Taiwan J For Sci 41(1): 99-143, 2026
https://doi.org/10.7075/TJFS.202603_41(1).0005

Research paper

Developmental Context and Local Practices of Satoyama

Jyun-Yan Li[1], Shyue-Cherng Liaw[1]

ABSTRACT

The term “Satoyama” is a traditional Japanese word. In 2010, during the 10th Conference of the Parties to the Convention on Biological Diversity (CBD COP10), the Ministry of the Environment of Japan and the United Nations University Institute for the Advanced Study of Sustainability (UNU-IAS) jointly proposed the “Satoyama Initiative” and its international partnership network. This initiative, which received significant attention from experts and scholars at the conference, was recognized as a potential tool for promoting biodiversity conservation. Shortly afterward, Taiwan also introduced the concept of Satoyama. Through the collaboration of government agencies, academia, and civil society organizations, efforts were made to revitalize rural communities, and the principles of the Satoyama Initiative gradually took root in Taiwanese communities, leading to many successful implementations. This literature review qualitatively examines recent developments in Satoyama. In total, 32 recent and significant international publications on Satoyama are analyzed and categorized in terms of four major themes: definition and components, management, applications, and challenges. The primary objective is to clarify the developmental trajectory of Satoyama, identify key findings from recent studies, and explore future trends. The review aims to provide a reference for future Satoyama research and practical implementation in Taiwan, while providing insights for future policy formulation.

Keywords: Satoyama, Landscape, Biodiversity, Ecosystem service

Li JY, Liaw SC. 2026. Developmental Context and Local Practices of Satoyama. Taiwan J For Sci 41(1): 99-143.

[1] 國立臺灣師範大學地理學系，106308臺北市大安區和平東路一段162號 Department of Geography, National Taiwan Normal University. No. 162, Sec. 1, Heping E. Rd., Da’an Dist., Taipei 106308, Taiwan.
通訊作者：廖學誠 Corresponding author: Shyue-Cherng Liaw, Email: liaw@ntnu.edu.tw
2025年3月送審，2025年11月通過。Received March 2025, Accepted November 2025.

INTRODUCTION

In 2010, the Aichi Biodiversity Targets were formally adopted. By 2020, however, some countries had failed to fully achieve the commitments under the Aichi Targets, and the number of commitments had declined markedly across successive stages of the process, from planning and reporting to implementation. Among these, Targets 8 (Pollution), 4 (Production and Consumption), and 18 (Traditional Knowledge) exhibited the lowest levels of effective implementation. Further, owing to marked disparities among countries, some were unable to fulfill their initial commitments, as they received insufficient financial support or had underdeveloped scientific and technological capacity. The limited effectiveness of biodiversity conservation is likely to exacerbate the global biodiversity crisis (Maney et al. 2024). In this context, the unique semi-natural conditions of Satoyama landscapes play a crucial role by enabling local residents to sustainably use the abundant natural resources while also conserving biodiversity, thereby raising broader public awareness of its importance. According to the National Biodiversity Strategy and Action Plan (NBSAP) of Japan, Satoyama has been implemented in 40% of the country's territory. Given the high biodiversity that this approach supports and the dependence of numerous species on anthropogenic habitat mosaics, NBSAP designates the conservation of Satoyama areas as a national priority for Japan (Dunbar and Yanagiya 2024). Other studies have noted that Satoyama has been implemented in approximately 67% of Japan's land area, mostly distributed across hilly, densely forested regions, linking urban areas with remote mountainous zones and integrating diverse environmental types, forming a complex mosaic (Fukamachi, 2017).

Japan's nationwide Satoyama assessment initiative can be traced back to 2007. The Japanese government collaborated with the United Nations University Institute for the Advanced Study of Sustainability (UNU-IAS) to launch the Japan Satoyama Satoumi Assessment (JSSA) (Dunbar and Yanagiya, 2024). This assessment, grounded in the theoretical framework of the United Nations Millennium Ecosystem Assessment published in 2005, recognized that long-standing and close interactions between humans and ecosystems have shaped and sustained Satoyama and Satoumi (Fukamachi 2020). The JSSA analyzed changes in Satoyama and Satoumi ecosystems over the preceding 50 years, along with the diverse driving forces behind these changes, including technology, climate change, socio-behavioral responses, and governmental and economic policies. The assessment also established possible future scenarios for 2050 (Fukamachi 2020). The findings of the JSSA revealed that Satoyama landscapes are not merely predefined models of pristine nature but are rather ecosystems shaped by varying degrees of anthropogenic disturbance. In practice, these landscapes can support higher biodiversity than many low-density land-use types, while simultaneously delivering human well-being in resilient communities. However, over the last decade, rapid industrialization, urbanization, and other threats have eroded traditional landscape management practices, imperiling biodiversity (Dunbar and Yanagiya 2024). The results of the assessment were ultimately released in 2010, followed by the 2012 publication of *Satoyama-Satoumi Ecosystems and Human Well-being: Socio-ecological Production Landscapes of Japan*. This publication provided comprehensive information on the status and trends of Satoyama and Satoumi

landscapes across Japan, establishing a robust scientific foundation for the *Satoyama Initiative* (Fukamachi 2020).

In October 2010, at the Tenth Meeting of the Conference of the Parties to the Convention on Biological Diversity (CBD COP 10) held in Nagoya, Aichi Prefecture, Japan, the Japanese Ministry of the Environment and the UNU-IAS jointly proposed the Satoyama Initiative, commonly referred to as the *Satoyama Initiative*. Formally adopted in Decision X/32, this initiative was recognized as an effective instrument for implementing the Aichi Targets and received considerable attention from scholars (Fukamachi 2017).

Taiwan introduced the Satoyama Initiative approach at the end of 2010, coinciding with the Rural Regeneration Plan, which was actively promoted at the time. The following year, National Dong Hwa University (NDHU) took the lead in applying to join the Initiative, becoming the first official member from Taiwan to join the International Partnership for the Satoyama Initiative. In 2016, the Forestry Bureau of the Council of Agriculture (now restructured as the Forestry and Nature Conservation Agency of the Ministry of Agriculture) established the Taiwan Partnership for the Satoyama Initiative with the assistance of NDHU. This network connects partners dedicated to Satoyama across Taiwan, facilitates the sharing of practical experience, and strengthens professional capacity.

This review of the recent international literature examines Satoyama in terms of four major themes: definition and components, management, applications, and challenges. The primary objectives are to clarify the developmental trajectory of Satoyama, identify key insights from the contemporary literature, and examine potential future developmental trends. The review aims to provide a reference for Satoyama-related research and practical implementation in Taiwan and to offer insights that may inform future policy development.

MATERIALS AND METHODS

To elucidate the recent developmental trajectory of Satoyama, this qualitative review analyzed multiple internationally published works on Satoyama. The steps for literature retrieval and screening are described as follows:

(1) Using “Satoyama” as the keyword, we conducted a literature search between November 4 and November 30, 2024, across multiple international academic electronic databases, including ScienceDirect On-line, MDPI, Taylor & Francis Online, Springer Nature Link, and the International Association for the Study of the Commons.

(2) The sources were initially ranked by their relevance to Satoyama using the built-in sorting function of each database, supplemented by manual eligibility screening to determine the final inclusion. In addition to journal articles, relevant thematic chapters from academic monographs were incorporated.

(3) Publications were further screened by publication year, with the primary selection focusing on studies published between 2020 and 2024. For instance, the unexpected outbreak of the COVID-19 pandemic in January 2020 and its impacts on Satoyama warrant in-depth exploration. Nevertheless, a number of seminal works published prior to this five-year window were retained for analysis, specifically studies by Kohsaka et al. (2013), Iwata et al. (2014), Fukamachi (2017), Kamada

(2018), and Saito et al. (2018). These studies were retained owing to their high citation frequency and foundational importance in Satoyama research.

(4) Although the Satoyama concept originated in Japan, analogous practices and philosophies have also emerged in regions outside Japan. We therefore included various studies conducted outside Japan that focused on Satoyama-like landscapes, to provide an overview of its development in other regions.

Ultimately, 32 English-language publications were selected, constituting the core literature database for this study. Since the concept of Satoyama originated in Japan, incorporating Japanese-language literature would be ideal for capturing the most current developments. However, owing to the authors' language constraints, the publications collected from the international academic databases were primarily in English. This represents a limitation of this study.

From the 32 publications included, the information on Satoyama was extracted and categorized, via an iterative process of reading and comparison, into four thematic categories–definition and components, management, applications, and challenges–to facilitate subsequent collation and analysis. The research workflow is illustrated in Figure 1.

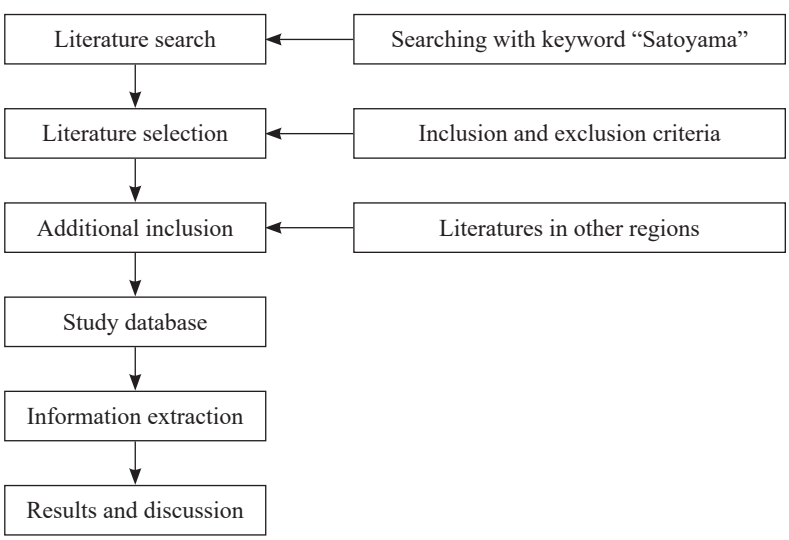

Figure 1. Review process workflow

RESULTS AND DISCUSSION

Definition and composition of Satoyama

The term *Satoyama* (里山) originates from the traditional Japanese word *Satoyama* (さとやま). Etymologically, it is a compound of *sato* (里), representing settlements or villages, and *yama* (山), referring to the surrounding hills and mountains. Geographically, Satoyama refers to the foothill zones between *Okuyama* (奥山) and *Satochi* (里地). Here, *Okuyama* refers to remote, inland mountainous regions that are traditionally regarded as the abodes of local deities, retain their primary forest physiognomy, and are rarely accessed by humans. In contrast, *Satochi* refers to the lowland plains that host human settlements and agricultural activities (Dunbar and

Yanagiya 2024).

In terms of Satoyama residents' perception their environment, the *mura* (village) lies at the core of the landscape, surrounded by *nora* (cultivated fields), which are in turn encircled by *yama* (woodlands), with the *Okuyama* (primitive forest) forming the outermost boundary. This structure forms a multilayered concentric pattern of village–farmland–forest (*mura–nora–yama*), shaping a space in which humans and nature have a symbiotic relationship (Matsumura 2022) (Figure 2).

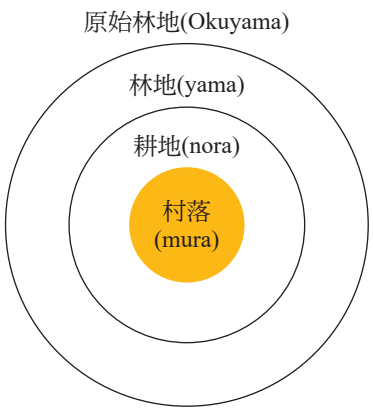

Figure 2. Residents' perception of the Satoyama structure (Adapted from Matsumura 2022).

In Kamiseya, Miyazu Cit (Kyoto Prefecture, Japan), the terraced paddy fields have undergone large-scale abandonment, resulting in the reforestation of some cultivated plots. Nevertheless, several terraced paddy fields surrounding residential areas have been retained and are still cultivated, thus preventing the disappearance of the traditional Satoyama village–farmland–forest land-use pattern (Fukamachi 2017).

According to JSSA records, the term *Satoyama* originally referred exclusively to "mountains surrounding rural villages, human settlements and houses". With the evolution of environments across time and space, an increasing number of studies on Satoyama have produced new findings, gradually expanding the definition of *Satoyama* to encompass a more comprehensive landscape framework. In addition to the original mountainous areas, this expanded definition incorporates human settlements, farmlands, grasslands, inland waters, and other landscape features (Dunbar and Yanagiya 2024). Consequently, a broader definition of *Satoyama* encompasses any "extensive rural environments regularly managed by humans" (Matsumura 2022).

The Satoyama Initiative is dedicated to advancing biodiversity conservation and the sustainable use of natural resources. It achieves this by drawing on exemplary landscape management practices from Japan and other regions of the world and by developing and supporting mutually beneficial relationships between humans and nature (Dunbar and Yanagiya 2024). The case studies by members of the Satoyama Initiative examine regions encompassing the most representative cultural landscapes worldwide. A common feature of the regions examined is the long-term interaction between humans and nature, through which multifunctional landscapes have been shaped over time. While maintaining or enhancing biodiversity, these landscapes also sustain the human well-being of local communities (Torralba et al. 2023). Beyond encouraging participation by national and local governments, the Satoyama Initiative actively welcomes membership applications from communities, indigenous peoples, private companies, academic institutions, and both intergovernmental and non-governmental organizations. After becoming official members, entities are obligated to submit at least one case study demonstrating the application of landscape approaches that balance productive economic development with the conservation of

socio-ecological values, thus sharing their implementation experiences with other members (Torralba et al. 2023).

The Japanese Ministry of the Environment, which has implemented ecological restoration in Satochi–Satoyama areas, defines "Satochi–Satoyama" as "conceptually, an area geographically situated between urban areas and pristine natural regions, whose environment is shaped by the efforts of diverse human activities and characterized by features such as secondary forests surrounding rural villages, as well as farmlands, ponds, and grasslands" (Iwata et al. 2014). In their study on Scenario B for a low-carbon society in Japan, Iwata et al. (2014) point out that Satoyama refers to "secondary forests that have historically supported rural villages by providing firewood, charcoal, and organic fertilizers for each household." Citing various studies, Sarker (2020) describes Satoyama as referring to "Japanese mountain villages composed of terraced paddy fields, secondary forests, irrigation ponds, and human settlements." Hirahara (2020) describes it as follows: "Satoyama originated in rural Japan, and this traditional landscape is composed of various ecosystems such as farmlands, secondary forests, and grasslands, sustaining the livelihoods of local residents. People collect organic fertilizer from grasslands for farming and produce firewood and charcoal in the surrounding forests."

In their questionnaire survey-based study, Nagao et al. (2021) describe Satoyama as "a traditional Japanese agricultural landscape including secondary forests, irrigation channels, rice paddies, pastures, and villages," providing photographs of actual Satoyama landscapes. Piras et al. (2022) describe it as "a traditional Japanese cultural landscape integrating diverse features of forests, rice paddies, grasslands, ponds and channels, with close functional interrelationships among distinct elements," emphasizing that *igune* landscapes and small woodland landscapes included in their study also fall within the scope of Satoyama. Finally, Katsuda et al. (2022) note that "Satoyama is a socio-ecological production landscape composed of secondary forests, farmlands, grasslands, and local communities. Within Satoyama, people have historically relied on natural resources for their livelihoods and inadvertently created favorable habitats for many animals and plants while conducting anthropogenic management activities." Therefore, although there are various different academic interpretations of Satoyama, these are not mutually contradictory. In summary, Satoyama integrates rural livelihoods, ecological conservation, and social culture, constituting a vibrant and inclusive landscape management model.

As a traditional Japanese rural landscape, the Satoyama Initiative describes Satoyama landscapes as socio-ecological production landscapes and seascapes (SEPLS). This concept refers to the landscapes formed by the interwoven features of different ecosystem types, including secondary forests, plantation forests, farmlands, irrigation ponds, wetlands, grasslands, beaches, coastal areas, and human settlements. In a broader sense, such landscapes incorporate both terrestrial Satoyama and marine coastal Satoumi areas (Saito et al. 2020). Under the long-term land-use practices of local residents, diverse ecosystems, such as paddy fields, dry farmland, forests, and ponds, have become interspersed to form a dynamic patch-mosaic landscape. Areas with diversified land use can provide various resources required for human life and agricultural production, including fallen leaves collected from forest floors (for field fertilization), wild plants gathered from

forests (for food preparation), human excreta from households (used as compost fertilizer), and roofing materials from large grasslands (for roof maintenance). Such use of natural resources does not deplete natural capital, but instead promotes biodiversity, and these environments often contain more species than areas with less diversified land-use (Kamada 2018).

Hara et al. (2021) analyzed parcel-level land-use changes over more than 40 years in Minabe Town and Tanabe City (Wakayama Prefecture, Japan), finding that in plum orchards, each parcel of land has a specific function that changed over time. Such management practices, in which land parcel function changes over time, are commonly observed in Japanese Satoyama landscapes. Compared with those in many other countries, the agricultural parcels in these plum orchards are extremely small, with the largest in the study sample area being only 0.23 ha (Hara et al. 2021). In other countries, in contrast, agricultural parcels are often much larger, containing multiple land-cover types such as ponds, forests, and grasslands. This difference implies that governmental land-use regulation needs to adopt different approaches. Hara et al. (2021) concluded that conserving the biodiversity within these parceled dynamic mosaic landscapes requires looking beyond single landscape parcels or individual species.

Kohsaka et al. (2013) have summarized the following four characteristics of Satoyama and Satoumi in Japan:

1. Satoyama landscapes exhibit a mosaic structure formed by interwoven terrestrial and aquatic ecosystems, including forests, plantation forests, grasslands, farmlands, pastures, ponds, and channels, with terrestrial ecosystems comprising the majority.
2. Satoumi refers primarily to the mosaic of marine and terrestrial ecosystems comprising coasts, rocky shores, tidal flats, coral reefs, and seaweed and seagrass beds.
3. The management of Satoyama and Satoumi landscapes requires the integration of traditional knowledge and modern science.
4. Biodiversity is central to the resilience and proper functioning of Satoyama and Satoumi landscapes.

Landscapes exhibiting Satoyama and Satoumi mosaic features are not confined to Japan, but are widely distributed worldwide. Although various functions and structures within these landscapes vary slightly by locality, and their names vary by region, they are conceptually similar (Kohsaka et al. 2013). For instance, In South Korea, traditional village groves, managed by the village's self-organized community, are the common property of the village. These cultural landscapes, known locally as *Maeulsoop* or *Bibosoop*, include well-maintained groves that serve protective functions, often providing flood control and acting as windbreaks. Such groves also have aesthetic value, are used for leisure, recreation, and prayer, and serve as wildlife habitats. During the period of Japanese colonial rule in Korea, however, grove ownership and usage rights were redistributed, reducing the villagers' ability to utilize them, leading to grove degradation (Kweon and Youn 2021).

In West Java Province, Indonesia, an agroforestry system called *Talun-Kebun* (or *Talun-Kebon*) has been developed based on local ecological knowledge. This system involves growing many species of perennial and annual plants in forests that structurally similar to natural forests. This system serves multiple functions for local residents, enabling them to cultivate high-value cash crops and providing temporary job opportunities for economically disadvantaged residents. The

system mitigates hydrological impacts and soil erosion, while providing a natural genetic reservoir owing to its high species diversity. This traditional and sustainable agricultural model is still practiced in parts of the region (Kurniawan and Kurniawan 2022).

A similar agroecosystem approach is found in Wayanad, Kerala, India, a cool upland region within the Western Ghats. Interestingly, the place name Wayanad derives from the local term *Vayal Nadu* (or *Wayal Nadu*), meaning "land of rice fields". The local rice agroecosystem comprises three cultivation zones: lowland paddy fields, farmsteads with nearby mixed woody-crop systems, and upland woody crops. Local farmers rely on ecosystem services such as food production, livestock rearing, and groundwater conservation for their livelihoods. In recent years, efforts have been made to promote the cultivation of traditional rice varieties by farming households (Bhatt et al. 2023).

In Spain, Dehesa represents a multifunctional system for livestock grazing and hunting. In areas practicing this system, more than half of the land is converted to pasture, which is interspersed with scattered acorn-producing trees; the acorns from these trees are used to feed a variety of native livestock, including Merino sheep and Iberian pigs. Dehesa involves agricultural practices complementary to grazing, including the cultivation of cereal crops, as well as forestry practices such as the seasonal utilization of oak trees. In addition, this system contributes uniquely to the cultural heritage of Europe, in that cork-oak bark is harvested every 8–10 years to produce cork stoppers for wine bottles (Ruiz-Labrador et al. 2023).

The Chyulu rangeland in Kenya is characterized primarily by arid and semi-arid landscapes. During the dry season, this land serves as a grazing reserve for wildlife and local agropastoral communities and is home to abundant flora and fauna. The grasslands support livestock, the source of the pastoralists' livelihoods, and the soil supports carbon sequestration. The Maasai people, who live in this harsh environment, practice the traditional Oloopololi management approach of rotational grazing, maintaining seed banks, and conserving biodiversity. They manage rangeland reserves effectively to support for livestock during the dry season, holding collective land ownership. Nonetheless, the land in Chyulu has become degraded owing to overgrazing, poor collective rangeland governance, and the decline of indigenous traditional knowledge. In response, local communities have recognized these problems and are actively intervening to reverse the trend of ecosystem degradation (Nyongesa et al. 2023).

Although the definition of Satoyama has broadened and its constituent elements have become more diverse, Iwata et al. (2014) point out that most Japanese people still regard densely forested areas as the ideal Japanese rural landscape type, Satoyama. This perception is reflected in the results of the public nomination project *Nihon no Sato 100* sen (The Top 100 Japanese Rural Landscapes), organized by the Asahi Shimbun. Among the nominated sites, 38% were classified as forest landscapes, with a forest-cover rate as high as 88% within one square kilometer, and forest-type landscapes ranked first on the nomination list.

Shimpo (2022) reviewed multiple academic articles on Satoyama conservation actions, reporting similar findings. In many of these studies, Satoyama is interpreted primarily as woodland: approximately half of them discuss woodland management, while few examine other components of Satoyama

such as grasslands, farmlands, ponds, and streams. Thus, both the public and researchers tend to associate Satoyama primarily with forests or woodland, although this perception does not fully reflect the broader definition of Satoyama.

As an example, the village of Iba (Higashiomi City, Shiga Prefecture, Japan) is located west of Lake Biwa and adjacent to Ibanaiko Lagoon, and the two waterbodies are connected by the Daido River. The village has low, flat terrain with crisscrossing waterways, and the landscape thus differs, in the public's perception, from the forest-rich Satoyama landscape. Woodland occurs only on Mount Kinugasayama in the southeastern corner, where vegetation such as jolcham oak (*Quercus serrata*), Japanese red pine (*Pinus densiflora*), and bamboo forests grow along the slopes. In contrast, reeds grow densely along the lakeshore, requiring regular burning or cutting, and non-native fish species must be removed from the lake on an ongoing basis (Fukamachi 2020). This case highlights the importance of continued Satoyama environmental education to gradually reduce such misconceptions.

Management of Satoyama

As emphasized in the core vision of the Satoyama Initiative, "realizing a society in harmony with nature", traditional Satoyama management practices have developed through the long-term use of these landscapes by local residents and the regular management of natural resources. Common practices, including collecting, burning, weeding, logging, soil tilling, and pruning, have historically supported the development of forestry and agriculture in Satoyama landscapes (Kamada 2018). Through ongoing interactions between humans and nature, anthropogenic disturbance plays a critical role in such landscapes (Hirahara, 2020). For instance, disturbances caused by regular weeding and branch pruning by residents inadvertently clear habitat space for certain species, forming important habitats and creating biodiversity hotspots. In a study conducted by Katayama et al. (2021) in rice paddy areas of central Japan, the extent of farmland abandonment at the landscape scale was found to determine habitat heterogeneity. Under a moderate abandonment rate, when cultivated land and abandoned farmland are interspersed, habitat heterogeneity increases with the number of abandoned farmlands, and bird occupancy and richness in the rice ecosystem reach their highest levels. However, at high abandonment rates, the landscape is dominated by abandoned farmland, and habitat heterogeneity may decrease, leading to a decline in species diversity. These findings indicate that mosaic landscapes formed by both managed and abandoned rice paddies benefit bird richness, and that appropriate Satoyama management remains necessary.

Iwachido et al. (2020) conducted a survey in Yokohama City and Kamakura City (Kanagawa Prefecture, Japan), comparing the diversity and species composition of plant and butterfly communities in parkland and agricultural land. Although these land-use types differed in native plant species composition, they did not differ significantly in native plant or butterfly species richness or diversity. Iwachido et al. (2020) reported that park management practices that emulate traditional agroforestry practices were implemented to maintain biodiversity; such measures included periodic interventions to prevent tree toppling and control succession from grassland to forestland. In contrast, lower diversity of both plant and butterfly communities was observed for land abandoned

for at least three years, where tall and highly competitive dominant plants species had become dominant. Their findings reveal that nature-oriented park use, retaining the original site landscape, topography, artificial waterscape, and vegetation, is a feasible alternative to maintain the rich biodiversity of the Satoyama ecosystem (Iwachido et al. 2020).

Residents can sustainably benefit from the various ecosystem services provided by Satoyama. Table 1 lists the many ecosystem services provided by Satoyama, in four key categories: providing resources for humans, regulating natural processes, providing cultural benefits, and supporting ecosystem processes. When examining public perceptions and values regarding landscapes, intangible assets, such as cultural ecosystem services, are important but easily overlooked. Katsuda et al. (2022) conducted a questionnaire survey of local residents, tourists, and high school students in Tsukuba City (Ibaraki Prefecture, Japan) to examine public perceptions of wild cherry blossoms and the social values associated with their ecosystem services. The perceived value of the ecosystem services provided by wild cherry blossoms varied considerably among these socio-cultural groups. Unlike local residents and tourists, high school students exhibited little interest in Satoyama's diverse cultural values in terms of aesthetics, recreation, and history, based on their evaluations of aesthetic values, knowledge of cherry blossom varieties, and the spatial distribution of the landscapes that they perceived as valuable. Using the landscape-value method, Kovács et al. (2022) examined visitors' perceived value of cultural ecosystem services in a peri-urban Satoyama forest known as "Kaisho no Mori" in Seto City (Aichi Prefecture). As with Katsuda et al. (2022), Kovács et al. (2022) found that forest-use patterns were significantly related to socio-demographic attributes. Visitors aged over 60 constituted the majority, with notably few solo female visitors; most of the female visitors were married women and were with their families. Most of the respondents perceived the Satoyama forest as possessing both natural and aesthetic values; based on a photo-evaluation survey, they assigned diverse values, including recreational, spiritual, educational, therapeutic, and cultural-historical, to this Satoyama forest.

Under local resource-sharing traditions, the mosaic structure of Satoyama landscapes is dynamically maintained through regular harvesting of natural resources. The different regional norms in resource-sharing, suited to the local conditions, help to avoid the "tragedy of the commons" (Kamada 2018). In the Fujiwara area of Minakami Town (Gunma Prefecture, Japan), the Uenohara landscape, located approximately 1100 m above sea level, is dominated by grasslands and *Quercus crispula* forests. The local community has established various institutions to manage the common resources and prevent their abuse. First, within the Uenohara landscape, the land with available resources is roughly equally allocated among groups of households known as *Kumi*, which function as labor-sharing units. Second, the leader of each *Kumi* determines when resource use is permitted. Those who violate the rules will be excluded from the benefits of the next season's cooperative labor activities (Hirahara 2020), and residents are strongly opposed to the disruption of community order by outsiders. For individuals, frequently relocation between such groups creates significant inconvenience; this disincentive has historically served as an informal mechanism for maintaining social order (Hirahara 2020).

Drawing on contemporary experience

Table 1. Ecosystem services provided by Satoyama landscapes.

Ecosystem Services	Items	References
Providing resources for humans	Abundant and high-quality water resources for agriculture	Fukamachi 2017
	Non-market food sources	Saito et al. 2018
	Reeds along the lagoon used for making sunshades	Fukamachi 2020
	Stone used as building materials for vegetable garden walls and terraced field embankments	
	"Kaya," which refers to grasses used for thatching roofs	Hirahara 2020
	"Kacchiki" and "Kapposhi," which refer to organic fertilizers for farming	
	"Igune" landscape, which provides ingredients for traditional medicine	Piras et al. 2022
Providing cultural benefits	Food-sharing culture	Saito et al. 2018
	Parks provide aesthetic and recreational value for urban residents	Iwachido et al. 2020
	Restorative and healing effects	Nagao 2021
	Food production education	Sehra and MacMillan 2021
	Maintaining and improving the physical and mental health of the elderly	Shimpo 2022
	Traditional Satoyama landscapes generally hold aesthetic, recreational, and historical value	Katsuda 2022
	Wild cherry blossoms draw people's attention to the environment	
	Viewing landscapes enhances aesthetic, natural, and spiritual values	Kovács et al. 2022
	Small shrines are considered to have cultural, historical, and religious value	
	Rice fields are attributed with productive, cultural–historical, natural, and educational value	
Regulating natural processes	Regulating water resources through the traditional "yugakari" system	Fukamachi 2017
	Controlling harmful insects in park grasslands	Iwachido et al. 2020
	"Noyaki," controlled burning to protect grasslands from shrub encroachment	Hirahara 2020
	Maintaining forests around plum orchards to protect watersheds and prevent slope collapse	Hara et al. 2021
	Allowing wild boar hunting to control population size	Sehra and MacMillan 2021
	Letting floodwaters inundate parts of rice fields	Katayama et al. 2021
	"Igune" landscape serve as a windbreak, preserving a stable growth environment for crops	Piras et al. 2022
Supporting ecosystem processes	Parks serve as habitats for native vascular plants and butterflies	Iwachido et al. 2020
	Thickets provide nesting spaces for Japanese honeybees, which pollinate plum trees	Hara et al. 2021
	In plum orchards, the growth of grass contributes to nutrient cycling	

with the resource utilization and management of Japanese rice terraces, Sarker (2020) classified rice-terrace commons that have been affected by recent population declines as a quasi-public economic resource. Sarker (2020) argues that the polycentric approach of Elinor Ostrom, which involves local, regional, and national stakeholders, can address the problem of insufficient production in depopulated commons. This approach allows local urban residents to purchase annual-usage rights for these rice terraces. However, despite the economic losses associated with high production costs, urban residents still produce rice in these rice terraces, which continue to provide ecosystem services that protect the landscape (Sarker 2020).

The Satoyama agricultural model has been widely recognized by the United Nations Food and Agriculture Organization (FAO), and many Satoyama landscapes in Japan have been added to the Globally Important Agricultural Heritage Systems (GIAHS) list. GIAHS is an international conservation initiative that actively promotes the national and international recognition of agricultural heritage systems to raise public awareness. Its guiding principles encompass the concept of SEPLS of the Satoyama Initiative (Saito et al. 2020). In 2011, the Satoyama and Satoumi landscapes of the Noto Peninsula, Japan, were added to GIAHS. The Noto Peninsula is characterized by continuous mountain and hill landscapes in which the agricultural land has been well maintained under traditional management practices, with terraced fields nestled between mountains and the sea. The peninsula, which is surrounded by the sea on three sides, boasts abundant marine resources, especially shellfish, and local residents have developed unique foods and a distinctive local culture based on these resources. Along with Sado Island in Sado City, Niigata Prefecture, these landscapes were the first sites in Japan to be added to GIAHS (Kamiyama 2020). In the Minabe–Tanabe Ume System in Wakayama Prefecture, the landscape primarily exhibits plum orchards, which are surrounded by coppice forests, hedgerows, bamboo, and other vegetation types. Hedgerows are planted in each plot to resist the strong winds, and local residents use the bamboo to make essential items for daily use. The vegetation in the Ume agroecosystem serves provides nectar, and the pollinating Japanese honeybee *(Apis cerana japonica*) inhabits the coppice forests. To improve plum production efficiency, some orchards are now located on flattened areas, recently developed through large-scale land excavation and filling. However, the traditional hillside plum orchards, which exhibit a dynamic landscape mosaic, host more native species and exhibit higher plant diversity (Hara et al. 2021).

The water resource management system of the traditional sustainable rice-paddy agricultural system in Osaki City (Miyagi Prefecture, Japan) has given rise to the traditional practice of "*igune*" landscape cultivation. "*Igune*"" plots are cultivated primarily on the northwest side of farmhouses and small cultivated plots, while low shrubs are planted on the south side of farmhouses to protect non-aquatic crops from damage by northern winds, while also allowing direct sunlight to reach the farmhouses and small vegetable gardens. Based on spatial analysis of "*Igune*" landscapes from 2002 to 2021, their number, size, and spatial pattern have hardly changed over this period. The concept of "*Igune*" embodies the identity of intangible cultural heritage, sustaining traditional forest-related knowledge and local identity (Piras et al. 2022). The three Japanese landscape types that have been added to GIAHS highlight the fact that "the rich and diverse agricultural

biodiversity is closely related to wild fauna and flora and contains precious indigenous knowledge and cultural resources." Notably, indigenous knowledge does not refer exclusively to knowledge from indigenous people, but includes all wisdom derived from long-term interactions between local residents and the environment. Many farmers also "rely on the various goods and services provided by agricultural heritage systems to obtain food and livelihood security" (Fukamachi 2017).

In contemporary society, Satoyama is no longer solely a rural concern. Urban-rural interactions have become increasingly dynamic, and a growing number of urban residents are willing to participate in Satoyama activities. For instance, willingness-to-pay systems, which reconnect urban residents far from Satoyama landscapes with farmers in these areas, can inject new vitality into Satoyama landscape management. Nagao et al. (2021) found that willingness-to-pay varies with respondents' perceptions of nature. Respondents who conceptualized nature in terms of Satoyama or natural forest expressed greater willingness, whereas those who conceptualized it as urban nature, suburban nature, or plantation forest expressed lower willingness. The greater willingness of the former group was due mainly to their greater concern for the environment. Those who conceptualized the landscape as Satoyama reported a greater sense of restoration from visiting these environments, while they did not experience this from visiting artificial natural environments. Satoyama landscapes provide the largest restorative effects, which are believed to originate from a sense of security and nostalgia for traditional Japanese agricultural landscapes (Nagao et al. 2021).

Sehra and MacMillan (2021) employed a combination of research methods, including choice experiments, semi-structured interviews, and field surveys, finding that consumers were willing to pay a higher price for rice produced in Satoyama landscapes (747 JPY more than for rice cultivated in non-Satoyama landscapes). Higher willingness-to-pay generates additional income for farmers, helping to support the management of Japan's extensive and fertile paddy fields and to maintain agricultural biodiversity and other environmental benefits at the landscape scale. The Satoyama revitalization policies implemented in Kamiseya, Miyazu City (Kyoto Prefecture) in the 1990s provide a further example. The Kyoto Prefecture and Miyazu City provided some financial support, and local private companies that recognized the value of Kamiseya's Satoyama landscapes provided funding to non-profit organizations, sparking new civic initiatives. Large areas of traditional terraced paddy landscape in the surrounding mountains were restored and preserved through this support. Although the total funding received for Satoyama revitalization was limited, it provided the driving force behind the initiation of Satoyama conservation in the area (Fukamachi 2017).

Applications of Satoyama

Many of the Japanese Satoyama landscapes discussed here are located in remote rural areas. However, it is also important to consider Satoyama activities conducted in peri-urban areas or urban green spaces. Depending on their proximity and accessibility, urban residents may be able to engage more closely with Satoyama landscapes, thus contributing to conserving these landscapes (Xiang et al. 2022). In the productive urban landscapes of the peri-urban areas of Tokyo, residents can participate in many different activities in the Satoyama woodlands, including branch thinning and pruning, weeding understory

shrubs, cultivating vegetables in abandoned fields, and making handicrafts using mountain and forest resources (Hino et al. 2023). Hino et al. (2023) studied the contributions of these activities to physical activity in 80 participants of similar ages, about half of whom were women. The participants spent more time (up to 4.4 hours) on woodland-related activities than on the other activity types, with woodland-related activities producing higher metabolic equivalent expenditure (Hino et al. 2023). Although elderly visitors to Satoyama woodlands exhibit relatively low metabolic energy equivalent expenditure rates, long-term low-intensity physical activity helps to promote health and well-being among the elderly. The total caloric expenditure of elderly people using Satoyama woodlands contributes about one-third of their national weekly recommended caloric expenditure. Satoyama woodland activities also provide elderly people with regular opportunities for social interaction with other participants (Hino et al. 2023). Further, urban residents with intellectual disabilities can also enjoy the health benefits of participating in Satoyama woodland management activities. From a social empowerment perspective, such activities enable people with disabilities to acquire vocational skills and engage in the production of vegetables and fruits (Shimpo 2022).

In urbanized landscapes, managing nature-oriented parks to emulate Satoyama systems can help to balance agricultural land-use and the need to respond to the accelerated abandonment of Satoyama landscapes (Iwachido et al. 2020). Such parks contribute to biodiversity conservation, help to maintain aesthetic landscape features, and provide cultural services in terms of their aesthetic and recreational value. Although the importance of Satoyama landscapes for maintaining biodiversity has consistently been emphasized, Shimpo (2022) found that urban residents were not aware of the direct benefits of participating in Satoyama-based activities. The motivation for engaging in Satoyama conservation extends beyond nature conservation, as it directly promotes health benefits, social cohesion, and recreation, while supporting resource utilization. Emphasizing the recognized short-term benefits of participating in Satoyama conservation will help to motivate more residents to participate (Shimpo 2022).

The integrated Satoyama landscape conservation system implemented in Niiharu (Yokohama City, Kanagawa Prefecture) is widely recognized as a successful model. The area originally exhibited a large expanse of neglected forests and farmland. In the early 2000s, the Niiharu Citizen Forest Conservation Association and the Niiharu Citizen Forest were established successively. The municipal government supported and facilitated this process and managed communications, successfully integrating public and private land in the region. Today, this citizen participation model brings together multiple stakeholders, including the original landowners, citizens interested in Satoyama conservation, and civic groups. Participant activities are run from the Niiharu Satoyama Exchange Center, which located in a renovated old house. In the next stage, a low-cost, open, and transparent decision-making process will be implemented to further improve Satoyama management (Matsumura 2022).

During the COVID-19 pandemic, the high transmissibility of the virus prompted governments worldwide, including that of Japan, to impose lockdown measures to prevent its rapid spread. Members of the public experienced physical and mental exhaustion

due to pandemic control measures. Even young people, generally regarded as the healthiest age-group, suffered from pandemic-related stress, developing mental health problems such as anxiety, depression, and fear. In a survey comparing participation in household food production and food-sharing systems before and after the COVID-19 pandemic, Kamiyama et al. (2023) identified voluntary self-isolation as a turning point. The pandemic prompted men, young people, and urban residents, who were previously less engaged, to participate in household food production and food-sharing activities, helping to reestablish the vitality of home gardens. The future development of local agriculture and food systems in Japan depends closely on whether residents can maintain these household consumption habits in the post-pandemic era.

Shortly after the pandemic, Xiang et al. (2022) examined the psychophysiological effects of routine Satoyama activities in small-scale urban green spaces in a mountainous forested part of Matsudo City (Chiba Prefecture, Japan). This revealed that such activities achieved significant benefits for both elderly and young people. In elderly people, both systolic and diastolic blood pressure were significantly lower after Satoyama activities, particularly among individuals with hypertension; further, indicators of negative emotions were reduced, indicating positive health outcomes (Xiang et al. 2022). For younger participants, blood pressure remained within the normal range before and after Satoyama activities, and while their psychological indicators improved, the magnitude of this improvement was smaller for elderly people. These findings suggest that encouraging urban youth to participate more actively in Satoyama activities may help to improve their mental well-being and alleviate pandemic-related stress (Xiang et al. 2022). The COVID-19 pandemic transformed urban life. To address societal vulnerabilities, ecologically oriented urban activities, including those involving Satoyama, should urgently be promoted and adapted to local conditions (Shimpo 2022). In this sense, the pandemic has created new opportunities for the development of Satoyama activities, which can provide stress relief for urban residents experiencing long-term distress.

SEPLS, of which Satoyama landscapes are an example, provide communities with abundant food resources, allowing residents to access agricultural products without direct monetary exchange. Via a nationwide online questionnaire survey, Saito et al. (2018) quantified the contribution of SEPL-based food-sharing services to daily life in Japan, in terms of food quantity and variety, comparing landscape types: in mountainous, semi-mountainous, and flatland agricultural areas, 16% of the total food supply came from non-market sources, whereas in urbanized areas only 10% came from such sources. On average, non-market sources supplied 32–34 different types of food, with no significant differences among agricultural landscape types, including urbanized areas with limited farmland. Vegetables were the most common items supplied by non-market sources. The areas of farmland and forest were significantly positively correlated with the quantity of most of the non-market food items, but not with the range of food types available. As land development increased, the supply of food from non-market sources tended to decline (Saito et al. 2018).

In addition to nationwide surveys, local-scale studies are useful to provide detailed insights. Based on a survey, people living in Satoyama-based rural villages and Satoumi-based fishing villages on the Noto Peninsula obtained far more food from their semi-

urban from home gardens, wild harvesting from forests and marine environments, and food-sharing services than those in semi-urban communities, in terms of both quantity and variety. They were thus able to maintain their nutritional intake while reducing their household expenses. In Satoumi-based fishing villages, households saved 119,881 JPY annually, the highest among these three socio-geographical communities (Kamiyama 2020). Although these three community types did not differ in numbers of food-sharing partners, semi-urban communities obtained the largest proportion of their food (42%) through sharing. This is largely explained by the geographic dispersion of sharing partners in semi-urban communities. Unlike in farming and fishing villages, where sharing occurs within the community, sharing in semi-urban communities relies on long-distance cross-community social networks, likely formed by residents who have previously lived in rural villages and continue to maintain ties with relatives and friends after relocating.

To further explore recent changes in household consumption patterns in Japan, Kamiyama et al. (2023) conducted a quantitative analysis of data from questionnaire surveys before and after the COVID-19 pandemic. Overall, total household food production increased after the pandemic, whereas the total volume of food sharing declined, likely owing to pandemic control measures that restricted interpersonal interactions. Nevertheless, most of the respondents reported that the pandemic did not substantially affect their household food production and sharing practices, implying that the existing household consumption systems are resilient. Direct access to ecosystem services and the culture of food-sharing in the Satoyama and Satoumi systems both contribute to strengthening resilience toward future socio-economic changes and natural disasters. This aligns with the principle of "improved community resilience" emphasized in the six ecological and socio-economic perspectives of the Satoyama Initiative, generating multiple benefits across ecological, social, cultural, and economic dimensions, particularly through ecosystem-based climate change mitigation and adaptation strategies.

The energy crisis exposed by the Great East Japan Earthquake on March 11, 2011, is relevant in terms of resilience. The accident at the Fukushima Daiichi Nuclear Power Plant forced the authorities to urgently address energy-security challenges. In this context, the use of Satoyama woodlands as an energy source to achieve regional energy self-sufficiency has emerged as a potential strategy (Matsumura 2022). The Geihoku area of Kitahiroshima Town (Yamagata District, Hiroshima Prefecture, Japan) has experienced a severe population decline, and few residents are willing to participate in restoring Satoyama landscapes. In response, a local non-profit organization was established; this organization collaborated with stakeholders to promote a recycling-oriented society, make flexible utilization of Satoyama forest resources, and achieve household energy self-sufficiency (Kamada 2018).

Terada (2020) evaluated the potential benefits of wood biomass reserves as emergency energy sources in Oaota no Mori, Kashiwa City (Chiba Prefecture). Their study simulated a scenario in which an emergency, such as a major earthquake in Tokyo, interrupts the power supply system, with insufficient regional reserve energy. In this simulated scenario, the improved suburban Satoyama woodlands were able to supply firewood to many nearby users and support the basic livelihoods of local residents. Given

that the use of biomass to obtain energy is not widespread in Japan, urban residents should be encouraged to consistently use biomass in everyday life and to maintain emergency reserves. Progress toward a resilient society requires supportive policies and legal frameworks. Fukamachi (2020) examined the trends and mechanisms of natural resource use in Iba (Higashiomi City) and Yahata (Otsu City) in Shiga Prefecture, explaining how national and prefectural policies are applied to two distinctly different Satoyama landscapes. Establishing Satoyama ecosystems as resilient socio-ecological systems requires a well-integrated regional policy framework, facilitating horizontal collaboration among autonomous smallholder farmers, as well as efforts to explore new values of Satoyama under challenging natural environments. As illustrated in the case of Yahata, farmers tend to make individual decisions based on their own circumstances, and in the absence of a comprehensive legal framework, many Satoyama-related civic activities are implemented on a case-by-case basis. Strengthening institutional coordination could enable these active local initiatives not only to enhance sustainable management of natural resources but also to improve disaster resilience (Fukamachi 2020). This also echoes the principle of "cyclic use of natural resources" within the six ecological and socio-economic perspectives of the Satoyama Initiative, which aim to improve regional resource utilization in normal times to avoid shortages during crises.

Challenges of Satoyama

In recent years, Japan has faced four major biodiversity crises, which have been formally recognized in the *Japan Biodiversity Outlook* and *NBSAP*. The first originated from resource overexploitation and water pollution. Although the impact of this crisis was far-reaching, it has somewhat diminished with the decline in development and slower economic growth. The second is the reduced use and insufficient management of SEPLS, and its impact has become increasingly severe with the sharp population declines and population ageing in rural Japan. The third refers to the human introduction of invasive alien species and chemical substances, and the fourth to climate change. Alarmingly, climate change amplifies the effects of the other three, highlighting the need to pay close attention to particularly vulnerable ecosystems (Saito et al. 2020).

Since the late 1950s, resource use has shifted from firewood and charcoal to fossil fuels. The fossil fuel revolution brought a series of challenges and crises to the development of Satoyama landscapes (Matsumura 2022). Japan relied increasingly on imported energy sources, including petroleum, natural gas, and electricity, which rapidly met the demands of daily life and facilitated the transition to modern lifestyles. This resulted in the rapid abandonment of the abundant natural resources of Satoyama landscapes (Kamada 2018). This is illustrated by the underutilization of natural resources that occurred in the Fujiwara area of Minakami Town (Gunma Prefecture). Around the 1950s, residents in the Fujiwara area abandoned the custom of replacing thatched roofs, because the replacement process was laborious and time-consuming. Coupled with external factors of modernization, traditional resource-use practices such as *Kayakari* and *Noyaki* gradually declined. The construction of four dams provided local residents with paid job opportunities, causing them to abandon their previous livelihoods. The opening of railways and highways brought a continuous stream of

tourists, and the grasslands that had once been surrounded by forests were subsequently converted into resorts. With the booming tourism industry, most of the residents chose to work in the accommodation and catering industries (Hirahara 2020), and the practice of obtaining fertilizers, fodder, and other necessities from the fields has since become rare. The grasslands have gradually been abandoned, and invasions of alien species were documented in 2000 (Hirahara 2020).

A similar trajectory was observed in Kosuge Village in Kitatsuru District, Yamanashi Prefecture, Japan. In this remote mountain village, 95% of the area was originally covered by secondary forests and artificial coniferous forests. However, after the widespread adoption of liquefied gas, consumption of firewood and charcoal decreased significantly, leading to the abandonment of pine and oak coppice forests in the early 1970s (Imai et al. 2023). In contrast, Piras et al. (2022) conducted a multi-temporal spatial analysis of data for a 20-year period; this revealed that while the Satoyama landscape shrank by 50.5 ha, owing to the loss of igune landscapes and other small woodlands, 34.3 ha of new Satoyama landscape were added, mostly due to agricultural abandonment and secondary succession, thereby sustaining it.

In Japan, the primary challenge facing Satoyama is the impact of urbanization. As rural populations are increasingly drawn to urban areas, human disturbance of the natural environment declines. This in turn threatens the development of Satoyama landscapes, which require regular human management to support biodiversity and to provide benefits for humans (Dunbar and Yanagiya 2024).

After World War II, Japan's reconstruction and rapid economic growth drove a steady surge in demand for construction timber (Kamada 2018). Since 1950, forest policies in Japan have promoted the large-scale planting of Japanese cedar (*Cryptomeria japonica* (Thunb. *ex* L.f.) D.Don), cypress (*Chamaecyparis obtusa* (Siebold & Zucc.) Endl.), and pines to supply large quantities of timber. These monoculture plantations have replaced the original high-biodiversity natural forests. The dense canopy shade created by these plantations negatively affects rice cultivation in Satoyama landscapes, while in remote areas, plantation-thinning operations often have low economic efficiency (Sehra and MacMillan 2021). In Fukushima Prefecture, farmers cultivating rice in Satoyama landscapes have indicated that the cedar trees on the surrounding mountains were planted through afforestation programs. As plantations have expanded and natural forests declined, the availability of food resources for wildlife in mountainous areas has declined. Consequently, in order to survive, wild boars increasingly descend into agricultural fields in search of food (Sehra and MacMillan 2021). The Satoyama landscape has gradually shifted from being a vibrant, diverse mosaic of natural forest patches into a single-function plantation forest, jeopardizing the ecological balance that had been maintained for generations.

In 1964, Japan liberalized the timber trade, allowing the large-scale import of cheap timber from overseas. At the same time, the rural depopulation and rising labor costs associated with economic growth created combined pressures, leading to the abandonment of extensive forestland, including of plantations established through afforestation programs. Japan's timber self-sufficiency rate declined dramatically from 95% in 1955 to only 28% in 2013 (Kamada 2018), further undermining forest resource management in Satoyama landscapes.

With the promotion of modernized agricultural production in Japan, agricultural machinery, agrochemicals, and chemical fertilizers have been introduced, leading many farmers to abandon traditional farming methods (Kamada 2018). Under demographic and socio-economic pressures, farmers often choose to abandon farmland or rely more heavily on chemicals, rather than adopting wildlife-friendly farming practices. Although extensive efforts have been made in recent years to reduce the use of chemical fertilizers and pesticides, farmers may still rely on them under unfavorable weather conditions or during periods of labor shortages (Sehra and MacMillan 2021).

Traditionally, Satoyama landscapes in Japan have been shaped by smallholder farmers through the intelligent use of their land and the surrounding natural environment, thereby ensuring biodiversity and fostering unique local cultures. Today, rural communities in Japan are facing severe challenges, forcing farmers to adopt alternative management strategies, consolidate farmland, and implement standardized mechanized production systems (Fukamachi 2020). Similarly, with the expansion of agricultural mechanization, there has been an increasing shift from multi-cropping systems to monoculture cultivation (Kohsaka et al. 2013). Modernized agricultural production involves changes in farmland use patterns. In the Minabe–Tanabe Ume System in southern Wakayama Prefecture, with the ageing of farmers and policy developments in the national agricultural sector, farmers have shifted to planting the plum orchards on the relatively flat terrain created through land excavation and filling or on converted rice paddies, causing a rapid increase in the abandonment of traditional slope-type plum orchards. In order to manage these abandoned slopes, the local government prioritized artificial afforestation with Quercus phillyraeoides, from which charcoal could be produced. However, owing to the shift away from slope-based farming and the increase in sudden landslides, all farming in this area had to stop, and the land was redesignated as a national landslide-protection forest. These changes, which have accelerated the shift from traditional farming methods, threaten the balance of the dynamic land-use system comprising plum orchards, forests, and other land uses (Hara et al. 2021).

In the Satoyama landscape of Yahata, Otsu City, the traditional stone and earthen embankments of rice terraces have a long history. However, since the 1990s, efforts to reduce the amount of maintenance work required (such as weeding) have led to large-scale slope modification, and many traditional embankments have been replaced with concrete (Fukamachi 2020). Although infrastructure improvements have helped to sustain agriculture in hilly and mountainous areas and in economically disadvantaged regions, the number of plant species recorded in the improved farmland is substantially lower than in the traditional farmland, reflecting its reduced ecological value (Fukamachi 2020). In some rural areas, agricultural modernization and mechanization have led to the establishment of monocultures, resulting in a sharp decline in biodiversity (Kohsaka et al. 2013).

Since the 1960s, the rapid industrial growth in Japan has generated numerous job opportunities, attracting rural populations towards cities. Consequently, rural areas have experienced population out-migration and aging, resulting in a sharp decline in the agricultural, forestry, and fisheries labor forces (Kamiyama 2020). Iwata et al. (2014)

conducted an online survey among individuals who had not participated in Satoyama-related activities. Among other questions, the participants were asked, "If you would like to live in a rural area but cannot do so, what would prevent you from doing so?" The top three answers were "unable to leave my current job", "few shopping options", and "no interesting jobs". These responses all reflect practical constraints, and young people aged 20–40 tend to express these views. The appeal of urban lifestyles has drawn many young Japanese people into metropolitan areas, and very few are willing to remain in remote areas to work in low-paying food production jobs. Consequently, a growing disconnection has emerged between Japanese people and their food production systems (Sehra and MacMillan 2021). Based on a study on farmland abandonment, the lack of successors for ageing farmers and the aging of rural populations have led to declining productivity in rice terrace systems (Sarker 2020). In the Minabe-Tanabe Ume System, population ageing has resulted in the abandonment of an increasing number of plum orchards, prompting local forestry authorities to initiate afforestation on abandoned slope-type orchards (Hara et al. 2021). In several regions of Japan, including Kanto, Chubu, Chugoku, and Shikoku, farmland abandonment is positively associated with steeply sloped paddy fields, as elderly farmers are unable to farm on such slopes. In remote areas of Fukushima Prefecture, the effects of population ageing are becoming more pronounced. Farmers have more land than they can effectively manage, but no successors willing to take over; as a result, they continue farming, but using chemicals rather than labor (Sehra and MacMillan 2021). Although Japan's agricultural policy is providing support to commercial farms through subsidies, loans, and financing to address labor shortages, these measures alone are insufficient to fundamentally alter the labor structure or ensure the long-term sustainability of rice production (Sehra and MacMillan 2021). When designing land-use strategies to support avian diversity, socio-ecological factors, such as the ageing farming population and rural depopulation, must be considered (Katayama et al. 2021). Even in some plain areas, the number of abandoned small-scale farmland plots has continued to increase. Katayama et al. (2021) suggest combining abandoned farmland plots into productive landscapes, thus providing birds with habitats that resemble natural wetlands.

Environmental knowledge is not easily disseminated into rural areas. Farmers who want to learn and implement environmentally friendly practices are constrained by the lack of an appropriate communications platform for knowledge exchange. Although the government and agricultural authorities frequently emphasize the importance of organic agriculture and biodiversity, farmers remain uncertain about how to address the difficulties they face (Sehra and MacMillan 2021). The mechanisms for sharing non-market food and the social networks that sustain them are gradually weakening. With the absence of younger generations in rural and fishing communities, it is becoming increasingly difficult to transmit traditional knowledge and associated skills through the medium of food-related practices, culture, or customs. The numbers of edible plants growing in mountain forests have declined sharply, and long-established lifestyles are likely to collapse, thereby increasingly threatening SEPLS (Kamiyama 2020). Kamiyama et al. (2023) analyzed data obtained using two online questionnaires on rates of household food consumption from

non-market exchanges in Japan, finding that those respondents who said that they participated in non-market exchanges were predominantly elderly. This survey revealed a decline in household non-market food consumption; although this decline was less pronounced than predicted by some earlier studies, it nevertheless warrants concern (Kamiyama et al. 2023). In the absence of proactive policy interventions, this decline is likely to persist. Owing to agricultural transformations and the westernization of Japanese food, Japanese people now rarely eat domestically produced white rice (Sehra and MacMillan 2021), and most are uninterested in the abundant food resources of Satoyama landscapes. Changing dietary habits in Japan have affected people's physical health, resulting in particular in chronic diseases associated with obesity (Kamiyama et al. 2023).

Between 1955 and 1975, Japan experienced rapid industrial expansion and high levels of economic growth, with its cities attracting large numbers of rural residents in search of employment. Within a short period, the cities absorbed large populations, particularly in the three major metropolitan regions of Tokyo, Osaka, and Nagoya, where limited land availability within the urban core made outward expansion inevitable (Kohsaka et al. 2013). With the outward expansion of cities, extensive Satoyama landscapes were incorporated into urban land and converted into residential areas, with land ownership transferred to local governments. The urban residents living around Satoyama landscapes were given few opportunities to participate in decision-making, and the land-use changes around these cites effectively eliminated their surrounding Satoyama landscapes (Kamada 2018).

In addition to agricultural intensification, urban expansion poses a serious threat to biodiversity, particularly by leading to landscape fragmentation (Piras et al. 2022). Yokohama City, in eastern Kanagawa Prefecture, is the second largest city in Japan after Tokyo. During the period of rapid economic development in the 1970s and 1980s, Yokohama City experienced a large influx of migrants, and its area of natural land decreased as the population grew. According to the statistics of the Environmental Planning Bureau of Yokohama City for 2013, the city's green-coverage rate dropped sharply from 50% in 1970 to 29.8% in 2009; many green spaces, including areas that had once been Satoyama landscapes, were lost to development and construction, and these landscapes were only partially preserved (Iwachido et al. 2020). In urban areas in Japan, agricultural land is mostly owned and managed by private landowners, and this has been the case for more than a century. The woodlands are dominated by deciduous broad-leaved forests, from which timber and wood fuel are obtained through thinning, while pests that restrict crop growth are eliminated through weeding. Satoyama landscapes typically feature hilly land and small stream valleys formed by water erosion. Today, however, many of these landscapes have been incorporated into urban areas and converted into parks, citizen forests, and other land uses, resulting in the loss of some traditional Satoyama ecosystem functions (Iwachido et al. 2020). Urbanization weakens the community ties and sharing mechanisms that support non-market food supply, especially in densely built urban environments, thereby reducing resilience to future socioeconomic changes and natural disasters (Saito et al. 2018).

Population ageing is a key problem, not only in rural Satoyama landscapes, but also in large cities and the surrounding

peri-urban areas. Ensuring an appropriate labor force to maintain the productivity of ecosystem services has thus become a top priority (Kohsaka et al. 2013). Shimpo (2022) reviewed Satoyama-conservation activities among urban residents in the Tokyo metropolitan region, finding that most of the participants in these activities were retirees aged over 60. In contrast, young people are typically busy with work and family life and are generally limited to participating in one-day activities. An ageing demographic such as this poses a challenge to the sustainability of routine conservation activities (Shimpo 2022). Similarly, the aforementioned study by Hino et al. (2023) revealed that, among various activity types in productive urban landscapes, woodland-related activities attracted the second-oldest participants (average age, 70.6 years). Participants over 70 years old frequently visited these productive urban landscapes and participated in related activities. Concerningly, population ageing may lead to a growing shortage of individuals capable of managing productive urban landscapes.

In recent years, global climate change has become a key factor affecting the survival of native species and the balance of species communities, transforming the entire ecosystem of Satoyama landscapes (Kohsaka et al. 2013). Invasive species may take advantage of landscape fragmentation or reduced habitat connectivity to invade Satoyama landscapes, thus profoundly affecting the natural communities (Piras et al. 2022). Iwachido et al. (2020) studied the nature-oriented parks of Yokohama City (Kanagawa Prefecture), hypothesizing that artificial structures such as paved sidewalks, playgrounds, and rest areas might increase the likelihood of alien species invasion; however, field investigations revealed that alien species invasions did not increase with the number of constructed areas. This finding is related to the fact that parks are naturalized areas with relatively high disturbance intensity in urban landscapes, with native plant species occupying complementary niches, thus limiting invasion by alien species (Iwachido et al. 2020). Similarly, in excavated and refilled plum orchard systems, nitrogen-fixing plants are often introduced to facilitate rapid greening, while conventional farming practices frequently use alien species to generate green manure or nectar for pollinators. However, Hara et al. (2021) found no significant differences between modified orchards and traditional plum orchard systems in the occurrence of alien species. Although these two studies did not reveal clear evidence of invasion, its risks should not be overlooked, and further research is required to clarify the underlying relationships.

Climate change is influencing wildlife-friendly farming practices within Satoyama landscapes, and this may negatively affect Japan's rice production systems in future (Sehra and MacMillan 2021). Rice farmers surveyed in the Fukushima, Tochigi, and Chiba Prefectures responded that the temperature "has never risen so high so quickly" and that weather patterns are changing rapidly. Consequently, the impacts of climate change need to be incorporated into policy analysis and economic assessments to support the sustainable production of high-quality rice in Satoyama landscapes (Sehra and MacMillan 2021).

Furthermore, in response to climate change, societies are reducing fossil fuel consumption and transitioning toward renewable energy. However, the land required for renewable energy development is increasingly encroaching upon Satoyama landscapes. Based on a land-use layer

intersection analysis for the period 2002–2021, Piras et al. (2022) observed relatively minor land-use changes in igune and other small forest patches over the period, with a net reduction of just 16.2 ha. Notably, the largest proportion of this loss was due to the expansion of solar panel installations, accounting for 44% of the lost area, followed by agricultural expansion (22%) and urban expansion (11%).

More recently, solar panel development has expanded into the Minabe–Tanabe Ume System, where the vegetation has been removed or farmland converted to accommodate energy infrastructure. Recognizing the potential threat to traditional plum orchard landscapes, the Wakayama Prefectural Government has begun actively promoting regulatory measures to prevent the excessive development of plum orchards (Hara et al. 2021).

CONCLUSIONS

This review of the recent international literature on Satoyama landscapes broadens the conceptual understanding of these landscapes and clarifies the developmental context. As we move toward the next generation of researchers while maintaining biodiversity and nature's contribution to humanity, we need to continue engaging with, and learning within, Satoyama landscapes, with the aim of creating a new set of values. The main conclusions of this review are as follows:

1. A widespread misconception equates Satoyama solely with forests. In fact, Satoyama landscapes comprise multiple interconnected elements, including forests, rice paddies, grasslands, lakes, and ponds, all of which play equally important ecological roles. Such a misconception hinders the promotion of landscape-scale environmental conservation, highlighting the need to enhance public understanding of Satoyama through environmental education.
2. The dynamic mosaic landscape characteristic of Satoyama relies on appropriate human management. Therefore, farmland abandonment should be minimized. Otherwise, unchecked vegetation succession and increasing wildlife populations may lead to more frequent environmental disturbance and ongoing biodiversity decline.
3. Whether in rural regions, peri-urban areas, or urban green spaces, participants in Satoyama activities are predominantly elderly, indicating that population ageing poses a growing challenge to Satoyama conservation. Identifying more diverse participation opportunities is therefore necessary to encourage broader public engagement across different social groups.
4. Young people, and particularly urban students, remain among the least engaged with Satoyama landscapes, often showing limited awareness of the cultural values embedded in nearby Satoyama environments. Nevertheless, they also represent a group with significant future potential. Encouraging younger generations to re-engage with Japan's agricultural production systems and rebuilding interactions between people and Satoyama landscapes are therefore important challenges.
5. In Satoyama-based communities, disaster resilience must be grounded in the sustainable use of natural resources during normal periods. Food-sharing traditions represent an important component of such resilience. These practices reflect traditional knowledge related to the sharing of ecosystem-based provisioning services. Although largely intangible, such knowledge can only be maintained and transmitted through repeated practice in everyday life.

RECOMMENDATIONS AND LIMITATIONS

Drawing on international experiences in Satoyama landscape management, this study proposes recommendations tailored to Taiwan's local context. Based on this assessment of the current challenges in the development of Satoyama landscapes in Taiwan, three recommendations are proposed:

1. Government agencies should establish a regional-scale governance framework for Satoyama management. Within an appropriately flexible regulatory environment, short- and medium-term economic support should be provided to Satoyama landscape managers through policy instruments such as subsidies, incentives, tax reductions or exemptions, and low-interest loans. Such support would help to create opportunities for ecological and agricultural recovery, thereby enabling the long-term development of Satoyama landscapes. In addition, particular attention should be given to the highly productive lowland areas within Satoyama landscapes. Once these areas become abandoned or idle, their restoration becomes considerably more difficult. Economic incentives provided by the government could encourage farmers to resume and maintain at least a minimal level of cultivation.
2. Given the ageing demographic of current Satoyama participants and the labour shortages faced in many rural areas, it is essential to broaden participation in Satoyama activities. Students and young people represent a particularly important potential group. Under Taiwan's *12-Year Basic Education Curriculum Guidelines* (the 108 Curriculum), teachers are increasingly adopting competency-based and place-based learning approaches. Satoyama landscapes provide valuable educational resources that can be integrated into local studies, subject-based learning, environmental education, outdoor education, and inquiry-based learning. These approaches may help students re-establish their connection with Satoyama through everyday learning experiences. Educational activities do not necessarily need to focus on well-known Satoyama sites in Taiwan, such as the Gongliao terraced rice fields in New Taipei City, the homegardens in the mountainous areas of Pingtung County, or the forest–river–village–sea landscape of Xinshe Village, Fengbin Township, in Hualien County. Instead, Satoyama environments located near homes or schools may better reflect the spirit of the Satoyama Initiative. Furthermore, Satoyama activities should not be limited to environmental conservation advocacy. Diverse forms of engagement, such as photography, sketching, picnics, community markets, light travel experiences, handicraft workshops, forest therapy, and ecological interpretation activities, may increase public engagement and enhance awareness of the ecological and cultural values of Satoyama landscapes.
3. Taiwan and Japan share similar environmental conditions, characterized by extensive mountain ranges, frequent earthquakes, and recurring typhoon impacts during summer and autumn. These factors often result in environmental disasters of varying severity. Under such circumstances, natural resources within Satoyama landscapes can provide important support. For example, residents may rely on locations where wild edible plants can be harvested, firewood collected for heating or cooking, and clean water obtained. These resources can temporarily help affected residents to sustain themselves,

contributing to local disaster resilience. However, disaster resilience depends on the regular and sustainable use of these natural resources during normal periods, as well as the transmission and application of local ecological knowledge. Routine practices such as pruning trees, collecting organic fertilizers, sharing food resources, and maintaining irrigation channels help to sustain the Satoyama system. Without such practices, Satoyama ecosystems may gradually degrade, ultimately reducing both ecological integrity and human well-being.

Several limitations of this study should be acknowledged. First, to maintain a clear focus on the research topic, only the term *Satoyama* was used as the primary keyword in the literature search, so the electronic databases returned primarily publications that explicitly used the term *Satoyama*. However, some studies may fall within the conceptual scope of Satoyama research without directly employing this term. Related studies may use alternative expressions such as traditional rural landscape in Japan or traditional Japanese rural landscapes; traditional agricultural landscape in Japan or traditional Japanese agricultural landscape; original landscape of the Japanese; a landscape with mosaics; or Socio-Ecological Production Landscapes and Seascapes (SEPLS). Such studies are also closely related to the Satoyama concept. Second, although the relevant literature was collected through electronic databases and recent journal articles were screened, it is possible that some important studies were not included in the review.

Finally, all of the articles included in this study were written in English, and Japanese-language publications were not incorporated. Researchers who wish to conduct more in-depth studies on Satoyama may therefore benefit from consulting the Japanese-language literature, as such sources may provide additional insights into the topic.

LITERATURE CITED

Bhatt A, Kumar NA, Dhanya CS, Vipindas P. 2023. Restoring Rice Paddies and Rice Agro-Ecosystem Services Through a Participatory Seed Conservation and Exchange Programme. In: Nishi M, Subramanian, SM editors.137-155 Ecosystem Restoration through Managing Socio-Ecological Production Landscapes and Seascapes (SEPLS). Satoyama Initiative Thematic Review. Singapore: Springer Singapore. p. 53-74.

Dunbar W, and Yanagiya M 2024. Satoyama. In: Sarmiento FO, Gunya A, editors. Mountain Lexicon. Montology, vol 2. Cham: Springer Cham.

Fukamachi K. 2017. Sustainability of terraced paddy fields in traditional Satoyama landscapes of Japan. J Environ Manage 202(3):543-49. https://doi.org/10.1016/j.jenvman.2016.11.061

Fukamachi K. 2020. Building resilient socio-ecological systems in Japan: Satoyama examples from Shiga Prefecture. Ecosyst Serv 46:101187. https://doi.org/10.1016/j.ecoser.2020.101187

Hara Y, Oki S, Uchiyama Y, et al. 2021. Plant diversity in the dynamic mosaic landscape of an agricultural heritage system: The Minabe-Tanabe Ume system. Land 10(6):559. https://doi.org/10.3390/land10060559

Hino K, Yamazaki T, Iida A, Harada K, Yokohari M. 2023. Productive urban landscapes contribute to physical activity promotion among Tokyo residents. Landsc Urban Plan 230:104634.

Hirahara S. 2020. Regeneration of underused natural resources by collaboration between urban and rural residents: A case study in

Fujiwara district, Japan. Int J Commons 14(1):173-90. https://doi.org/10.5334/ijc.977

Imai N, Otokawa H, Okamoto A, et al. 2023. Abandonment of cropland and seminatural grassland in a mountainous traditional agricultural landscape in Japan. Sustainability 15(10):7742. https://doi.org/10.3390/su15107742

Iwachido Y, Uchida K, Ushimaru A, Yokota S, Sasaki T. 2020. Nature-oriented park use of Satoyama ecosystems can enhance biodiversity conservation in urbanized landscapes. Landsc Ecol Eng 16:163-72. https://doi.org/10.1007/s11355-020-00413-y

Iwata Y, Yumoto T, Morimoto Y. 2014. Can Satoyama Offer a Realistic Solution for a Low Carbon Society? Public Perception and Challenges Arising. In: Nakagoshi, NA, Mabuhay J, editors. Designing Low Carbon Societies in Landscapes. Ecological Research Monographs. Tokyo: Springer Japan.

Kamada M. 2018. Satoyama landscape of Japan—past, present, and future. In: Hong SK, Nakagoshi NA editors. Landscape Ecology for Sustainable Society Cham: Springer International Publishing. p 87-109.

Kamiyama C. 2020. Food Provisioning Services via Homegardens and Communal Sharing in Satoyama Socio-Ecological Production Landscapes on Japan's Noto Peninsula. In: Saito O editors Sharing Ecosystem Services. Science for Sustainable Societies. Singapore: Springer Singapore. p 35-53.

Kamiyama C, Hori K, Matsui T, Pretty J Saito O. 2023. Longitudinal analysis of home food production and food sharing behavior in Japan: Multiple benefits of local food systems and the recent impact of the COVID-19 pandemic. Sustain Sci 18(5):2277-91. https://doi.org/10.1007/s11625-024-01511-8

Katayama N, Mashiko M, Koshida C, Yamaura Y. 2021. Effects of rice-field abandonment rates on bird communities in mixed farmland–woodland landscapes in Japan. Agric Ecosyst Environ 319:107539. https://doi.org/10.1016/j.agee.2021.107539

Katsuda K, Saeki I, Shoyama K, and Kamijo T. 2022. Local perception of ecosystem services provided by symbolic wild cherry blossoms: toward community-based management of traditional forest landscapes in Japan. Ecosyst People, 18(1):275-88. https://doi.org/10.1080/26395916.2022. 2065359

Kohsaka R, Shih W, Saito O, Sadohara S. 2013. Local Assessment of Tokyo: Satoyama and Satoumi – Traditional Landscapes and Management Practices in a Contemporary Urban Environment. In: Elmqvist T, Fragkias M, Goodness J, Güneralp B, Marcotullio PJ, McDonald RI, Parnell S, Schewenius M, Sendstad M, Seto KC, Wilkinson C, editors. Urbanization, Biodiversity and Ecosystem Services: Challenges and Opportunities. Dordrecht: Springer, Dordrecht. p. 93-105.

Kovács B, Uchiyama Y, Miyake Y, Quevedo JMD and Kohsaka R. 2022. Capturing landscape values in peri-urban Satoyama forests: Diversity of visitors' perceptions and implications for future value assessments. Trees For People 10:100339. https://doi.org/10.1016/j.tfp.2022.100339

Kurniawan T, Kurniawan E. 2022. Policy on utilizing indigenous knowledge in critical land rehabilitation and fulfillment of sustainable food security in Indonesia: Regrowing "Talun-Kebun" as part of the local permaculture model in west java. Environ Sci Proc 15(1):2. https://doi.org/10.3390/environsciproc2022015002

Kweon D, Youn YC. 2021. Factors influencing sustainability of traditional village groves (Maeulsoop) in Korea. For Policy Econ 128:02477. https://doi.org/10.1016/j.forpol.2021.102477

Matsumura M. 2022. The Satoyama Move-

ment and Its Adaptability: Beyond Ideology and Institutionalization. In: Miyauchi T, Fukunaga M, editors Adaptive Participatory Environmental Governance in Japan: Local Experiences, Global Lessons. Singapore: Springer Nature Singapore. p 67-92.

Maney C, Guaras D, Harrison J, et al. 2024. National commitments to Aichi Targets and their implications for monitoring the Kunming-Montreal Global Biodiversity Framework. npj Biodivers 3(1):6. https://doi.org/10.1038/s44185-024-00039-5

Nagao Y, Nishikori A, Imoto T. 2021. The relationship between the conception of nature and environmental valuation. Sustainability 13(22):12683. https://doi.org/10.3390/su132212683

Nyongesa JM, Donatti CI and Kiptenai TK. 2023. Community-Based Rangeland Restoration for Climate Resilience and Pastoral Livelihoods in Chyulu, Kenya. In: Nishi M, Subramanian SM, editors Ecosystem Restoration through Managing Socio-Ecological Production Landscapes and Seascapes (SEPLS). Satoyama Initiative Thematic Review. Singapore: Springer Singapore.

Piras F, Fiore B, Santoro A. 2022. Small cultural forests: Landscape role and ecosystem services in a Japanese cultural landscape. Land 11(9):1494. https://doi.org/10.3390/land11091494

Ruiz-Labrador EE, Sánchez-Martín JM, Gurría-Gascón JL. 2023. The agritourism value chain: an application to the dehesa areas of extremadura. Agriculture 13(11):2078. https://doi.org/10.3390/agriculture13112078

Saito O, Kamiyama C, Hashimoto S. 2018. Non-Market Food Provision and Sharing in Japan's Socio-Ecological Production Landscapes. Sustainability 10(1):213.

Saito O, Subramanian SM, Hashimoto S, Takeuchi K. 2020. Introduction: Socio-ecological Production Landscapes and Seascapes. In: Saito O, Subramanian S, Hashimoto S, Takeuchi K, editors. Managing Socio-ecological Production Landscapes and Seascapes for Sustainable Communities in Asia. Science for Sustainable Societies. Singapore: Springer Singapore. p 1-10.

Sarker A. 2020. Economics of underproduction: A polycentric approach for a depopulated commons in Japan. Ecol Econ 171:106597. https://doi.org/10.1016/j.ecolecon.2020.106597

Sehra KK, MacMillan DC. 2021. Wildlife-friendly food requires a multi-stakeholder approach to deliver landscape-scale biodiversity conservation in the Satoyama landscape of Japan. J Environ Manage 297:113275.

Shimpo N. 2022. Urban ecological life in a metropolitan area—an insight from Satoyama conservation activities in the Greater Tokyo Area. Landsc Ecol Eng 18(1):109-19. https://doi.org/10.1007/s11355-021-00484-5

Terada T. 2020. Evaluating landscape improvement scenarios from the perspective of biomass production: a case study of peri-urban satoyama woodland in the Tokyo Metropolitan Area. Sustain Sci 15(5):1495-510.

Torralba M, Nishi M, Cebrián-Piqueras MA, Quintas-Soriano C, García-Martín M, Plieninger T. 2023. Disentangling the practice of landscape approaches: a Q-method analysis on experiences in socio-ecological production landscapes and seascapes. Sustain Sci 18(4):1893-906.

Xiang Q, Yuan Z, Furuya K, Kagawa T. 2022. Verification of psychophysiological effects of Satoyama activities on older adult volunteers and young people in post-COVID-19 society: A case study of Matsudo City, Japan. Int J Environ Res Public Health 19(17):10760.

研究報告

里山的發展脈絡與在地實踐

李駿彥[1]、廖學誠[1]

摘 要

里山一詞源自日本傳統詞彙，日本環境省和聯合國大學永續性高等研究所於2010年聯合國第十屆生物多樣性公約大會上，正式提出里山倡議，獲得與會的專家學者們高度重視，視為實踐生物多樣性的潛在工具。不久後臺灣亦引入里山概念，在政府、學術和民間團體通力合作之下，活化農村社區發展，里山倡議精神逐漸紮根於臺灣社區之中，並有許多成效顯著的成功案例。本研究為了解里山近期發展脈絡，乃採用質性研究方法之文獻分析法，分析32篇近期國外已發表的里山相關重要文獻，分成四大部分，依序探討里山的定義與組成、經營、應用以及挑戰，主要目的是梳理里山的發展脈絡，近期研究中發現那些重要新知，以及往後的發展趨勢為何，期能提供臺灣里山研究及實務推動之參考，也為後續政策擬定作為借鏡。

關鍵詞：里山、地景、生物多樣性、生態系服務

李駿彥、廖學誠。2026。里山的發展脈絡與在地實踐。台灣林業科學41(1): 99-143。

[1] 國立臺灣師範大學地理學系，106308臺北市大安區和平東路一段162號 Department of Geography, National Taiwan Normal University. No. 162, Sec. 1, Heping E. Rd., Da'an Dist., Taipei 106308, Taiwan.
通訊作者：廖學誠 Corresponding author: Shyue-Cherng Liaw, Email: liaw@ntnu.edu.tw
2025年3月送審，2025年11月通過。Received March 2025, Accepted November 2025.

前言

2010年「愛知生物多樣性目標」(Aichi Biodiversity Targets)正式通過，不過截至2020年為止，各國未能完全實現「愛知目標」(Aichi Targets, AT)中的承諾，從計畫、執行報告到實施每一階段的承諾數量明顯下降，其中目標八汙染、目標四生產與消費以及目標十八傳統知識更被列入「有效實施」承諾最低，而且國家間存在顯而易見的差距，甚至是部分國家因為欠缺資金援助或是科學技術落後，因而無法兌現最初的承諾，生物多樣性保護成效不彰，這恐怕加劇全球生物多樣性危機(Maney et al. 2024)。而里山(Satoyama)這種獨特的半自然環境，正好扮演既能讓在地居民永續利用豐富的自然資源，又能夠維護生物多樣性的關鍵角色，從而促使更多民眾認識生物多樣性的重要性。《日本國家生物多樣性策略和行動計畫》指出里山遍布日本總面積的40%，考量到里山擁有高度生物多樣性，並且有許多物種依賴人為經營之下所塑造各類棲息地的鑲嵌形狀，計畫中強調里山區域的保護是國家級優先任務之一(Dunbar and Yanagiya 2024)。亦有研究表示日本約有67%土地被里山覆蓋，大多位於多丘陵和林木叢生地區，連接都市與深山，混合各種類型的環境，猶如錯綜複雜的馬賽克樣貌(Fukamachi 2017)。

日本推動全國性里山調查可追溯到2007年，日本政府與聯合國大學永續性高等研究所(United Nations University Institute for the Advanced Study of Sustainability, UNU-IAS)攜手合作，啟動「日本里山－里海評估」(Japan Satoyama Satoumi Assessment, JSSA) (Dunbar and Yanagiya 2024)。這一項調查立基於2005年聯合國「千禧年生態系統評估」(Millennium Ecosystem Assessment, MA)的理論架構，在架構中認定長期以來人類與生態系統密切互動，形成和維持里山和里海(Fukamachi 2020)。調查中，分析近50年來里山和里海生態系統遭逢哪些變遷，以及促使改變的各種驅動力，包括科技、氣候變遷、社會行為反應、政府和經濟政策等因素，並為2050年確立可能的未來情境(Fukamachi 2020)。調查發現里山地景不是預設的原始自然模型而已，而是混合不同程度的人類擾動對生態系統之影響，實際上比起許多低密度土地利用，可以產生更高層級的生物多樣性，同時在有韌性的社區中為人類提供福祉；但是近10年間，快速工業化、都市化和其他威脅，傳統地景經營的行使不再，危害到生物多樣性(Dunbar and Yanagiya 2024)。調查成果最終在2010年公諸於世，又於2012年出版「里山–里海生態系統與人類福址：日本的社會–生態–生產地景一決策者摘要」(Satoyama-Satoumi Ecosystems and Human Well-being: Socio-ecological Production Landscapes of Japan)，公佈眾多當前日本里山和里海的現況與趨勢的資訊，提供日後「里山倡議」(Satoyama Initiative)強而有力的科學基礎(Fukamachi 2020)。

2010年10月在日本愛知縣名古屋市舉辦的聯合國《生物多樣性公約》第十屆締約方大會(the Tenth Meeting of the Conference of the Parties to the Convention on Biological Diversity, CBD COP 10)上，日本環境省(Ministry of the Environment Government of Japan, MOEJ)和聯合國大學永續性高等研究所(UNU-IAS)共同提交「里山倡議」，作為實踐「愛知目標」的有力工具，並於第32號決議(Decision X/32)中通過，受到學者們高度重視(Fukamachi, 2017)。臺灣也在2010年底引進里山倡議的做法，正好與極力推行的農村再生計畫不謀而合，翌年東華大學率先申請加入里山倡議，成為臺灣首位里山倡議正式會員，2016年農業委員會林務局(現改制為農業部林業及自然保育署)在東華大學協助之下，成立「臺灣里山倡議夥伴關係網絡」(Taiwan Partnership for the Satoyama Initiative, TPSI)，串聯全臺各地致力於里山的夥伴，分享實務經驗，培養專業能力。

本研究回顧近年來國外多項在里山中進行的研究，分成四大部分，依序探討里山的定義與組成、經營、應用以及挑戰，主要目的是梳理里山的發展脈絡，近期研究中發現哪些新知，以及往後的發展趨勢為何，期能提供臺灣里山研究及實務推動之參考，也為後續政策擬定作為借鏡。

研究方法

本研究為了解里山近期發展脈絡，乃採用質性研究方法之文獻分析，分析多篇國外已發表的里山相關文獻。本研究文獻檢索與篩選之步驟詳列如下：

(一) 本研究使用「Satoyama」作為關鍵字，在2024年11月4日至11月30日期間，於多家國外學術電子資源平台上檢索，包括Science Direct On-line (SDOL)、MDPI、Taylor & Francis Online、Springer Nature Link、International Association for the Study of the Commons(IASC)等。

(二) 先是透過電子平台中的相關功能，排序出與里山相關性較高的文獻，再輔以本研究者主觀認定，需要將哪些文獻選入。除了期刊論文外，還納入學術專書中的專篇章節。

(三) 依照出版日期進一步篩選，最主要選定在2020年至2024年期間出版的文獻，像是2020年1月突如其來的新型冠狀病毒大流行，這會對里山產生何種影響，是值得深入探討的。然而也有少數非近5年內的文獻，即Kohsaka et al. (2013)、Iwata et al. (2014)、Fukamachi (2017)、Kamada (2018)和Saito et al. (2018)的研究，因在里山相關研究文獻上常被引用，甚具重要性，故納入分析之中。

(四) 另外，里山概念雖源自於日本，但相似的作法及理念也發生於日本以外其他地區，因此，本研究在進行文獻分析時，亦收集到數篇非日本境內，但相近似於里山地景的文獻，用以概述其他地區的發展情況。

(五) 最終，總共蒐集32篇文獻，皆以英文撰寫，大致完成本研究資料庫建置。

(六) 里山的概念起源於日本，本研究理應涵蓋以日文撰寫之文獻，才能獲得里山發展的最新消息。由於作者並非精通日文，因此，在上述國外學術電子資源平台中，仍以收集英文文獻為主，實為一項研究限制。

本研究針對這32篇文獻中，提取有關於「里山的定義與組成」、「經營」、「應用」以及「挑戰」的資訊，並給予這些資訊逐一分成上述四大類，以利後續的整理與分析。簡單來說，透過不斷瀏覽和交叉比對文獻，進行主題歸納具體步驟，並據此來撰寫結果與討論的內容。上述研究流程重複進行，直至本研究資料庫中所有文獻皆分析完畢為止。圖1為本研究流程。

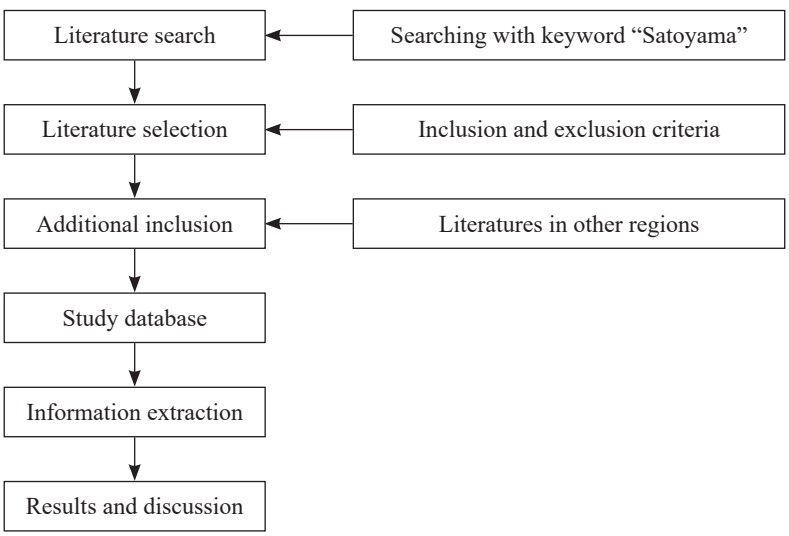

Figure 1. Review process workflow

結果與討論

里山的定義與組成

「里山」(Satoyama)源自日本傳統詞彙さとやま，從字面上來看，是由「里」(Sato)代表的聚落、村莊加上「山」(yama)意指周圍的山地、丘陵所構成，空間範圍則大致介於「奧山」(Okuyama)與「里地」(Satochi)之間的淺山丘陵地帶，這裡的奧山是指更內陸的深山，通常被認定是當地神靈的住所，保留著原始林相，人跡罕至，而里地表示集結人們居住和農事活動的平原低地(Dunbar and Yanagiya 2024)。若改從里山中居民的識覺空間(perceptional space)來看，村落(mura)就位在地景的核心，四周為耕地(nora)所圍繞，再向外又被林地(yama)環繞，直到最外圍的原始林野(Okuyama)，結構近似多層同心圓狀(mura-nora-yama)，形塑出一種人類與自然共生的空間(Matsumura 2022)，如下圖2所示。日本京都府宮津市上世屋曾經面臨水梯田(terraced paddy fields)大面積廢耕，只好將部分田地重新造林，儘管如此，圍繞在住家的一些水梯田被保留下來，用於耕作，村莊—耕地—森林(village-farmland-forest)這樣的傳統里山土地利用模式才不至於消失(Fukamachi 2017)。依照日本里山—里海評估(JSSA)的記錄，早年里山一詞專指「圍繞農村、人類居住地和屋舍的山地」，隨著時空環境的演進，愈來愈多的里山研究有了新的發現，逐步擴展里山的定義，試圖涵蓋更為全面的地景，除了原有的山地，還納入人類居住地、農田、草地、內陸水域和其他地物(Dunbar and Yanagiya 2024)。是故，「由人們定期經營的大片農村環境」皆屬於更廣義的里山(Matsumura 2022)。

里山倡議致力於將日本與世界各地良好的地景經營案例作為基礎，藉由發展和支持人類與自然互利互惠的相處關係，得以促進生物多樣性的保護和自然資源的永續利用(Dunbar and Yanagiya 2024)。里山倡議的案例研究廣納世界地區最典型的文化地景，這些案例的共通點是人類與自然長時間的互動，隨著時間的推移，形成多功能的地景，在保持或增進生物多樣性之下，也維持在地社區的人類福祉(Torralba et al. 2023)。除了以國家或地方政府的身分加入里山倡議國際夥伴關係網絡，同樣歡迎社區、原住民、民間公司、學術機構、政府間組織、非政府組織等申請入會，若是成為正式會員，會員義務是需要提交至少一項案例研究，採用何種地景取徑使生產經濟發展及社會生態價值的保護取得平衡，向其他會員分享執行的經驗(Torralba et al, 2023)。

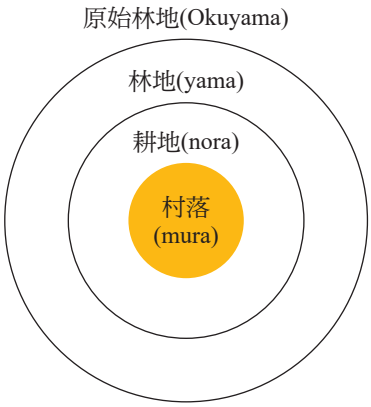

Figure 2. Residents' perception of the Satoyama structure (Adapted from Matsumura, 2022).

關於其他里山的定義，日本環境省對「里地里山」(Satochi-Satoyama)地區進行生態復育，其中將里地里山一詞定義為「概念上，地理區域位於都市與原始自然區域之間，其環境是在各種人類活動的努力下形成，並由農村周圍的次生林(secondary forests)與農田、水池和草地等特徵建構而成」(Iwata et al. 2014)。Iwata et al. (2014)在日本低碳社會情境B的研究中，指出里山是「附屬於農村的次生林，過去為每個家庭提供木柴、木炭與有機肥料」。Sarker (2020)在概述重要名詞時引用前人對里山的說法，「里山是由水稻梯田、次生林地、灌溉池塘以及人類居住地構成的日本山村」。Hirahara (2020)說明「里山發源自日本鄉村地區，這片傳統地景由農地、次生林和草地等各種生態系統組成，維繫著在地居民的生計。人們取用草地上的有機肥料耕作，並在周遭的森林中生產木柴和木炭」。Nagao et al. (2021)在問卷

調查中將里山描述為「日本傳統農業地景，包括次生林地、灌溉渠道、稻田、牧場和村莊」，並附上里山實景照片。Piras et al. (2022)對里山做出解釋，「里山是日本傳統文化地景，集合森林、稻田、草地、池塘和溝渠的多種特徵，相異的元素間具有緊密的功能性相互關係」，並強調該研究中的居久根(igune)和小型樹林地景亦屬於里山。Katsuda et al. (2022)提到「里山是由次生林、農田、草地和在地社區組成的社會–生態–生產地景。位處里山之中，歷史上人們利用自然資源維生，人為經營時不經意地替許多動植物創造有利的棲息地」。由此可見，各家學者對里山持有多樣化的詮釋，這些詮釋彼此間卻又不衝突，里山中農村生計、生態保育和社會文化兼備，是為一種生機盎然且兼收並蓄的經營模式。

里山地景作為一種傳統日本鄉村/農村地景，在里山倡議中被描述為「社會–生態–生產地景與海景」(socio-ecological production landscapes and seascapes, SEPLS)，是指由次生林、人工林、農田、灌溉池塘、濕地、草地、海灘、沿海地區，以及人類居住地等不同生態系統類型的特徵交織而成，廣義來說，此地景範圍涵蓋陸域的里山和沿海海域的里海(Satoumi) (Saito et al. 2020)。在地居民經年累月地對土地的使用方式之下，水田、旱田、林地、水塘等各種生態系統彼此鑲嵌而成動態斑塊地景，有如馬賽克拼貼一般，多樣化的土地利用供給人類生活和農業生產所需的各式財貨，像是從森林地面蒐集落葉用於田間施肥，採摘森林中的野生植物可供應烹煮食材，家戶中的人類排泄物作為堆肥，大面積的草地則被保留下來以作修繕屋頂的材料，在人類合理使用自然資源，卻不會損耗自然資本，反而增加該地的生物多樣性，往往會在環境中發現更多物種(Kamada 2018)。Hara et al. (2021)針對日本和歌山縣南部町與田邊市，分析40多年間坵塊尺度(parcel-level)的土地利用變遷，梅園中坵塊都有其特定用途，並隨著時間而轉變，這樣的經營方式在日本里山地景中是習以為常的。若與國外相比，梅園中坵塊面積極小，該研究樣區中最大塊僅有0.23公頃，國外坵塊經常是大面積，之中又包含水池、森林、草地等多種土地覆蓋類型，這也意味著政府的土地利用管制要有所不同，只是關注某一坵塊用途以及特定物種，均不利於保護該地區以坵塊為基礎的動態馬賽克地景(dynamic mosaic landscape)所賦予生物多樣性(Hara et al. 2021)。Kohsaka et al. (2013)針對日本里山和里海總結以下四點特徵：

1. 里山是陸域及水域生態系統交織的馬賽克形狀，包含林地、人工林、草地、農田、牧場、池塘與渠道，其中陸地生態系統佔大多數。
2. 里海主要指水域生態系統，但同時是由海岸、礁岩海岸、潮汐灘地、珊瑚礁及海藻/海草床構成之水、陸域生態系統馬賽克狀。
3. 里山和里海需要整合傳統知識與現代科學來經營地景。
4. 生物多樣性是里山和里海地景中韌性與正常運作的關鍵要素。

這種馬賽克地景不僅存在於日本的里山和里海而已，實際上遍布世界各地，只是地景內部某些功能和結構因地方性(locality)略有相異，各地對這種地景給予不同的稱呼，在概念上實則相通 (Kohsaka et al. 2013)。南韓傳統村莊樹林(traditional village groves)係由各個村莊的自主組織(self-organized community)來經營，屬於該村共有財產(common property)，當地則會以Maeulsoop或Bibosoop來稱呼這片文化地景，受到妥善照顧的樹林被賦予保護村莊的功用，常用以防洪、防風、美學、休閒遊憩、祈求平安，也是野生動物棲息地，只是日本殖民時期分配這些樹林的所有權或使用權，削減村民參與使用的機會，反而導致森林退化(Kweon and Youn 2021)。印度西爪哇省(West Java Province)基於社區傳統知識發展出一種混農林業系統(agroforestry system)，稱作Talun-Kebun或Talun-Kebon，由多年生植物和地面上的一年生植物(perennials and annuals)所組成，之中蘊藏眾多物種，近似於天然森林結構，對於在地居民而有具有多種功用，收成的高經濟作物來出售，同時貧困者能獲得短暫工作機會，減緩水文和土壤侵蝕，而且在多物種混雜之下，是一座天然的基因保存庫，至今仍有居民維持住這種地方

傳統永續農業的模式(Kurniawan and Kurniawan 2022)。印度喀拉拉邦瓦亞納德縣(Wayanad)坐落在西高止山脈一處氣候涼爽的丘陵地上，有趣的是瓦亞納德此一地名源自本土語Vayal Nadu，亦有拼音成Wayal Nadu，意指「稻田之地」(land of rice fields)，該地水稻農業生態系統是由低地水稻田、農莊和附近的混合木本作物系統加上高地木本作物三種耕作帶構成，在地農民利用糧食生產、放養牲畜、涵養地下水等生態系服務(ecosystem services, ES)來生活，如今正積極推動農業家庭耕種傳統水稻品種(Bhatt et al. 2023)。西班牙Dehesa被視為多功能牲畜和狩獵開發利用系統，一半以上的土地被開闢成牧場，一些橡果生產樹散佈其中，放養多種本地牲畜，並用橡果飼養如美麗諾羊、伊比利豬等牲畜，與放牧互補的農業用途有種植麥類穀物，林業用途則是橡樹的季節性使用，每8到10年還會取軟木橡樹皮用於製作酒瓶的軟木塞，在歐洲屬於獨一無二的文化遺產(Ruiz-Labrador et al. 2023)。乾燥和半乾燥地景正是肯亞凱烏魯牧場(Chyulu rangeland)鮮明的特徵，旱季時，它為野生動物和在地農牧社區提供一塊放牧保護區(grazing reserves)，擁有豐富的動植物，草場養活牲畜，是牧民生計來源，土壤亦能固碳，馬賽人(Maasai)就在惡劣的環境中生活，實行Oloopololi制度，一種輪牧、種子庫和維護生物多樣性的傳統經營方式，在旱季為牲畜妥善管理牧場保護區，並共同擁有土地，只是過度放牧、集體治理牧場不佳以及原住民傳統知識式微，導致凱烏魯土地退化，如今在地社區意識到這些問題，積極介入並扭轉生態系統退化的頹勢(Nyongesa et al. 2023)。

雖然隨著里山的定義放寬和組成多元化，但根據Iwata et al. (2014)研究指出，大多數日本人仍將森林蓊鬱的地區視為理想上日本鄉村地景，亦即里山地景，可見於日本朝日新聞社「日本百大鄉村地景」(Nihon no Sato 100 sen / The Top 100 Japanese Rural Landscapes)公眾提名，有38%提名地點被歸類為森林類型，這裡一平方公里內森林覆蓋率高達88%，森林類型地景高居提名榜上第一。Shimpo (2022)回顧多篇與里山保育行動相關的學術文章，也歸納出類似結果，里山在多數情形下，被研究者們理解為林地，因為大約一半的文章都在論述林地經營，鮮少涉及里山其他組成部分，如草地、農地、池塘和小溪。無論是民眾還是研究者的認知，皆是偏好將里山理解成森林或林地，若由廣義里山的定義可知，實則不然。例如日本滋賀縣東近江市伊庭，位處琵琶湖(Lake Biwa)以西，毗鄰伊庭內湖(Ibanaiko Lagoon)，這兩座湖泊以大同川(Daido river)相通，村中地勢低平，水路縱橫交錯，並非大眾印象中森林繁盛的里山地景，林地僅分布在東南角的繖山(Kinugasayama)，山坡上生長著枹櫟、赤松、竹林等植被，反倒是湖畔蘆葦生長茂密，需要定時焚燒或伐除湖畔蘆葦灘，以及清除非原生魚類(Fukamachi 2020)。這一方面就有賴相關部門持續推廣里山環境教育，逐步消除偏見。

里山的經營

誠如里山倡議的核心精神「實現與自然和諧共處的社會」(realizing a society in harmony with nature)，傳統的里山經營方式透過在地居民長時間使用，加上定期自然資源管理，常見的做法有採集、焚燒、刈草、伐木、土壤翻攪、整枝修剪，里山中林業及農業得以發展起來(Kamada 2018)。就在人類與自然一來一往之間，其中人為擾動扮演至關重要的角色(Hirahara 2020)。居民定期且局部地除草和修剪樹枝所引起干擾，對某些物種而言，人類無意間替牠們清出生存空間，形成重要的棲息地，亦建立生物多樣性熱點。Katayama et al. (2021)在日本中部的稻田區所進行的研究，在地景尺度上，農田廢耕面積的多寡會決定棲地異質性，在中等廢耕率之下，也就是說耕地與廢耕地相互混雜，棲地異質性會隨著廢耕地數量的增加而上升，水稻生態系統中鳥類的占域和豐富度達到最高，但是在較高的廢耕率，地景中僅呈現廢耕農地，棲地異質性可能會下降，物種多樣性連帶降低，可以見得受經營和廢耕稻田形成的馬賽克拼貼有利於鳥類豐富度，適當的里山經營還是必須的。另一項研究是Iwachido et al. (2020)在日本神奈川縣橫濱市及鎌倉市進行

的調查，透過比較公園用地與農業用地中植物和蝶類群聚之多樣性與物種組成，結果顯示兩地原生植物的物種組成不盡相同，原生植物和蝶類的物種豐富度和多樣性未發現顯著差異，公園經營可模仿傳統農林業的作法改變環境，避免樹木傾倒、控制從草地演替到林地等週期性的人為干擾，進而維持生物多樣性。再與荒廢至少3年的土地相比，植物和蝶類群聚的多樣性較低，高大且具競爭力的優勢物種佔據優勢地位，因此自然為導向的公園利用(nature-oriented park use)，採取現地原始景觀、地形、人工水景和植被，是一項可行的替代方案，仍維持里山生態系統中豐富的生物多樣性(Iwachido et al. 2020)。

此外，居民也能夠以永續的方式享受里山向人類提供多種有益的生態系服務，本研究根據這次蒐集到的文獻，整理出里山提供眾多的生態系服務，如表1所列，包括供給、調節、文化及支持四大面向的生態系服務。然而文化生態系服務(cultural ecosystem services, CES)這一類無形資產很容易遭到人們忽略，有必要進一步了解人們的認知與價值。Katsuda et al. (2022) 向日本茨城縣筑波市在地居民、遊客和高中生進行問卷調查，欲了解人們對野生櫻花的認知及其認為生態系服務的社會價值，結果發現這三組社會–文化群體對於野生櫻花所提供生態系服務的價值認知存在相當大的差異，對比在地居民和遊客的認知，高中生無論是在美感價值評斷、櫻花品種，還是價值認知的空間分布，似乎不太在意里山提供美感、娛樂和歷史之多元文化價值。相似地，Kovács et al. (2022) 使用景觀價值(landscape value, LV)法，選定一處位於日本愛知縣瀨戶市名為海上之森的都市近郊里山森林，探討遊客的文化生態系服務知覺價值(perceived value)，得出森林利用方式與社會人口屬性有著顯著關係，60歲以上的老年人占多數，隻身造訪的女性甚少，通常是已婚且全家一同出遊，遊客大多認為里山森林具有自然價值和審美價值，亦在照片評估(photo-evaluation)中賦予娛樂、精神、教育、具有療效、文化歷史等多元價值。

在資源共享的地方規範之下，透過定期採伐的使用自然資源方式而得以動態模式維持著里山馬賽克結構，每個地區都建立符合自身情況的規範，目的是在避免「公有地悲劇(tragedy of the commons)」(Kamada 2018)。在日本群馬縣水上町藤原地區，有一片坐落在海拔1100公尺左右，以草原和水楢林(Quercus crispula)為主的地景，稱作上野原(Uenohara)，該社區為了管理共有資源(common pool resources, CPRs)而建立起一套制度，防止自然資源濫用，其一上原野中資源可用的土地大致均分給一群勞動互助的家戶(Kumi)，其二互助家戶群體之領導者決定何時啟用資源，特別是不守規矩者，就讓他們無法從下一季的勞動互助中獲益(Hirahara 2020)。另外，居民對於擾亂社區秩序的外來者十分反感，在群體間不斷搬遷，會給當事人生活上帶來諸多不便，彼時能夠發揮維護社會秩序的作用(Hirahara 2020)。Sarker (2020)借鏡日本水稻梯田當前的資源利用與管理經驗，從經濟學角度出發，將新出現人口減少的水稻梯田公有地歸類為近公共財，認為伊莉諾・歐斯壯(Elinor Ostrom)提出由地方、區域和國家利害關係人組成的多中心法(polycentric approach)有望解決人口減少公有地的生產不足問題。這種多中心法允許在地都市居民每年購買水稻梯田的使用權，儘管生產成本高造成經濟損失，都市居民仍在水稻梯田生產稻米並提供生態系服務，以保護景觀環境(Sarker 2020)。

里山農耕模式也是備受聯合國糧食及農業組織(United Nations Food and Agriculture Organization, FAO)高度認同，日本有多處里山地景入選全球重要農業文化遺產系統(Globally Important Agricultural Heritage Systems, GIAHS)。至於全球重要農業文化遺產系統則是另一項國際保育倡議，積極推動國家內和國際上認同的農業遺產系統，以提升大眾覺察與認知，其追求的理念亦涵蓋里山倡議之社會–生態–生產地景與海景(Saito et al. 2020)。2011年能登里山里海(Noto's Satoyama and Satoumi)入選全球重要農業文化遺產系統，能登半島是一處山地、丘陵綿延的環境，在傳統經營方式之下農業地景維護良好，依山面海的梯田，三面環海使其蘊藏豐沛的海洋資源，

Table 1. Ecosystem services provided by Satoyama landscapes.

Ecosystem Services	Items	References
Providing resources for humans	Abundant and high-quality water resources for agriculture	Fukamachi 2017
	Non-market food sources	Saito et al. 2018
	Reeds along the lagoon used for making sunshades	Fukamachi 2020
	Stone used as building materials for vegetable garden walls and terraced field embankments	
	"Kaya," which refers to grasses used for thatching roofs	Hirahara 2020
	"Kacchiki" and "Kapposhi," which refer to organic fertilizers for farming	
	"Igune" landscape, which provides ingredients for traditional medicine	Piras et al. 2022
Providing cultural benefits	Food-sharing culture	Saito et al. 2018
	Parks provide aesthetic and recreational value for urban residents	Iwachido et al. 2020
	Restorative and healing effects	Nagao 2021
	Food production education	Sehra and MacMillan 2021
	Maintaining and improving the physical and mental health of the elderly	Shimpo 2022
	Traditional Satoyama landscapes generally hold aesthetic, recreational, and historical value	Katsuda 2022
	Wild cherry blossoms draw people's attention to the environment	
	Viewing landscapes enhances aesthetic, natural, and spiritual values	Kovács et al. 2022
	Small shrines are considered to have cultural, historical, and religious value	
	Rice fields are attributed with productive, cultural–historical, natural, and educational value	
Regulating natural processes	Regulating water resources through the traditional "yugakari" system	Fukamachi 2017
	Controlling harmful insects in park grasslands	Iwachido et al. 2020
	"Noyaki," controlled burning to protect grasslands from shrub encroachment	Hirahara 2020
	Maintaining forests around plum orchards to protect watersheds and prevent slope collapse	Hara et al. 2021
	Allowing wild boar hunting to control population size	Sehra and MacMillan 2021
	Letting floodwaters inundate parts of rice fields	Katayama et al. 2021
	"Igune" landscape serve as a windbreak, preserving a stable growth environment for crops	Piras et al. 2022
Supporting ecosystem processes	Parks serve as habitats for native vascular plants and butterflies	Iwachido et al. 2020
	Thickets provide nesting spaces for Japanese honeybees, which pollinate plum trees	Hara et al. 2021
	In plum orchards, the growth of grass contributes to nutrient cycling	

特別是貝類捕撈，居民更發展出獨特飲食和地方文化，與新潟縣佐渡市佐渡島(Sado island)，同為日本首次入選(Kamiyama 2020)。在日本和歌山縣南部與田邊的梅林系統(Minabe-Tanabe Ume System)裡，以梅園為中心，周圍種植萌芽矮林和樹籬、竹子等其他植被，每一地塊都栽種樹籬抵禦強風，竹子被在地人製成生活用品，梅林農業生態系統(Ume agroecosystem)的植被皆能作為花蜜來源，授粉的日本蜂(*Apis cerana japonica*)就棲息於萌芽矮林之中，儘管一些生產活動轉移到近年來透過大規模挖填土地開發而成較平坦的梅園，用意是提高生產效率，不過傳統山坡型梅園依舊擁有更多的原生物種和較高的植物多樣性指數，呈現出動態地景鑲嵌體(Hara et al. 2021)。另一個是日本宮城縣大崎地傳統永續稻田農業的水資源管理系統，創造「居久根」(igune)這種習俗，主要圍繞著農舍和小耕地的西北側，農舍南側則種植低矮灌木，防止無法在水中生存的農作物受到北風侵害，而且陽光還能直射農舍和小菜園，再從2002年到2021年間空間分析來看，居久根的數量、大小和空間模式幾乎沒有改變，居久根彰顯無形文化資產的身分，維繫著傳統森林相關知識(traditional forest-related knowledge, TFRK)和地方認同感(Piras et al. 2022)。由日本這三處全球重要農業文化遺產系統的案例，均凸顯出「豐富多彩的農業生物多樣性(agricultural biodiversity)，與野生動植物息息相關，蘊含珍貴之在地知識(indigenous knowledge)和文化資源」，需要特別注意的是在地知識並非一定直指原住民族知識，只要是在地居民長時間與環境互動中而衍伸出的智慧皆屬之，眾多農民亦「仰賴農業遺產系統提供之各種財貨和服務，獲得糧食安全和生計保障」(Fukamachi 2017)。

當代社會中，里山不只是鄉村的事務而已，城鄉互動開始活絡起來，愈來愈多都市居民有意願參與里山活動，支付意願(willingness-to-pay, WTP)就是其中一種手段，重新將遠離里山的都市居民與身處里山中耕作的農民連結起來，為里山經營注入一股活水。Nagao et al. (2021)發現支付意願因受訪者對自然的看法而異，想像成里山和天然森林的受訪者支付意願很高，而想像成都市自然、郊區自然和人工林者較低，進一步分析前兩類受訪者為何有較高的支付意願，主要是因為擁有較高的關懷感。想像成里山的人們有較高的恢復感，然而人工自然(artificial nature)就缺乏恢復感，里山的自然提供最多的恢復感，這被認為是源自於安全感和對日本傳統農業地景的懷舊(Nagao et al. 2021)。Sehra and MacMillan (2021)混合選擇試驗法(choice experiments, CE)、半結構化訪談、實地訪查等研究方法，證實消費者願意為里山地景中生產的稻米支付更高的價格，相較非里山地景中耕種的稻米高出747日圓，意味著消費者較高的支付意願，替農民帶來額外的收入，這筆收入將會用來經營日本大面積富饒的稻田，有助於實現地景尺度之農業生物多樣性和其他環境效益。另外，日本京都府宮津市上世屋的案例中，1990年代振興里山的政策之下，除了受到京都府和宮津市財務支持，在地民間公司亦體認到上世屋里山價值的重要性，向非營利組織挹注資金，促發新公民行動，在群山環繞中，修復並保留一大片傳統梯田地景，儘管這些經濟支持十分有限，卻是開啟里山保育行動的動力(Fukamachi 2017)。

里山的應用

前文談論許多日本里山地景，這些地景多數位於偏僻荒遠的鄉村地區，但是在都市近郊或是都市綠地空間(urban green spaces, UGS)進行的里山活動也是值得討論的，近在咫尺的可及性，使得都市居民更加親近里山，也能達到保護里山的功效(Xiang et al. 2022)。在日本東京郊區的生產性都市地景(productive urban landscapes, PULs)，里山林地提供可選擇的活動種類繁多，包含疏剪樹枝、林下灌叢除草、在廢棄田地種植蔬菜、利用山野資源製作工藝品等，參與者年齡差異較小且女性人數約占一半，他們長時間待在里山林地裡，停留時間長達4.4小時是五種活動類型中最久，也因此消耗最高的代謝當量(metabolic equivalent, METs) (Hino et al. 2023)。雖然里山林地中的活動強度(METs per hour)最低，可對於老

年人來說，長時間且低強度的身體活動是有益於身體健康和福祉，加總起來的熱量消耗平均約為全國老年人每週建議量的三分之一，另一方面，亦提供老年人定期與其他參與者交際往來的機會(Hino et al. 2023)。居住都市的智能障礙人士同樣享有經營里山林地帶來改善健康的好處，進一步從社會培力(social empowerment)的角度來看，借助里山活動讓殘疾人士從中習得專業技能，並投入蔬菜和水果的生產(Shimpo, 2022)。

都市化地景內，效法里山生態系統，自然為導向的公園利用，在維持農業使用與加速廢棄取得平衡，有助於生態多樣性保育的效用，也維護美學景緻，為都市居民提供一系列美學與休閒價值之文化服務，無疑適用於日本其他面臨里山加速廢棄的都市化地區(Iwachido et al. 2020)。有趣的是，雖然一直強調里山對維持生物多樣性的重要性，然而在都市居民的認知中，參與里山活動之目的與從中獲得的益處並沒有如此直接關係，參與里山保育的動機不僅限於自然保育，居民往往是考量到其他益處，認同健康促進、社會凝聚力、休閒和資源利用方面的直接效益，所以要廣納這些動機多元的參與者，強調短期內備受認可的效益，吸引更多都市居民參與里山保育(Shimpo 2022)。日本神奈川縣橫濱市新治地區對里山地景的整體保育系統深受推崇，原是一大片疏於管理的森林和耕地，2000年初，新治市民之森保護協會以及新治市民之森相繼成立，市政府居中扮演支持、輔助和溝通的角色，順利地整合區域內公有和私有土地，如今這一套市民參與模式(citizen participation model)，匯聚原有的土地所有人、對里山保育感興趣的市民、市民團體等參與者，眾人以一幢老宅翻新後的新治里山交流中心(Niiharu Satoyama Exchange Center)為營運基地，下一階段朝向以低成本且公開透明的決策程序，方能更有效地治理里山(Matsumura 2022)。

2019年新型冠狀病毒大流行期間，由於新冠病毒高傳播力，各國政府無不頒布禁足令，來防止病毒在人群間迅速傳播，日本也不例外，民眾因防疫措施身心俱疲，就連一般被視為最健康的年輕人都飽受防疫壓力，出現焦慮、憂鬱、恐懼等心理疾病。Kamiyama et al. (2023)於新冠疫情前後的比較調查中，研判自願居家隔離(voluntary self-isolation)是一個轉捩點，疫情促使興致缺缺的男性、年輕人以及都市居民投入食物自產和共享行動，家庭農園(homegarden)重新活絡過來，更重要的是後疫情時代居民能否維持家庭消費習慣，而非曇花一現而已，這對於地方農業及糧食發展深具意義。另一項後新冠疫情時代(post-COVID-19 pandemic)的研究，選定日本千葉縣松戶市的山間森林做為案例研究區，檢驗人們在不起眼的小型都市綠地空間中，進行平時里山活動的心理生理效果(psychophysiological effects)，分別比較兩組受試者的生理和心理數據後，顯示老年人和年輕人在小型都市綠地空間的里山活動都能獲得顯著的成效，對老年人而言，里山活動後收縮壓(systolic blood pressure)和舒張壓(diastolic blood pressure)明顯下降，尤其是患有高血壓的老年人，同時負面情緒的指標下降，有益於身體健康(Xiang et al. 2022)。此外，對年輕人的影響，里山活動前後的血壓維持在正常範圍，心理指標亦有下降，只是下降幅度不如老年人來的明顯，未來可以鼓勵居住在都市內的年輕人親近里山，從活動中提升心理健康，紓解新冠疫情大流行所帶來的壓力(Xiang et al. 2022)。新冠疫情轉變習以為常的都市生活，立基於包括里山活動在內的都市生態生活，急需因地制宜來實現生態和健康生活，彌補所處社會的脆弱性(Shimpo 2022)。新冠疫情為里山發展帶來新的契機，提供煩悶已久的都市居民一條釋放壓力的管道。

眾所皆知，以里山為首的社會–生態–生產地景與海景供給社區來源豐富的食物，居民能在無須花費金錢下使用農產品。Saito et al. (2018)透過全國性網路問卷調查，從食物數量和種類兩方面量化日本社會–生態–生產地景與海景中共享食物供應服務對日常生活的貢獻，並分析這些共享方式在不同地景類型中的差異，研究發現山地、半山地和平地農業區食物總量的16%來自非市場來源，都市化地區則僅有10%，非市場來源供給的食物種類平均為32-34種，不同類型的農業區之間並無顯著差異，包括擁有少量農地的都市化

地區，其中蔬菜是非市場食物供應常見品項。再根據土地利用類型與非市場食物供應之間的相關分析，還發現農田和森林與大多數非市場食物品項在數量上有顯著的正相關，種類上則無高度相關，愈趨高度開發地區，非市場食物供應量就愈少(Saito et al. 2018)。除了全國性調查，也有地方尺度的調查，能登半島的案例則呈現更深入的成果。在能登半島的調查中，里山農村和里海漁村於家庭農園中收成、從山林或海洋中採集，以及透過他人共享取得的食物，無論數量或是種類遠比半都市化社區(semi-urban community)來得多，為此維持營養攝取，也節省家庭開銷，里海漁村每年省下119881日圓，是為三種社會地理特徵社區中最高(Kamiyama, 2020)。Kamiyama (2020)進一步指出三種不同社區內共享夥伴人數並無差異，半都市化社區從他人獲取食物的比例卻是最高，占比42%，關鍵在於半都市化社區擁有地理空間上分散(dispersion)的共享夥伴，相較於農漁村是在社區範圍內共享，這是跨社區尺度的遠距社會網絡，很可能是半都市化社區居民曾經在農漁村生活過，儘管他們已搬離舊址，至今仍與親朋好友保持聯繫所形成。Kamiyama et al. (2023)為探討最近年來日本家庭消費的狀態與變化，量化分析新冠疫情前後兩次之問卷調查資料，綜觀疫情後家庭總生產量增加，反之總共享量下滑，很可能是疫情爆發當下多重防疫措施的緣故，侷限住人與人之間的互動，然而大多數受訪者卻表示疫情對家庭生產和共享行為沒有明顯影響，意味著家庭消費是富有韌性的系統。里山和里海中直接取用生態系服務及食物共享文化，均有助於提升抵抗未來社會經濟變遷和自然災害的韌性，里山倡議裡面六項生態與社會經濟觀點所揭櫫的「提升社區韌性」(improved community resilience)，達成涵蓋生態、社會、文化、經濟等多種效益，特別是基於生態系統的氣候變遷減緩與調適策略(climate change mitigation and adaptation strategies, CCMS and CCAS)。

另一個與韌性相關的案例則是2011年3月11日東日本大地震暴露出的能源危機。福島第一核電廠事故迫使當局盡速解決能源安全的難題，運用里山林地作為能源來源，為區域實現能源自給，似乎成為一種應對方法(Matsumura 2022)。日本廣島縣山縣郡北廣島町芸北屬於重度人口流失地區，少有居民願意投入里山環境恢復，當地成立一個非營利組織，再由組織和利害關係人協力推動循環型社會(recycling-oriented society)，活用里山森林資源，實現家庭能源自足(Kamada 2018)。Terada (2020)評估日本千葉縣柏市大青田之森內，木質生物質(wood biomass)儲備作為緊急能源的效益，模擬東京遭受大地震等緊急狀況下，電力供應系統中斷，甚至是區域儲備能源不足，此時經過改善的都市近郊里山林地，能為周遭大量用戶提供木質能源，支持在地居民基本維生，考量到日本並非普遍使用生物質的國家，應該倡導都市居民在平時持續使用生物質，以及保有一定的安全儲存量。邁向韌性社會的途中，還需要政策和法令的支持，Fukamachi (2020)檢視日本滋賀縣東近江市伊庭和大津市八屋戶自然資源利用的趨勢與機制，並說明國家與縣級政策如何應用於兩個截然不同的里山地景，欲確立里山生態系統作為有韌性社會生態系統的未來途徑，需要建立一個良好的整合區域政策架構，橫向聯繫具自主性小農，且在不利的自然環境中發掘里山新價值。正如八屋戶個案中所現，農民各自視情況而定，里山公民行動的各項任務都是逐案處理，毫無完整的基礎法律架構可言，若能改善運作關係，該地區內積極的地方行動不僅能加強自然資源的永續經營，也能提升災害韌性(Fukamachi 2020)。這裡也呼應到里山倡議六項生態與社會經濟觀點之「自然資源的循環利用」(cyclic use of natural resources)，平時增進區域資源使用率，避免危機來臨時沒有資源可以使用。

里山的挑戰

近年來日本面臨到四次生物多樣性危機，且被《日本生物多樣性展望》和《日本國家生物多樣性策略和行動計畫》正式承認。第一次生物多樣性危機源自於過度開發和水污染，雖然此次危機影響深遠，不過開發活動的縮減與經濟成長趨緩而讓危機稍微降低。第二次危機是社會–生態–

生產地景與海景使用減少以及經營不足，此次影響隨著日本鄉村地區人口銳減和高齡化日漸嚴重。第三次危機由人類引進外來入侵種和化學物質造成。第四次危機則是氣候變遷，可怕的是氣候變遷強化其他危機的作用，提醒人們需要認真關注某些特別脆弱的生態系統(Saito et al. 2020)。

1950年代末期，資源使用從木柴和木炭轉變成化石燃料，化石燃料革命(fossil fuel revolution)為里山的發展帶來一系列挑戰和危機(Matsumura 2022)。從國外大量進口能源，無論是石油、天然氣，還是電力供應，迅速滿足人們日常生活需求，並邁向現代化的生活方式，頃刻間里山中豐厚的自然資源遭到遺棄(Kamada 2018)。日本群馬縣水上町藤原地區正好詮釋自然資源未充分利用的案例，約莫1950年代，藤原地區的居民捨棄替茅草屋頂更換的習俗，因為更換茅草屋頂費心勞力，“Kayakari”和“Noyaki”這種傳統資源利用方式逐漸式微，再加上現代化的外在因素使然，四次水壩建設工程為在地居民提供支薪的工作機會，迫使他們放棄以前的工作，鐵公路開通後帶來絡繹不絕的遊客，昔日原是一片周遭被樹林包圍的草原，隨後被轉移且開發成渡假村，觀光業蒸蒸日上，多數居民也選擇到旅宿業和餐飲業就業(Hirahara 2020)。此後，在地居民鮮少從田野間獲取肥料、草料等維持生活，不被利用的草原呈現荒廢樣貌，並在2000年時發現外來物種侵入草原(Hirahara 2020)。日本山梨縣北都留郡小菅村也有相似經歷，這是一處偏僻的山間鄉村，原先有95%面積為次生林和人工針葉林覆蓋，然在液化氣體廣泛使用後，大幅減少木柴與木炭的使用量，導致松樹和橡樹矮林於1970年代早期被放棄(Imai et al. 2023)。在Piras et al. (2022)研究中另有不同結果，20年間多時空分析顯示居久根與其他小型樹林的面積儘管減少50.5公頃，卻有34.3公頃的增加，很大一部分是來自於農業廢耕與次生演替的貢獻，繼續維繫著這一片里山地景。然而，里山相較世界其他地方社會–生態–生產地景與海景面臨到的問題，最大不同在於受到都市化影響，農村人口被吸引到都市生活，以致於欠缺人類對自然環境的干擾，進而威脅到里山的發展，因為里山需要經常性的人類經營，才能實現生物多樣性與對人類的益處(Dunbar and Yanagiya 2024)。

二戰後，日本重建家園和經濟快速成長促進建築用木材需求節節攀升(Kamada 2018)。1950年以來的森林政策，大規模種植柳杉(*Cryptomeria japonica* (Thunb. *ex* L.f.) D.Don)、扁柏(*Chamaecyparis obtusa* (Siebold & Zucc.) Endl.)

和松樹，供應大量木材，這些單一樹種取代生物多樣性較高的天然林，樹林遮蔽光線不利於里山中水稻生產，偏遠地區的疏伐作業經濟效益較低(Sehra and MacMillan 2021)。以福島縣為例，在里山中種植水稻的農民指出，山上的雪松是造林計畫所種植的，人工林漸增、天然林則減少，因此，山區的動物能攝取食物也就愈來愈少，山豬因生存不易被迫下山到農田裡覓食(Sehra and MacMillan 2021)。里山地景從繽紛的多樣天然林馬賽克斑塊，轉變為功能單一的人工林結構，長久以來維繫的生態平衡岌岌可危。不僅如此，1964年起，日本宣布木材貿易自由化，開放從國外輸入大批廉價木材，國內則是鄉村地區人口銳減且在經濟成長之下推升勞動成本，雙重夾擊之下，最終大面積的林地棄而不用，當然也包含造林計畫下的人工林，木材自給率從1955年95%下跌到2013年僅有28% (Kamada 2018)，里山中的林木資源再次受到重創。

日本推行現代化生產，引進農機具、農業化學品和化學肥料，農民紛紛捨棄傳統耕作方式 (Kamada 2018)。處於人口和社會經濟壓力之下，農民往往選擇廢耕或使用更大量的化學品，而非採用友善野生生物耕作法(Wildlife-friendly farming, WFF)，雖然目前化學肥料和殺蟲劑已盡可能減少施灑，但若在天氣不佳或欠缺人力耕作時，則別無選擇只好繼續使用(Sehra and MacMillan 2021)。對比傳統日本里山是由小農有智慧地利用自有土地和周圍自然環境發展而來，確保生物多樣性，並培養獨特的地方文化，如今日本農村社區面臨到更嚴峻的形勢，讓農民別無選擇，只好採用不同的經營策略、整併土地，還在重劃土地上進行標準化生產的機械化產

業(Fukamachi 2020)。從複作制度改為單一作物耕作，也因為農業機械化變得更加普及(Kohsaka et al. 2013)。現代化生產還涉及農地利用方式的轉變，在日本南部與田邊的梅林系統的案例中，隨著農民老化和國家農業部門的政策發展，農民偏好由挖填或稻田開發而成地形較平坦的梅園，致使傳統坡地型梅園荒廢面積大增，地方政府被迫人工造林烏岡櫟(Quercus phillyraeoides)，用作燒製木炭，再加上突如其來的崩塌，這一區塊的農民只好停止耕種，並改列為國有崩塌保護林(national landslide protection forest)，加速傳統耕作方式的轉移，威脅到梅園、森林和其他土地利用之間所形成動態土地利用系統之平衡(Hara et al. 2021)。日本滋賀縣大津市八屋戶的里山之中，水稻梯田的傳統石堤和土堤擁有悠久的歷史，只是1990年代起，為減少除草等改善工作卻造成大面積斜坡，並以混凝土取代多處傳統堤岸(Fukamachi 2020)。雖然基礎建設的改善有助於維持丘陵地、山區以及其他貧困地區的農業，但若將傳統農地和改善後相比較，現地觀察到的植物物種數量有顯著差異，生態價值大幅減少(Fukamachi 2020)。在農村地區，農業現代化和機械化造成單一種植，使得生物多樣性急遽減少(Kohsaka et al. 2013)。

1960年代以來，日本工業快速成長，創造眾多工作機會，吸引鄉村人口向都市集中，農村人口外移且平均年齡增長，農、林和漁業勞動力大幅萎縮(Kamiyama 2020)。Iwata et al. (2014)透過網路向未參與里山活動的人們進行調查，其中一則問題詢問「如果你想住在農村地區，你卻不能住在那裡，那會是什麼原因呢?」，統計前三名的答案分別為「無法離開目前的工作」、「購物選擇少」以及「沒有有興趣的工作」，這些都是很實際的考量因素，20到40歲年輕人也傾向於此。嚮往都市生活吸引日本年輕人遷往都市，很少年輕人願意待在偏遠地區從事低報酬的糧食生產，因此，出現日本人與糧食生產系統之間日益脫節的現象(Sehra and MacMillan 2021)。一項分析土地棄耕現象的研究指出，由於農村地區老年農民後繼無人以及人口衰減，這些因素導致水稻梯田生產不足(Sarker 2020)。在和歌山縣南部與田邊的梅林系統之中，隨著人口老化，愈來愈多的梅園不得不棄耕，地方林業部門已經開始在棄耕的山坡型梅園積極造林(Hara et al. 2021)。在日本關東、中部，以及中國、四國等一些區域，農地棄耕與坡度陡峭的稻田呈現正向關係，因為年老的農民實在是無法在陡坡上耕作，在福島縣偏僻地區，人口老化的效應日益擴大，農民坐擁過多的土地而無法經營，又沒有繼承人願意接手，只得繼續施灑化學品耕作(Sehra and MacMillan 2021)。儘管日本農業政策正透過補助、貸款和融資給予商業性農場，以解決勞力短缺的問題，但單靠這些並不能有效改變勞力結構或稻米生產的長期永續性(Sehra and MacMillan 2021)。Katayama et al. (2021)研究指出在支持鳥類多樣性的土地利用策略中，必須顧及到日本農民老化和人口凋零之社會生態因素，即使在一些平原地區，小面積農田的廢耕數量也在持續增加，建議將廢耕農田納入少有或沒有廢耕土地的生產地景之中，讓鳥類能在近似天然溼地的環境中棲息。此外，環境相關知識不易傳遞到農村，農民欲學習並力行有利於環境的作法，卻沒有一個知識交流的平台，一位里山研究員也證實這項問題，政府和農業主管常提及有機農業和生物多樣性非常重要，但農民卻不知道如何改善農業困境(Sehra and MacMillan 2021)。非市場食物的共享機制以及人與人之間連結正在衰弱，農漁村中年輕人不在，傳統知識(traditional knowledge, TK)與技能很難透過食物傳承下去，山林中可食用的植物數量銳減，歷史悠久的生活方式很可能瓦解，步步進逼社會–生態–生產地景與海景(Kamiyama 2020)。Kamiyama et al. (2023)分析兩次日本線上問卷調查資料後，亦有發現以年長參與者居多的相似情境，雖然不如一些研究預測非市場交易的家庭消費行為顯著衰退，但依舊不可掉以輕心，從長時間尺度來看，加上無積極配套措施，衰退趨勢仍會持續下去。上述的農業形勢，加上飲食西化(food westernization)，大多數民眾甚少食用本土生產的白米(Sehra and MacMillan 2021)，亦對里山中豐富的食物不感興趣，飲食習慣連帶影響人民的身體健康狀況，

尤其是以肥胖為首的慢性疾病(Kamiyama et al. 2023)。

1955年到1975年期間，日本工業蓬勃發展，經濟成長率維持在高點，吸引鄉村人口遷入都市尋求工作，短時間內都市容納龐大人口，尤其是日本東京、大阪和名古屋三大都市圈，內部土地不足，勢必向外擴張(Kohsaka et al. 2013)。隨著都市向外延伸，廣闊的里山被迫併入都市用地，興建成住宅區，而且土地所有權轉移給地方政府，居住在里山周遭的都市居民少有決策機會，可以說土地利用變遷消弭里山地景(Kamada 2018)。除了前述的農業集約化(agricultural intensification)，都市擴張通常被認定對生物多樣性會造成嚴重的威脅，特別是透過它們對地景破碎化的影響(Piras et al. 2022)。日本神奈川縣東部的橫濱市，是僅次於東京的第二大都市，在1970-1980年代經濟快速發展時期，橫濱市吸引大量外來人口，自然面積伴隨人口成長而減少，根據2013年橫濱市環境規劃局的統計數據，綠覆率從1970年50%迅速下滑至2009年29.8%，包含曾作為里山使用的綠地，有些因開發建設而消逝，只剩一部分被保留下來(Iwachido et al. 2020)。都市中農業用途類型，土地所有人用於農業生產至少一個世紀以上，林地以闊葉落葉樹林為主要植被，藉由疏伐來取得木材和木質燃料，以及透過除草來消滅限制作物生長的害蟲，呈現丘陵地與流水侵蝕的小溪谷地形，是典型的里山地景，如今則被併入都市地景之中，轉為公園、市民之林等其他用途，喪失里山原有的一些功能(Iwachido et al. 2020)。都市化削弱非市場食物供應的社區聯繫和共享機制，尤其是在建築密集的都市環境中，連帶影響預防未來社會經濟變化和自然災害的韌性(Saito et al. 2018)。人口高齡化的問題不只出現在鄉村里山，也是大都市和周圍郊區遇到的重要課題，該如何確保維持生態系服務生產的勞動力已成為當務之急(Kohsaka et al. 2013)。Shimpo (2022)回顧日本東京首都圈都市居民的里山保育活動，發現大多數參與里山活動都是60歲以上的退休人士，反之年輕人忙於工作和家庭生活，只能參與一日的行程，這樣高齡化的人口特徵對於例行性活動的永續性形成挑戰。Hino et al. (2023)評估80位參與者在生產性都市地景(PULs)中進行的五種活動對於促進身體活動的貢獻，從事里山林地活動者平均年齡為70.6歲，為五種活動類型中第二高，70歲以上的參與者經常造訪生產性都市地景，並在裡面活動一段時間，這不免得讓人憂心人口老化加劇，能夠擔任都市生產性地景經營人才日漸短缺。

近年來，全球氣候變遷已成為影響本土物種存在的關鍵因素，以及物種固有的平衡，因此也會使整個里山地景的生態系統產生轉變(Kohsaka et al. 2013)。外來物種可能趁著地景破碎或棲息地連接度降低而入侵里山，對生物族群產生深遠影響(Piras et al. 2022)。日本神奈川縣橫濱市自然為導向的公園中，研究者認為鋪設的人行道、遊樂場和休息區等人工建設，可能會增加外來種入侵的機率，然而經過現地調查和數據分析，與研究者原先的假設相反，在公園利用中，並未觀察到外來種因增加人工建築區域數量而入侵的現象，這跟公園是都市地景中干擾強度相對較高的自然化區域，以及原生植物物種互補棲位的佔據很有關係，因而侷限和防止生物入侵(Iwachido et al. 2020)。此外，挖填式梅園採用快速綠化的固氮植物，施行慣行農法也常使用這類用於綠肥和蜜源植物的外來種，但是再進一步比較傳統梅園的外來種，兩者之間並沒有達到顯著差異(Hara et al. 2021)。儘管上述兩個案例中，尚未出現外來種入侵的跡象，但仍不可不以為意，還需要更詳實的研究來釐清關聯性。另外，氣候變遷正影響著里山地景中野生動物友善耕作，未來可能會對日本稻米生產系統產生負面衝擊(Sehra and MacMillan 2021)。Sehra and MacMillan (2021)在福島縣、栃木縣和千葉縣進行實地考察，稻農表示氣溫「從來沒有這麼快就這麼高」，並表示天氣模式正迅速變化，這就需要將氣候變遷的影響納入政策分析及經濟評估之中，以支持里山地景永續地生產優質稻米。人類為因應氣候變遷，減少化石燃料的使用，改用再生能源，所需的能源用地卻漸漸地侵入里山。Piras et al. (2022)運用2002年和2021年圖層之間的交集分析得知，近20年間居久根與

其他小型樹林土地利用變遷十分細微，僅僅減少16.2公頃，值得注意的是減少的面積與太陽能電板擴張最有關連，佔消失面積的44%，其次才是農業擴張和都市擴張，分別佔22%以及11%。近期太陽能板發展也進入南部與田邊的梅林系統，將地表植被清除或農地棄耕，和歌山縣政府意識到危機，正積極推動法令，以避免梅園過度開發(Hara et al. 2021)。

結論與建議

結論

本研究在回顧近年來里山相關外文文獻的基礎上，擴展里山的見解，梳理里山發展脈絡。邁向下一個世代，在維持生物多樣性與自然對人類的貢獻(nature's contributions to people, NCPs)之下，吾人仍需要在里山環境中努力和學習，期待創造新價值。根據本研究的結果，得出以下幾項結論：

1. 人們普遍存有里山即是森林的刻板印象，其實在里山地景之中，森林與稻田、草原、湖泊、池塘等元素同樣重要，且不利於推動地景尺度下的環境保育，有必要透過里山環境教育，開拓人們對里山的認知。
2. 里山的動態馬賽克地景有賴於人為適度經營，盡可能避免農地廢耕，否則放任植生演替和野生動物激增之下，環境災害頻傳，生物多樣性將會持續減少。
3. 無論是鄉村地區、都市近郊，還是都市綠地空間，里山活動的參與者皆以老年人居多，意味著人口老化正威脅著里山，應以多元化的活動目的來吸引各個族群踴躍參加。
4. 年輕人是鮮少親近里山的族群，特別是都市中的學生，漠不關心身旁里山之美的文化價值，但同時他們也是極具潛力的族群，如何讓年輕一代重新加入日本農業生產系統之中，重新建立起人們和里山地景互動的關係，已然成為重要課題。
5. 災害時的韌性需要建立在平時合理使用里山自然資源，食物共享文化即是韌性的一環，像是這一類共享生態系統供給服務的智慧，它屬於一種抽象的概念，需要人們在日常生活中反覆實踐，方能流傳下來。

建議與限制

有關里山經營的建議，本研究借鏡國外里山實務經驗，嘗試融入臺灣本土特色，試想臺灣里山發展過程中，還有哪些不足之處，或是可以進一步改善之，就此提出三點建議：

1. 政府部門需要提出一個區域尺度之治理框架，在適度放寬法律規範之下，向里山經營者提供短、中期的經濟援助，例如補助、誘因、減免、低利率貸款等，先使里山有恢復的機會，才會有日後發展的可能性。另外，還需持續關注於里山中生產力較高的平地地區，這裡一旦形成荒廢閒置現象，是最不樂見的情況，若政府提供經濟誘因，有望讓農民恢復並維持最低限度的耕作。
2. 有鑑於當前里山活動參與者普遍高齡化，且偏遠地區甚至面臨勞動力短缺的困境，針對廣納里山活動之參與者，應該倡導學生和年輕人均是潛在族群。在臺灣「十二年國民基本教育課程綱要」(簡稱108課綱)之下，教師採以素養導向教學，而里山正是一項十分貼近在地生活的教學素材，舉凡融入地方學、各科學習內容、環境教育議題、戶外教育議題、探究與實作等等，旨在透過課程讓學生重新建立起與里山的關係。而教學上也不必捨近求遠，一味地前往那些知名的臺灣里山案例，例如新北市貢寮水梯田、屏東縣山區的家庭農園或花蓮縣豐濱鄉新社村森─川─里─海，反而是鄰近住家或學校的里山，才是契合里山倡議精神。另一方面，舉行里山活動不能只有宣傳環境保育而已，應該要標榜多元活動目的或形式，譬如攝影、素描、野餐、市集、輕旅行、手作課、森林療育、生態導覽等等，如此才會打動人心，大眾才更有意願參與，並提升對里山的認知。
3. 臺灣和日本的自然環境背景相似，山脈橫亙，地震頻仍，夏、秋季颱風侵襲，往往造成地方

上嚴重程度不一的環境災害，此時里山中的自然資源就能發揮功用，何處有野菜可以採摘，何處有薪材能夠生火，又何處能汲取乾淨水源，得以幫助受困居民短暫過活，是為災害韌性。只是災害韌性必需建立在平時活用這些自然資源，同時涉及到在地知識的流傳和應用，即居民時常修剪樹枝、蒐集肥料、共享食物或是修整水路，否則里山生態系統將面臨退化形式，還會削減人類福祉。

無可否認，本研究存在一些限制。首先，為了便於聚焦主題，在檢索相關文獻時，僅使用「里山」(Satoyama)一詞作為關鍵字，電子資源平台只會羅列出有描述到里山的文獻，由於有些屬於里山的研究，但某些研究者很可能不是直接使用里山一詞，而是使用傳統日本鄉村地景(traditional rural landscape in Japan or traditional Japanese rural landscapes)、傳統日本農村地景(traditional agricultural landscape in Japan or traditional Japanese agricultural landscape)、日本原始景觀(the original landscape of the Japanese)、馬賽克地景(a landscape with mosaics)或是社會一生態一生產地景與海景(socio-ecological Production Landscapes and Seascapes, SEPLS)等來論述分析，這些研究也跟里山密切相關。其次，本研究透過電子資源平台蒐集相關文獻，再經過挑選近期重要期刊文章後，難免會遺漏某些關鍵研究成果。最後，本研究挑選的文獻皆為英文撰寫，未使用日文書寫的文獻，建議欲向下鑽研里山的研究者，若是具備較佳的日文閱讀能力，不妨瀏覽日文書寫的文獻，會有更多的收穫。

引用文獻

Bhatt A, Kumar NA, Dhanya CS, Vipindas P. 2023. Restoring Rice Paddies and Rice Agro-Ecosystem Services Through a Participatory Seed Conservation and Exchange Programme. In: Nishi M, Subramanian, SM editors.137-155 Ecosystem Restoration through Managing Socio-Ecological Production Landscapes and Seascapes (SEPLS). Satoyama Initiative Thematic Review. Singapore: Springer Singapore. p. 53-74.

Dunbar W, and Yanagiya M 2024. Satoyama. In: Sarmiento FO, Gunya A, editors. Mountain Lexicon. Montology, vol 2. Cham: Springer Cham.

Fukamachi K. 2017. Sustainability of terraced paddy fields in traditional Satoyama landscapes of Japan. J Environ Manage 202(3):543-49. https://doi.org/10.1016/j.jenvman.2016.11.061

Fukamachi K. 2020. Building resilient socio-ecological systems in Japan: Satoyama examples from Shiga Prefecture. Ecosyst Serv 46:101187. https://doi.org/10.1016/j.ecoser.2020.101187

Hara Y, Oki S, Uchiyama Y, et al. 2021. Plant diversity in the dynamic mosaic landscape of an agricultural heritage system: The Minabe-Tanabe Ume system. Land 10(6):559. https://doi.org/10.3390/land10060559

Hino K, Yamazaki T, Iida A, Harada K, Yokohari M. 2023. Productive urban landscapes contribute to physical activity promotion among Tokyo residents. Landsc Urban Plan 230:104634.

Hirahara S. 2020. Regeneration of underused natural resources by collaboration between urban and rural residents: A case study in Fujiwara district, Japan. Int J Commons 14(1):173-90. https://doi.org/10.5334/ijc.977

Imai N, Otokawa H, Okamoto A, et al. 2023. Abandonment of cropland and seminatural grassland in a mountainous traditional agricultural landscape in Japan. Sustainability 15(10):7742. https://doi.org/10.3390/su15107742

Iwachido Y, Uchida K, Ushimaru A, Yokota S, Sasaki T. 2020. Nature-oriented park use of Satoyama ecosystems can enhance biodiversity conservation in urbanized landscapes. Landsc Ecol Eng 16:163-72.

https://doi.org/10.1007/s11355-020-00413-y

Iwata Y, Yumoto T, Morimoto Y. 2014. Can Satoyama Offer a Realistic Solution for a Low Carbon Society? Public Perception and Challenges Arising. In: Nakagoshi, NA, Mabuhay J, editors. Designing Low Carbon Societies in Landscapes. Ecological Research Monographs. Tokyo: Springer Japan.

Kamada M. 2018. Satoyama landscape of Japan—past, present, and future. In: Hong SK, Nakagoshi NA editors. Landscape Ecology for Sustainable Society Cham: Springer International Publishing. p 87-109.

Kamiyama C. 2020. Food Provisioning Services via Homegardens and Communal Sharing in Satoyama Socio-Ecological Production Landscapes on Japan's Noto Peninsula. In: Saito O editors Sharing Ecosystem Services. Science for Sustainable Societies. Singapore: Springer Singapore. p 35-53.

Kamiyama C, Hori K, Matsui T, Pretty J Saito O. 2023. Longitudinal analysis of home food production and food sharing behavior in Japan: Multiple benefits of local food systems and the recent impact of the COVID-19 pandemic. Sustain Sci 18(5):2277-91. https://doi.org/10.1007/s11625-024-01511-8

Katayama N, Mashiko M, Koshida C, Yamaura Y. 2021. Effects of rice-field abandonment rates on bird communities in mixed farmland–woodland landscapes in Japan. Agric Ecosyst Environ 319:107539. https://doi.org/10.1016/j.agee.2021.107539

Katsuda K, Saeki I, Shoyama K, and Kamijo T. 2022. Local perception of ecosystem services provided by symbolic wild cherry blossoms: toward community-based management of traditional forest landscapes in Japan. Ecosyst People, 18(1):275-88. https://doi.org/10.1080/26395916.2022. 2065359

Kohsaka R, Shih W, Saito O, Sadohara S. 2013. Local Assessment of Tokyo: Satoyama and Satoumi – Traditional Landscapes and Management Practices in a Contemporary Urban Environment. In: Elmqvist T, Fragkias M, Goodness J, Güneralp B, Marcotullio PJ, McDonald RI, Parnell S, Schewenius M, Sendstad M, Seto KC, Wilkinson C, editors. Urbanization, Biodiversity and Ecosystem Services: Challenges and Opportunities. Dordrecht: Springer, Dordrecht. p. 93-105.

Kovács B, Uchiyama Y, Miyake Y, Quevedo JMD and Kohsaka R. 2022. Capturing landscape values in peri-urban Satoyama forests: Diversity of visitors' perceptions and implications for future value assessments. Trees For People 10:100339. https://doi.org/10.1016/j.tfp.2022.100339

Kurniawan T, Kurniawan E. 2022. Policy on utilizing indigenous knowledge in critical land rehabilitation and fulfillment of sustainable food security in Indonesia: Regrowing "Talun-Kebun" as part of the local permaculture model in west java. Environ Sci Proc 15(1):2. https://doi.org/10.3390/environsciproc2022015002

Kweon D, Youn YC. 2021. Factors influencing sustainability of traditional village groves (Maeulsoop) in Korea. For Policy Econ 128:02477. https://doi.org/10.1016/j.forpol.2021.102477

Matsumura M. 2022. The Satoyama Movement and Its Adaptability: Beyond Ideology and Institutionalization. In: Miyauchi T, Fukunaga M, editors Adaptive Participatory Environmental Governance in Japan: Local Experiences, Global Lessons. Singapore: Springer Nature Singapore. p 67-92.

Maney C, Guaras D, Harrison J, et al. 2024. National commitments to Aichi Targets and their implications for monitoring the Kunming-Montreal Global Biodiversity Framework. npj Biodivers 3(1):6. https://doi.org/10.1038/s44185-024-00039-5

Nagao Y, Nishikori A, Imoto T. 2021. The

relationship between the conception of nature and environmental valuation. Sustainability 13(22):12683. https://doi.org/10.3390/su132212683

Nyongesa JM, Donatti CI and Kiptenai TK. 2023. Community-Based Rangeland Restoration for Climate Resilience and Pastoral Livelihoods in Chyulu, Kenya. In: Nishi M, Subramanian SM, editors Ecosystem Restoration through Managing Socio-Ecological Production Landscapes and Seascapes (SEPLS). Satoyama Initiative Thematic Review. Singapore: Springer Singapore.

Piras F, Fiore B, Santoro A. 2022. Small cultural forests: Landscape role and ecosystem services in a Japanese cultural landscape. Land 11(9):1494. https://doi.org/10.3390/land11091494

Ruiz-Labrador EE, Sánchez-Martín JM, Gurría-Gascón JL. 2023. The agritourism value chain: an application to the dehesa areas of extremadura. Agriculture 13(11):2078. https://doi.org/10.3390/agriculture13112078

Saito O, Kamiyama C, Hashimoto S. 2018. Non-Market Food Provision and Sharing in Japan's Socio-Ecological Production Landscapes. Sustainability 10(1):213.

Saito O, Subramanian SM, Hashimoto S, Takeuchi K. 2020. Introduction: Socio-ecological Production Landscapes and Seascapes. In: Saito O, Subramanian S, Hashimoto S, Takeuchi K, editors. Managing Socio-ecological Production Landscapes and Seascapes for Sustainable Communities in Asia. Science for Sustainable Societies. Singapore: Springer Singapore. p 1-10.

Sarker A. 2020. Economics of underproduction: A polycentric approach for a depopulated commons in Japan. Ecol Econ 171:106597. https://doi.org/10.1016/j.ecolecon.2020.106597

Sehra KK, MacMillan DC. 2021. Wildlife-friendly food requires a multi-stakeholder approach to deliver landscape-scale biodiversity conservation in the Satoyama landscape of Japan. J Environ Manage 297:113275.

Shimpo N. 2022. Urban ecological life in a metropolitan area—an insight from Satoyama conservation activities in the Greater Tokyo Area. Landsc Ecol Eng 18(1):109-19. https://doi.org/10.1007/s11355-021-00484-5

Terada T. 2020. Evaluating landscape improvement scenarios from the perspective of biomass production: a case study of peri-urban satoyama woodland in the Tokyo Metropolitan Area. Sustain Sci 15(5):1495-510.

Torralba M, Nishi M, Cebrián-Piqueras MA, Quintas-Soriano C, García-Martín M, Plieninger T. 2023. Disentangling the practice of landscape approaches: a Q-method analysis on experiences in socio-ecological production landscapes and seascapes. Sustain Sci 18(4):1893-906.

Xiang Q, Yuan Z, Furuya K, Kagawa T. 2022. Verification of psychophysiological effects of Satoyama activities on older adult volunteers and young people in post-COVID-19 society: A case study of Matsudo City, Japan. Int J Environ Res Public Health 19(17):10760.