden cultivation is allowed only where community forestry is also carried out with the swidden fields located far from the residential area and used in a cycle of upland rice cultivation for a single year with a subsequent fallow period of six years. Maize for feedstuff has been recently cultivated in some rotational swidden fields and forest that is in use (Matsushima et al., 2007; JWRC, 2009).

The Karen people in the lives on rice cultivation and swidden cultivation. They also use forest resources as their commons. Under certain rules, they normally picked and used the edible and medicinal wildlife resources around their settlements or in the adjacent forest. The substantial amount of cash required for a major milestone in life, such as school enrollment or marriage, is also gained from the use of resources in their communal forests. Thus, the forests are closely tied to the lives of the villagers. Another example was the local custom of designating a tree for each newborn by tying the baby's umbilical cord around the trunk.

This tied tree is supposed to grow well, just as the child will in the same village. The "umbilical cord forest" was a crucial custom to inform their offspring of the importance of forests, as well as providing a spiritual pillar for the village people. Animism involved other different customs, including the following taboos: "Do not let animals move around in the forest of the spirits (the forest that mourns the dead) located at the heart of the village"; and "Do not enter such forests except on ritual days." These sustainable uses of the forest are said to have become subject to change around 20-30 years ago, when external capital started to flow into the villages and forest resources such as tree bark came to be traded. Having felt a sense of crisis due to the decline in wild fauna and flora and the emerging devastation of the forests, the local people established a Network Committee with the assistance of an NGO to use the community forestry scheme promoted by the government to revitalize mountain villages (JWRC, 2009).

16.3 Challenges and Responses

The main challenge now concerns the expansion of maize cultivation for feedstuff funded by urban capital (Photo 2). Maize cultivation required the extension of a new frontier of cultivation since it reduces the soil fertility and involves harmful consequences from continuous cropping. The resulting higher temporary income, however, has led to an increase in the number of farmers engaged in maize cultivation. Continuous clearing for maize cultivation in communal forests that are in use, as well as in a portion of the swidden fields, has become a major factor causing the decline of community forests. It is often the case that the farmers have fallen in a vicious cycle of repeated cultivation to pay back the loss of the financial balance due to the substantial burden of the initial investment, including the purchase of fertilizers and pesticides, and the repayment of loans, including interest (JWRC, 2009).

Photo 2. A maize field (on the gentle slope at the center) (photo: Japan Wildlife Research Center)

To cope with the expansion of maize cultivation, the NGO Raks Thai Foundation, which supports the community, aims at a fundamental resolution by raising awareness and enhancing development capacity among the local people through environmental education for their self-reliance, not by addressing cases directly. In addition to the curriculum prepared by the central government for formal education in Thailand, the community has incorporated its own original one in which the villagers teach about local

matters in the schools. The traditional skills of handloom weaving, basket making, etc., are handed down from one generation to next in such a way that those who have the skills can directly teach them to children in the schools. Children are also given opportunities to join in the rotational swidden cultivation and reforestation activities. Other activities for village self-reliance proposed by the NGO include eco-tourism in a modernized form of umbilical cord forest, as well as the use of biogas (JWRC, 2009).

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17 Vietnam: Use of Natural Resources in the Central Mountainous District

17.1 Backgrounds

The central mountainous district in Vietnam consists of ranges of mountains located to the east of the Annamese Cordillera in eastern Indochina, and its highest peak reaches 2,600 m above sea level. It has a tropical monsoon climate with its rainy season extending from September to March due to monsoons from the South China Sea. Annual precipitation ranges from 3,000 to 4,000 mm, and average annual temperature is 25°C. The terrain is rugged, and this area is often visited by disasters such as floods and the collapse of slopes, mainly due to typhoons. Since its temperature and precipitation are high enough for the growth of plants, this region originally considered to have a high level of biodiversity. One example of an area having such biodiversity is the Bach Ma National Park. Called the center of plant diversity in Vietnam, the National Park comprises tropical lowland forests, which spread at an altitude of 900 m above sea level or less, and subtropical mountain forests, which stretch at altitudes of 900-1,450 m. A total of 2,147 species of vascular plants have been identified in the park. These account for one-fifth of the plant species that have so far been identifled in Vietnam.

However, because the forests were destroyed with defoliants and bombs used during the Vietnam War, even today, 36 years since the war, forests are still in the process of transition. In 1978, the Vietnamese government, which aimed to swiftly restore the forests, carried out afforestation projects in the central mountainous district by planting trees that grew fast. It distributed the seeds of *Acacia mangium*, a fast-growing leguminous plant, to promote afforestation, and has had these trees harvested for pulp materials in a short cycle of five to seven years. As a result, the percentage of natural forests remains at about 50%. The government also prohibited the swidden cultivation that minorities in the mountainous district have traditionally practiced.

The largest ethnic group in Vietnam is Kinh, but various minorities such as Katu, Paco, and Taoey live in mountainous areas. Traditionally, these ethnic groups have been engaged in rotational swidden cultivation, and their livelihoods have depended on natural resources from forests. They also have a tradition of eating abundant wild animals and plants close to them and using them for medicinal purposes (Gannon et al., 2008; Mizuno, 2008). Similar types of land and resource use are found in the areas of northern Thailand where mountain minorities live. There are, however, differences between the two in terms of social systems that support the respective lifestyles. There are cases where events sometimes occur to Socio-Ecological Production Landscapes, suddenly changing the lives of people and ecosystems there, and in Vietnam, needless to say, the Vietnam War, which continued from 1960 to 1975, was one of such events. From the viewpoint of natural environments, natural forests, which foster natural resources, are still in the process of transition, making it necessary to take measures to prevent the deterioration of forests and promote their transition. In terms of social environments, mountain minorities, who had evacuated because of the war, could not return to the villages where they had originally lived and therefore relocated to build new villages, and for this and other reasons, there were cases where the traditions that had continued until before the war were temporarily disrupted. This disruption of traditions characterizes SEPL in Vietnam's central mountainous district.

17.2 Semi-domestication of wildlife and swidden cultivation

Residents in Vietnam's central mountainous district, particularly mountain minorities, have maintained a lifestyle of using natural resources continuously as typified by traditional rotational swidden cultivation and the semi-domestication of wildlife at places close to them for food and medicine as well as livestock husbandry, hunting, the collection of forest products. Yamasaki et al. (2007) report 58 kinds of edible wild and semi-wild plants as examples of use of natural resources around settlements. Major edible plants include ginger, red pepper, mints, and long coriander *(Eryngium foetidum)*, water spinach *(Ipomoea aquatica)*, bitter gourd *(Momordica charantia)*, dokudami *(*Korean houttuynia, *Houttuynia cordata)*, and wild betel leaf *(Piper sarmentosum)* (used for salad and soup); taro and banana (sources of starch); and mangos and papayas (fruits). Many of these species are the same as those eaten in such countries as Laos, Thailand, and Cambodia. In Indochinese countries, as many as 550 species of wild and semi-wild animals and plants are eaten on a daily basis (JWRC, 2011). People grow useful plants at places close to them and collect them as necessary, and this way of using natural resources is shared by all countries in this region, although there are slight differences among ethnic groups in terms of preference. These plants are grown mainly in each family's home garden and left to grow in other places such as vacant lots around settlements and along roads, canals, and paddy fields and ridges between them. Usually, these plants can be freely collected on a daily basis, and major collectors include workers who are on their way home from rice cultivation or hunting and children or elderly people who take charge of their households during others' absence (JWRC, 2011). In Vietnam's central mountainous district as well, edible wild plants similar to those mentioned above are quite commonly observed in home gardens as well as in settlements and their vicinities (JWRC, 2009a). In the villages along the shore of Lake Tonlé Sap in Cambodia, wild and semi-wild plants account for 50-80% of all vegetables eaten by local residents (JWRC, 2009b), and in the Laotian province of Vientiane, they represent nearly half of all plant ingredients used for food (JWRC, 2011). This is highly effective in reducing food expenses. These investigations show that the old traditions of using natural resources in a sustainable way have survived to the present day (Boivin, 2006; Yamasaki, 2007; JWRC, 2009a).

Photo 1. Hong Ha Commune, Thua Thien-Hue Province (photo: Kei Mizuno, Kyoto University Graduate School of Global Environmental Studies)

Hong Ha Commune of Thua Thien Hue Province's A Loui District (Photo 1), which is located in a mountainous area 45 km away from Hue, a city situated in central Vietnam. This commune was built by people who evacuated to Laos to escape the ravages of the Vietnam War and after the war, in compliance with government guidance, relocated to the site in the upstream area of the Bo River where the commune is located (see Table 1).

Table 1: Overview of the History of Arom Village in Hong Ha Commune

1974	Villagers were relocated to the upstream district of the Bo River according to government guidance.
1976	Rice cultivation in paddy fields began.
1978	The Forest Protection Bureau issued an order to farmers to prohibit swidden cultivation for forest protection.
1993	Farmers accepted the Forest Protection Bureau's order to discontinue swidden cultivation. Afforestation plans to plant acacias began.
1995	Many of the villagers discontinued swidden cultivation. The water control committee started forest management (Forest land was not distributed to the village). As part of its flood control projects, the Forest Protection Bureau distributed the seeds of acacia to afforest the village again.

Source: Modified based on Hong, N. X.,2002

Its population consists of several minorities, including Katu, Paco, Taoey, and Kinh (Gannon et al., 2008). While approximately 50% of its land is currently covered with natural forests, including young forests, which are currently being regenerated, 43% is covered with artificial forests such as acacias and rubber trees. Their traditional economy mainly comprised swidden cultivation, livestock husbandry, hunting, the collection of forest products, textile manufacture, and the gathering of fuel materials. It is recognized to a certain extent that this traditional swidden cultivation was sustainable (Fukui, 1983), and it occupied an important position in the villagers' traditional activities to make a living. Since 1975, when the Vietnam War ended, villagers have mainly been engaged in afforestation, dry field farming, fish culture, paddy-rice cultivation, and small commercial transactions.

However, it took about 15 years after the government's order to prohibit swidden cultivation before many of the villagers abandoned the traditional style of agriculture. In addition, the current lives of villagers, particularly words that indicate the characteristics of soil and farming calendars, unmistakably reflect the central role that swidden cultivation has in their lives (Table 2; Hong, 2002).

Even today, the lives of villagers in this district still retain traces of traditional swidden cultivation, and villagers continue to use natural resources close to them such as edible wild plants. If no action is taken and the current situation continues, however, the traditional culture of using natural resources continuously is expected to disappear in due course as the market economy spreads to mountain villages.

Table 2: Katu Agricultural Calendar

Month	Name of each month as the Katu call it	Experience (Distinguishing marks)	Major activities
1	Xe Muoi	Coldness accompanied by rain	Hunting
2	Xe Bar	The sun starts to become high	Selection of lots for swidden farming, sowing of corn seeds, cultivation of sweet potatoes, and hunting
3	Xe Pa	The sunlight is warm, and many bees appear.	Felling of trees in the forest, weeding of corn fields, and cultivation of cassava
4	Xe Puon	The sunlight is warm, many bees appear, and rice flowers come into bloom.	Firing, sowing of rice seeds in dry fields, and harvest of corn and cassava
5	Xe Xan	Cloudy weather and rainstorms	Sowing of rice seeds in dry fields, weeding of cassava fields, and harvest of corn
6	Xezpak	Warm sunlight, rainstorms, and cicadas	Weeding of dry rice fields, construction of huts for field work, hunting, and search for honey
7	Xe la pang	Many ants	Nursing of rice in dry fields, installation of fences on agricultural land, construction of rice storage, and hunting
8	Xe Tcan	Many birds' notes	Harvest of three-month rice, weeding of seasonal rice fields, hunting, and craftwork (knitting)
9	Xettri	Rain	Harvest by women and hunting by men, knitting, and repair of houses
10	Xe Mzieo	Cloudy and rainy weather	Harvest of rice and collection of bamboo shoots and mushrooms
11	Xe Zieomai	Coldness	Drying and storage of rice, hunting, and fishing
12	Xe Zieo bar	It becomes even colder.	New rice festival

17.3 Challgenges and Responses

Participatroy Forest Management

While the government prohibited shifting agriculture, it paved the way for forest management that involved local residents by encouraging them to promote resource protection while using forests in a sustainable way. In accordance with the Land Law of 1993 and other legislation, it launched a project to distribute land and forests to individuals and organizations. Local residents, who obtain the right to use land and forests, can use a tract of land and forests distributed by the government for 20 years if they cultivate annual crops and for 50 years if they grow perennial crops. Examples of forest management that involves local residents include afforestation and forest preservation programs implemented in production forests, maintenance forests, and special use forests as stipulated in the Forest Protection and Development Act of 1991, and Inoue (2000) cites four forest preservation programs: contracts to protect special use forests and ecosystem restoration areas, management of special use forests and buffer zones, contracts to protect preservation forests and priority areas, and afforestation activities in production forests in distributed land.

Restoration of Minorities' Villages in the Central Mountainous District

In Hong Ha Commune, a project aimed at improving the living standards of villagers and their ability to prevent disasters and achieve natural resource management was implemented from 2006 to 2009 with the support of Hue University and Kyoto University (*Note). This project, which was designed to upgrade the foundations of people's lives in the area it covered, adopted a method of drawing the wisdom and potential of local residents by involving them in the project and hearing their opinions. The results of its multifaceted activities are summarized by Gannon (2008) and other researchers. One example of such activities is the reproduction of traditional housing. Villagers strongly desired to restore the community house located at the center of the commune, which had been used for various ceremonies and daily joint activities. In response to their strong desire, the project organizers held thorough discussions with the villagers, and as a result, it was agreed that a truly traditional community house should be constructed using traditional materials and methods. All villagers helped procure and process diverse construction materials from the forests (College of Agriculture and Forestry, Hue University and Graduate School of Global Environmental Studies, Kyoto University. 2008; Kobayashi et al., 2008; Kobayashi and Iizuka, 2010). The building thus completed not only reproduces the structure, designs, and decorations that are peculiar to the minorities but also provides a place of meeting for many local residents as a community house that is owned by the villagers themselves, and this has enhanced the pride of the minorities and strengthened the union of the local community (see Photo 2).

Photo 2. Community House, Hong Ha Commune (photo: Kei Mizuno, Kyoto University Graduate School of Global Environmental Studies)

Another effect of the project was that the traditional knowledge, wisdom, and techniques of the minorities related to forest resources, which are being lost, were handed down to younger generations through the process of construction. In addition, female project members skillfully sounded out women, who had been reluctant to express their opinions because of their low status in the commune, about their real feelings and concluded that acquiring traditional textile techniques could be one realistic activity goal. As a result of this activity,

women who acquired textile techniques helped not only improve the economy of their households but also strengthen the solidarity of women learning textiles and nurture a better understanding of project activities among their husbands and other family members. At first, these activities groped for ways of increasing household income and raising the social status of women, but one additional outcome was cultural revival. Specifically, the project provided an opportunity for restoring traditional techniques that had been left in the local community and handing them down to the next generation. This outcome indicates that continuation of traditional styles in a mountain village provides a realistic and economic means of restoring the village economically by involving its residents.

* Note: In addition, Hue University and the Canadian government provided support for Phase I (1998-2001) and Phase II (2002-2004). The GSGES Asia Platform, co-hosted by Hue University and Kyoto University Graduate School of Global Environmental Studies, and the JICA project to help improve the lives and safety of people in the areas of Vietnam's central district that are frequently stricken by disasters were implemented from 2006 to 2009.

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18 Iraq: Traditional Agriculture by Marsh Arabs in the Southern Marshes

18.1 Background

Iraq's southern marshes (Mesopotamian marshes) are located at the point where the Tigris and Euphrates rivers meet, spreading over the so-called "Fertile Crescent." Almost the whole area of the country has a desert climate, and the summer season is dry, boosting the maximum temperature above 50°C. In Basrah, the central city of southern Iraq, the world's highest temperature (58.8°C) was recorded in 1921. Even in this hot, dry climate, the streams of the Tigris and Euphrates maintain the southern marshes, which boast the largest area of marshes in the Middle East, and it is estimated that they formerly covered an area of 15,000 - 20,000 km^2 (areas shaded in gray in the Figure 1). In the Middle East, which is dominated by arid land, this area with a favorable aquatic environment and a wide variety of plants is said to have been used as a model for the Garden of Eden, which is described in the Old Testament.

Figure 1. Iraq's Southern marshes (Source: UNEP Iraq Project http://marshlands-jp.unep.or.jp/)

21 of 33 wetlands in Iraq located in lower Mesopotamian marshes. Eight major wetland types in lower Mesopotamian marshes are identified as below (Scott, 1995);

1. Permanent fresh water lakes with a rich submergent growth of aquatic vegetations and typically with marginal zone of floating aquatic vegetation.
2. Permanent freshwater marshes dominated by tall stands of *Phragmites*, *Typha* and *Cyperus*.
3. Rivers, streams, canals and irrigation channels, typically with little emergent vegetation and steep earth or muddy banks.
4. Permanent ponds, mainly man-made irrigation ponds and duck-hunting ponds, typically with a pronounced drawdown in summer and little emergent vegetation.

5. Seasonal freshwater marshes dominated by rushes and sedges, typically occurring as a broad belt around the edge of the permanent marshes.
6. Seasonally flooded mudflats and semi-desertic steppe.
7. Irrigated land and seasonally flooded arable land.
8. Shallow, brackish to saline lagoons, mostly seasonal and often with extensive areas of *Salicornia*.

Permanent marshes, which are constantly wet, are covered with a species of common reed (*Phragmites communis*) called "gasab," which grows to a height of over seven meters. Seasonal marshes, which dry up during the dry season from summer to autumn, are mainly covered with a species of common cattail (*Typha angustata*). A species of sedge (*Scirpus brachyceras*) is dominant in the temporary marshes, which are submerged only when the rivers overflow (Thesiger, 2009).

Geographically, the southern marshes consist of three major areas: the central marshes, the Hammar marshes, and the Al-Hawizeh marshes (Aoki et al., 2011; UNEP, 2006). Al-Hawizah marsh were designated as first globally importance wetland of Iraq in Ramsar Convention (Ramsar-1971) in 17 Oct. 2007. It is an integral part of the Mesopotamian marshlands complex centered at the confluence of the Tigris and Euphrates rivers. In spring, meltwater from the snows of the higher reaches of Iran and Turkey and Syria flows into the Tigris and Euphrates, causing the two rivers to periodically overflow. It is believed that this vast expanse of wetlands was formed by these repeated seasonal floods (Thesiger, 2009).

This area also abounds in indigenous species of animals and plants. It boasts an extremely high biodiversity and provides spawning grounds for fish and shrimps, the fishery resources of the Persian Gulf. In addition, the vegetation that spreads over the marshes and their surroundings provide permanent habitats for millions of birds, and surveys conducted in the 1970s confirmed the existence of over 80 species of birds. In particular, it is said that the southern marshes serve as an important relay point for migratory birds that travel from Western Siberia and Central Asia to Africa (Richardson et al., 2006). It is also claimed that Iraq's southern marshes function as a filter for waste and pollutants that flow into the Tigris and Euphrates from their catchment areas, and that their existence helps protect the quality of the water in the Persian Gulf (Richardson and Hussain, 2006).

"Marsh Arabs" is the name the Westerners gave to the people who live around the southern marshes in Iraq. Of these inhabitants, the tribes who settle mainly in the marshes are locally called Ma'dān (meaning "dwellers in the plains (*adan*)" in Arabic) (Thesiger, 2009).

18.2 Traditional farming and fishery of the Marsh Arabs

The Marsh Arabs started to settle in Iraq's southern marshes 5,000 years ago and have since lived there while being engaged in traditional agriculture and fisheries. They earn a living mainly by cultivating rice, wheat, and other grains as well as date palms and other fruit, raising cattle and buffalos, and catching fish and shellfish (Thesiger, 2009). Most of the Ma'dan are semi-nomadic, but some of them are settled in villages. Their settlements are located on the edges of the marshes, or stand on artificial floating islands that are regularly reinforced with reeds and mud (UNEP, 2001).

The main characteristic of the traditional lifestyle of the Marsh Arabs is the construction of houses and canoes using gasab, which grows on the shores of the rivers. Since the period before Christ, when the Sumerians lived, gasab has been an indispensable natural resource for the lives of Marsh Arabs. First, when they construct a house, they build a small island called a "Kibasha." In autumn, when the water level is low, they surround a certain area of shallows with a long reed

fence, fill the area inside the fence with layers of reed and rush, and solidify the foundation with mud picked up from the water. On this foundation, they set up arch-shaped pillars made from bundled reeds and then attach walls woven from reeds to the pillars to complete the house. Canoes called "Zaima," which are made from hard reed stems, are used as a means of travel or transport in the wetlands. They make a living by raising many buffaloes as livestock and mainly drink the milk produced by them. Fresh plants are needed as feed for the buffaloes, and the new buds of reeds that grow abundantly in the marshes and their vicinity, as well as herbs growing along the waterside such as *Polygonum senegalense*, *Jussiaea diffusa*, *Potamogeton lucens*, and *Cyprus rotundus* are the main feed provided to the buffaloes.

In addition to hunting birds and wild boars that visit the wetland, the Marsh Arabs catch freshwater fish. Most of the Ma'dān spear the fish, but the members of a tribe called Berbera, who specialize in fishing, use cast nets and fixed shore nets to catch large amounts of fish and carry out poison fishing using toxic substances extracted from the Hindu datura (*Datura stramonium*) and other plants. In both cases, they formerly caught only the amount of fish they needed for self-sufficiency, but in recent years, they have been catching large amounts of fish to sell to other tribes.

In areas where seasonal or temporary marshes are located, some tribes cultivate such grains as wheat, barley, and rice. Called "Fallah," which means "farmers," they are distinct from the Ma dān, who live on buffalo breeding in the wetlands. Formerly, the Fallah cultivated rice and other crops only during the period when the water retreated from the flood plains, but in recent years, when it became possible to drain water from the marshes using power-driven pumps, an increasing number of Fallah tribes have started to cultivate the land permanently (Thesiger, 2009).

18.3 Challenges and Responses

During a period of over a century, more than 30 huge dams and other structures have been constructed along the Tigris and Euphrates in Iraq for such purposes as flood control, irrigation, water supply, and hydroelectric power generation, but since the 1970s, development and irrigation projects have been energetically carried out in the upper reaches of the Tigris and Euphrates outside Iraq, reducing the amount of water that flows into the southern marshes. Furthermore, starting in the 1990s, drainage, reclamation, canal construction, and other projects were implemented inside the marshes as well, decreasing their total water volume, and as a result it is estimated that 90% of the southern marshes had been lost by 2001 (UNEP, 2009; Aoki et al., 2011).

Moreover, the marshes were devastated by various projects such as the construction of dams and outflows that were implemented by the former Saddam Hussein administration up to 2003. These projects are said to have been intended not to develop the marshes but to intentionally destroy them because Shiite tribes, who were opposed to the Hussein administration, lived there and used them as a base for antigovernment operations (Aoki et al., 2011). Driven away from the marshes due to such environmental destruction as well as political repression, the Marsh Arabs dispersed and fled to other areas in Iraq or other countries. Not only the ecosystem of the marshes, but also the traditional lifestyle of the Shiites was substantially destroyed. At one time, the population of Marsh Arabs, which was once estimated to be 300,000-500,000, declined to as few as around 100,000.

Marsh Arabs who fled to other areas of Iraq or overseas when the Hussein administration collapsed in 2003 are gradually returning to the marshes and their vicinity. They themselves destroyed the outflows built under the Hussein regime and opened the gates that had limited the flow of water to the marshes. As a result, it is said that the marshes have been restored to around 30% of the previous

level. Furthermore, the United Nations Environmental Programme (UNEP) and other international organizations, positioning the present condition of Iraq's southern marshes as an important environmental and humanitarian issue, are implementing collaborative projects aimed at not only restoring the marshes to their original state, but also improving the overall living environment of the Marsh Arabs such as through revegetation, removal of the damage caused by saltwater, irrigation, and the improvement of water quality and sanitation. In 2006, thanks to the results of these projects, it is reported that about 50% of the marsh environment was being restored (UNEP, 2006).

As described above, due to the cooperation of people in Iraq and abroad in recent years, the total area and vegetation cover of the southern marshes are being substantially restored, but on the other hand, new problems are emerging. In some areas, water introduced again to restore the marshes has in turn raised the concentration of salt and pollutants, preventing the ecosystem from recovering. Those who are engaged in fisheries extensively practice poison fishing because it enables them to easily catch a large amount of fish at low cost, and the effects of water contamination on the health of humans and other forms of life are becoming a problem. In order to prevent such pollution, education of the fishermen is also considered necessary (UNEP, 2006). Moreover, wetlands in southern Iraq also suffered water shortage according to the significant human demand for water. In recent years, desertification due to regional drought and human-caused water shortages has claimed much of Iraq's arable land in wetlands. There are also conflicts over water resources between Iraq and other countries such as Turkey, Syria, and Iran, whose territory covers the upper reaches of the Tigris and Euphrates. Not only this water shortage, but other problems such as the maintenance of public order in Iraq to carry out various projects, the allocation of water resources between farmers who have settled on the reclaimed land and the future of UNEP's projects to restore the marshes are also left unresolved (UNEP, 2006; 2009).

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19 Oman: Use and Management of Frankincense Trees in the Dhofar Region

19.1 Background

Oman is located in the southeast of the Arabian Peninsula, facing the Arabian and Oman Seas. It is one of the Gulf oil countries, with a public administrative system of 4 Governorates and 5 Regions. The country has a land area of some 310,000 km^2, of which the plains account for about 3%, the mountains for some 15% and barren desert for about 82%. The mountainous area is composed of the Hajar Range stretching along the Oman Gulf in the north, and the Dhofar Mountains comprised of three mountain ranges around Salalah in the south.

In Oman, irrigated agriculture is practiced both in the coastal area of the Oman Gulf, using groundwater from the Hajar Range with the highest peak at over 3,000 m, and in the inland areas, using oases (Japan Cooperation Center for the Middle East, 1996). The current cultivation area in the country amounts to 2.3 million ha, accounting for about 7% of the total land area (Shima, 2009). Of the cultivated area, the irrigated land area constitutes over 40% (3% of the total land area). In the arid area, as well as the livestock industry, frankincense (resin from frankincense trees) as a non-timber forest product has been collected.

In Oman, where the political system is an absolute monarchy, the Sultan started an environmental conservation initiative in the 1970s to protect its unique natural environments, as well as historical remains, including the establishment of nature reserves. The Jabal Samhan Nature Reserve, for instance, covers a total area of 4,500 km^2 around the habitat of frankincense trees in the Dhofar region in the south, and the Ra's al Hadd Turtle Reserve for sea turtles is situated in the northern coastal area. In the inland area, the irrigation facilities ("flaj") are inscribed in the UNESCO World Heritage List due to the highly appreciated cultural aspect of the country's long history, representing the fact that human beings have used such natural resources since the pre-Christian era (Hammer et al., 2009). One could argue that, owing to its topographical characteristics, the country's national land possesses a greater variety of landscapes compared to other Persian Gulf Arab states (Coppi et al, 2010).

From June to September, the Dhofar region in the south has high precipitation due to the influence of the monsoon, and hence is covered with a carpet of green as it rains almost every day in that season (Japanese Embassy in Oman, 2011). This region, with a precipitation of 182 mm/year, is among the highest rainfall areas in Oman (Kwarteng et al, 2009). In terms of its ecological features, the Dhofar region can be categorized into desert, semidesert scrub, short grassland, long grassland and woodland areas, according to the influence of the mountain ranges (Al-Zidjali, 1995). The desert area stretches throughout the mountainous area at a higher altitude, while the grassland area spreads over the foot of the mountain ranges. The woodland is located in the coastal areas, where agriculture is also practiced. With such varied ecological characteristics, the Dhofar region has the greatest biodiversity in the country. The description below will mainly concern the desert and semidesert scrub portions of the Dhofar mountainous area, where grasslands spread out and frankincense trees grow wild.

19.2 Use and Management of Frankincense Trees

Grazing prevails in the grasslands around the Dhofar mountainous area, and about two-thirds of the local people earn their livelihoods by dairy husbandry (pasturage) (Shima, 2009). It based on 1.6 million head of goats, 350,000 head of sheep, 335,000 head of cattle and 123,000 head of camels according to the 2004-05 census. Commercial chicken farming is also on the rise (Shima, 2009). In the mountainous area, nomads have lived in caravans with camels as their mode of transportation.

In the Dhofar region, frankincense trees (*Boswellia sacra Acacia spp.*) grow and produce a variety of products that represent the country (Photo 1). The habitat of frankincense trees is limited to areas behind the Dhofar ranges blown by the monsoon winds, and the arid areas where the monsoon rain does not reach, but cool winds blow (Miller and Morris, 1988). The frankincense trees distribute between 60 m and 1,770 m above sea level. There are four varieties of frankincense trees: Hojar/ Habjar, Nejdi, Shazri and Sha'bi, with a different habitat for each variety (Mohamud 2009). They have been maintained by manual planting, as well as by direct seeding by camels. They grow wild along areas where there is groundwater in arid areas. The Dhofar ranges with desert and semidesert scrub have been famous as a habitat for high-quality frankincense trees (Fisher and Fisher, 1999). A frankincense tree has a high content of viscous resin and the tapped resin becomes hard like a piece of white stone. The use of frankincense resin has a long history: it was utilized as a perfume and a medicine and traded to Mesopotamia and Egypt since 2000 BC. Until AD 300, the resin trade flourished in the Arabian Peninsula (Blom et al., 2000), and even extended to Greece and the Roman Empire (Fisher and Fisher, 1999). The resin was brought to Mecca and Medina from the Dhofar region between 200 BC and AD 300 (Hammer et al., 2009). In Oman, the resin was traditionally used as a disinfectant and a medicine for mitigating hyperemesis gravidarum (Van Beek, 2006) and was also burned as an insect deterrent and incense since its distinctive aroma was perceived to remove evil spirits and calm people down. The soft resin when harvested was chewed like chewing gum to enhance the teeth and gums and prevent halitosis (Miller et al., 1988).

Photo 1. Frankincense Trees (Photo: Ministry of Tourism, Sultanate of Oman)

Photo 2. Frankincense (Photo: Ministry of Tourism, Sultanate of Oman)

The frankincense trees have been owned and managed by local kinship groups of herders mainly grazing goats and sheep. Trees over 5-6 m high, in particular, are considered to produce a larger amount of resin, and hence have been managed with greater care. Basically, their ownership is inherited and divided as the generation changes.

As for the tapping method, in principle, the main tree trunk is slit once and again at the same spot in 14 days, and for the third

time in another 14 days before collecting the resin oozing out of it. The collected frankincense is dried and offered for sale in the main cities in Dhofar, including Salalah city as the regional center. The nomad's caravans with camels moved to the market places while collecting the resin little by little from the frankincense trees along their route, and used the frankincense as a cash income source or a trade resource. Thus, even non-owners were allowed to use the frankincense trees owned by the herders. The utilization of frankincense trees both by the herders as the owners and the nomads as the non-owners has been said to be sustainable due to their minimal amount of harvest. Today, the frankincense is tapped mainly by migrant workers from Somalia, a neighboring country, mainly due to the migration of the herders to urban areas. The frankincense is used as an aromatic material within the country or exported abroad.

19.3 Changes in Use and Management of Frankinecense

Frankincense provides the herders with an economic value as a cash income source, while nomadic caravans use it as a resource for cash income or exchange in kind even in extremely arid areas. Camels, which only require a minimal amount of forage, can sustain their physical strength for a long time in arid areas by eating the leaves of the frankincense trees. Nomadic caravans conducted transportation activities passing through the desert area while tapping the frankincense in the Dohfar ranges.

The increase in cash income, as a result of migration for work, has enabled the nomads to start a semi-sedentary life instead of their traditional life style of high mobility, and hence they have come to purchase donkeys instead of camels for their mode of transportation. Donkeys, however, require more forage (pasture, etc.) than camels. Thus, today when a caravan uses donkeys for their mode of transportation, they do not take the route passing over the mountain range in the desert area where the frankincense trees grow, but choose to move to the market places through the grasslands at the foot of the mountain range. Therefore, the opportunities for the nomads to use the frankincense trees have declined, and hence their economic value is on the decline, while over use of pastures at the foot of the mountain rage is leading degradation of the grassland ecosystem of the area.

The traditional uses of frankincense trees by the herders are also on the wane. This is partly because young people wish to get high-income jobs in the oil-related industry, which has been boosted since the late 1970s. Another reason for the decline is the harsh manual labor involved in frankincense tapping. The owners of the frankincense trees have recently migrated for work and have rented the rights to use the trees for tapping to the Omani frankincense buyers or migrants from Somalia. Prior to 1970, the number of Somali people that were engaged in the tapping of frankincense accounted for less than 10% of the Omani people involved. In 1998-1999, however, approximately 95% of the Somalis living in Oman worked for the tapping of frankincense, which is considered to be almost their only source of cash income. Nowadays, in the Dohfar region, around 3,000 households are engaged in the tapping of frankincense, the economic value of which, however, has been changing for the herders.

On the other hand, through inheritance, the frankincense trees and the relevant owned land have been increasingly subdivided among the herders who own and still tap the frankincense without renting out the rights to use them. In this context, the people have tried to increase the amount of the frankincense by shortening the tapping cycle (once every 14 days) to increase the frequency of tapping. This imposes an additional stress on the frankincense trees, allegedly causing damage from diseases. In addition, there is a possibility that the continuation of excessive tapping over a short period leads to the decline of seed production and the degradation of the trees. Moreover, it is considered that the soil fertility has also been increasingly degraded due to the excessive plantation to increase frankincense production.

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20 Saudi Arabia: Grazing and Oasis Agriculture along the Northern Coastal Region of the Red Sea

20.1 Background

Saudi Arabia, which occupies most of the Arabian Peninsula, on the whole has a warm-desert climate under the Köppen climate classification. In Riyadh, the country's capital located inland, the average annual temperature is 26.0 degrees Celsius and the average annual precipitation amounts to only 135.7 mm. Along the northern coast of the Red Sea, the average annual precipitation is much lower at 40 mm. Out of the total land area of 2,15million km^2, agricultural land only accounts for 1.8% (38,000 km^2) and forest land comprises 0.5% (9,770 km^2). In contrast, the area of pastureland is quite large, accounting for 79.1% (1.7 million km^2) (FAOSTAT's figure in 2009).

The Red Sea, located between the Mediterranean Sea and the Indian Ocean, is a semi-enclosed coastal sea with a long narrow area, extending approximately 2,000 km from north to south. The depth of the seabed is almost 3,000 m at its deepest point since the Red Sea is an extension of the Great Rift Valley in Africa. With no inflowing rivers and limited development due to the extreme aridity of the surrounding area, the transparency of the seawater of the Red Sea has remained high. The high transparency of the seawater is important for the photosynthesis of the zooxanthella that live symbiotically with the coral. This creates good conditions for the habitat and breeding of the hermatypic coral, coupled with the high temperatures and salt concentration of the Sea. The coastal area exhibits unique biodiversity with mangroves (two species of *Rhizophora mucronata* and *Avicennia marina*) and halophytes.

In the central portion of the Red Sea coastal area, cities such as Mecca and Jeddah have prospered since the seventh century, when Arabs began to exert their growing political power with the birth of Islam. Jeddah is the largest city in the Red Sea coastal area with a population of over 2 million. In contrast, the coastal area of 600 km extending from Umluj to Haql has a very much lower population density of 2.2-3.4 people/km^2, compared to the national average of 11.8 people/km^2, and has been mainly inhabited by nomads (Table 1). Nomadic pastoralism was the key industry in Saudi Arabia until recently. Since the worldwide oil crises of 1973 and 1978, the exploration of abundant oil resources that the region along the Arabian Gulf is endowed with has yielded massive profits, and hence made Saudi Arabia a major destination for many workers from abroad (Figure 1).

Table 1: Population Density and Proportion of Foreigners in the Major Cities in relation to the Total Number of the Population and the Proportion of Foreigners in the Corresponding Provinces of the Northern Coast of the Red Sea

Administrative area	Province	Tabuk				Medina	Mecca
Name of the locality	City	Haql	Duba	Al-Wajh	Umluj	Yanbu	Mastoorah
Population	People	19,323	39,100	32,644	44,091	172,086	5,207
Area (estimated)	km^2	5,643	15,750	15,000	16,000	4,250	25
Population density	People/ km^2	3.4	2.5	2.2	2.8	22.2	208.3
Proportion of foreigners	%	17.1	19.1	13.3	11.5	22.2	14.6

Administrative area	Province	Tabuk Province	Medina Province	Mecca Province
Population	People	486,134	1,084,947	4,467,670
Proportion of foreigners	%	17.3	22.8	37.8

Sources: 1. Saudi Arabia Population Census in 1992
2. The proportion of foreigners in the cities was estimated from the data from public hospitals in each city.

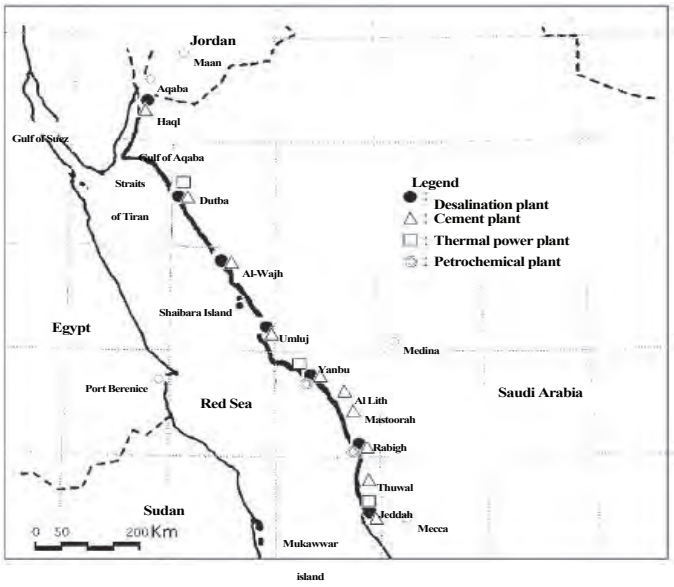

Figure 1. Cities and the Progress of Development along the northern coast of the Red Sea, Saudi Arabia (JWRC and and Oceanographical Consultants Co. Ltd, 2000)

20.2 Oasis Agriculture and Grazing System

Oasis Agriculture

In the coastal area of the northern Red Sea, sandy and rocky deserts extend throughout the region dotted with open forests and a sparse distribution of *Acacia ehrenbergiana* and farms using oases as their water source. These oases and "wadis" (valleys with flowing water only at the time of rainfall or in the rainy season, being underlain by underground water veins) are considered to be supplied with moisture from the high humidity (60% on average) along the Red Sea coast.

Along the Red Sea coast, there are sparsely scattered oasis farms, where irrigated agriculture is practiced, using the oases or wadis as their source of water. These oasis farms save water and fuel oil with a time-limited supply of water in the morning and afternoon while estimating the sales of the cultivated cash crops in monetary terms. A main crop is the date palm, which is drought-resistant and can grow in the unfavorable conditions of oases with little water that is saline. The dried fruit of this palm is a traditional source of carbohydrates. Other crops that can be cultivated under these unfavorable conditions of water quality in oasis farms include pasture, which in sold in the form of hay. Vegetables and fruit trees are cultivated in places where the water quality is good and the supply is abundant. Recent oasis farms have come to practice a combination of date cultivation and sheep raising, supported by hired foreign workers.

Grazing and the *"Hima"* System

In areas with scarce plant resources, nomadic pastoralism has been practiced by Arab nomads (Photo 1). In arid areas, where there are a few plant resources directly available for human beings, they are engaged in production activities through livestock browsing (Miyazaki and Ishida, 1996). The forage for sheep, goats and camels, which are able to cope with a very hot environment and dryness, includes herbaceous perennials such as *Panicum* and the leaves and bark of bushes growing in sandy land. In addition to the grasses and bushes that are also eaten by sheep, camels eat shrubs with long needles (Ishida and Miyazaki, 1996) and are even fond of mangroves and halophytes along the seashore. The underlying factor that has made nomadic pastoralism possible in the sandy and rocky deserts over a long historical period is the existence of the generational succession of a chain of "*hima*" or pasture reserves where the scarce plant resources have been used sustainably instead of being overexploited.

Photo 1. Grazing of sheep and goats along the northern coast of the Red Sea (photo: Japan Wildlife Research Center)

"*Hima*" are pasture reserves consisting of rangelands surrounded by stones and have been extensively demarcated since time immemorial in the Arabian Peninsula and these remain to this date in Oman, Syria and the Yemen, as well as Saudi Arabia. The "*hima*" system is an essential element of self-sufficient production in semi-arid or arid areas in general (Child and Grainger, 1990).

As the word "hima" dates back to the mid-fifth century in the Arab region, resource management based on the "hima" system is considered to have a history of more than 1,000 years. In its earliest form, however, "hima" meant land protected by the clan heads and sharifs, where hunting, tree-cutting and plant-collecting were banned. Then, its functions were transformed due to the development of Islamism. In the seventh century, for example, Umar ibn al-Khattāb, the second truly legitimate caliph, allowed the "hima" to be utilized for the protection of the poor. Thus, the "hima" system has constituted a form of resource management for communities, based on Islamic laws and the customs of tribes (Nawata, 2009). According to a survey conducted in 1960, the "hima" management system is exemplified by the following five cases of "hima": (1) where livestock grazing is always prohibited and forage is allowed to be cut only in drought years; (2) where grazing and the cutting and gathering of grasses and other plants are allowed only after the grasses and plants have grown and become lush; (3) where grazing is allowed, depending on the type of livestock; (4) where beekeeping is practiced; and (5) where trees are essentially protected (Child and Grainger, 1990).

Continuity between Nomadic Pastoralism and Oasis Agriculture

A field study in the 1970s (Katakura, 1977) pointed out the continuity and the exchanges conducted between people involved in nomadic pastoralism and oasis agriculture (Table 2). The nomads have a tendency to live in a dispersed pattern due to their environment with scarce resources while maintaining day-to-day contact with farmers, or in some cases working in farming for themselves, as well as actively coming into contact with urban areas (Katakura, 1977).

Table 2: Arabian Dwelling Patterns, Livelihoods, Cash Sources, Average Number of Livestock per Household and Geographical Features

Dwelling pattern	Livelihood	Cash sources	Average number of livestock per household	Geographical features
Migratory	• Herding (nomadic migration for water and plants)	• Sheep and goats and their cream and hair • Camels and their dried milk lees and hair	• Camels - 20 head or more • Sheep and goats - 100 head or more	• Sandy desert • Rocky desert
Semi-migratory	• Rainfed agriculture • Migration for work • Hunting and herding	• Agricultural products (watermelons, forage such as hay) • Labor force • Cattle dung (manure) • Cattle	• Camels: three head or less • Sheep and goats: 50 head or less • Cattle: 1-2 head	· *Wadi* and mountainous areas • Suburbs of cities (Mecca, Jeddah etc.)
Sedentary	• Oasis/ well-watered agriculture • Secondary jobs	• Agricultural products • Cattle and donkeys • Pigeons and chicken eggs	• Sheep and goats: 2-10 head • Donkeys: 1-2 head • Cattle: 1-2 head	• Oasis · *Wadi*

Source: Modified from Katakura (1977)

The nomads and sedentary farmers share a common recognition of the harsh natural environment in the Arabian Peninsula (Katakura, 1977), while the need for sharing access to scarce resources has been understood at least by those who live in rural areas in Saudi Arabia since time immemorial (Child and Grainger, 1990). Moreover, sedentary farmers have another reason to manage the "*hima*", that is, to prepare for the hearty appetite of the herds of sheep and camels of the nomads. They have protected the crops on their farms from these animals by providing a portion of the "*hima*" resources to the nomads (Child and Grainger, 1990). Based on a common recognition of the need for sharing the scarce resources between the nomads and the sedentary farmers, the "*hima*" have been sustainably conserved in the way that the nomads, as "*hima*" users, have refrained from overusing the "*hima*" resources.

20.3 Challenges and Responses

Along the northern coast of the Red Sea, those who once managed nomadic pastoralism and oasis farms have come to work for companies in the oil-related industry and desalination plants, as well as in government offices and the coast guard, as Saudi Arabia became an affluent country due to its oil resources. In Saudi Arabia, 85% of the rangelands were substantially degraded in the 1970s. The "*hima*", which amounted to around 3,000 in 1965, had been mostly abandoned, resulting in a significant decrease in the number of "*hima*" by 1990 (Child and Grainger, 1990). The nomads have become sedentary and changed their lifestyle substantially. While the "*hima*" system has been degraded and is on the wane, full scale nomadic pastoralism is no longer practiced and grazing, which moves the livestock over a shorter distance, is found to be common in the area. There is an increasing tendency towards dependence on workers from abroad in general and in grazing and agriculture in particular. There are significant variations in the extent of such dependence due to the rapid changes in lifestyle among the different generations of Saudi Arabians: those in their 70s or older have been engaged in the nature-based work without any reliance on foreign workers; those in their 40s to 60s have been engaged in such work with a substantial dependence on them; and those in their teens to 30s are fully dependent on them. It has been pointed out that local environmental conservation requires the consolidation of relationships with foreign workers while recognizing the existence of these intergenerational differences (Nawata, 2008).

In response to these changes, in 1989 Saudi Arabia established the Saudi Wildlife Commission (SWC), a government agency with the aim of the protection and rehabilitation of wildlife and ecosystems in the country. The Commission is authorized to prepare natural environment management plans for the protection of rare wildlife and ecosystems and to establish and manage nature reserves. In fact, it has advanced the establishment of natural reserves based on Islamic traditions with the recognition that the traditional "*hima*" system in the country is an example of conserved rangelands and forest lands that have been sustainably managed and that have worked well since the early era of Islam (SWC, 2011).

The demarcation of nature reserves has in effect taken over the traditional "*hima*" system to continue certain social, economic and cultural characteristics (SWC, 2011). Thus, the SWC set forth criteria for the establishment of nature reserves comprising not only bio-ecological ones, but also socio-economic ones, especially focusing on the willingness of local people to maintain them, such as through "obvious economic benefits to the local people" and "the perceptions of local people concerning traditional protection systems." The Commission officially announced the establishment of 56 terrestrial reserves, 47 marine reserves and coral reefs for eligibility as nature reserves. Out of these, 15 sites have so far been designated as nature reserves, the total area of which amounts to eight percent of the total national land with the aim of increasing this to over 10% in the near future, taking into account local support, disputes over land use, etc (SWC, 2011).

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21 Syria: Olive Cultivation on Hilly Land in the Northwestern Part of the Country and along its Mediterranean Coast

21.1 Background

Olives are one of the world's oldest fruit trees grown by human beings, extensively cultivated in the coastal areas of the Mediterranean from Spain to the Middle East. It is believed that in human history olives were first discovered and used in Syria and that their cultivation began around 2400 B.C. For this reason, there are many wild varieties of olive trees distributed around Syria and it is claimed that Syria is an important area for the maintenance of the genetic diversity of the olive species (Five major varieties of olive account for 89% of all those cultivated) (Embassy of the Syrian Arab Republic, n.d.).

Olive cultivation flourishes on hilly land that extends over the governorates of Aleppo and Idlib in the northwestern part of the country, as well as on the land that spreads along the mountains running in parallel with the Mediterranean coastline (mainly the governorates of Lattakia and Tartous) from the boundary with Turkey to the administrative district of Damascus. Syria is divided into five major agro-climatic zones (Table 1). Ninety percent of olive cultivation is based on rain-fed agriculture. In Syria, olives are mostly grown in Zone 1 which receives more than 350 mm of rainfall and this zone is blessed with more rainfall than others. In general, these areas have much rain in winter. In summer, it is hotter and drier than in winter in these areas (Wattenbach, 2006).

Agriculture has been Syria's most important industry since the country became independent in 1946, and in the 1940s to 1950s it achieved the fastest growth among all industries. In the 1970s and 1980s, however, its importance declined in relative terms because other industries grew, and the number of people engaged in agriculture, which accounted for about 50% of the working population in the 1970s, fell to about 30% in the 1980s (Collelo, 1987). Under these circumstances, the Syrian government initiated an agricultural promotion policy in the mid-1980s, expanding arable land and developing irrigation facilities. As a result, the number of people engaged in farming in the country exceeded 1.4 million in 2008, nearly double that for 1980.

The government took measures such as encouraging farmers to develop waste land and subsidizing part of the price of olive seeds when distributing them, and because of these measures, olive cultivation began to grow in the 1980s, and furthermore, it achieved rapid growth in the 1990s and thereafter. In 1990, there were 44.6 million olive trees in plantations nationwide that covered an area of 390,000 ha, and in 2008, the number of olive trees and the area of olive plantations increased to 90 million and 620,000 ha, respectively. In particular, the governorates of Idlib, Aleppo, Lattakia, and Tartous account for 72% of the area of olive plantations and 68% of the total olive production (Embassy of the Syrian Arab Republic, n.d.)

Table 1 Agro-climatic Zones in Syria

Zone 1	With an annual precipitation of more than 350 mm, Zone 1 is divided into the following two types: Type A: Areas with an annual precipitation of 600 mm or more (along the coast of the Mediterranean Sea) Type B: Areas with an annual precipitation of 350-600 mm where 300 mm of rain or more falls during two thirds of the period when crops grow and two seasons of seeds can be planted over three years (Homs, Hama, Aleppo, and other governorates located in the northwestern part of the country) Olives are cultivated mainly in these areas.	14.6% of the national land
Zone 2	Areas with an annual precipitation of 250-350 mm where 300 mm of rain or more fall during two thirds of the period when crops grow and two seasons of barley seeds can be planted over three years	13.3% of the national land
Zone 3	Areas with an annual precipitation of 250-350 mm where 250 mm of rain or more fall during half of the period when crops grow and one to two seasons of seeds can be planted over three years	7.1% of the national land
Zone 4	Areas with an annual precipitation of 200-250 mm where 200 mm of rain or more fall during half of the period when crops grow	9.9% of the national land
Zone 5	Deserts and steppes, which are not suitable for rainfed agriculture	55.1% of the national land

Source:Compiled based on Agricultural Development Consultants Association (1995) and Wattenbach (2006)

Syria has adopted a socialist system since it began to deepen its relationships with the Soviet Union around 1960. Therefore, all banks and other private enterprises that had up to then operated under a liberal system were nationalized. In 1958, the government carried out land reforms, setting an upper limit to the area of land that individuals were allowed to own in order to reduce the disparities in the area of land owned by individuals and confiscating the portion of land that exceeded the limit for nationalization. Approximately 22% of the cultivated land owned by individuals was nationalized through these reforms, but the government did not nationalize the land within the limit, and has until today allowed much of the agricultural land to be owned by individuals (Ciroet and Jacques, 2003; Agricultural Development Consultants Association, 1995). Therefore, most of the land where olives are cultivated is privately-owned land.

Since the hilly regions where olive cultivation is prosperous are densely populated compared to other regions, the average area of cultivated land per owner is 3.06 ha, smaller than the national average of 5.77 ha. For this reason, these regions are highly dependent on income from industries other than agriculture (Wattenbach, 2006).

Table 2 Form of Land Ownership in Syria (2000 figures; Unit:1 million ha)

<table>
<tr><td rowspan="3">Total area of national land

18.5</td><td rowspan="2">State-owned

11.5 (62%)</td><td>Non-registered state land 7.7</td><td>• Public land used for general purposes (such as forests, pastures, steppes, waste land, rivers, lakes, and roads)</td></tr>
<tr><td>Registered state land

a) State land registered before the land reforms 2.4

b) State land newly registered through the land reforms 1.4</td><td>• Public sector (such as state-run farms)
• Land distributed to individuals after the land reforms and leased land</td></tr>
<tr><td>Privately owned

7.0 (38%)</td><td colspan="2">Cultivated land 6.5 (including most of the land where olives are cultivated)

Uncultivated land 0.5</td></tr>
</table>

Source: based on Ciro and Jacques (2003)

21.2 Characteristics of Olive Cultivation in the Region

Rainfed agriculture is practiced in the hilly land areas that extend from northwestern Syria to the Mediterranean coast with irrigation facilities remaining practically undeveloped. Olive cultivation is most successful in this region, and in addition, wheat and cherries are grown there although their share of the total agricultural production is small (Wattenbach, 2006).

Hills where olive cultivation is prosperous account for a large percentage of the area of MagharaVillage in the northwestern governorate of Aleppo. In this village, land is cultivated to plant olive seeds during the period from autumn to spring when much rain generally falls. The most commonly used method of cultivation (fadhan) is to have donkeys or mules pull a plow, an agricultural implement to turn the soil over first in preparation for the sowing and the planting of the seedlings. In general, while fadhan is used for steep slopes and irregular land, mechanized farming is employed for the easily accessible, large tracts of land. Some farmers cultivate strips of land along the contours (contour plowing), a way of farming that is effective in preventing soil erosion due to rainwater and the outflow of water, while others till the slopes vertically from high to low levels, which causes soil erosion. Most of the farmers do not use agricultural chemicals for olive cultivation, but they often put fertilizer on the olive groves. The olives are generally harvested from the end of October to the end of December, and the harvesting season is sometimes extended to January. Olives are usually picked by hand, and in many cases, harvesting work is performed by members of each farmer's family (Van der Zanden, 2011). Furthermore, traditional techniques are used in the olive orchards to protect soil and water. One prominent example of these is the use of stone walls. Other examples include vegetation strips, which are formed by leaving wild plants uncut along the contours, and a combination of stone walls with semi-circular terraces created on the lower part of slopes where the trees grow. All these techniques are effective in reducing the volume and rate of flow of surface water to prevent soil erosion. They are also effective in increasing the ability of the soil to retain moisture. Still another example is a water collection technique that involves raising the ground level around trees in a V shape to channel all the rainwater running in the ditches to sink into the ground because part of the hilly land in the northwestern part of the country is often plagued by water shortages (Van der Zanden, 2011).

The stone wall technique has traditionally been handed down from generation to generation. In olden times, land was manually developed bit by bit using this technique starting from areas in which the conditions were favorable. Old terraced fields use the microtopography of slopes skillfully, and it is inferred that in an effort to minimize the labor required for the construction of stone walls and to maximize their effects, farmers observed the original geographical features, the way the rainwater flows after rainfall, and other conditions in extreme detail. The stone walls that have been mechanically built according to design drawings in recent years, meanwhile, are said to be more likely to collapse than traditional ones, although they are beautifully finished at first glance (Appropriate Agriculture International Co., Ltd., 1997).

Olive cultivation is the most important traditional agricultural activity in the Mediterranean coastal areas, and olive orchard landscapes are culturally valuable (Van der Zanden, 2011). They are also important for food production, providing local residents with part of the food they need. One of its economic benefits is to contribute to value added agricultural production and the gross national product (GNP), and another is the acquisition of foreign currency through the export of olives and olive oil. Syria is currently the world's fifth largest olive producer with olives accounting for 65% of the country's garden produce. Olives are one of Syria's most important crops in that the olive sector earns the nation 25% of its income directly or indirectly through their cultivation and processing into olive oil (80% of the total olive production), storage, transport,

export, and so forth, and olive cultivation is considered an important industry for the creation of employment (Embassy of the Syrian Arab Republic, n.d.).

The environmental importance of olive cultivation lies in the prevention of soil erosion using traditional techniques such as stone walls and techniques for the effective use of water, as well as the utilization of land (such as semidry areas, slopes, and other types of land) for which there are only limited uses other than olive culture. Furthermore, olive cultivation is effective in curbing the process of desertification.

21.3 Challenges and Responses

According to Syria's national biodiversity strategy in 2000, the rapid rate of population growth (annual rate of 3.6% or more) is a factor that has had the most serious impact on the preservation of biodiversity. Changes in land use are considered to have major adverse effects on agricultural biodiversity. Examples include a shift in land use from agricultural and grazing land to housing land, the disappearance of forests in mountainous districts and coastal areas where the original, wild species of currently cultivated olives, almonds, and other fruits grow due to development, and the discontinuation of traditional uses of the land (Syrian Arab Republic, 2000).

In recent years, olive cultivation has spread from the northwestern region, previously the center of olive culture, to neighboring areas, including the southern and eastern regions, which are extremely dry and poor in water resources. The spread of olive cultivation is seen mainly in marginal lands with many of the newly developed olive plantations found on steep slopes. Steep slopes are prone to soil erosion, but olive cultivation has been expanded without taking into consideration the danger of soil erosion. In these regions, water shortages and the excessive pumping of groundwater are also becoming problems (Barneveld et al., 2009). In the future, it will be necessary to both take measures to control soil erosion and deal with water problems and maintain the productivity of olive culture in order to help farmers to earn a livelihood.

In addition, protecting soil on steep slopes in hilly areas is an important issue to be addressed. Most of the gentle slopes are used for olive cultivation, and the traditional stone wall technique is also observed there. But on steep slopes, which cannot be used to raise crops, soil protection measures are taken through tree planting and other projects, but significant collapses are taking place on these slopes depending on the nature of the soil (Appropriate Agriculture International Co., Ltd., 1996), and more effective countermeasures are required.

In the rapidly deteriorating mountain watershed located in the northwestern part of the country where olive cultivation is flourishing, the United Nations Development Programme (UNDP) in Syria is implementing a three-year project as a GEF Small Grant Programme (GEF SGP). The project is called "Land and Water Management, Diversification and Micro-Credit to Combat Land Degradation and Improve Livelihoods in the Mountains of Afrin," which began in September 2008. This project aims to ensure the sustainable and effective use of land and water resources and stabilization of the lives of farmers mainly by developing land and water resources management technologies. The project is working to develop a micro-credit system to support land and water resources management. The project is also working to increase agricultural income through the diversification of agriculture such as the cultivation of medicinal herbs and fruits and the production of honey. Moreover, it is helping farmers to reconstruct the rapidly deteriorating olive plantations using the increase in income they have achieved by themselves.

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