# The Satoyama Landscape of Japan: The Future of an Indigenous Agricultural System in an Industrialized Society

**Kaoru Ichikawa and Gregory G. Toth**

**Abstract** Satoyama refers to an indigenous agricultural system of Japan that evolved through long-term interaction between human beings and their local environments. As in many indigenous agricultural systems, it is characterized by integrated landscapes comprised of diverse uses including, but not limited to, paddy fields, farmland, managed and secondary woodland, grasslands, irrigation ponds and canals, and human settlements, all located in close proximity to one another. In environmental terms, this land use variety translates into "biodiversity," a benefit that synergistically aids both the human inhabitants and the nature it consists of. Further benefits include sustainability, supplemental income, building materials and food, adjusting local microclimate, flood prevention, and culture preservation. Satoyama landscapes, like other systems based on indigenous knowledge around the world, have suffered a period of decline. Efforts are being taken in Japan to revive and conserve these systems and the indigenous knowledge and cultural heritage they represent, and international initiatives (e.g., the *Satoyama* Initiative) have begun to collect and distribute relevant information on these systems, such as management techniques and cultural value, in hopes of aiding biodiversity-focused land use and the associated human benefits everywhere.

K. Ichikawa (✉)
United Nations University Institute of Advanced Studies, 6th floor, International Organizations Center, Pacifico-Yokohama, 1-1-1 Minato Mirai, Nishi-ku, Yokohama 220-8502, Japan
e-mail: Ichikawa@ias.unu.edu

G.G. Toth
School of Forest Resources and Conservation, IFAS, University of Florida, Gainesville, FL 32611, USA
e-mail: gtoth@ufl.edu

P.K.R. Nair and D. Garrity (eds.), *Agroforestry - The Future of Global Land Use*, Advances in Agroforestry 9, DOI 10.1007/978-94-007-4676-3_18,

**Keywords** Biodiversity conservation • Indigenous knowledge • Landscape mosaic • Urbanization

## Introduction

With growing awareness about the adverse impact of high-input agriculture involving heavy use of agrochemicals, the importance of traditional, integrated land use systems is increasingly being recognized. These systems are based upon indigenous knowledge (IK), developed over generations of interactions between communities and their surrounding environments. In many parts of the world, IK has considerably contributed to conservation and enhancement of biodiversity through sustainable agricultural and natural resource management practices, with the support of institutional systems based on the view that environments and societies are inexorably linked (Berkes et al. 1995). For example, diversified cropping is of particular importance as the interactions it facilitates among crops, animals, and trees create advantageous synergisms that typically allow these ecosystems to promote their own soil fertility, pest control, and productivity (Altieri 2005). However, many forms of indigenous practices are becoming endangered by modernization of farming techniques, land use dynamics, and, oddly, some of the conservation practices (Oudenhoven et al. 2010) that are based on the assumption that nature and human society are separate entities.

*Satoyama* is an indigenous land use system traditionally practiced in Japan and a prime example of a sustainable agricultural system based on IK. It evolved through long-term interaction between human beings and their local environments involving "frequent but undestructive exploitation and interventions by farmers" forming its mosaic-like appearance (Fig. 1) of secondary forest, water bodies, paddy fields, crop fields, and grasslands maintained through "pruning, mowing and weeding, burning, and irrigation and drainage management" (Kato 2001). However, such characteristics are contradictory to the standard concept of environmental protection that emphasizes exclusion of human impacts. In addition, satoyama landscapes, like so many other systems based on indigenous knowledge around the world, have suffered a period of decline in a changing world marked by population increase, technological advances, and an increasingly globalized economy. This chapter illustrates the importance of satoyama landscapes and indigenous knowledge, analyzes the dynamics of the system in Japan, and discusses its principles and conservation measures that may be applicable elsewhere.

## The Satoyama Landscapes

### *Background and Essential Features*

Originally, the term "satoyama" represented the woodlands that were used for supporting agricultural production and obtaining fuelwood and charcoal (Shidei 1974)

**Fig. 1** The mosaic feature of the satoyama landscapes in Japan (Photo: K. Ichikawa)

in Japan. Etymologically, *satoyama* originated from "sato" meaning village and "yama" meaning wood or grassland. It implies the closeness of the woodland to villagers' lives, not only spatially but in terms of their interdependence. The woodlands supplied numerous resources: necessities such as firewood, charcoal, organic manure, fodder, thatch, medicinal plants, mushrooms, and other edible wild plants, to name a few. Beyond sustenance, selected resources such as firewood and charcoal were also important as some of the few sources of income for farmers. Later, as the importance of satoyama and its neighboring environments became better understood by people involved with nature conservation, the term "satoyama" came to be used in a wider sense. For example, since around the 1980s, the term has often been used to mean not only woodland but also a set of land uses including woodlands, agricultural fields, settlements, irrigation ponds, and canals. While there is no unified definition, this chapter will use "satoyama landscapes" (SL) for such interlinked sets of agricultural landscapes and "satoyama woodlands" (SW) for secondary woodlands in satoyama landscapes (Takeuchi, 2003).

Satoyama landscapes are often described as being located between cities and *okuyama*, or "deep mountains." However, clear spatial delineation is difficult because their structure, pattern, and scale are locally dependent, and the transition from SL to city or from SL to okuyama is usually continuous. In spite of these characteristics, the Ministry of Environment of Japan attempted to assess the current area of satoyama landscapes in Japan by setting criteria for the major components,

**Fig. 2** A rice paddy field and adjacent woodlands in a typical satoyama landscape in Kanto District, Japan (Photo: K. Ichikawa)

that is, secondary forest, farmland mixed with secondary forest, and secondary grassland (Ueda 2002). The results show that up to 40% of the national territory of Japan is satoyama landscapes.[1] As Japan stretches from 45°51′N to 20°25'N, containing several different climate zones, the vegetation of satoyama woodlands varies. These variations are primarily the result of climatic and edaphic conditions and how they are managed. Four types of satoyama woodlands have been identified in terms of vegetation: mizunara (*Quercus crispula* Blume), konara oak (*Q. serrata* Thunb. ex Murray) (Fig. 2), red pine (*Pinus densiflora* Siebold & Zucc.), and evergreen broad-leaved species such as *Castanopsis sieboldii* (Makino) Hatusima ex Yamazaki et Mashiba and *Q. myrsinaefolia* Blume.

In many satoyama landscapes, communal use of woodlands and grasslands was established during the feudal period of Japan (commonly referred to as the Edo Era, 1603–1868). In the modernization process of the following period (Meiji Era: 1868–1912), a policy to separate land ownership into either private or public was undertaken. Extensive amounts of land that had been owned by communities were designated as public and taken away from villagers, although some were approved for collective use by communities under Civil Code as a result of farmers' strong requests (Otsuka et al. 2009).

## *Biodiversity Benefits of Satoyama*

As previously mentioned, satoyama landscapes present a mosaic pattern created by different land uses each with its own associated plants, constituting habitats for a wide variety of animals and insects, and resulting in a high degree of biodiversity. This structure allows various organisms to move among habitats and use different habitat types to obtain different resources (Katoh et al. 2009). This is particularly important for species such as dragonflies and frogs that live in water environments early in life and move to woodland and grassland environments as adults. Similarly, birds of prey often breed in woodlands but prey in grassland and wetlands (Azuma 2003; Washitani 2003).

In addition to this structure, management of satoyama landscapes is critical to maintaining their biodiversity. In satoyama woodlands, after trees such as *Q. acutissima* and *Q. serrata* are cut to harvest firewood and charcoal, the stumps of the trees are left to sprout so they can be harvested again after 15–30 years. Traditionally, farmers thinned and cleared the underbrush in order to obtain stems and fallen leaves and grasses needed for compost and fuels, which simultaneously allowed regeneration of new sprouts. The collection processes were closely guided, especially in communal woodlands and grasslands, by community rules that prevented overexploitation of natural resources. High species richness is maintained by these anthropogenic intermediate disturbances (e.g., coppicing) that serve to protect habitats that would otherwise be overtaken by a smaller number of competitive species. For example, without disturbance of the vegetation, bamboo grass (*Pleioblastus chino* Makino) becomes dominant in the shrub and herb layers and evergreen tree species become dominant in the tree layers in the Kanto district, which would result in a decrease of diversity (Washitani 2003). The spread of other types of bamboo, such as *Phyllostachys pubescens* Mazel ex J. Houz. which was vegetated in limited areas such as near residential zones for use as building materials and commodities, is now becoming another problem (Suzuki and Nakagoshi 2011). At an even deeper level, litter removal from the woodland floor for use as fertilizer inhibits soil eutrophication which suppresses domination of competitive species and allows diverse species to survive. Grasslands and paths between fields harbor numerous grassland species while irrigation ponds, irrigation ditches, and paddy fields are suitable habitats for aquatic macrophytes, amphibians, aquatic insects, water birds, fishes, etc. (Amano et al. 2008; Kadoya et al. 2009). Selective clear-cuts continue the mosaic theme even within landscape elements, allowing vegetation age differences among patches within forest (Washitani 2003). Due to the unique characteristics associated with various stages of forest growth, this continued succession further propagates the richness of biodiversity and host environments.

## *Benefits to Humans*

Using the framework of the sub-global assessments (SGA) developed by the United Nations Millennium Ecosystem Assessment (MA), the Japan Satoyama Satoumi

Assessment (JSSA) identified and assessed the ecosystem services provided by satoyama landscapes and their associated changes (JSSA 2010). As mentioned above, satoyama woodlands provide a variety of materials for buildings, furniture, agricultural activities such as poles or baskets, fuels, food, and medicines; grasslands provide materials for fodder, thatch, and compost, while farmlands and paddy fields produce a variety of foods including rice. In addition to these many provisions, satoyama landscapes provide regulating services. The Science Council of Japan[2] identified and evaluated multiple functions of agricultural lands and forests including, for example, adjustment of local microclimates and air and water quality through phytoremediation, prevention and/or mitigation of flooding through retention of water in paddy fields which are framed by levees, and prevention of soil erosion through processes such as detection and repair of damaged agricultural lands at early stages.

The human inhabitants of the satoyama landscapes benefit in more ways than would be immediately apparent from their interactions with nature. For Japanese people, there is existence value to some of the species that benefit from these human influenced environments. The maintenance of secondary woodlands creates suitable environs for these species. For example, larvae of the national butterfly (Omurasaki (The Great Purple) *Sasakia charonda*) depend on the host tree *Celtis sinensis* Pers. var. *japonica* Nakai, a typical species in managed satoyama woodlands, and the adults feed on sap that is only secreted from younger *Q. acutissima* Carruth. trees. Some areas are used for shiitake mushroom (*Lentinula edodes* Berk.) production in special, aged woods, which, upon completion of their expected services, are brought back to decompose on the forest floor, providing the specific habitat necessary for the grubs of the Japanese rhinoceros beetles (*Allomyrina dichotoma*) – a valued symbol of Japanese youth and organic material for the soil.

## *Cultural Significance*

Satoyama landscapes have and continue to offer rich cultural services. In the same long-term process between humans and nature that developed the satoyama landscapes, much traditional knowledge such as farming and forestry practices and use of medicinal plants has been accumulated (JSSA 2010). Furthermore, many Japanese regard satoyama landscapes as sources of aesthetic beauty (often describing satoyama as idyllic rural images) and value them with nostalgia for their recreational benefits. Satoyama landscapes also provide spiritual benefits: rituals and festivals hoping for or celebrating agricultural fertility are still performed in many communities.

Cultural, natural, and historical features of the satoyama landscapes are the base of the identity and uniqueness for the regions of Japan where they exist. Additionally, satoyama landscapes have become increasingly valued in the context of regional development both in urban and rural areas and are even being recognized in recent governmental policies and laws. The policy for making “attractive agricultural

landscapes"[3] shows the government's recognition that the unique and beautiful scenery of agricultural areas reflects the diverse natural and cultural conditions shaped in those areas. Similarly, the "Law for the Protection of Cultural Properties" was amended in 2004 recognizing the cultural value of landscapes that have developed in association with the modes of life or livelihoods of people and the natural features of the region by including the new category of "cultural landscape."

## Satoyama in Decline

Mirroring the fate of many other indigenous systems throughout the world, the number of satoyama landscapes within Japan has been in decline for quite some time. Rapid economic growth in Japan following World War II brought many changes to satoyama landscapes due to urbanization and modernization both in terms of land use and lifestyles of the inhabitants. Responding to the rapid population increases in urban areas, large-scale development projects replaced the agricultural fields and woodlands in the periurban areas, such as the outskirts of Tokyo (Ichikawa et al. 2006). A number of golf courses and other resort facilities were constructed in rural areas supported by policies aiming to boost local economies and thus correct the economic disparities that had existed between urban and rural areas. This resulted in the destruction of the natural environments of the satoyama landscapes. In rural areas, the other side of urbanization, outward migration, took effect as depopulation and aging of rural populations furthered the abandonment of the surviving wood and agricultural lands. Beyond the encroachment of these urban areas, those that continue to live in satoyama landscapes face financial difficulties as many of the products they once obtained for use and sale from the SLs are now purchased from overseas and replaced with modern equivalents, such as biomass fuels like charcoal and firewood being supplanted by fossil fuels and farmers becoming more dependent on chemical fertilizers rather than compost from woodlands. These changes decreased the need for the woodlands which were then left unmanaged, allowing the natural succession of vegetation, which in turn caused the loss of many species dependent on the environment once created by human intervention. As the SLs are the habitats and growth environments for many endangered species of plants and animals, their loss becomes a matter of conservation with "underuse" as the serious issue rather than overexploitation. In addition, the changes brought about by urban development not only diminished the number of SLs but also affected the beauty and uniqueness of those that remain, as removal of elements that no longer have a practical purpose affects the overall landscape, leading to less inspired (and less biodiverse) styles of landscapes becoming more ubiquitous. There have been several research projects within Japan highlighting the decline of SLs; two such projects that demonstrate regional uniqueness and public perception of the landscapes concerning the Tokyo Greater Area are mentioned here.

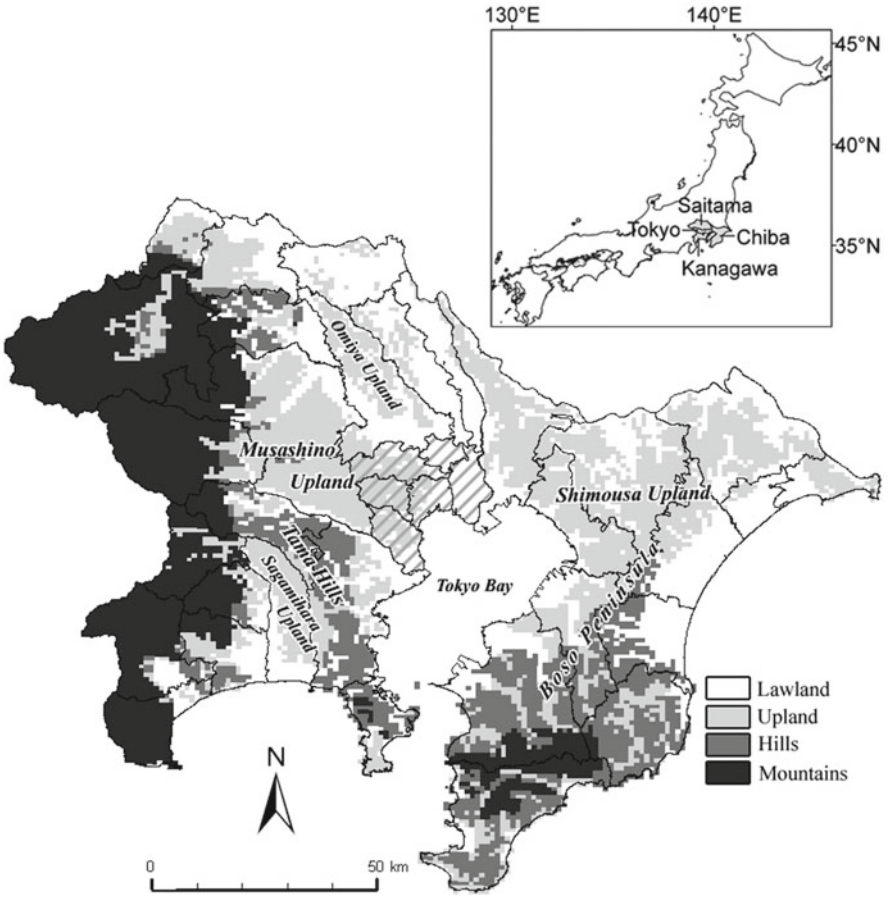


**Fig. 3** Location of the Tokyo Greater Area (TGA), Japan, and the boundaries of counties and landforms. The map in the *upper right* shows the location of the TGA in Japan, which is comprised of the Tokyo Metropolis, Saitama, Kanagawa, and Chiba Prefectures. An administrative unit of "county" (one order lower than a prefecture) was used as a unit of data collection and analysis (Source: Modified after Ichikawa et al. 2008b)

## *Changes in Regional Differences of Landscapes in the Tokyo Greater Area*

The Tokyo Greater Area (TGA) is composed of the Tokyo Metropolis and three surrounding prefectures: Saitama, Chiba, and Kanagawa (Fig. 3). Tokyo, one of the largest cities in the world today, has been the center of politics and governance in Japan for about 400 years. Beginning in the Edo Era, the central part of what is now Tokyo (called Edo) became the epicenter of Japan's feudal system with SLs spread through all the surrounding areas in order to provide for the needs of this burgeoning

capital. After the end of the Edo Era in 1868, and especially after the end of World War II in 1945, rapid urbanization took place in the TGA drawing people from rural areas all over Japan. As a consequence, the population of the TGA increased from 4 million in 1884 to 12 million in 1950 and 34 million by 2009 within an area of 13,600 km$^2$.

The TGA varies in topographic conditions (Fig. 3) and can be divided into four major types of landforms: lowland, upland, hilly, and mountainous. Lowlands are mainly in the middle of the region from north to south. Several uplands are distributed through the middle of the region in addition to a wide area of upland called Shimousa Upland located to the east. There are some hilly areas in southern peninsula and between the uplands and mountainous areas to the west.

A recent study evaluated the structure of the landscapes of 41 counties, represented by their land use compositions[4] and major forms of woodland vegetation (Ichikawa et al. 2008b), in order to understand the regional difference of the SLs and their succession. Land use and vegetation data for 1910, 1960, 1980, and 2000 were obtained from statistical figures (yearbooks kept by local government and information from the national agricultural census). The data were analyzed using GIS in order to examine their relationship with landform. In 1910, landscapes in the TGA were diverse in structure. Throughout the TGA, land use patterns varied, with paddy fields, farmlands, and woodlands spread the most widely and urban land use occupying less than 10% of each county (Fig. 4). As a whole, land use in 1910 was generally distributed in a way that corresponded with the distribution of landform. Socioeconomic factors such as local industries, which needed fuels made of certain preferred species, also seemed to have affected differences in woodland vegetation. This was most clearly observed in counties located in the upland areas, while woodlands in eastern uplands were largely dominated by pine, and woodlands in some parts of the western uplands were dominated by broad-leaved species.

Analysis of the landscape structures in later years (1960, 1980, and 2000) showed that the arrangement of the satoyama landscapes in the TGA had largely changed. After 1960, urbanization proceeded much more quickly than before, especially within a 50 km radius of the center of Tokyo. By 2000, despite a few pairs that had initially shown the strongest correlation between land use and landform remaining similar to their initial condition, more than 25% of the areas were dominated by urban land use, regardless of landform (Fig. 5). In contrast to the increase of urban areas, paddy fields, farmlands, and woodlands decreased largely in these areas. Infrastructure development, technological advances, and landform transformation contributed to accelerated urban development; location (not suitable location) became more influential to urban development than landform. A good example for this phenomenon is the Tama New Town started in1966; it is a planned development on 2,900 ha providing housing for 340,000 people, in the Tama Hills of western Tokyo.

Drastic changes in woodland vegetation after 1910 are obvious when comparing the distribution of woodland vegetation at that time with that in 1980 and 2000. An outbreak of pine wilt disease caused by the nematode, *Bursaphelenchus xylophilus,* and air polluted with sulfur dioxide from nearby industries caused extensive damage to pine woodlands, reaching peak destruction in 1979.[5] By this time, demand for

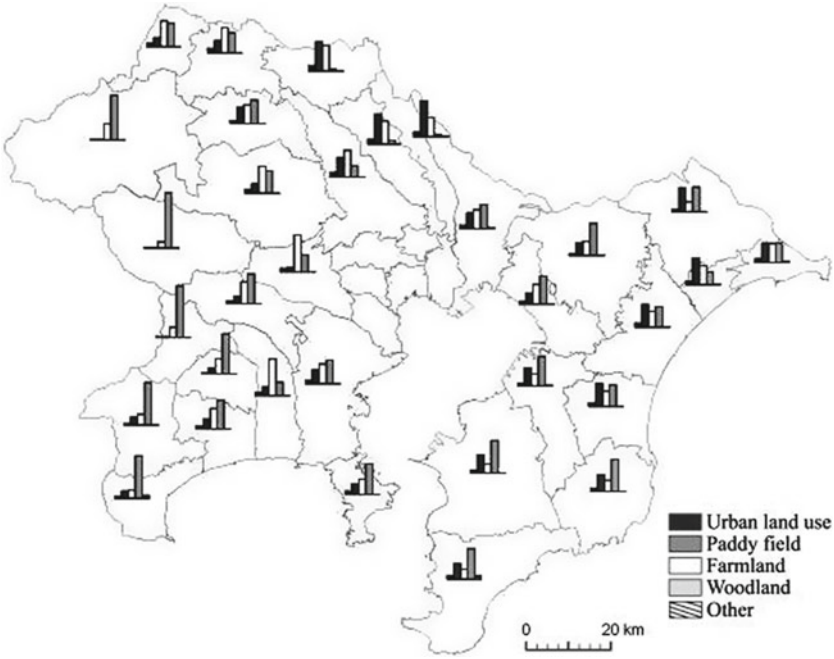


**Fig. 4** Relative distribution of various land uses in Tokyo Greater Area (TGA), Japan, 1910. The data were obtained from statistical figures from yearbooks published by each prefectural government[4]

pinewood as fuel largely decreased with the shift to fossil fuels. Furthermore, a policy to extend forestation areas was promoted after World War II in response to the increased demand for new houses. These areas were subsequently used for replanting of Japanese cedar (*Cryptomeria japonica* D. Don) and Japanese cypress (*Chamaecyparis obtusa* (Siebold & Zucc.) Endl.) trees, or left abandoned during periods of low demand for land, allowing for natural regrowth of broad-leaved trees. Through these transformations, satoyama landscapes in the TGA were drastically altered by the year 2000 resulting in decreased structural diversity. Currently, landscapes within 50 km radius of Tokyo are of uniform structure, dominated by urban land use, with the remaining woodlands mainly composed of broad-leaved species and some Japanese cedar and Japanese cypress.

## *Local Stakeholder's Perception of Past Woodland Vegetation*

The local stakeholders of three different study sites previously considered SLs (altered by the aforementioned urbanization process) were selected to conduct a questionnaire survey on their recognition of the past vegetation. Three types of local stakeholders were considered in terms of their relationship with the satoyama

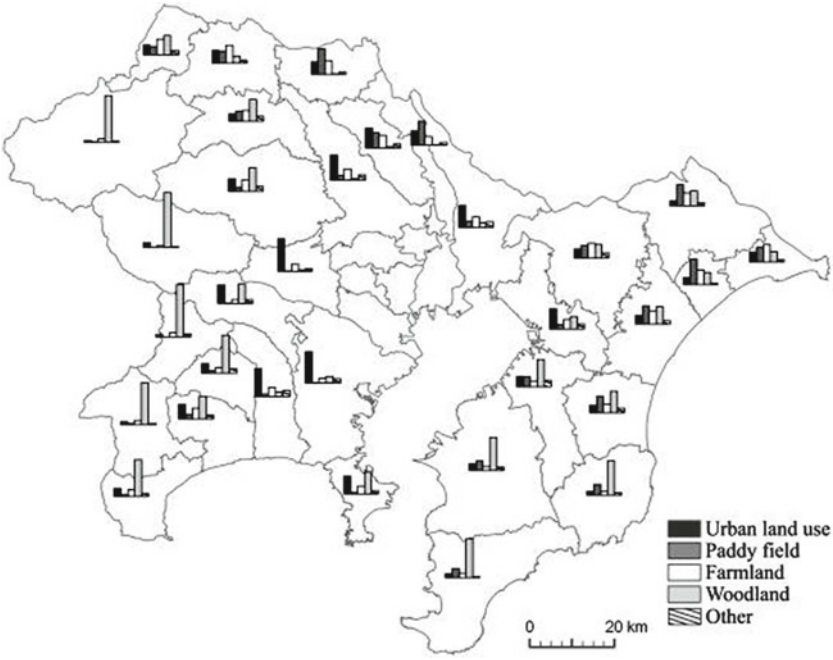


**Fig. 5** Relative distribution of various land uses in Tokyo Greater Area (TGA), Japan, 2000. The data were obtained from statistical figures from yearbooks published by each prefectural government[4]

woodlands, namely, longtime residents (communities existing since before the 1920s), new residents (communities living in areas developed in the 1960s), and volunteers (from groups that work to conserve satoyama woodlands). The three selected study sites were again located within a 50 km radius of Tokyo. In the survey, the local stakeholders were encouraged to recollect their memories of the previous states of woodlands and the data so collected were analyzed.[6] This allowed for comparison of the local residents' interpretation of the past woodland in each of the study sites and the actual past condition (based on old maps and aerial photographs).

The results of the survey (Fig. 6) show that the local people's perceptions of the past woodland vegetation of these areas differed. Longtime residents, who were thought to be knowledge transmitters, knew the most, but they were few in number. The volunteers who actually manage the woodlands had less (and sometimes biased) knowledge, depending on the group's characteristics. Newer residents had the least knowledge of past woodland vegetation. Communication among these groups should be helpful in decreasing the knowledge gaps. However, even this may not be sufficient for transmission of accurate knowledge of past conditions, given that no group had a complete grasp of the information. The use of objective references such as old maps and aerial photographs should help facilitate proper understanding of the past landscape and thus improve understanding of regional characteristics in a historical context.

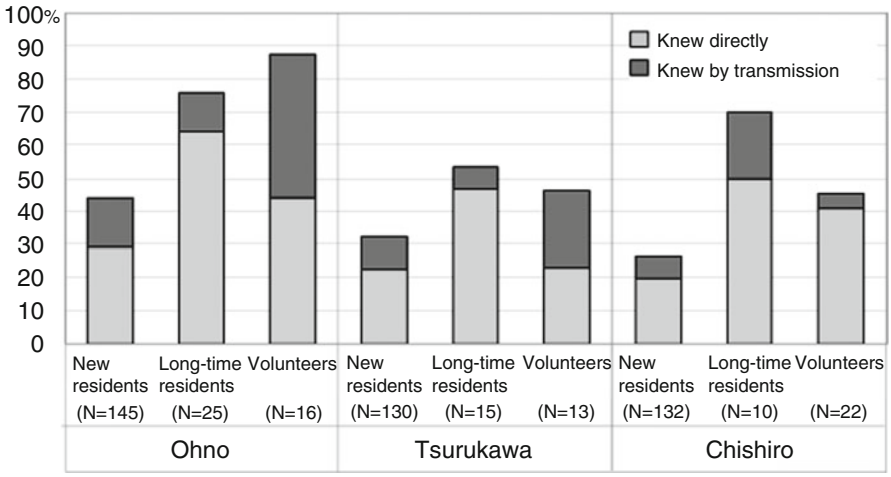


**Fig. 6** Recognition of past woodland vegetation by different local stakeholders in three different study sites in Tokyo Greater Area (TGA), Japan. Three types of local stakeholders (long-term residents since before the 1920s, new residents since the 1960s, and volunteers from groups that work to conserve) in each of three different study sites were selected to conduct a questionnaire survey on their perceptions of the past vegetation[6]

## Satoyama: Looking Forward

Decrease and abandonment of the satoyama landscapes during the rapid economic growth after the late 1960s ironically promoted gradual development of awareness and interest among Japanese people to the value of the satoyama landscapes. Today, many conservation and restoration efforts at local and national levels are taking place in response to the SLs' decline. A report by the Nature Conservation Bureau, Ministry of the Environment of Japan[1], counts as many as 972 volunteer groups doing activities in SLs in 1,023 fields within Japan. Another survey by the Forestry Agency records an increase in the number of volunteer groups that work in woodlands and forests. While there were only 277 groups in 1997, the number increased to 2,677 by 2009, 73% of which were working on management of satoyama woodlands.[7] Today, volunteers play an important role in the management of woodlands in urban environments.

However, considering the reasons for the decline of the SLs, it is apparent that the traditional management system in SLs will not work effectively under the present socioeconomic environment (Katoh et al. 2009) and volunteer management alone will not be enough to sustain them in perpetuity (Tsunekawa 2003). Yokohari and Bolthouse (2011) suggests the dynamic nature of SLs stems from having changed over time synchronous to the evolving needs of successive generations, necessitating recognition of the importance of contemporary needs in redeveloping relationships between communities and nature. Thus, new uses of SLs must be

explored for their survival. For example, growing awareness among consumers of the need for food safety measures and environmental conservation may support the revitalization of SLs by paying attention to the growing number of certification systems to identify goods produced under environmentally friendly conditions in SLs. Certain fauna species such as the Oriental stork (*Ciconia boyciana*) and Japanese medaka fish (*Oryzias latipes*) are often used to symbolize these agricultural activities, such as reducing or not using pesticides or chemical fertilizers and flooding paddies in winter time (for restoring the biodiverse environment key to that particular species). For example, 39 brands of rice are now identified as being produced in this way.[8] Moreover, many new uses for the woody biomass from SWs as an energy source are also being explored (Terada et al. 2010). Additionally, these systems are being looked at for their ability to enhance carbon sequestration, contributing directly to climate change mitigation (Nair et al. 2009; Nair 2012). The beautiful scenery, local foods, and variety of nature and cultural activities in each satoyama landscape are expected to continue to increase tourism, revitalizing the economies of these rural areas suffering from depopulation. To promote this, the Ministry of Agriculture, Forestry, and Fisheries (MAFF) proposed in 1992 an overnight-stay activity in rural areas called "green tourism" and enacted a law to further facilitate green tourism in 1994. Moreover, the SLs provide an excellent setting for environmental education. Ultimately, efforts that do not consider the synergies and trade-offs between ecological and communal welfare are unlikely to be effective (Chapin et al. 2009).

## Global Relevance of Satoyama

Satoyama landscapes are excellent examples of indigenous systems that are environmentally sustainable, biodiverse, and able to appropriately provide for their human inhabitants. Considering the variety of issues that global societies are facing, such as biodiversity degradation, poverty, climate change, and food security, the multifunctional aspect of IK systems and characteristics which support these functions should be clearly recognized. Such multifunctionality can be understood by using the framework of Millennium Ecosystem Assessment, which groups different types of ecosystem services (provisioning, regulating, cultural services). The basic overriding principles of traditional SLs that are common to most IK systems, such as the mosaic of land uses, maintenance of closed cycles of materials and wastes, and application of traditional knowledge and techniques, result in high species numbers and structural diversity (Gliessman 1998; Altieri 2005), making it an excellent example for understanding the significance of IK systems in general. A measure for assessing this agricultural landscape heterogeneity and the contribution of nonagricultural land use has been proposed by Kadoya and Washitani (2011) in the form of a Satoyama Index. While there are basic commonalities within various IK systems around the world, each landscape has distinguishing features, as each has evolved under different natural and social conditions. Comparing agroforestry in the Western

Ghats in India and SLs, Kumar and Takeuchi (2009) pointed out similarities such as basic landscape structure, multifunctionality of the system, high biodiversity, and potential to reduce carbon in the atmosphere. They also identified some of the differences including canopy architecture (the multi-tiered structure of agroforestry and the more or less unitary canopy of satoyama) and land ownership pattern (privately owned/managed agroforestry holdings vs. community local government or private ownership). Therefore, further research is necessary for exploring the realistic transference of management techniques between cultures. One manner of approach would be the deciphering of the current "black box" situation of many elements of IK systems (in which the necessary inputs and the typical outputs are understood but many of the underlying interactions are not fully charted) and further scientific understanding of the nature of these systems and the indigenous knowledge associated with them that has stood the test of time.

Just as in Japan, IK-based systems are diminishing and degrading throughout the world: victims of urbanization, industrialization, modernization of agriculture and forestry and fishery techniques, population increase, aging of rural population, and the resulting loss of biodiversity. As many of these forces are similar throughout the world (Ichikawa et al. 2010), comparing the systems, the benefits they provide, and the measures they take will help determine the next steps to follow. Based on this understanding, the *Satoyama* Initiative was initiated jointly by the Ministry of the Environment of Japan and the United Nations University Institute of Advance Studies. The International Partnership for the *Satoyama* Initiative (IPSI) was established as a platform for collaboration among a broad range of entities and organizations for conservation, restoration, and revitalization of such systems toward its vision of "realizing society in harmony with nature." The *Satoyama* Initiative builds on the understanding that if the interactions between humans and nature are properly maintained, the result is landscapes which sustain healthier ecosystems and biodiversity, while at the same time contributing to human well-being. The recognition that ecological, social, and economic aspects are linked to each other in these landscapes has led to the coining of the term "socio-ecological production landscape" to describe the target area of the *Satoyama* Initiative.

The fact that other initiatives with similar orientations exist attests to the general belief by the global community in the importance of IK. One example is the GIAHS (Globally Important Agricultural Heritage Systems) begun by the Food and Agriculture Organization (FAO) in 2002. The GIAHS refers to remarkable land use systems and landscapes which are rich in globally significant biological diversity evolving from the coadaptation of a community with its environment and its needs and aspirations for sustainable development.[9] By identification and registration of these systems, GIAHS seeks to promote international recognition, conservation, and sustainable management, supporting food security and agricultural biodiversity in conjunction with their contributions to natural landscapes, cultural heritage, and indigenous knowledge systems (Boerma 2002).

Considering the ever evolving needs of society and the current situation of SLs and other systems based on indigenous knowledge described above, adjustments

and innovation are needed to respond accordingly. For example, satoyama is being considered for meeting more recent types of demands as well: the utilization of biomass for energy production and the concept of the high carbon stock potential of such systems in Japan are being studied (Yokohari and Bolthouse 2011; Terada et al. 2010), which helps set precedence for similar studies elsewhere. While these types of resources are not enough to meet the energy needs of an entire country, they may be able to provide reasonable supplements when worked into a mixed energy source system and, in doing so, provide good secondary income to the communities who are in charge of managing these environmentally crucial landscapes.

In periurban areas of Japan, even though the encroachment of cities has largely changed satoyama landscapes, there are still woodlands and agricultural lands that have "survived" the rapid urbanization; some are still privately owned by (former) farmers, but others, especially the woodlands, are designated as parks or nature conservation areas, which prevent them from being converted to urban land uses. It is important to conserve the remnants of former agricultural landscapes, as more than half of the global population lives in or around such new urban and periurban areas today. These areas are important for creating good environments and atmosphere and providing nearby places where people can go to enjoy nature.

Considering the historic and symbolic associations of woodlands and trees (O'Brien 2005), in Japan, the remaining SLs are also valuable symbols of each region's unique characteristics, history, and culture. The process of understanding the past landscapes and their changes also provides a valid context in which to identify issues, problems, and desired outcomes in planning (Marcucci 2000), as well as useful wisdom or inspiration for future management, restoration, and creation of landscapes (Antrop 2005). Recognition of the unique characteristics of regional SLs by local stakeholders, bearing in mind historical perspectives, an provides an important foundation for regional development which other countries with similar circumstances may take note of.

## Conclusions

Each indigenous knowledge system is essentially location specific. Even within Japan, landscapes are regionally shaped over time based on local landform, land use, vegetation, and socioeconomic requirements. However, the basic overriding principles among SLs and other IK systems in the world, as well as issues facing them, are similar. There are also lessons others can observe in Japan in terms of treatment of such systems within an industrialized country, be it via cultural or governmental recognition. Further approaches must be explored not only to conserve or restore but also to revitalize the satoyama landscapes. These must meet with contemporary needs of the societies with which they are associated. International efforts to share information are essential in order for similar systems throughout the world to deal with common issues brought on by continuing globalization.

## End Notes

1. Nature Conservation Bureau Ministry of the Environment of Japan (2001) Nihon no satochi-satoyama no chousa bunseki ni tsuite -Chukan houkoku- (Survey and Analysis on Satochi-Satoyama in Japan -Interim Report-). Available at http://www.env.go.jp/nature/satoyama/chukan.html (accessed 30 July 2011)
2. Science Council of Japan (2001) Chikyu kankyo, ningen seikatsu ni kakawaru nogyo oyobi shinrin no tamentekina kinou no hyoka ni tsuite (Valuation of multifunctionality of agriculture and forest related to the global environment and human life). Available at http://www.scj.go.jp/ja/info/kohyo/pdf/shimon-18-1.pdf. (accessed 30 July 2011)
3. MAFF (Ministry of Agriculture, Forestry and Fishery) (2003) Mizu to midori no "Binosato" Puran (Plan 21 for "beautiful villages" rich with water and green). Available at http://www.maff.go.jp/j/nousin/nouson/bi21/index.html (accessed 30 July 2011)
4. Ichikawa K (2008) Transition and Conservation of Satochi Landscape in the Greater Tokyo Area. PhD Thesis, The University of Tokyo.
5. Forestry Agency (2010) Zenkoku no Matsukui-mushi higairyou no suii (Transition of the damaged volume by the pine diseases in the nation). Available at http://www.rinya.maff.go.jp/j/press/hogo/pdf/100831-01.pdf (accessed 24 July 2011).
6. Ichikawa K, Okayasu T, Aoyagi-Usui M, and Takeuchi K (2008) Knowledge of residents and volunteers on the woodland in the suburban areas. Proceeding of the Spring Meeting of The Association of Rural Planning. Tokyo, Japan, 5 April, 2008: 1–2.
7. Research, Extension, and Environment Policy Division Forestry Agency (2010) Mori zukuri katsudou ni tsuiteno anketo syukei kekka (Result of the questionnaire survey on the forest management activities). Available at http://www.e-stat.go.jp/SG1/estat/GL08020103.do?_toGL08020103_&listID=000001067029&requestSender=dsearch. (accessed 30 July 2011)
8. PRIMAFF (Policy Research Institute, Ministry of Agriculture, Forestry and Fisheries) (2010) Seibutsu tayosei hozen ni hairyo shita nogyoseisan no eikyohyoka to sono sokushin hosaku (Impact evaluation and promotion of agricultural production in consideration of biodiversity conservation). Environmental Project Research Material No2. 112pp.
9. FAO (n.d.) GIAHS Definition. Available at http://www.fao.org/nr/giahs/whatare-giahs/definition/en/ (accessed 24 July 2011)

## References

Altieri MA (2005) Agroecology. In: Altieri MA, Nicholls CI (eds) Agroecology and the search for a truly sustainable agriculture. United nations environment programme, environmental training network for Latin America and the Caribbean, Colonia Lomas de Virreyes, Panama City, pp 73–97

Amano T, Kusumono Y, Tokuoka Y, Yamada S, Kim EY, Yamamoto S (2008) Spatial and temporal variations in the use of rice–paddy dominated landscapes by birds in Japan. Biol Conserv 141:1704–1716

Antrop M (2005) Why landscapes of the past are important for the future. Landsc Urban Plan 70:21–34

Azuma A (2003) Birds of prey living in Yatsuda and Satoyama. In: Takeuchi K, Brown RD, Tsunekawa A, Washitani I (eds) SATOYAMA-the traditional rural landscape of Japan. Springer, Tokyo, pp 102–109

Berkes F, Folke C, Gadgil M (1995) Traditional ecological knowledge, biodiversity, resilience and sustainability. In: Perrings CA, Mäler KG, Folke C, Jansson BO, Holling CS (eds) Biodiversity conservation. Kluwer, Dordrecht, pp 281–299

Boerma D (2002) Globally important ingenious agricultural heritage systems. In: Biodiversity and the ecosystem approach in agriculture. Forestry and Fisheries FAO, Rome, pp 1–10

Chapin SF, Carpenter SR, Kofinas GP, Folke C, Abel N, Clark WC et al (2009) Ecosystem stewardship: sustainability. Trends Ecol Evol 25:241–249

Gliessman SR (1998) Agroecology: ecological process in sustainable agriculture. Ann Arbor Press, Michigan, p 357p

Ichikawa K, Okubo N, Okubo S, Takeuchi K (2006) Transition of the satoyama landscape in the urban fringe of the Tokyo metropolitan area from 1880 to 2001. Landsc Urban Plan 78:398–410

Ichikawa K, Okayasu T, Takeuchi K (2008b) Characteristics in the distribution of the woodland vegetation in the southern Kanto region since the early 20th century. J Environ Info Sci 36(5):103–108

Ichikawa K, Wong BYL, Bélair C, Mulongoy JK (2010) Overview of features of socio-ecological production landscapes. In: Bélair C, Ichikawa K, Wong BYL, Mulongoy KJ (eds) Sustainable use of biological diversity in socio-ecological production landscapes. Background to the 'Satoyama Initiative for the benefit of biodiversity and human well-being' (CBD Technical Series 52). Secretariat of the Convention on Biological Diversity, Montreal, pp 178–181

JSSA (Japan Satoyama Satoumi Assessment), (2010) Satoyama-Satoumi ecosystems and human well-being: socio-ecological production landscapes of Japan – summary for decision makers. United Nations University, Tokyo, 36p

Kadoya T, Washitani I (2011) The Satoyama index: a biodiversity indicator for agricultural landscapes. Agric Ecosys Environ 140:20–26

Kadoya T, Suda S, Washitani I (2009) Dragonfly crisis in Japan: a likely consequence of recent agricultural habitat degradation. Biol Conserv 142:1899–1905

Kato M (2001) Satoyama and biodiversity conservation: Satoyama as important insect habitats. Glob Environ Res 5:135–149

Katoh K, Sakai S, Takahashi T (2009) Factors maintaining species diversity in Satoyama, a traditional agricultural landscape of Japan. Biol Conserv 142:1930–1936

Kumar BM, Takeuchi K (2009) Agroforestry in the Western Ghats of peninsular India and the Satoyama landscapes of Japan: a comparison of two sustainable land use systems. Sustain Sci 4:215–232

Marcucci DJ (2000) Landscape history as a planning tool. Landsc Urban Plan 49:67–81

Nair PKR (2012) Climate change mitigation and adaptation: a low-hanging fruit of agroforestry. Springer, Dordrecht, pp xx–xx

Nair PKR, Nair VD, Kumar BM, Haile SG (2009) Soil carbon sequestration in tropical agroforestry systems: a feasibility appraisal. Environ Sci Policy 12:1099–1111

O'Brien E (2005) Social and cultural values of trees and woodlands in northwest and southeast England. For Snow Landsc Res 79(1/2):169–184

Otsuka E (2009) Hyakusho no Tochi Shoyu (Landholdings of Farmers). In: Watanabe T, Gomi F (eds) Tochi Syoyu-shi (History of land tenure). Yamakawa Shuppansya, Tokyo, pp 274–305

Oudenhoven FJ, Mijatović D, Eyzaguirre PB (2010) Bridging managed and natural landscapes. In: Bélair C, Ichikawa K, Wong BYL, Mulongoy KJ (eds) Sustainable use of biological diversity in socio-ecological production landscapes Background to the 'Satoyama Initiative for the

benefit of biodiversity and human well-being (CBD Technical Series 52). Secretariat of the Convention on Biological Diversity, Montreal, pp 178–181
Shidei T (1974) Mori ya Hayashi (Woods and forest). Chuokoronsha-Sha Inc., Tokyo, 206p
Suzuki S, Nakagoshi N (2011) Sustainable management of Satoyama bamboo landscapes in Japan. In: Hong SK, Wu J, Kim JE, Nakagoshi N (eds) Landscape ecology in Asian Cultures. Springer, Tokyo, pp 211–220
Takeuchi K (2003) Satoyama landscapes as managed nature. In: Takeuchi K, Brown RD, Tsunekawa A, Washitani I (eds) SATOYAMA–the traditional rural landscape of Japan. Springer, Tokyo, pp 9–16
Terada T, Yokohari M, Bolthouse J, Tanaka N (2010) "Refueling" Satoyama woodland restoration in Japan: enhancing restoration practice and experiences through woodfuel utilization. Nat Cult 5:251–276
Tsunekawa A (2003) Strategic management of Satoyama landscapes. In: Takeuchi K, Brown RD, Tsunekawa A, Washitani I (eds) SATOYAMA–the traditional rural landscape of Japan. Springer, Tokyo, pp 102–109
Ueda A (2002) Satochi satoyama no zenkoku bunpu to tokusei ni tsuite (Nation-wide distribution and of the satoyama landscapes its characteristics). J Jap Inst Landsc Arch 65:268–269
Washitani I (2003) Satoyama landscapes and conservation ecology. In: Takeuchi K, Brown RD, Tsunekawa A, Washitani I (eds) SATOYAMA – the traditional rural landscape of Japan. Springer, Tokyo, pp 16–23
Yokohari M, Bolthouse J (2011) Keep it alive, don't freeze it: a conceptual perspective on the conservation of continuously evolving satoyama landscapes. Landsc Ecol Eng 7:207–216