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REVIEW

Traditional Farming Landscapes for Sustainable Living in Scandinavia and Japan: Global Revival Through the Satoyama Initiative

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Abstract Traditional, pre-industrial farming was adapted to the natural environment—topography, geology, hydrology, climate, and biota. Traditional land use systems are still to be traced in Scandinavia as an "infield/outland landscape", and in Japan as a "Satoyama landscape." There are obvious similarities and differences in land use—the main difference being that pasturing of cattle and sheep has been less important in Japan. These land use systems can be traced back to early sedentary settlements 1500–2500 years ago. In both regions, traditional management almost ceased in the mid-twentieth century leading to afforestation and decreased biological diversity. Today, there is in Japan a growing movement for landscape restoration and promotion of a sustainable living countryside based on local agrarian and forestry production, local energy, tourism, etc. With this background, the so-called Satoyama Initiative has been organized and introduced as a global socio-ecological project with ecosystem services for human well-being.

Keywords Agrarian land use history · Satoyama landscape · Infield/outland · Nature restoration · Biodiversity changes · Deforestation history

INTRODUCTION

Landscapes with traditional farming methods show broad similarities all over the world dependent on climate, geology, hydrology, biota, etc., as well as ethnological traditions. Agrarian land use has often been adapted to an ecological gradient from fertile soils with favorable nutrient and water conditions toward poor, less-suitable soils for cultivation purposes. This is most obvious in landscapes with some topographic relief, where valleys or coastal plains with good soils contrast hilly uplands, sometimes described as a dichotomy between lowlands and uplands (Barnes 2010). Crop production is then concentrated to the valley plains, while nearby hilly areas are used for forest products such as timber, fuel, and sometimes used as pastures for live-stock.

For sedentary farms or farm villages in Scandinavia, we use the term infield/outland system, or *infield/outland landscapes*. Settlements were placed beside cultivated lowland areas, near the borders between infields and outlands. Forest products were obtained from the outlands which also were used for pasture. When land use of this kind was established in a forested region, it resulted in a change toward a mosaic landscape with higher biological diversity. Because of industrialization, afforestation, and depopulation of the countryside, such traditional farming landscapes have become very rare in Europe. Today 57 % of the land area in Sweden is covered with productive forests, while 9 % is cropland and pastures.

A comparison with related *Satoyama landscapes* in Japan is relevant, but here dry-field cultivation, carried out in valleys as well as on hill slopes, has been almost replaced by rice cultivation on irrigated lowland fields (paddy fields). As in Scandinavia, traditional farming has been modernized since the mid-twentieth century. Today 13 % of the land area is cropland. Japan is a mountainous country with 66 % forest coverage. About 40–50 % of Japan, ranging from lowland up to 500–800 m elevation, belonged to the Satoyama landscape, which was a mosaic of woodlands, plantations, grasslands, farmlands, irrigated ponds, canals, etc. Today, the former Satoyama woodlands have to a great extent been afforested like the outlands in Scandinavia.

In Scandinavia, small-scaled farming has almost ceased but local historical and nature protection societies manage some areas that are regarded as remains of the cultural heritage. In Japan, much attention has recently been paid to

Fig. 1 Infield/outland in southern Sweden, a reconstructed landscape image from Late Iron Age AD 500–1000. Infield on fertile soils with meadows and fields surrounded by a main fence. Outland a half-open wood pasture with a swidden field. *Arrows* indicate transport of hay and leaves from meadows, straw from fields to the barn, manure from the barn to the fields, and cereals from the field to the farm house. Drawing by Nils Forshed (Ekstam et al. 1988, by courtesy of Forshed)

the Satoyama landscape as a socio-ecological model of sustainable lifestyle in harmony with nature—the *Satoyama Initiative* (*SI*), a model for "Human Well-Being" to be applied worldwide. This is now linked to the United Nations through the program "Globally Important Agricultural Heritage Systems" (GIAHS), a collaboration so far between 11 countries.

TRADITIONAL FARMING LANDSCAPES

Infield/Outland Landscapes in Scandinavia

From prehistoric time, farming in Scandinavia has combined crop production with animal husbandry—cattle, sheep, goats, and horses. Crop fields and hay meadows were situated close to the farms, collectively forming the *infields*. The meadows were often sparsely wooded. Herb-rich hay, together with tree twigs obtained by pollarding (Rackham 1988), was important for winter fodder. Such meadows were characteristic in European farm villages based on traditional farming methods. They contributed to the high diversity of plants, insects, birds, etc. Infields were fenced off by stone walls or wooded fences from surrounding outlands. This was to protect the infields from animals grazing in the *outlands*, which were often large upland areas of common land. Enclosure regulations in the eighteenth century or later led to the division of this outland between individual farms. This partition of land between infields and outlands and between different land owners, is still visible in the terrain in southern Sweden and Norway, where fences were built of stones. Such walls are also regarded as belonging to the cultural heritage. The nutrient circulation based on infield meadows and outland pastures using animal manure as fertilizer was essential for the infield/outland system (Emanuelsson 1988; Olsson 1988). See scheme of an Iron Age hamlet in Fig. 1 and photos in Fig. 2.

Originally, outlands were forested areas on poor ground, sometimes rocky or rich in boulders. Exceptions were the coastal plains where outlands were sometimes fertile, and following drainage in the nineteenth century, became cultivated. Depending on grazing pressure, the outlands became deforested and developed into half-open wood pastures. Intense grazing, sometimes in combination with

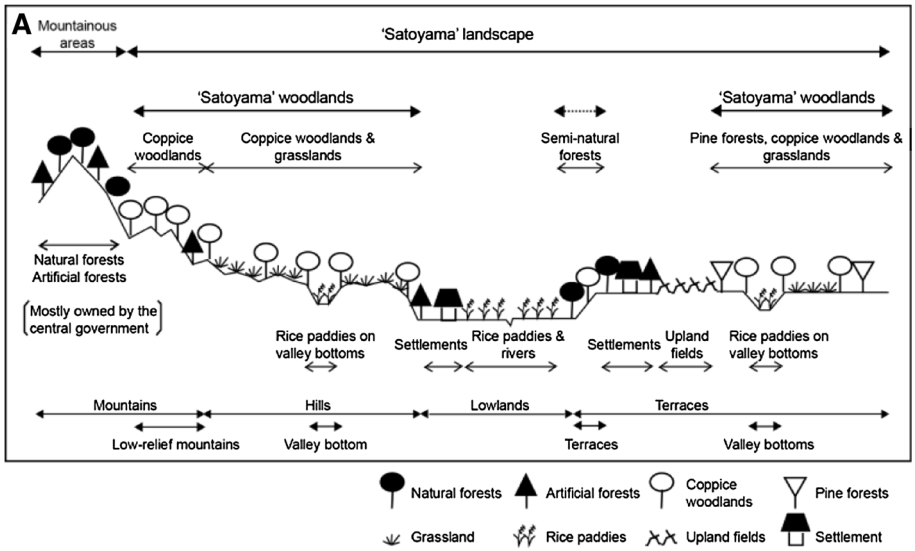
Fig. 2 Photo collage based on photos from a farm in southern Sweden with traditional land use until 1970s, today managed as a culture and nature reserve where a "nature school" is located. Photos **a**–**c** from the infield area, photos **d** and **e** from the outland area. Photos **a**–**d** from 1968 to 1974, **e** from 2010. **a** Meadow with pollarded ash trees in front of the farm house. **b** The farmer Josef collecting leaves. **c** A small field mowed by scythe. **d** The cows are waiting outside the outland gate. Outland pasture partly overgrown by spruce. **e** Today, the outland has been cleared for modern pasturing. View from the old outland gate. Photo Björn E. Berglund

slash-and-burn (swidden), led to treeless heath areas, particularly in mountainous and coastal areas such as western Denmark and Norway, or steppe-like areas on the limestone islands Öland and Gotland in the Baltic Sea. Outlands were important for various forest products like timber, fuel, charcoal, tar, game, berries, and other plant resources (Tunon et al. 2005). Trees were often coppiced to obtain more timber and wood for various tools (Rackham 1976, 1988). Traditional use of woodlands for pasturing, coppicing, etc., is also known from uplands in Central and Southern Europe (Pott 1993; Emanuelsson 2009).

Outlands were also important in that they offered possibilities for agricultural expansion (Lagerås 2007). When needed, infield cultivation was complemented by temporary cultivation in the outlands. In the long run, however, the pressure from population growth could only be solved by the establishment of new farms and hamlets in the outlands.

Satoyama Woodlands and Satoyama Landscapes in Japan

Originally, the term *Satoyama*—from *sato* = village and *yama* = upland—was used for forested, often hilly areas situated beside farm villages—this definition has been traced back to the eighteenth century (Tokoro 1980). Shidei (1973, 2000) has been credited for introducing this name to science and for emphasizing that Satoyama woodlands and grasslands were important for the cultivation of dry-field vegetables and rice. Wet-rice cultivation dependent on irrigation was carried out in the plains and valley bottoms. Today, the terminology has been changed so that *Satoyama*



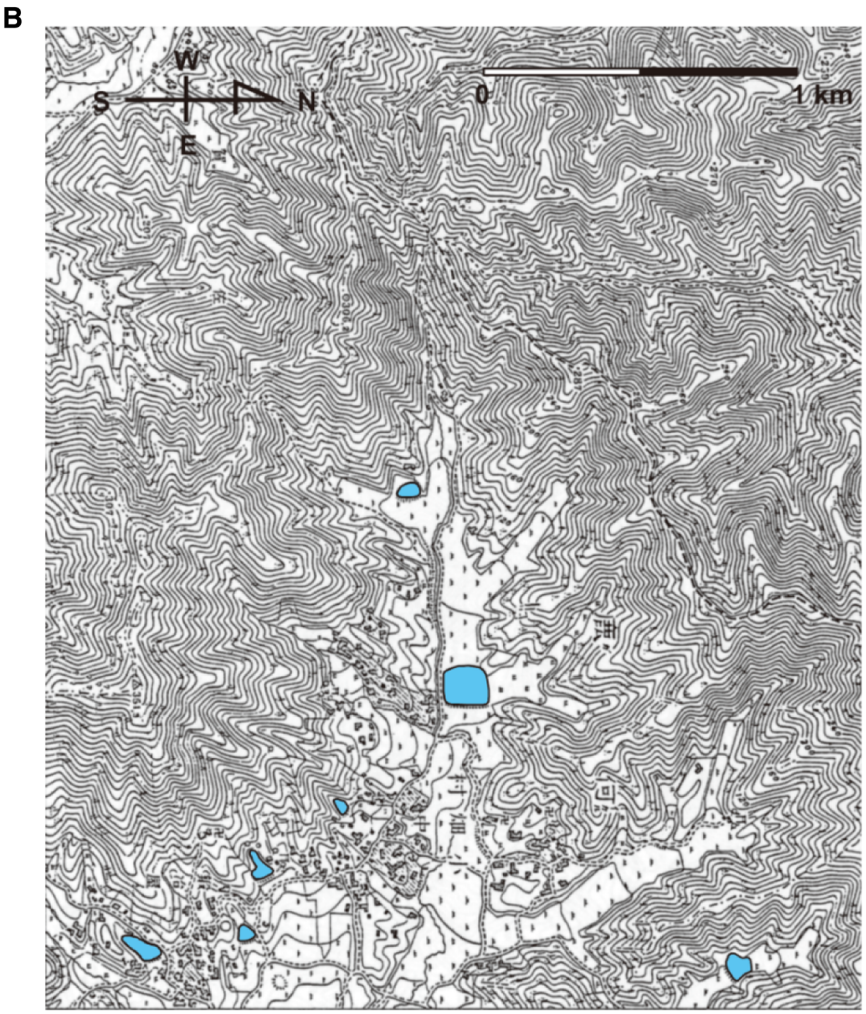


Fig. 3 **a** Schematic transect of a river valley with various landscape elements, defining Satoyama woodlands and Satoyama landscape (Yamamoto 2001, from Takeuchi 2003, by courtesy of Yamamoto and Takeuchi). **b** Excerpt from the Meiji Map [c. 1900, Chizusiryo-hensankai 2001)] with a small river valley cut into the uplands north of Ayabe village, c. 60 km NW Kyoto. The hamlet Kajiya is situated here with croplands in the valley bottom and ponds along hill slopes (see Fig. 4b). Note the high relief of the uplands reaching c. 300 m above the valley bottom, several mountain tracks and scattered tree symbols indicating half-open Satoyama woodlands

woodland refers to hilly uplands, often with some croplands, outside the village and *Satoyama landscape* to the entire area around the village—not only the hilly woodlands but also valley areas, plains with farmlands, settlements, water reservoirs, and all elements belonging to the agrarian land use system (Yamamoto 2001; Takeuchi 2003). In remote mountain areas, rather untouched forests, named *Okuyama*, occurred. Concepts as well as the public view related to Satoyama are described in a concise manner by Morimoto (2011, Table 1). See Satoyama scheme and map excerpt in Fig. 3, photos in Fig. 4. In addition, *Satoumi* (from *sato* = village and *umi* = sea) is a coastal area where people are dependent on sea fishing (Yanagi 2006). Satoumi is extremely important, traditionally as well as today, as Japan is a large archipelago with a long open-ocean coastline as well as inland sea.

Before the introduction of commercial fertilizers in the mid-twentieth century, gathering of litter in the Satoyama woodlands was very important. Open grasslands in the uplands were laid out and harvested for compost litter and grass thatching. It has been calculated that a village with 50 ha of rice paddy fields needed 5–600 ha of Satoyama woodlands for litter gathering (Mizumoto 2003). Trees were coppiced in order to get more tree trunks for timber, fuel, and charcoal production. This meant a rotation time of about 15–20 years. Coppicing occurred even in distant mountainous areas. Even today, large areas of coppiced woodlands are to be seen, but in general these are overgrown woodlands as large-scaled coppicing ceased in the mid-twentieth century. Food products were gathered, such as shoots of bamboo, ferns and herbs, nuts of chestnut (*Castanea crenata*) and horse

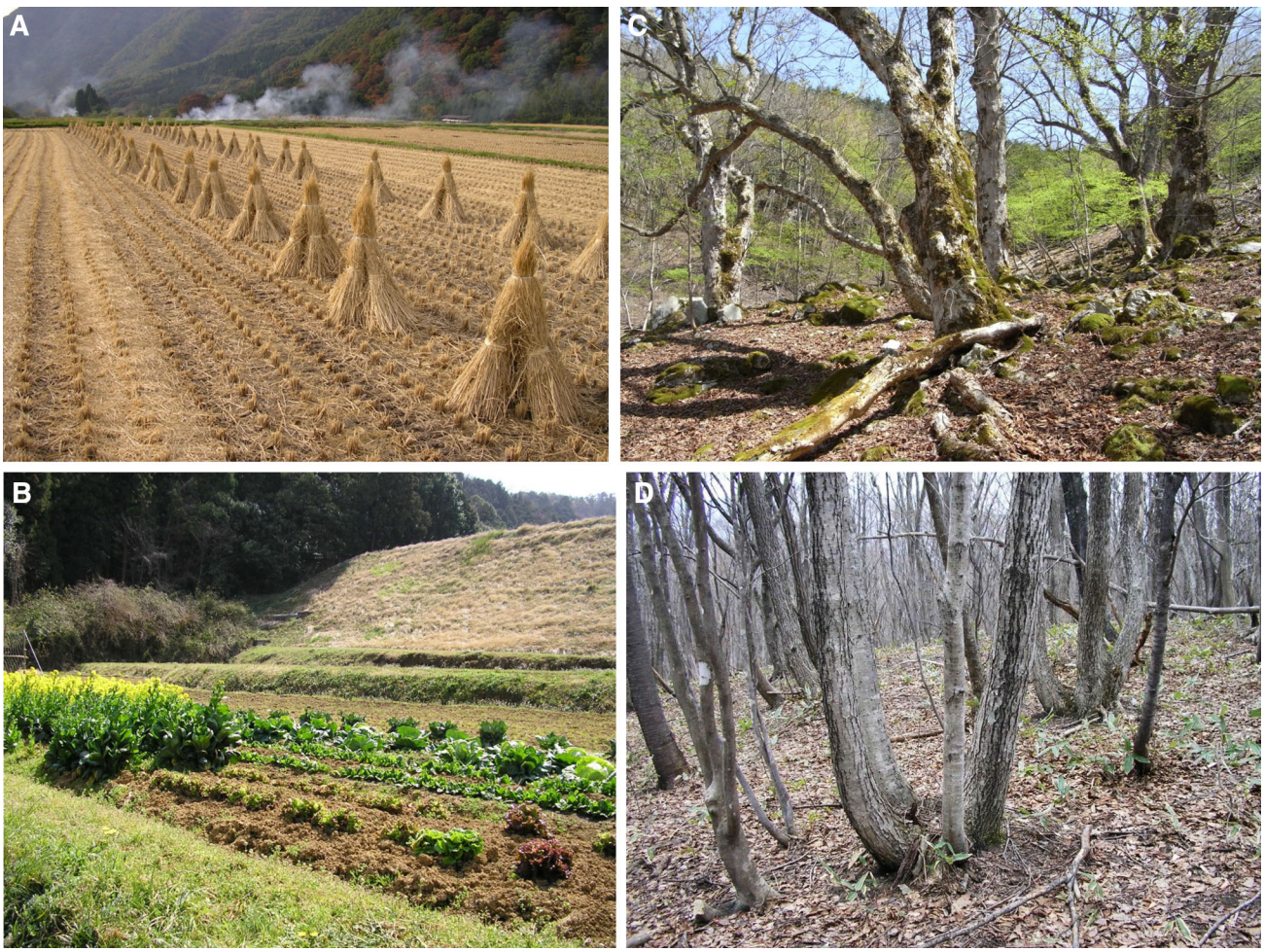


Fig. 4 Photo collage based on Satoyama field studies in Honshu, Japan. **a** Harvested rice field with Satoyama forest on the hill slope behind, Yumoto-Onsen, Tenei valley, c. 60 km W Fukushima, Fukushima Prefecture (Oct. 2008). **b** Vegetable field nearby the dyke of an irrigation pond in a side valley at Kajiya, near city Ayabe, c. 60 km NW Kyoto (May 2005). **c** Satoyama woodland (c. 600 m a.s.l.) with horse chestnut trees (*Aesculus turbinata*) on a mountain slope c. 200 m above the hamlet Koya, NE Ayabe, c. 50 km NW Kyoto. Nuts are still harvested here for biscuit production (April 2012). **d** Coppiced woodland (mainly *Quercus serrata*, *Q. crispula*, and *Fagus crenata*) on the slope of Mt. Zao, c. 600 m a.s.l., 40 km SW Sendai, Miyagi Prefecture (April 2005). Photo Björn E. Berglund

chestnut (*Aesculus turbinata*), berries, mushrooms, game, etc. Gathering of chestnuts is still practiced in mountain areas.

Animal husbandry has been quite different from Europe. The staple food for common people was vegetables and seafood. Cattle (oxen) were mainly used as draft animals, even horses to some extent. When Buddhism became a national religion in the seventh century, the cattle meat was regarded unchaste. In the year 676, the emperor prohibited consumption of meat from cattle and horses which lasted until 1871 (Harada 1993). In contrast, rice had a special meaning in Japanese myths, "rice as deities", and, therefore, authorities favored rice instead of meat production (Ohnuki-Tierney 1995, unpubl.). However, archeological investigations in Kyoto and other places have shown that carcasses of cattle and horses were butchered for several purposes including meat consumption (Matsui 2011). In general, cows were not kept for milk production as Japanese people have difficulties digesting milk products (Yoshida et al. 1975). Because of this, only restricted numbers of oxen were kept in each hamlet and these were kept in cowsheds. Local small-scale milk production did occur, but traditionally, farming cows were kept indoors. Cheese production was rare until the Meiji period (starting 1868), when the government did support cheese production as an element in the national nutritional strategy (Otani 2007). Altogether, it was not important to use woodlands as pastures (with the exception of horses important for military needs), and so there was no need to have fences around the hamlets. Sometimes, stone fences were built as protection against wild animals like boars and deers. Modern ranches for meat production were introduced only 50–60 years ago, mainly in northern Honshu and on Hokkaido. Sheep and goats have been present temporarily and locally since the fifteenth century, but more frequently at the end of the nineteenth century (Nakagawa 2003). Today, sheep are less frequent and goats are quite rare. Except for Hokkaido, sheep and goats did not have any important impact on the landscape in contrast to the situation in Europe.

Farming and settlement expanded within Satoyama woodlands during certain periods (Totman 2005). In some mountain areas, dry-field cultivation occurred together with swidden fields and some rice paddy fields (see Barnes 2010, Fig. 20.10). Silk worms were produced in areas where mulberry trees (native in Japan) were growing, and silk production was carried out from the Late Yayoi period 2000 years ago (Nunome 1979, 1988). There are mountain areas where mulberry trees have been cultivated for local silk worm production until recently, e.g., Shiramine Mountains in Ishikawa Province.

In contrast to the land use in Scandinavian outlands, the Satoyama woodlands were used for dry-field cultivation, at least close to the farms. This was characteristic for valley slopes as illustrated in old photos or nineteenth-century drawings.

Historical Documentation: Archeology, Paleoecology, Archives

Infields/Outlands in Scandinavia

The land use system with infields/outlands is linked to the introduction of sedentary settlement. In Scandinavia, many remains of ancient agriculture are preserved in situ, particularly in today's pastures and woodlands where they have escaped destruction by modern cultivation. One type of such remains is the stone walls and stone foundations for wooden fences, which were built around farms, fields, and meadows, and along cattle paths leading from settlement to the outland pastures (Fig. 5). They have been documented by archeologists and human geographers and dated back to AD 200 (Lindquist 1974; Widgren 1983; Pedersen and Widgren 2011). However, the tradition of building stone walls continued until the nineteenth century. Stone walls were permanent boundaries, and their introduction about AD 200 represents the establishment of sedentary agriculture with an infield/outland system. Possibly, an infield/outland system was established at even earlier dates in coastal plains and expanded later toward inland/upland areas.

Another type of agricultural remains is the clearance cairn, i.e., heaps of stones cleared away from cultivated fields. Large areas of such ancient clearance cairns are common in forested uplands. They cover a long time span, beginning approx. 2000 BC. The majority of them, however, date from the interval AD 0–1500, i.e., from the Iron Age and the Middle Ages (Lagerås and Bartholin 2003; Lagerås 2013). They seem to represent a rather mobile agricultural system, which was practiced parallel to the infield/outland system for a long time. However, by AD 1000, most farms were based on an infield/outland system, with permanent fields and meadows separated from surrounding outlands. Some mobile agriculture, particularly slash-and-burn, continued on the outlands, but only as a complement to the cultivation on permanent fields.

Archeological information on past agriculture is complemented by paleoecological studies of pollen and seeds (Fig. 6). In particular, pollen data from sediment and peat sequences provide valuable information on the long-term development of the cultural landscape. In southern Scandinavia, they demonstrate deforestation and expansion of arable land, meadows, and pastures during the period 1000 BC to AD 500 (Aaby 1988; Odgaard 1994; Lagerås 1996; Berglund et al. 2002b). This change of landscape use occurred earlier on the fertile coastal plains (c. 1000–500 BC), than

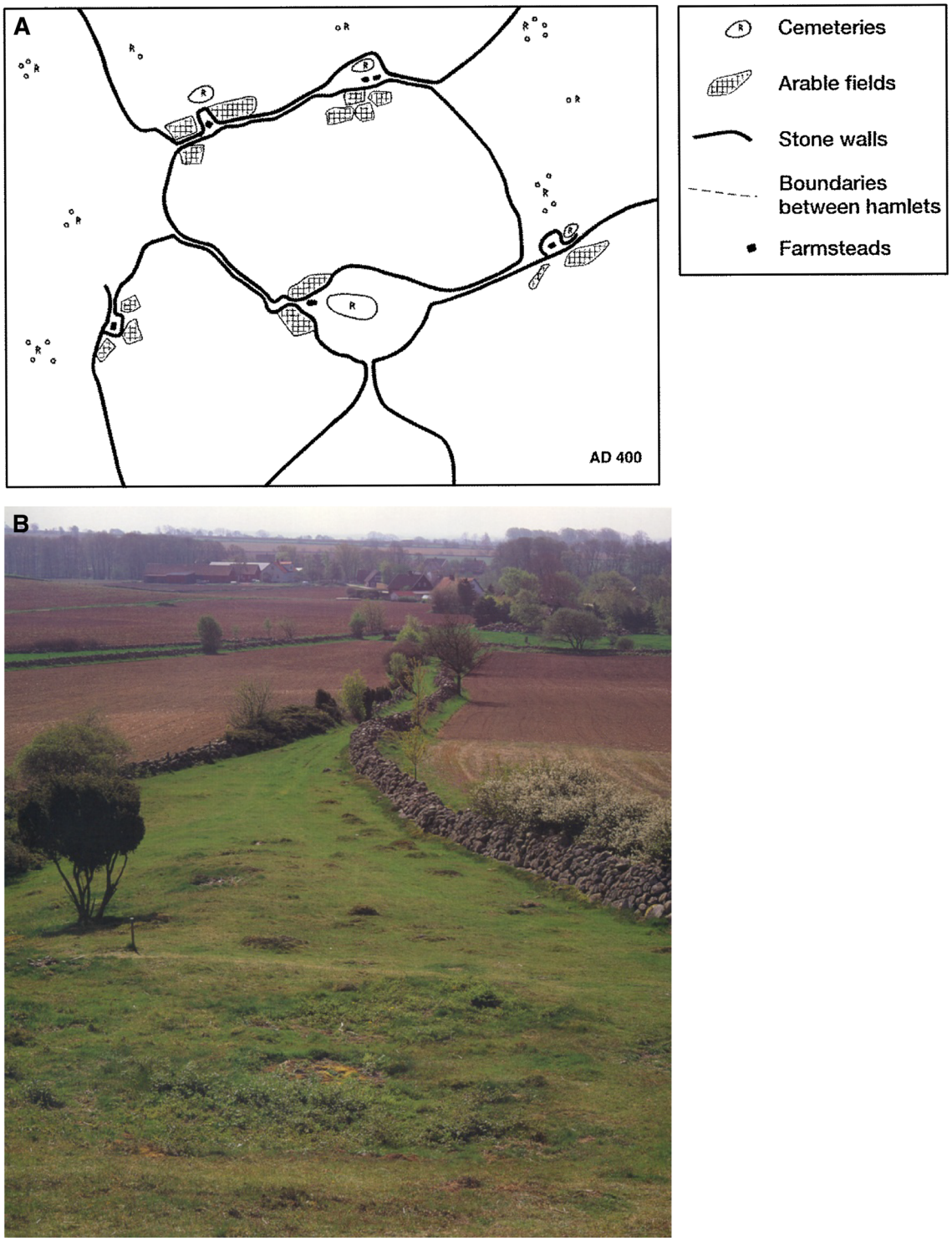


Fig. 5 **a** Archeologically documented farm landscapes from AD 400, with stone walls, arable fields, and cemeteries. Note the narrow cattle paths between outlands and infields. Province of Östergötland, southern Sweden (Widgren 1983, by courtesy of Widgren). **b** Modern cattle path with stone walls linking grazed outlands with the hamlet and the infield area (cropland). Grevie village, Province of Skåne, Sweden. Photo Kenneth Bengtsson (Sporrong et al. 1995, photo by courtesy of Bengtsson)

in the uplands (c. AD 0–500) (Berglund et al. 1991). On the coastal plains, the agricultural expansion 1000–500 BC was probably linked to the establishment of an agricultural system with infields and outlands. Further agricultural expansion started in the Early Middle Ages, approx. AD 1000.

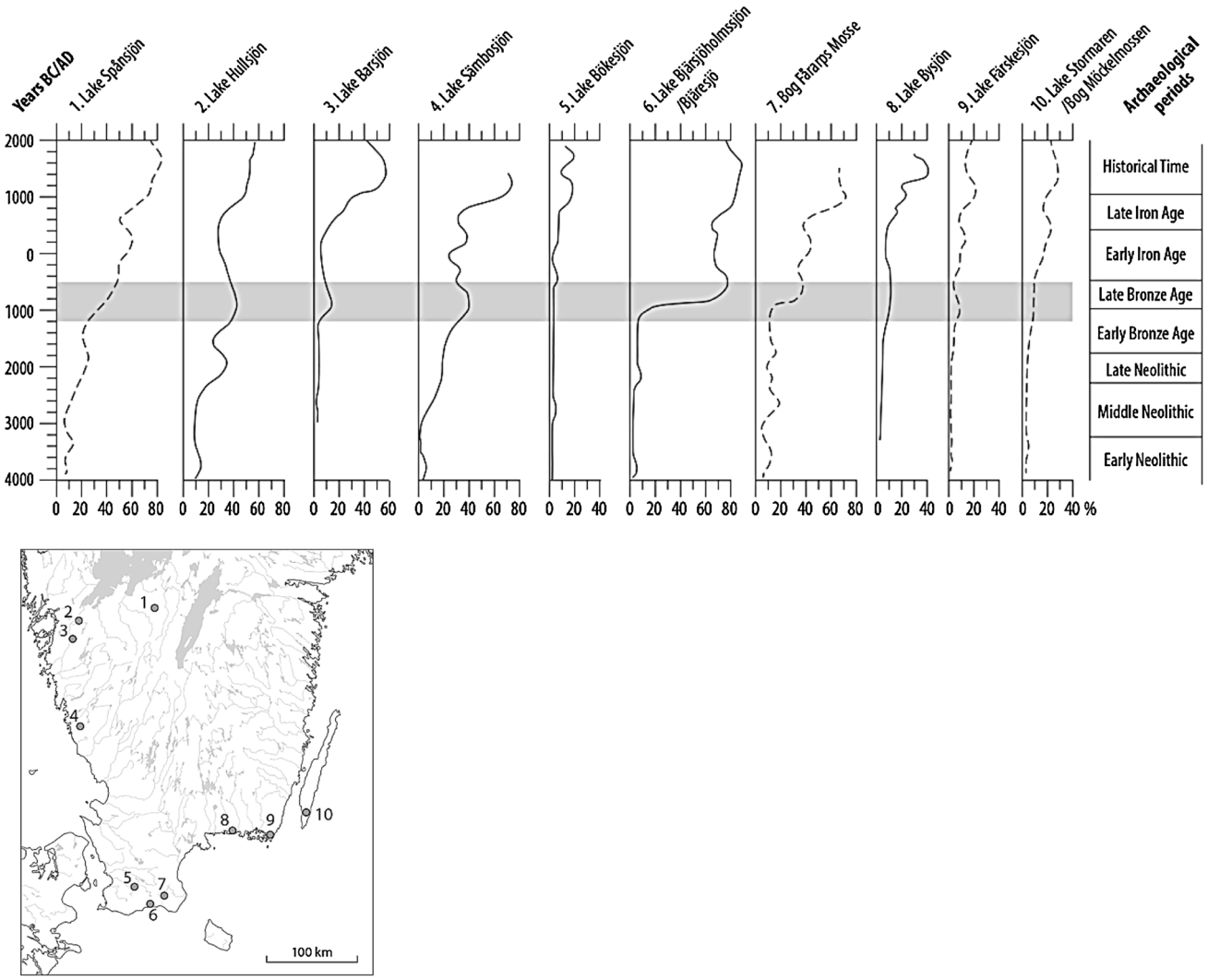


Fig. 6 Agrarian landscape expansion in southern Sweden, illustrated by pollen frequencies of open land indicators (herbs, grasses, dwarf shrubs, and juniper bushes) at 10 sites, plotted on the map. The main expansion dated to 1200–500 BC is indicated. From Berglund et al. (2002b)

From the Middle Ages, AD 1000–1500, the first written documents provide important information on agricultural techniques and practices (e.g., Myrdal 2011, 2012). The historical studies cast light upon the enormous importance of livestock. Animals provided milk, meat, hides, etc., and oxen were important draft animals. Outlands were heavily grazed, and only areas remote from farms and villages remained forested. Even islands along the coast were used for grazing and had the advantage of not needing fences and less herding (Myrdal 2012, pp. 155–198). In northern Scandinavia, cattle, sheep, and goats were brought to high elevation summer farms during the grazing season. This transhumance system has lost its earlier importance but is still practiced in some mountain areas of Sweden and Norway (Olsson et al. 2000; Axelsson Linkowski 2010). In Norway, this system of summer farms has been traced back about 2000 years (Kvamme 1988) and it was expanding during the eighteenth century (Norderhaug et al. 2000). In Sweden, it was introduced far later, probably during the Middle Ages, reaching a peak in the early eighteenth century, after which it reduced to a small number today (Larsson 2013).

From the seventeenth century onwards, Scandinavian countries have had a wealth of detailed maps of individual farms and villages, including descriptions of infields and outlands (Helmfrid 1994). With care, these maps may be used in a retrospective way providing information even on Middle Age field systems and boundaries. Such maps are important even for interpreting the landscape of today, for "reading the landscape."

Several integrated projects between archeologists, paleoecologists, historians, geographers, and ecologists in Sweden have made it possible to reconstruct the landscape development and visualize this on paleogeographical maps

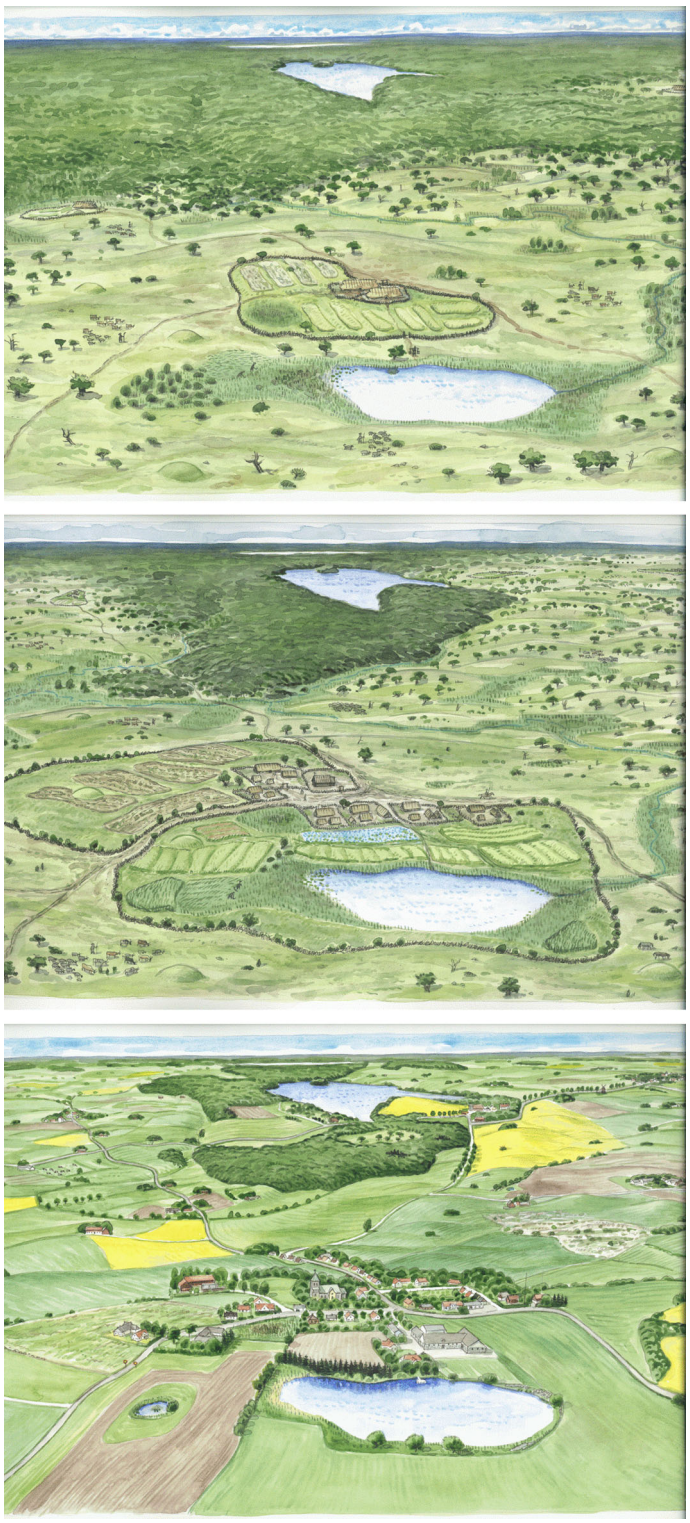


Fig. 7 Landscape reconstructions based on paleoecological studies in southernmost Sweden, nearby the city Ystad—a coastal plain with an upland in the background. *Upper* In Bronze Age ab. 1000 BC, a double farm with fenced infields was surrounded by grazed outlands. *Middle* In Late Iron Age ab. AD 1000, a hamlet had expanded to five farms and a large infield area surrounded by a vast outland pasture, common land for several hamlets, and with woodlands in the remote uplands. *Lower* Today, this hamlet has grown to a small village and the former outlands have been drained and cultivated—ancient woodlands surrounding a large lake are preserved within a big aristocratic estate. Drawings by Nils Forshed (Berglund et al. 1994, paintings by courtesy of Forshed)

(see Berglund 1991; Berglund et al. 2002a). This is illustrated by a sequence from a village situated on the coastal plain in southernmost Sweden (Fig. 7), where the outland pastures became deforested around 1000 BC, leaving only a small upland area as a remnant woodland. Here, the main part of the former outlands was drained and cultivated over the last 300 years (Berglund et al. 1994).

Satoyama Landscape in Japan

Dry-field cultivation or horticultural farming combined with the gathering of wild plants, such as nuts of chestnuts (*C. crenata*) and horse chestnuts (*A. turbinata*), has been recorded from archeological excavations (Kitagawa et al. 2004; Kitagawa and Yasuda 2004, 2008), This occurred as early as the Jomon period, from about 5000 to 1000 BC, and was probably related to mobile settlements in hilly landscapes. Wet-rice cultivation was introduced from the Korean peninsula about 1000 BC and expanded during the Yayoi period, 800 BC–AD 200 (Crawford 1992; Nasu 2003). The wet-rice technology with irrigation, etc., implied permanent farming and settlement (Barnes 2010). This was the pre-requisite for the important population expansion that occurred during this time (Totman 2005). It is reasonable to assume that the Satoyama landscape with efficient land use can be traced back to early Yayoi. These early farm hamlets were concentrated to the plains and river valleys. Parallel to this expansion were hunter gatherer people in the mountains with a basic food of fish, game, herbs, insects like silk worms, etc., as documented in the ancient chronicles (Nunome 1979, 1988; Takatori 1993; Barnes 2010). These people probably ranged in remote forested areas beyond the Satoyama woodlands of valley farmers.

Paleoecological studies are also in Japan a complement to the archeological information. Seeds linked to dry-field cultivation during the Jomon period are documented at several sites. Expanded farming with wet-rice cultivation during the Yayoi period is also evident (Nasu 2003). However, interpretation of upland deforestation based on Japanese pollen diagrams is more complicated than in Europe, where numerous pollen taxa are available as indicators of human impact (Behre 1981; Gaillard 2007). Satoyama woodland gaps are not well recorded by pollen from the ground flora which means that clearings followed by successions have to be traced in the changes in tree composition. In a regional Japanese context, many pollen diagrams demonstrate a rise of pine pollen in the Late Holocene, often dated within the time span 1000 BC to AD 1000, and interpreted as caused by clearings, timber cutting, etc. (Yasuda 1978, 1982; Tsukada 1988; Takahara 1998). Some pollen diagrams indicate an expansion of rice pollen about 1000–500 BC which supports the archeological dating of expanding rice cultivation (Okada 1997; Inada et al. 2004, 2008). Although many pollen diagrams are old and not dated with high precision, there seems to be a time transgression for deforestation and expansion of wet-rice cultivation, from 1000 BC on northern Kyushu northwards to central Honshu around 500 BC to AD 500 (Tsukada 1986).

As an example, we present a synthesis of landscape change based on a paleoecological case study within the Tamba Highlands (Sasaki and Takahara 2011, 2012), Fig. 8. Pollen and charcoal records from Jaga-ike site infer two local fire events which caused a vegetation change from cool-temperate mixed forest composed of Japanese cedar and beech (included in "other deciduous trees") to more open forest composed of pine and light-demanding trees such as hornbeams, chestnut, evergreen trees, and deciduous oaks. A fire event at c. AD 500 might be human induced, but there is no direct evidence of human activity except several archeological sites of Jomon and Yayoi periods located within a 10-km radius. If people lived around the site, fuel wood and timber were possibly harvested. After the fire at c. AD 900, grass (Poaceae) and wormwood pollen increased and occurred continuously. It indicates existence of open grassland around the site. Secondary forest components (pine, deciduous oaks, and light-demanding deciduous trees) also increased. Deciduous oaks have often been maintained as coppiced woodland and used as fuel and for charcoal production. Pine is tolerant to dry and infertile environments and used as fuel wood. Based on historical documents, it can be estimated that there was a paddy field system including woodlands and grasslands around the site at least from fourteenth century, and possibly back to tenth century. Other documents record that this area was a major supply area of charcoal for Kyoto until the mid-twentieth century. On the topographic map published in the early 1900s, a mountain ridge in this area is indicated as grassland. It suggests that the Satoyama landscape including hamlet, paddy field, grassland, and woodlands existed here from Medieval time to mid-twentieth century. Based on pollen assemblages, a similar landscape probably already existed here from 500 BC to AD 500 (Yayoi to Kofun period). However, we have no direct evidence for human activity near the site for this period.

Written sources are available in Japan during the Kofun period AD 250–AD 710 and onwards (Totman 1989) at the time when chieftains and the early state emerged. Forest exploitation with partial deforestation has been documented for the ancient period AD 600–850, early modern 1570–1670, and modern 1900–1959. The main causes were coal production, cutting of firewood, and exploiting timber for buildings. This deforestation affected forested uplands belonging to different kinds of owners—the state, private land owners, etc.—as well as woodlands situated nearby farm villages. The serious

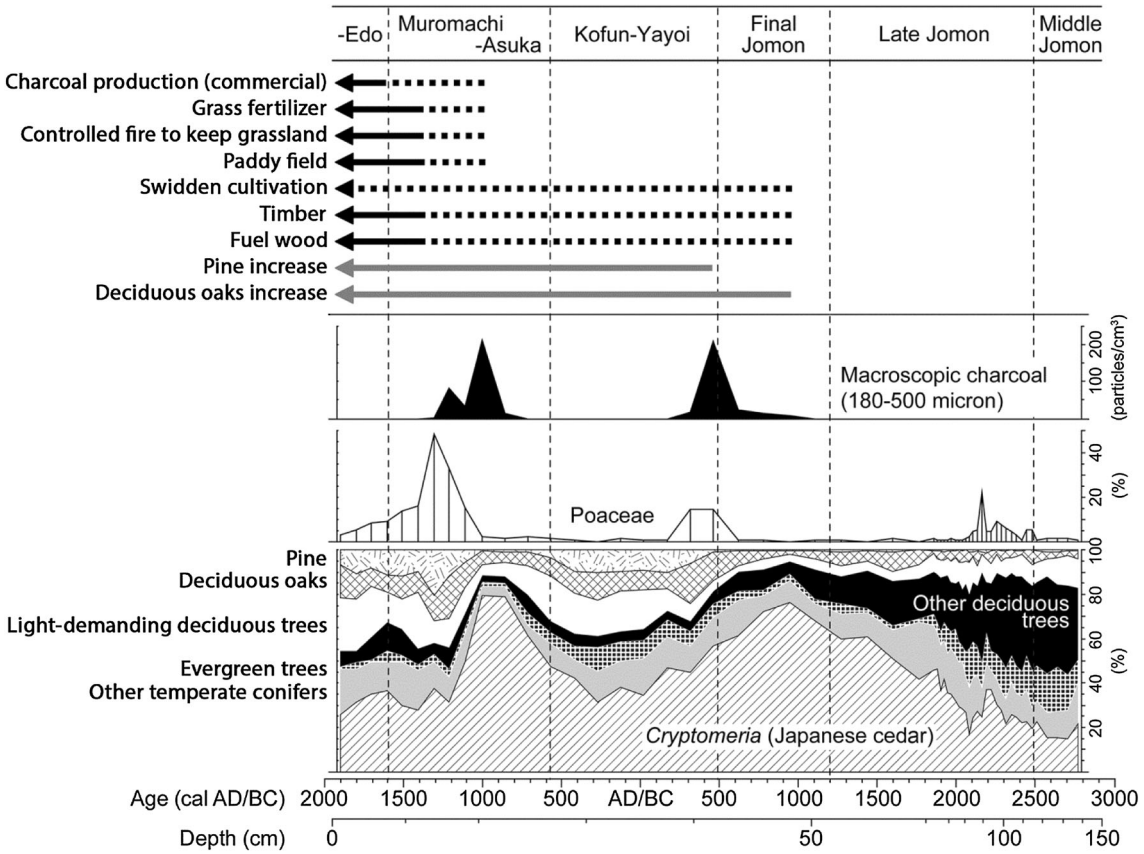


Fig. 8 Synthesis of landscape and land use changes within the Tamba Highlands (c. 35 km NW Kyoto, Kyoto Prefecture) based on paleoecological studies at the mire Jaga-ike (Sasaki and Takahara 2012, scheme compiled by Dr. Sasaki). Pollen percentages are based on a tree pollen sum. *Black solid lines* indicate probable human activity inferred from historical records, and *dashed lines* indicate possible human activity without local historical/archeological evidence. *Gray lines* show important woodland changes inferred from pollen records

situation for the environment was realized already in the seventh century when authorities and landowners emphasized the importance of restricting the general access to forests (Totman 1989, pp. 26–29). A document from AD 821 underlines the importance of water and forests by saying that the "fundamental principle for securing water is found in the combination of rivers and trees" showing the roots for environmental care in Japan. Already, in the ninth century tree planting was promoted. "Regenerative forestry" was introduced around 1600. Forest exhaustion was avoided thanks to strict regulations and large-scale afforestation (Totman 1989, 2005; Yasuda 2001; Diamond 2005). The situation was repeated during the first half of twentieth century. When the traditional use of Satoyama woodland ceased around 1950, they became available for modern forestry (Iwamoto 2002). This led to large-scale plantations, mainly of cedar (*Cryptomeria japonica*) and cypress (*Chamaecyparis obtusa*). Drawings by the landscape artists Hiroshige and Eisen (Izzard 2008) as well as old photos describe quite well the Satoyama landscape from the nineteenth century (Fig. 9).

BIOLOGICAL DIVERSITY CHANGES

Forest clearings and traditional farming gave rise to a mosaic landscape with high biological diversity (Eriksson et al. 2002). By applying rarefaction analysis (Birks and Line 1992; Birks et al. 1988) on pollen data with high resolution (pollen identification, stratigraphic chronology, etc.), it has been shown that plant biodiversity increased in southern Sweden since introduction of farming 6000 years ago (Berglund et al. 1991, 2008). Lindbladh and Bradshaw (1998) and Lindbladh (1999) analyzed short cores from wetlands at two farm hamlets in this region with the aim to compare the vegetation dynamics in infields with outlands. These hamlets were settled around AD 1000 (Early Middle Age). The number of pollen taxa, used as proxy floristic diversity at Råshult, was low and rather stable from 2500 BC to AD 1100 (Fig. 10). At the infield site, the number increased around 1100 and remained high until 1900. This is interpreted as the result of the establishment of farms with fenced infields for crop fields and hay meadows. This traditional farming was abandoned during the last century which has resulted in overgrowing and reduced plant diversity within

Fig. 9 Hamlet with paddy fields in the foreground and Satoyama woodland behind the farm houses—a half-open slope with bushy character and scattered, possibly coppiced, trees at horizon and patches of open grassland to the left. Photo from central Honshu, c. 1900. From "Yokohama Album" in archive "Early Photographs" at International Research Center for Japanese Studies, Kyoto

the infields, also documented in this pollen study. Similar analyses at another hamlet with similar settlement history, Osaby, demonstrate almost identical development of the diversity changes since 2500 BC (Lindbladh 1999).

Studies by Reitalu (2008) on the Baltic Sea island of Öland in Sweden and in the coastal area of Estonia have shown that plant species diversity in semi-natural grasslands (pastures and meadows) increases with grassland age. Pärtel et al. (2007) have shown that plant diversity in grasslands is positively correlated with Late Iron Age (AD 800–1000) settlement. It is well known that areas with abandoned meadows and pastures followed by woodland successions during the last half-century demonstrate a reduced and fragmented biological diversity, floristically from 40–60 to 10–20 species/m^2 (Kull and Zobel 1991; Bernes 1994; Cousins et al. 2007). In contrast to this trend, nature reserves with relict farming landscapes until mid-twentieth century have sometimes been restored through clearings and reintroduction of hay making, resulting in a recovered species-rich flora (e.g., Jonsson 1995).

Within Japan, there are so far no paleoecological long-term records of floristic diversity changes. However, we may assume that early deforestation and farming created a mosaic landscape with high biological diversity, as described by Katoh et al. (2009). Abandoned small-scale farming of plains and valleys together with afforestation and urban expansion has led to a serious deterioration during the last 60 years. One study within the Tokyo metropolitan area, based on a map sequence for the period 1880–2001, clearly shows that a mosaic Satoyama landscape existed with dominant woodlands until 1961 but was then almost totally replaced by urban land use (Ichikawa et al. 2006). Fukamachi et al. (2001) has analyzed the causes behind the changes of the Satoyama landscape since 1900 within the Tango Peninsula at the Japanese Sea, NW Kyoto, and summarized this in a scheme that is representative for large areas of Japan (Fig. 11). The importance of remaining fragments of Satoyama habitats as reservoirs of biological diversity has been emphasized (cf. Koyanagi et al. 2012).

The situation for the Satoyama landscape in modern Japan and the biodiversity threat is described by ecologists, conservation ecologists, landscape architects, rural engineers, and others in a monographic volume, "Satoyama,

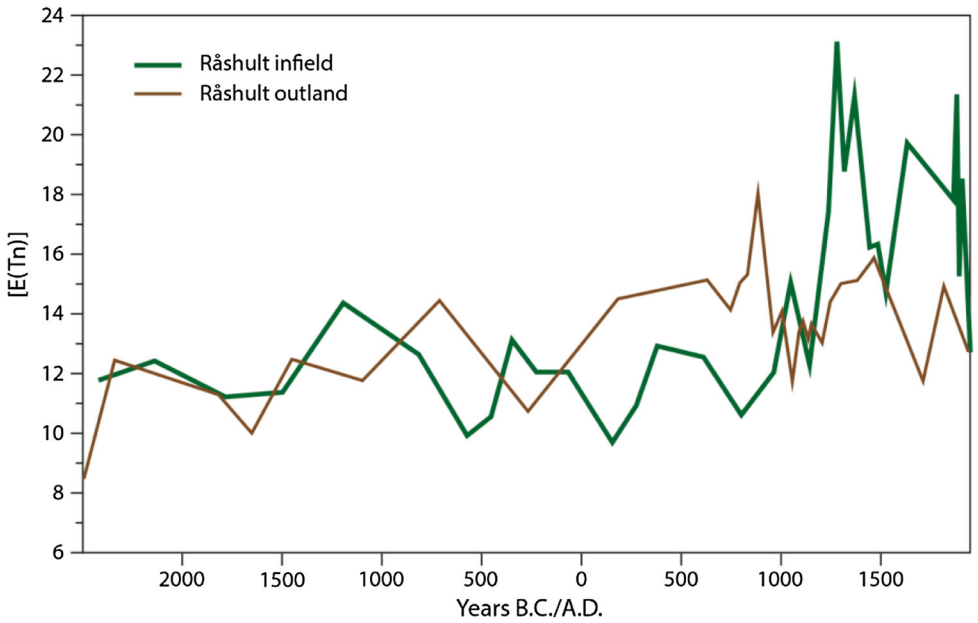


Fig. 10 Palynological richness (proxy plant diversity) based on pollen counts from two peat sequences (time span 2500 BC–present, chronology based on radiocarbon dates), Province of Småland, southern Sweden. The pollen data from Råshult infield indicate a distinct rise of plant diversity c. AD 1100, which corresponds to the establishment of the local hamlet with its infield meadows and arable fields. The outland sequence has continuously low values indicating low plant diversity throughout the time period as expected within more closed woodlands. Revised from Lindbladh and Bradshaw (1998), by courtesy of Lindbladh

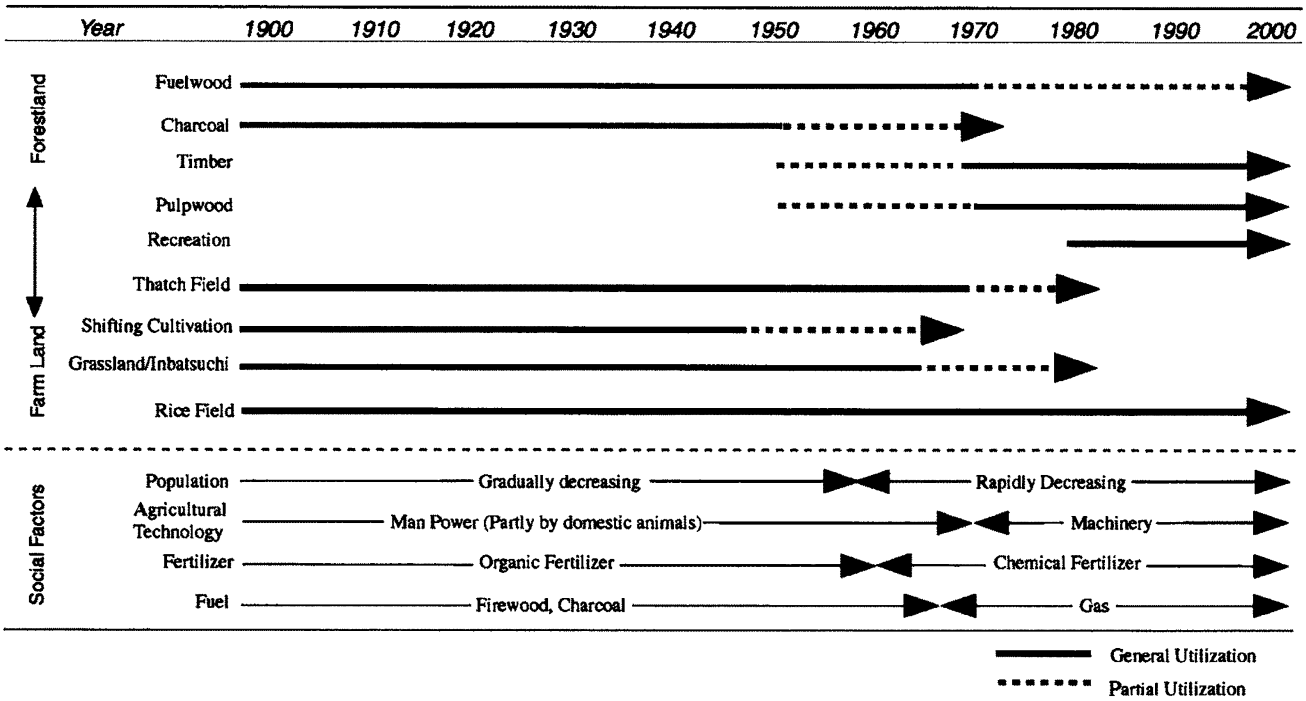


Fig. 11 Scheme of land use and social changes in Kamiseya, a mountainous area of the Tango Peninsula, c. 70 km NW Kyoto. Note the total change of the rural economy, agriculture, and energy system after 1950. From Fukamachi et al. (2001), by courtesy of Fukamachi

The Traditional Rural Landscape of Japan" (Takeuchi et al. 2003): biodiversity as concerns plants and birds, insects and plants, and wetland environments. This volume had a great impact on the restoration efforts in Japan. A rich illustrated textbook about Satoyama ecosystems and their ecological value today has stimulated the interest for

Fig. 12 Local farmers planting rice on terraced paddy fields, where local and urban volunteers work for the conservation practice. Senmaida at the north coast of Noto Peninsula at the Japanese Sea. Photo Per Lagerås, May 2012

Satoyama restoration and ecotourism among common people (Tabata 1997).

RESTORATION AND REVIVAL OF SATOYAMA WOODLANDS

Over the last 30 years, there has been a growing concern about the deterioration of Satoyama due to, firstly, destruction by human activities such as urban development and, secondly, under-management by decreasing and aging population in the local communities of the Satoyama areas. People in Japan have a strong interest in restoration of the Satoyama landscape because of its nature as well as culture values, in modern terminology "ecosystem services." Scientists as well as common people have rediscovered the social and economic importance of Satoyama in Japan's history.

There is a growing interest in preserving and managing Satoyama landscapes as nature reserves or recreational areas, particularly close to cities and villages (Kobori and Primack 2003; Iwata et al. 2011). Citizens have organized associations for voluntary woodland restoration by clearing and coppicing woods, making joint excursions, etc. People are also invited to rent small field lots for cultivating rice, vegetables, etc. (example in Fig. 12). Some nature areas have designed walk paths with instructive posters for school children and other interested parties. A national movement named *Mura-Okoshi*, Village Reactivation, is growing with the aim to integrate rural areas with cities (Iguchi 2002). In Sweden, there is a related interest for the traditional farming landscape reflected in excursions organized by nature organizations, voluntary activities like hay making of traditional meadows, nature schools organized for school children, etc. The medical importance for active recreation in easy accessible nature areas has also been realized. In Japan, this is sometimes named forest therapy (Kuramoto 2003; Takeuchi 2003) and in Sweden practiced as nature and garden rehabilitation (Grahn 1994; Grahn and Stigsdotter 2003).

Ecologists and environmental engineers have also emphasized the value of forest products when coppiced woodlands are restored (Tabata 2001). One research group linked to Tokyo University (Terada et al. 2010) has developed a model for "refueling Satoyama woodlands" by producing carbon neutral energy based on large-scaled, industrial coppicing. A project at Tohoku University (Ikegami and Niitsuma 2006) has studied the traditional energy system in the Tenei mountain valley at Yumoto-Onsen, west of Fukushima, northern Honshu. With this background, they propose the local communities should utilize the wood biomass energy, creating new employment for local people (Ikegami and Niitsuma 2008).

Fig. 13 Concept and characteristics of Satoyama according to Japan Satoyama-Satoumi Assessment (2010). **a** coppice woodland **b** coniferous plantation **c** red pine woods, **d** homestead woodland, **e** bamboo grove, **f** grassland, **g** rice paddy field, **h** field, **i** irrigation channel, **j** irrigation pond, **k** settlements, **l** livestock, **m** wild vegetables and mushrooms, **n** burning of grassland, **o** maintenance of irrigation channel, **p** management of coppice woodland and bamboo grove, **q** management of coniferous plantations, **r** collecting leaves for compost, **s** charcoal burning, **t** shitake mushroom production, **u** shrine, **v** northern goshawk, **w** Japanese salamander, **x** kingfisher, **y** farmers and foresters, **z** hikers. From Japan Satoyama-Satoumi Assessment (2010, Fig. 4), published by courtesy of United Nations University, Tokyo

THE JAPAN SATOYAMA–SATOUMI ASSESSMENT

In Japan, much attention has been drawn to the traditional Satoyama rural landscape because of its destruction and deterioration due to societal changes since the end of World War II. In response to these trends, The Satoyama and Satoumi Assessment (JSSA) was initiated as an international project from 2007 to 2010, led by the Institute of Advanced Studies of United Nations University (UNU-IAS) and the Japanese Ministry of the Environment (Duraippah et al. 2012). It is an assessment of the current state of knowledge—a critical evaluation of information on the interaction between humans and Satoyama-Satoumi landscapes in Japan. More than 200 authors, stakeholders, and reviewers from Japan and abroad were involved. It aims to provide scientifically credible and policy-relevant information on the significance of ecosystem services provided by Satoyama and Satoumi landscapes and their contribution to economic and human development for the use of policymakers. In an international context, JSSA defines Satoyama and Satoumi landscapes as dynamic mosaics of managed socio-ecological systems producing a bundle of ecosystem services for human well-being. Later, it has been named socio-ecological production landscapes (SEPLs) and used as a key concept in the Satoyama Initiative (SI, Takeuchi 2010). The study also identifies plausible alternative futures of those landscapes in the year 2050, taking into account various drivers such as governmental and economic policies, climate change, technology, and socio-behavioral responses. The concept of modern Satoyama is illustrated in Fig. 13.

In line with JSSA, Yumoto and colleagues (Yumoto 2012a) carried out a big project entitled "A New Cultural and Historical Exploration into Human-Nature Relationships in the Japanese Archipelago" from 2003 to 2010. Their project has provided the most comprehensive information on historical changes of Satoyama in Japan published in a Japanese encyclopedia (Yumoto 2012b). Important conclusions and messages have contributed to the report "Japan Satoyama-Satoumi Assessment 2010" for the Convention of Biodiversity (COP10) in Nagoya 2010 and for Duraippah et al. (2012).

THE SATOYAMA INITIATIVE AND ITS GLOBAL APPLICATION

As mentioned above, the SEPLs help to communicate Satoyama outside Japan and have been used by the SI to refer to examples in other parts of the world where landscapes and land use have been shaped and maintained in a broad variety of different ways by harmonious interactions between people and nature. For example, Korea is home to *manuel* landscapes, Spain has *dehesa* landscapes, France has *terroirs*, and Japan has *satoyama*. To recognize the manifold linkage between terrestrial and aquatic ecosystems, SEPLs were replaced by SEPLS, socio-ecological production landscapes and seascapes (SEPLS). It has become clear that these SEPLS and the sustainable practices and knowledge they represent are increasingly threatened in many parts of the world. Commonly recognized causes include urbanization, industrialization, and rapidly shrinking rural populations.

The SI started as a joint collaboration between the Environment of Japan (MOE) and the United Nations University Institution of Advanced Studies (UNU-IAS) with the vision of acknowledging societies in harmony with nature. It aims to build on mutually beneficial human–nature relationships, where the maintenance and development of socio-economic activities, including agriculture, forestry, and fishery, line up with natural processes. SI has taken a global perspective and sought to consolidate expertise from around the world regarding the sustainable use of resources in SEPLS. The concept and elements of activities of SI were clarified by the "Paris Declaration on the Satoyama Initiative" (January of 2010). SI was recognized in the 10th Meeting of the Conference of the Parties to the Committee on Biological Diversity (CBD/COP 10) in Nagoya (2010). The COP endorsed SI recognizing the potential usefulness "to better understand and support human-influenced natural environments for the benefit of biodiversity and human well-being." At CBD/COP10, the International Partnership for the Satoyama Initiative (IPSI) was launched to promote the activities identified by SI. A total of 51 organizations entered into a partnership as founding members of IPSI. The number of the IPSI members increased to 145 at the fourth IPSI Global Conference held in Fukui Prefecture, Japan in September, 2013.

A global initiative relevant to SI is "GIAHS," which was launched by the Food and Agriculture Organization (FAO) of the United Nations in 2002. The overall goal of the initiative is to identify and safeguard GIAHS and their associated landscapes, agricultural biodiversity, and knowledge systems through catalyzing and establishing a long-term support program and enhance global, national, and local benefit derived through sustainable management and enhanced viability. Traditional agriculture systems are still providing food for some two thousand million people today and also sustain biodiversity, livelihoods, practical knowledge, and culture. So far, a total of 25 GIAHS areas have been designated from 11 countries, including Algeria, Chile, China, India, Japan, Mexico, Morocco, Peru, Philippines, and so on. From Japan, "Noto's Satoyama and Satoumi" in Noto Peninsula, Ishikawa Province and "Sado's Satoyama in harmony with Japanese crested ibis" in Sado Island, Niigata Province were designated as GIAHS in 2011, and in addition, 3 other sites from Oita, Kumamoto, and Shizuoka Provinces have been certified in May, 2013. All these sites are categorized as Satoyama with different land use systems, i.e., Noto and Sado are characterized as rice paddy fields, Oita as oak forests and rice paddies with irrigation ponds, Kumamoto as grassland at the foot of the volcano Aso, and Shizuoka as traditional tea plantations. The GIAHS initiative is as important as SI for conservation and sustainable development of SEPLS (for details, see http://www.fao.org/giahs/giahs-home/en/).

CONCLUSIONS

Landscapes formed by small-scale farming since prehistoric time still exist all over the world. We have compared the situation in Scandinavia with Japan. We are using the terms *infield/outland landscape* for Scandinavia and the *Satoyama landscape* for Japan. Based on field and literature studies as well as discussions with colleagues, we conclude the following:

1. Archeological, historical, and paleoecological studies indicate that the land use system with infield/outland landscape in Scandinavia and Satoyama landscape in Japan can be traced back to the time span 1000 BC–AD 500, a period with expanding population, particularly in Japan. Timing varies between regions depending on ecological, social, and demographic conditions.
2. In Scandinavia as well as in Japan, traditional farming occurred until mid-twentieth century. Since then, such rural areas have suffered from depopulation resulting in abandoned fields, meadows, pastures, etc., followed by forest successions and plantations.
3. In Scandinavia, and elsewhere in European uplands, traditional farming was concentrated to fenced infields, and in Japan to non-fenced fields in Satoyama valleys as well as in Satoyama woodlands. Crop production has been different because of climatic and cultural differences—in Scandinavia categorized as cereals-meat-milk-culture, and in Japan as rice-fish-seafood-culture (Yasuda 2002).

4. Forested uplands were extensively used for various forest products, in Scandinavian village outlands as well as in Satoyama woodlands: timber, fuel, charcoal, mushrooms, nuts, berries and other plant products, game, etc. Coppicing of trees was applied in both regions in order to obtain valuable wood and easy accessible fuel. In Japan, litter and grass were collected in the woodlands and used as manure in arable fields.
5. Village outlands in Scandinavia were used as pastures for cattle, sheep, and goats. Overgrazing and tree cutting gave rise to open heaths along the Scandinavian coasts, but normally village outlands were half-open wood pastures. Satoyama woodlands were half-open hill slopes near settlements, or more closed woodlands at higher elevation and more distant places (Okuyama). Pasturing by cattle and sheep did not occur in these uplands.
6. In Scandinavia, winter fodder (hay and leaves) was obtained from infield meadows, whereas in Japan, it came from crops in nearby villages and grasslands within Satoyama woodlands. In both regions, straw from cereals and rice was also important.
7. Both the Scandinavian and the Japanese land use utilized a soil nutrient circulation system based on organic fertilization (compost and dung) and field rotation that was sustainable for sedentary settlements, involving only minor leakage of soil nutrients (Emanuelsson 1988, 2009).
8. Exploitation of timber, particularly for monumental buildings and for charcoal production, caused serious deforestation and erosion of the Satoyama woodlands during expansive periods of Japanese society. This led to an awareness of forest protection already from ninth century. Considering the relatively low population, this was less serious in Scandinavia although the deforestation in Denmark and southern Sweden during the nineteenth century caused a shortage of fuel and building material.
9. Traditional infield/outland landscapes had a mosaic character that favored biological diversity. The situation was the same for the Japanese Satoyama landscapes. Abandonment of this land use during the last half-century has led to forest successions and afforestation followed by decreased diversity. Some species of plants and animals are threatened today.
10. In Scandinavia today, economic forestry dominates over nature restoration, although local communities, nature, and cultural organizations manage small areas of traditional farming environments such as hay meadows and wood pastures. In Japan, the social aspects are more prominent and more supported by the community.
11. In Japan, there is a recent movement to restore the Satoyama landscape, as well as the related coastal landscape Satoumi, by supporting rural people living sustainably outside big cities, taking advantage of local resources from small-scaled farming, forestry, fishing, tourism, etc. This is the background for the Satoyama Initiative in Japan, a concept to be applied worldwide through the program "GIAHS" launched by United Nations.

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