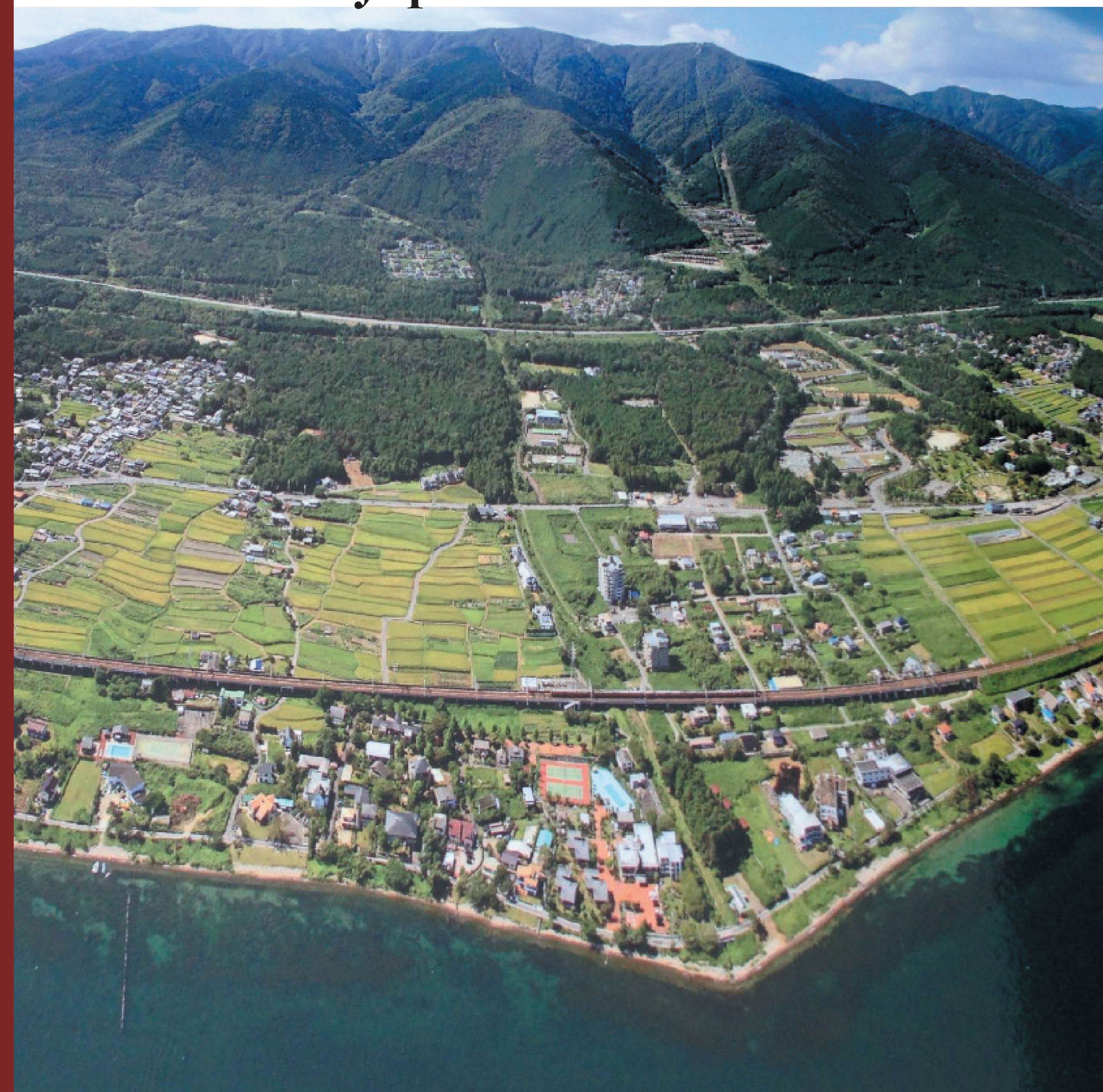
Eco-DRR as Learned from Local History

Traditional and Local knowledge of Eco-DRR from different locations of Japan



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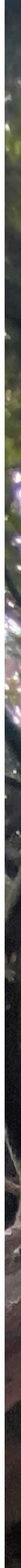
Research Institute for Humanity and Nature Eco-DRR Project

Eco DRR

Research Institute for Humanity and Nature
大学共同利用機関法人 人間文化研究機構 総合地球環境学研究所



Photo：MATSUI Koumei

Traditional and Local knowledge of Eco-DRR from different locations of Japan

Photo：FUKAMACHI Katsue

Foreword

Nature of Japan is inherently very rich. The climate and topography vary from place to place, and the four seasons are distinctly changing. The land and ocean are full of diverse ecosystems and habitats for a rich diversity of organisms. Our daily lives and society are based on the abundant blessings of this rich nature. On the other hand, nature can also bring disasters and other difficulties. The same nature can bring us both blessings and disasters. In each local community, knowledge, wisdom, and techniques to cope with various disasters and to utilize the abundant blessings have been accumulated and passed down as traditional and local knowledge by predecessors in each community.

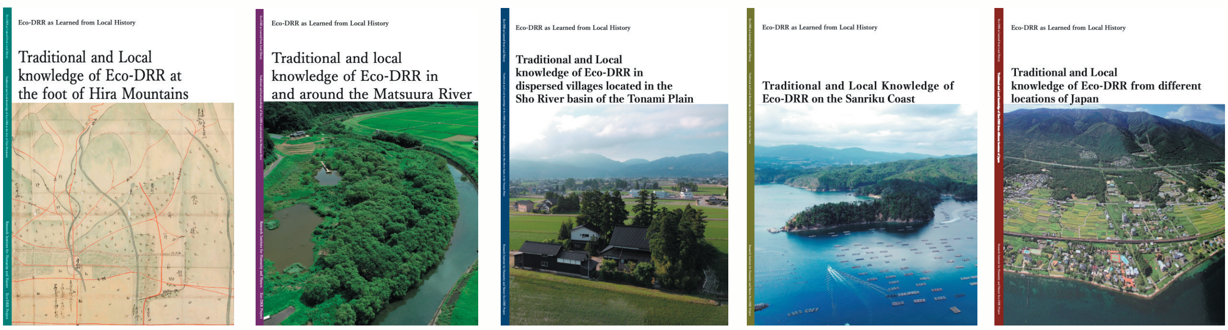
The traditional responses to disasters have been passed down all over Japan, and if we examine them carefully, we can find them accompanied by the abundant blessings that nature brings us as well. These responses to disasters are based on the deep understanding of the interlinkage between nature's blessings and disasters. We can see a way of living that accepts disasters while taking advantage of the blessings. This way of thinking, known today as Ecosystem-based Disaster Risk Reduction (Eco-DRR) or Green Infrastructure, has been a longstanding tradition in Japan. In the traditional disaster responses, careful consideration and creative measures have been taken to avoid losing the rich natural resources, based on a good understanding of where disasters occur and the characteristics of disasters.

The traditional responses to disasters have not only been used to avoid disasters and reduce damages, but also to recover and rebuild from disasters. Not only are the memories of recovery and rebuilding from past

All five volumes of the series "Eco-DRR as Learned from Local History" (Japanese edition) disasters embedded in traditional and local knowledge, but also such knowledge only survives if community development is seen as a long-term process. The recovery and rebuilding from disasters including the Great East Japan Earthquake teach us this point.

The many cases from around Japan covered in this series tell us about the importance of utilizing traditional and local knowledge to realize sustainable local communities. Unfortunately, however, traditional and local knowledge is being lost at an alarming rate. In order to successfully pass down traditional and local knowledge, we need to have the sensitivity to feel and accept the existence of nature's blessings and disasters, including those that are difficult to observe or invisible to our eyes. The shared sensitivity of individuals will build a common asset of traditional and local knowledge in each local community.

This book about traditional and local knowledge from various places of Japan constitutes the fifth volume of the series "Eco-DRR as Learned from Local History". We hope that the synopsis of the history of the relationships between people and nature presented in this volume will contribute to building the improved relationships in face of the current serious challenges of climate change and socioeconomic transformation. If this book can move us forward in the right direction even a little, the hard work of all those involved in its publication will be rewarded. Although we have a long way to go, steady progress is being made in this endeavor.



All five volumes of the series "Eco-DRR as Learned from Local History" (English edition)

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Research Institute for Humanity and Nature, and University of Tokyo

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【Case Studies from Around the Country】

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Traditional land use in the Tabashine mountain area, Iwate Prefecture

Tabashine mountain World Agricultural Heritage Recognition Promotion Council
SATO Masumi

The Tabashine Foothills area is a farming community located in the south of Iwate Prefecture, straddling the three cities and town（Figure 1）.

Our ancestors in this region have residential a unique land use system based on a spirit of cooperation and mutual aid to protect life and livelihood against natural disasters such as floods and droughts.

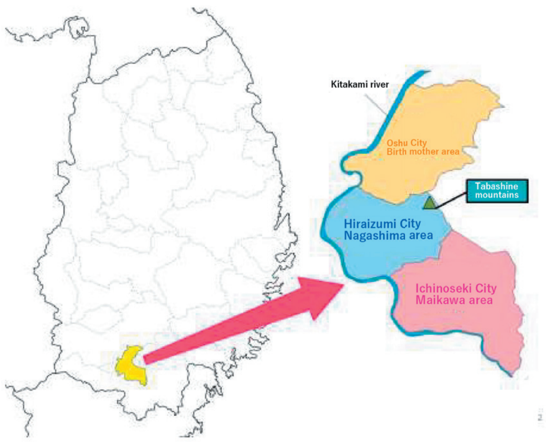


Figure 1: Location of the Tabashine Mountain Foot Area

Regional overview

The Tabashine Foothills area includes Tabashine Mountain to the east and the Kitakami River, the largest river in the Tohoku region, flowing through it to the west. The area is about 6 km from east to west, and consists of low-lying areas, foothills, and mountainous areas. The villages that serve as centers of daily life are located in the foothills (Figure 2).

Hiraizumi, registered as a World Heritage Site, is located across the Kitakami River, and there are many shrines, temples, and cultural traditions in the area that indicate the relationship with the Oshu Fujiwara clan.

Risk diversified land use

The people of the Tabashine Mountain area have long lived in the foothills of the mountain. Due to topographical factors, flooding damage caused by typhoons and heavy rains occurs once every two years, and there is also the risk of sediment

Figure 2: Kitakami River and the Tabashine foothills area

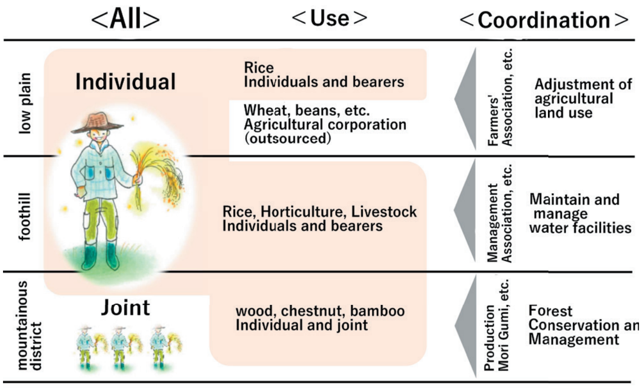


Figure 3-1: Land Ownership and Use (Individual: Pink)

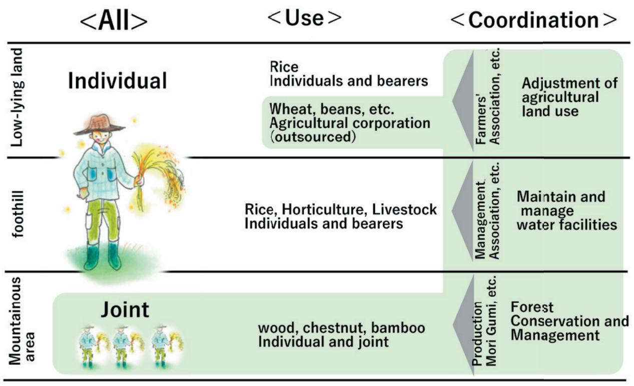


Figure 3-2: Land Ownership and Use(Joint : Green)

disasters. The foothills have also suffered from droughts due to the lack of powerful water sources.

In order to minimize the impact of these natural disasters and to secure food and income, the community has jointly managed the reservoirs and forests that are necessary for livelihood and farming. They have also residential a land use system that disperses multiple disaster risks by owning farmland in both the foothills and low-lying areas, and by devising ways to manage their farms. This system is supported by the spirit of cooperation and mutual aid that has been nurtured by the activities of local people.

Land ownership and use

This section describes the "land ownership and use" system that forms the foundation of the system in the Tabashine Foothills area.

As shown in pink in Figure 3-1, while "land ownership and use" is based on the individual, the region has a system of joint and mutual assistance that supports three dimensional land use, which extends from the mountains to the lowlands

Table 1: Three water-related disasters

	Disaster	Counter-measure	Support
Low-lying land	Flooding	Avoid Water	· Diversify farmland ownership · Avoid flood periods · Choose where to plant
Foothill	Drought	Conserve Water	· Preserve reservoirs and waterways · Do not waste water · Share water equally
Mountains	Landslides	Protection from Water	· Forest Preservation · Planting trees in hazardous areas

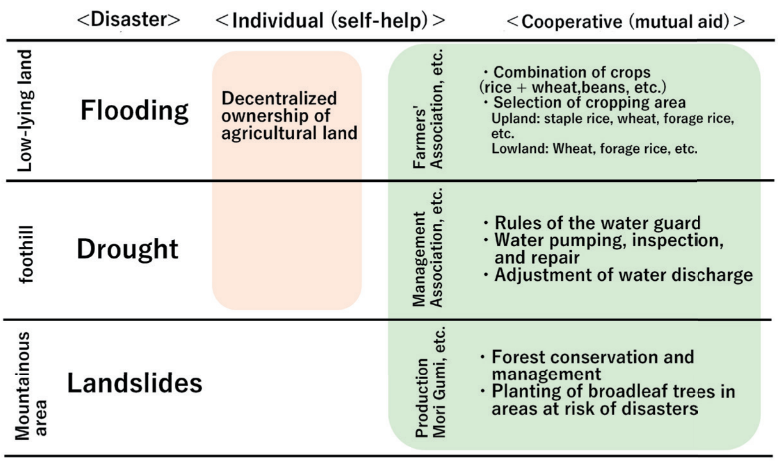


Figure 4: Layered Risk Diversification

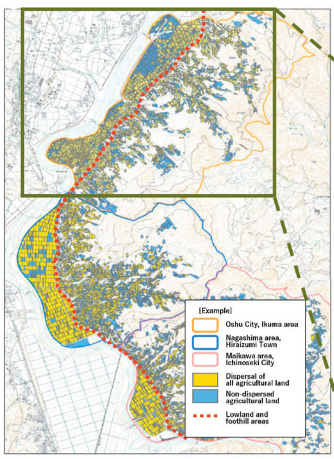


Figure 5: Dispersed ownership of farmland

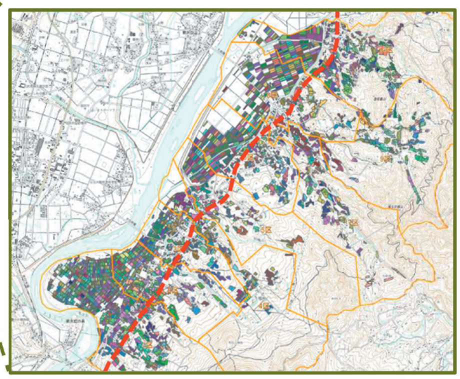


Figure 6: Graphical representation of dispersed ownership of all farmers (example of Seibo district, 8 Oshu City)

of the Tabashine Foothills region.

As shown in green in Figure 3-2, the farmers' cooperative is responsible for coordinating the use of farmland in the low-lying areas, while agricultural corporations are in charge of shifting crops such as wheat and beans. In addition, water utilization

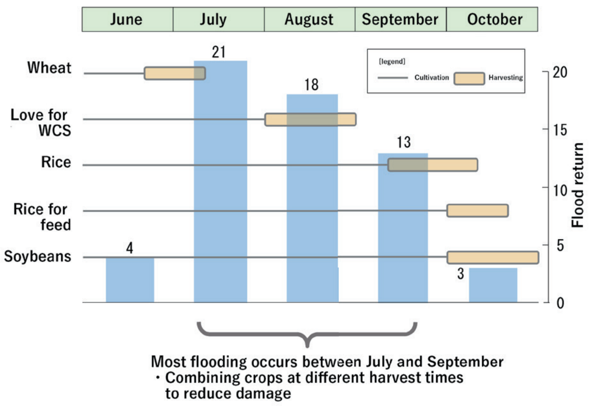


Figure 7: Combination of crops at different harvest seasons

Photo 1: Flooded soybean field in July 2020

Photo 2: Flood conditions during the July 2002 flood (low-lying (alluvial) areas in the region were almost completely inundated)

facilities such as reservoirs in the foothills and forests in the mountains are jointly managed under the awareness that they are common property of the community. In this way, a variety of cooperative and mutual aid mechanisms make the land use in this region three-dimensional.

Disaster risk diversifi cation

(1) Disaster risks in the region

There are three disaster risks in the Tabashine foothills area (Table 1). All of them involve water, but their countermeasures are very different from each other: "avoid water" for flood damage, "conserve water" for drought, and "protect from water" for sediment disasters.

(2) Disaster risk diversifi cation

Disaster risk diversification can be done through individual and joint efforts. As shown in the pink portion of Figure 4, the diversified ownership of farmland is an individual initiative, where farmland is owned both in low-lying areas that are at risk of flooding but still profi table, and in foothill areas that are not at risk of flooding.

The green area in Figure 4 is a joint effort. In the low-lying areas, the agricultural corporations are preparing for flood damage by devising combinations of crops and planting locations.

In the foothill areas, the reservoir management association inspects and repairs reservoirs, and in the mountain areas, the production forestry association protects forests in disaster-prone areas to prepare for drought and Sediment disaster disasters.

In this region, there is a joint mechanism to support individual three-dimensional land use as explained in Figure (3), and furthermore, as shown in Figure (4), a powerful feature of this region is the "multilayered" risk dispersion to cope with each disaster.

a. Dispersed ownership of farmland by individuals

Figure 5 shows the status of dispersed ownership

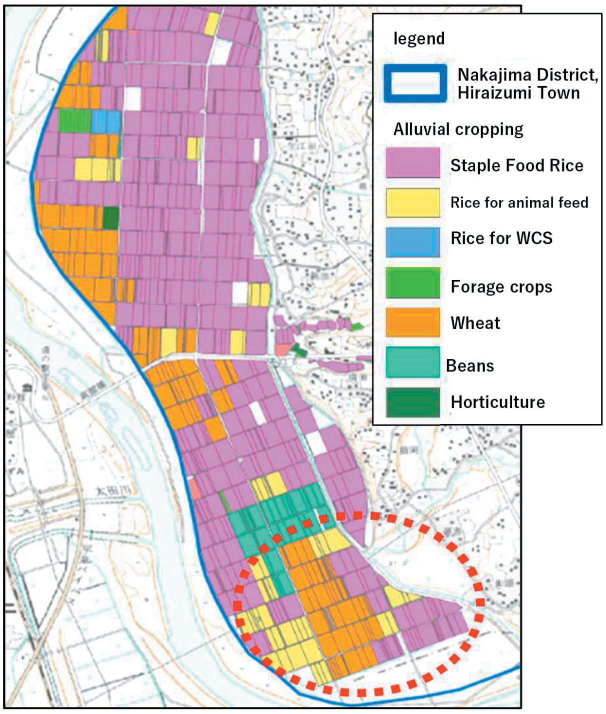


Figure 8: Cultivation of low-lying areas (Hiraizumi Town, Nagashima District)

of farmland in the region as a whole. Yellow is farmland under dispersed ownership. The left side of the red dotted line is low-lying land and the right side is foothill land. Eighty-seven percent, or about 90 %, of the farmers who own farmland in low-lying areas also own farmland in the foothills.

In the case of the Seibo district of Oshu City, 352 households own farmland scattered throughout the district.

(a) Risk diversifi cation through joint efforts
(i) "Avoiding water" in low-lying areas
Figure 7 shows, by month, the number of floods as light blue bars, and by crop, the harvesting period as orange squares.

Most of the floods occur between July and September (Photo 1 and 2), and crops with diff erent harvesting periods are combined in order to limit damage (*Flood frequency is the number of flood damages by season since the Meiji era).

Figure 8 illustrates the cropping situation in lowlying areas. As shown in photo 3, when flooding occurs, the floodwaters inundate from low lands downstream. Such land is planted with wheat and feed rice, which can be harvested without the risk of floods.

For shifting crops other than rice for staple food, the contracted agricultural corporation disperses the risk of flood damage by devising the combination of crops and planting locations.

(2) "Protecting Water" in the Foothills
There are approximately 900 reservoirs in the foothills of the mountains, and many of them are distributed around farmland, as shown in Photo 4.

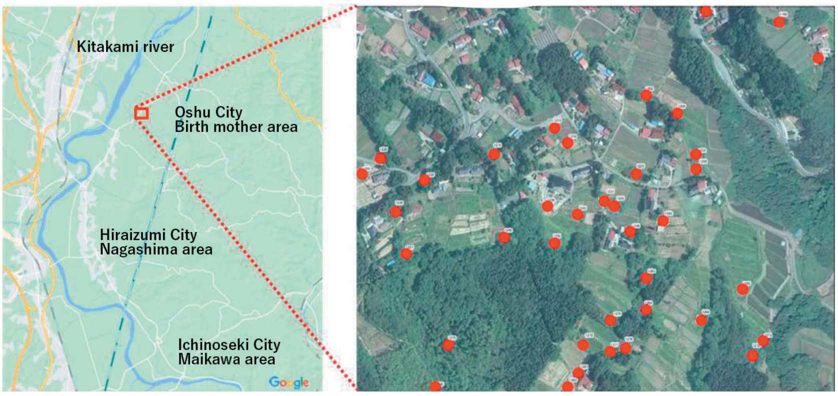
Figure 9 shows a color-coded map of water sources in the current farmland. In the foothills, there are many water sources such as springs, streams, and reservoirs, which are color-coded in light blue, and the local people are jointly responsible for the maintenance and conservation of water facilities.

As a response to drought conditions, the reservoir is inspected and repaired by the local beneficiaries to ensure that there are no leaks, as well as to improve the flow of water. (Photo 5).

Low lands that are flooded with water are planted with wheat, forage rice, etc., instead of rice for staple food.

Photo 3: Flood conditions (low-lying area in the island district in October 2022)

3) "Protection from water" in mountainous areas
Figure 10 shows a hazard map of the Seibo district of Oshu City, where the red areas are special Sediment disaster hazard areas. The Seibo Production Forest Cooperative in the same district is cutting down cedar trees in the upstream area



*Reservoir (●)

Photo 4: Location map of reservoirs (part of Seibo district in Oshu City is extracted)

and planting broadleaf trees with extensive roots (Photo 6). The community jointly manages the forest and "protects it from water," thereby preventing sediment disasters.

In this way, wisdom to protect life and livelihood based on years of experience has been passed down to the present as traditional knowledge.

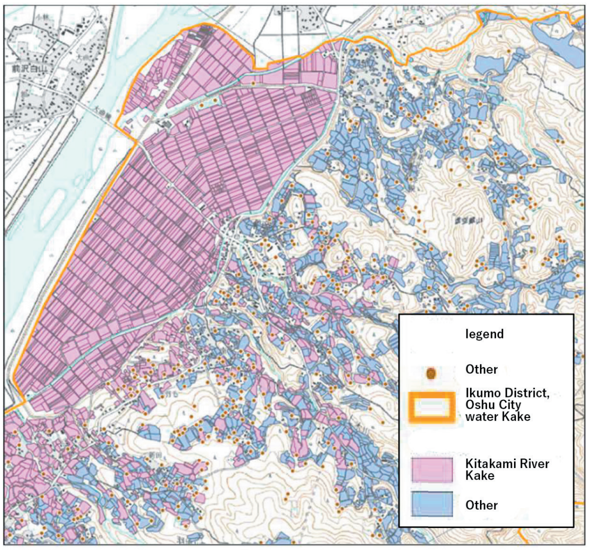


Figure 9: Current water benefit chart (a portion of the Seibo district of Oshu City was extracted.)

Photo 5: Inspection and repair of waterways

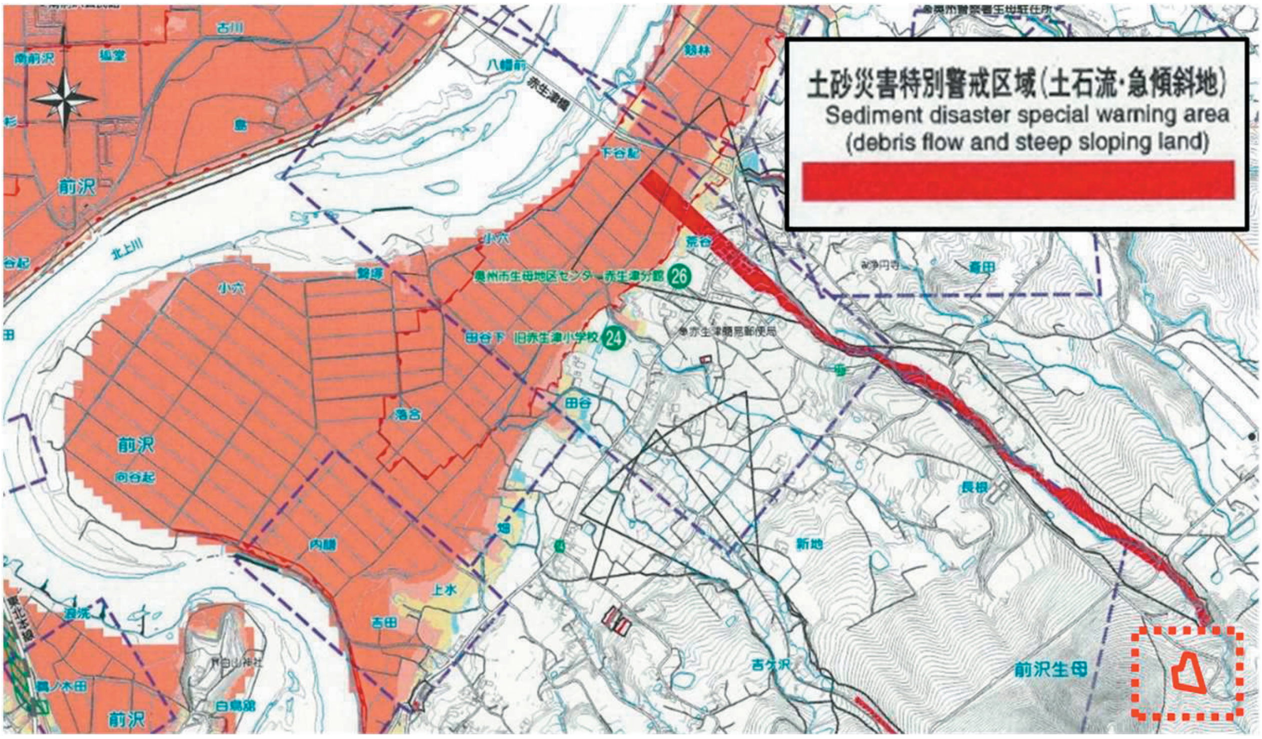


Figure 10: Location map of the special Sediment disaster hazard warning area and Irohamomiji Forest (part of the Seibo district of Oshu City is extracted) *The red dotted line indicates the Irohamomiji Forest.

Photo 6: Iroha maple forest

In the foothills, he grows rice and vegetables for his own use, and in the mountains, he makes an occasional income from thinning cedar trees to produce timber. Mr. M's land use is supported by a farming corporation and a farmers' cooperative in the low-lying areas, and by a farmers' environmental conservation association in the foothill and mountain areas, which he represents.

Example of Mr. M, a dual-income farmer (Figure 11)

Mr. M is a fifteenth-generation dualincome farmer who has lived in the
foothills of the mountain. In addition to growing rice for sale on his low-lying land, he also grows wheat on consignment for an agricultural corporation.

If flood damage occurs due to heavy rainfall, food can be secured in the foothill areas. In the event of a drought, there are low-lying areas (Figure. 12). Owning multiple agricultural lands in a threedimensional manner minimizes damage, but it is also because of the joint support system that individual three-dimensional land use can continue.

History of risk diversification

The current system of land use with risk diversification has been passed down through the

	<Disaster>	<Individual (self-help)>	<Cooperative (mutual aid)>	
Low-lying land	Flood	70a (Rice) 5a (Wheat)	Farmers' Association, etc.	· Combination of crops (rice + wheat,beans, etc.) · Selection of cropping area Upland: staple rice, wheat, forage rice, etc. Lowland: Wheat, forage rice, etc.
foothill	Drought	140a (Rice) 19a (Vegetables)	Management Association, etc.	· Rules of the water guard · Water pumping, inspection, and repair · Adjustment of water discharge
Mountainous area	Landslides	100a (Cedar)	Production Mori Gumi, etc.	· Forest conservation and management · Planting of broadleaf trees in areas at risk of disasters

Figure 11: Case study of Mr. M, a dual-income farmer

	<Disaster>	<Individual (self-help)>	<Cooperative (mutual aid)>	
Low-lying land	$\boxed{\text{Flood}}$	~~70a (Rice)~~ ~~5a (Wheat)~~	Farmers' Association, etc.	· Combination of crops (rice + wheat,beans, etc.) · Selection of cropping area Upland: staple rice, wheat, forage rice, etc. Lowland: Wheat, forage rice, etc.
foothill	Drought	140a (Rice) 19a (Vegetables)	Management Association, etc.	· Rules of the water guard · Water pumping, inspection, and repair · Adjustment of water discharge
Mountainous area	Landslides	100a (Cedar)	Production Mori Gumi, etc.	· Forest conservation and management · Planting of broadleaf trees in areas at risk of disasters

Figure 12: In the event of flood damage

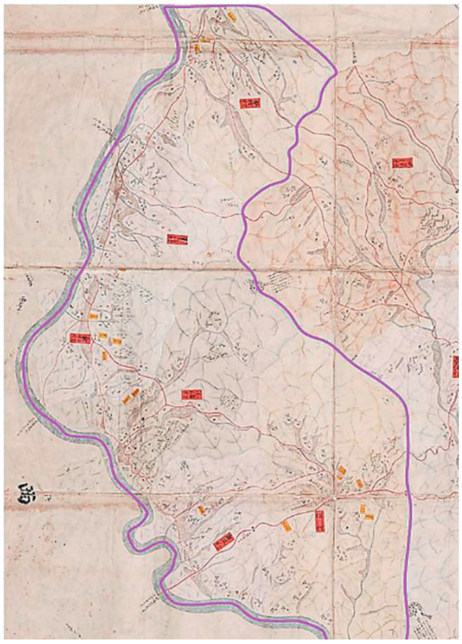


Figure 13-1: The area in the frame (in pink) is Tanashibe Foothills area 13-1 Higashiyamabunkenezu (1698 (Genroku Higashiyama-bunken-ezu, dated 1698 (Genroku 11))

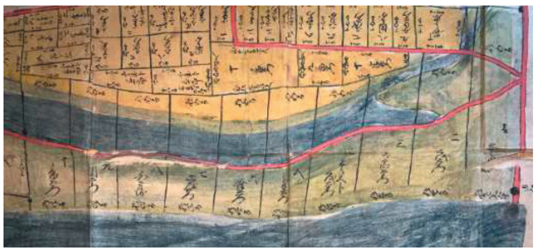


Figure 13-2: Cultivated land in low-lying areas (1731)

Table 3: Old family land holdings with roughly 100 years of succession

Region	Name	Low-lying land (Alluvial)	foothill(Mid-mountainous area)	Mountain
Ichinoseki City Maikawa area	A氏	和田62-3　他２筆	境40　他３筆	境37-1　他８筆
	B氏	西中島157　他１筆	平90-1	平70　他４筆
	C氏	河岸2-1　他11筆	河岸19-2　他４筆	河岸19-1　他９筆
	D氏	土橋77-1　他９筆	山根114-5　他６筆	湯坪45-2　他１筆
	E氏	－	平石23　他９筆	水無沢59-2　他21筆
Oshu City Birth mother area	F氏	－	笹森98　他８筆	笹森102-1　他３筆
	G氏	－	長根19-1　他５筆	－
	H氏	－	下沢田5-1　他４筆	天王27-1　他１筆
	I氏	上谷起109　他１筆	壇ノ腰37-1　他８筆	下沢田34-3　他４筆
	J氏	－	北羽毛71-11　他24筆	北羽毛71-1　他７筆
	K氏	中道186-2	市ノ渡144-2　他５筆	市ノ渡70
	L氏	－	地蔵壇42	－
	M氏	－	地蔵壇18-53　他15筆	地蔵壇18-3　他２筆
Hiraizumi City Nagashima area	N氏	字沢口67　他１筆	字柳沢15　他２筆	字前林55　他１筆
	O氏	字下古川31-1　他７筆	字二反田68　他２筆	字月舘73-1　他２筆
	P氏	字里前82　他３筆	字滝ノ沢52　他４筆	字滝ノ沢52-3　他２筆
	Q氏	字里82　他３筆	字竜ヶ坂50-2　他１筆	－
	R氏	字菊の沢49　他９筆	字矢崎44-1　他１筆	字石合43　他３筆
	S氏	字出谷起170	字下田21-ア　他２筆	字小倉39
	T氏	字覆盆子77　他９筆	－	字大槻田2-7　他２筆
	U氏	－	－	字大槻田3-1　他１筆
	V氏	字中島16　他４筆	字田頭2	－

The 22 old houses were identified and confirmed in the old land registry and closed registry at the Legal Affairs Bureau.

ages.

(1) Coordination of agricultural land use
Figure 13 is a pictorial map drawn in the 17th and 18th centuries, and shows that about 300 years ago, the use of agricultural land was coordinated on a village or hamlet basis.

(2) Land ownership
Table 3 summarizes the status of land ownership with more than 100 years of inheritance, by extracting old family properties that have continued for more than 10 generations, indicating that they have owned land in each area for a long time.

(3) Use of reservoirs, terraced rice paddies, and forests
Reservoirs and forests are also described in old pictorial maps (Figure 14). Many of the reservoirs in the Kanayama terraced rice paddies, which remain as they were in the Edo period, have been inherited and are still being used today (Photo7).

The concept of "Ohayashi," a public interest initiative by the Sendai clan to manage and protect forests, and "Iriasoyama" as common property, has been inherited to this day. Photo 8 shows the list of the association that managed the common kayano. This association has changed its name to the Production Forest Association, and is still engaged in conservation and management of the forest.

Joint and mutual aid supporting the system

The spirit of community and mutual aid that has

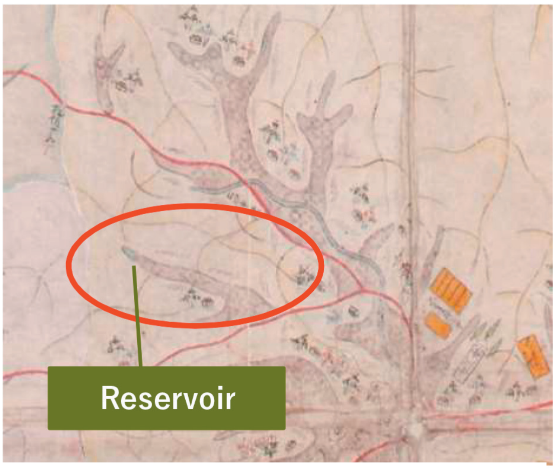


Figure 14-1: Inside the circle: Kanayama terraced rice field area (Higashsoyama Minute Map)

Figure 14-2: Ennai: Ohayashi (Illustration of Higashsoyama Minute)

Photo 7: Reservoirs and terraced rice paddies are still being inherited today (Kanayama terraced rice paddies)

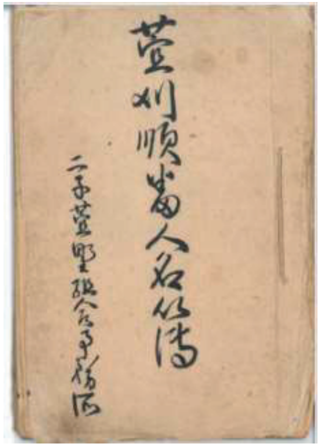


Photo 8: Kayakari orderly person list (Futago Kayano Kayakari Orderly Person List Association)

preserved the community and cultural traditions while cherishing the relationship with the Hiraizumi culture under the harsh conditions of frequent natural disasters is the foundation that supports the system in the Tabashine Foothills area (Photo 9).

Recognition as "Japan Agricultural Heritage*" (January 2023)

In January 2023, the area was recognized as a "Japanese Agricultural Heritage Site" for its highly resilient land use system that has been passed down for over 300 years, which is based on the decentralized ownership of farmland by individuals and the traditional management of common forests, reservoirs, and waterways by local community organizations. In January 2023, it was recognized as a "Japan Agricultural Heritage Site" for its "disaster riskdispersive land use system in the Tabashine
Mountain Foothills area.

The Tabashine Foothills area has the following characteristics.

(1) Food and Livelihood Security (Figure 15)
Over the years, the combined farming system combining rice and commodity crops has been inherited and food and livelihood security has been maintained.

ききもせず　束稲山の　さくら花
吉野の外に　かかるべしとは
（西行法師：山家集）

国破れて山河あり、城春にして草青みたりと、
笠打敷て、時のうつるまで泪を落し侍りぬ
（松尾芭蕉：奥の細道）

Formerly a joint effort (tying together) Historic sites related to rain-making Traditional Folk Performing Arts

Photo 9: Joint and Mutual Assistance Supporting the System

	Feudal era	Feudal era～Showa period	Late Showa～Present
Low flat land (alluvial land)	● Hemp ● Mulberry (seric ulture)	● Rapeseed	● Rice ● Wheat・Beans ● Rice for feed
Foothills (mountainous areas)	● Rice ● Wheat and beans ● Mulberry (seri culture) ● Tobacco		● Vegetables ● Apple ● Livestock
Mountainous Areas	● Wood and bamboo ● Firewood ● Bamboo shoots and chestnuts		

Figure 15: Transition of agriculture and forestry in the Tabashine Mountain Foothills

(2) Maintenance of Diverse Ecosystems (Photo 10)
The area is home to more than 660 species of plants and animals, including rare plants and animals designated as endangered species by the Ministry of the Environment and the prefecture.

(3) Characteristic Landscape (Photo 11)
The land use system that people have developed over a long period of time while dealing with natural disasters has created a distinctive landscape. The land has been used as a symbol of the region in Japanese poetry since ancient times.

(4) Contribution to Solving Contemporary Issues
Land use systems that protect lives and livelihoods from natural disasters are also expected to be highly resilient to socioeconomic changes and contribute to solving issues such as sustainable food production and biodiversity conservation.

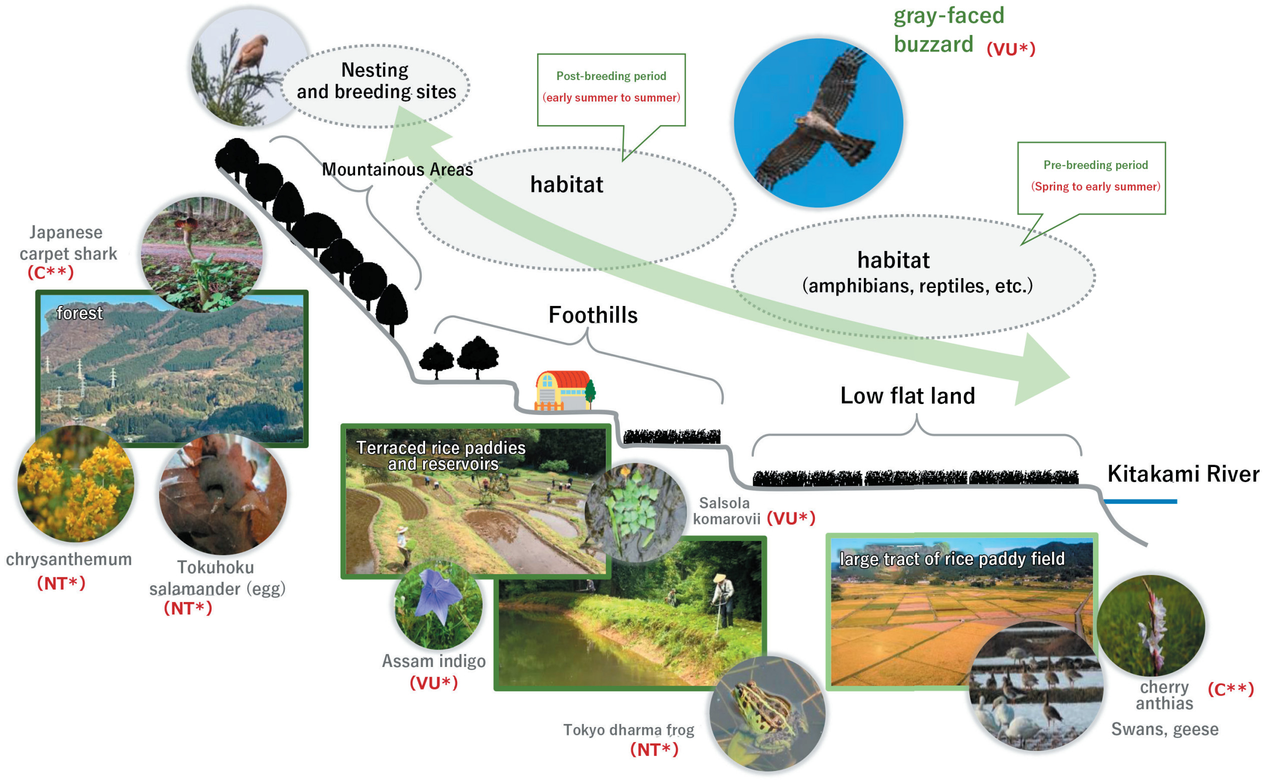


Figure 16: Diverse ecosystems nurtured by the region

Photo 10: Characteristic landscape created by three-dimensional land use

Connecting to the Future

We will share widely the historical value and contemporary significance of the land use system that our predecessors inherited, protecting lives and livelihoods from disasters in a spirit of cooperation and mutual aid, and together with the local people, we will connect this "model of sustainable agriculture and forestry in mountainous areas" to the future.

※ Japan Agricultural Heritage is an important traditional agriculture, forestry, and fisheries model (agriculture, forestry, and fisheries system) in Japan that integrates a unique traditional agriculture, forestry, and fisheries industry. It has been passed down over generations while adapting to society and the environment, and the culture, landscape, seascape, and agricultural biodiversity which are closely interrelated.

Flood damage response and land use change in the middle reaches of Tone River and Arakawa River

FUKAMACHI Katsue
WANG Wen
XIE Yusong
Kyoto University

Photo 1: People evacuated to a levee during flooding (cited from "Saitama Flood Damage in 1947: Annexed Photo Book")

Introduction

The Tone River and the Arakawa River are class A rivers that flow through the Kanto Plain. the Tone River currently has moved its mainstream from the Kazo Lowland to the lower Kinugawa Lowland, with a trunk river channel extension of 322 km and a basin area of 16,840 ㎢. The Arakawa River flows from the Arakawa lowlands to the Tokyo lowlands, with a trunk river channel extension of 173 km and a basin area of 2,940 ㎢.

Both rivers have played an important role in social and economic activities as water sources for the Tokyo metropolitan area, but they have a long history of hardship in dealing with flood damage over the years. For example, the August 1910 flood overflowed the middle and lower reaches of Tone River, Agatsuma River, Karasu River, Watarase River, Arakawa River, and other low-lying areas over a wide area. In addition, the damage caused by river flooding from Typhoon Kathleen in September 1947 was enormous. Photo 1 shows people in Kurihashi, Kuki City, Saitama Prefecture, was evacuating on a levee or moving by Lifting Boats, as shown in the "Saitama Flood Damage in 1947: Annexed Photo Book".

Topography of the middle reaches of Tone River and Arakawa River

The Flood Control Topographic Classification Map (prepared by the Ministry of Land, Infrastructure, and Transport) shows detailed topographic classifications such as fans, natural levees, old river channels, and hinterland wetlands, as well as embankments, to promote flood control measures. The Flood Control Topographic Classification Map enables us to understand how the land is formed and to estimate the risk of natural disasters such as floods and earthquakes that may occur there.

The Flood Control Topographic Classification Maps (Figure 1) of the middle reaches of Tone River and Arakawa River show that there are natural levees (micro elevations) along the rivers, flood plains and hinterland wetlands on both sides of the rivers. Most of the areas where the majority of the population and assets are concentrated are located on plains, and most of these plains are sedimentary plains formed by sand and gravel carried by rivers. The terrace surfaces of the plateaus and terraces are widely distributed between and near rivers. The old river channel before Tone River and Arakawa River were largely repaired meanders, and embankments and reclaimed lands, which are man-made modified landforms, are dispersed throughout

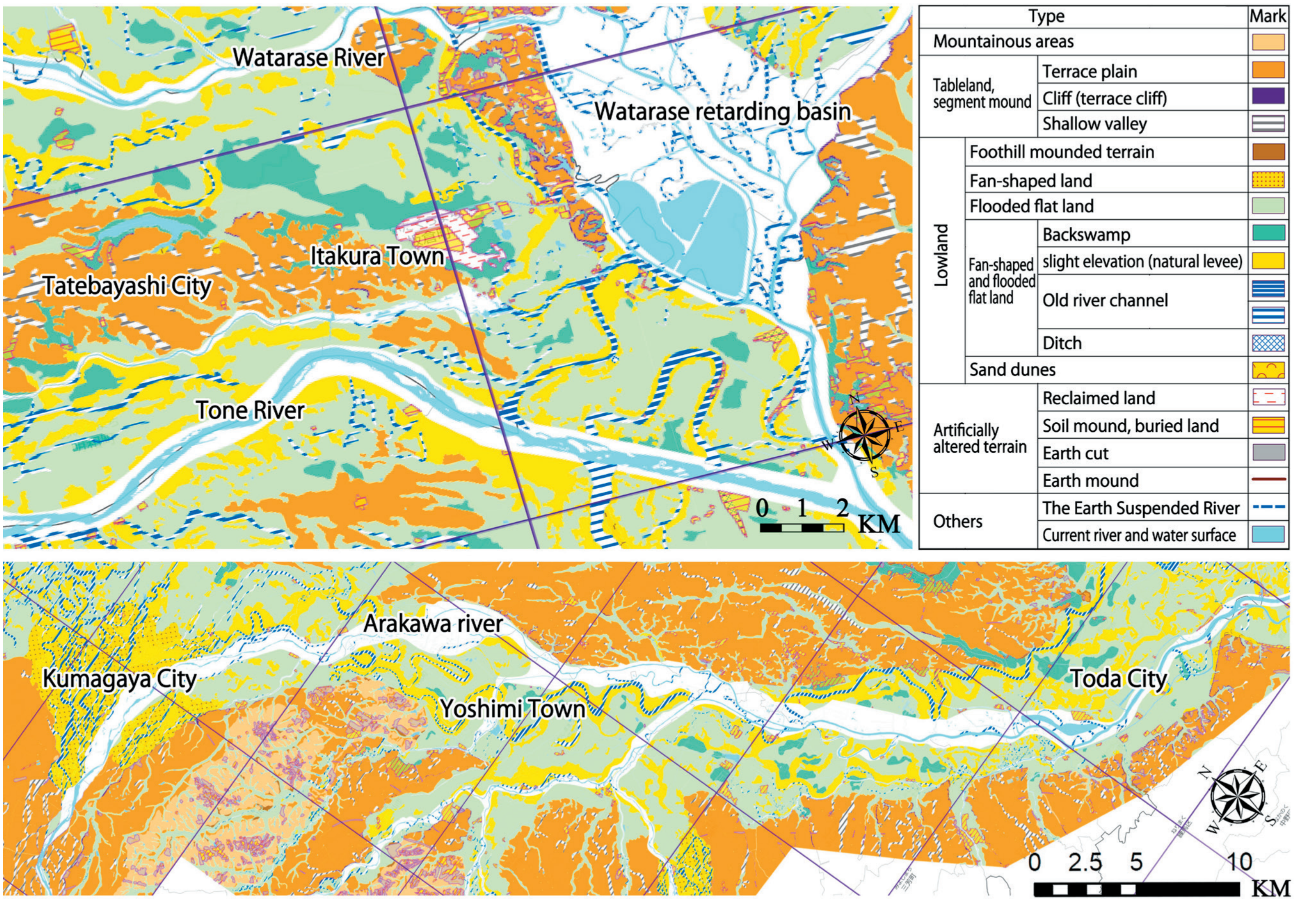


Figure 1: The Flood Control Topographic Classification Map of the middle reaches of Tone River (top) and Arakawa River (bottom) (based on the map made by GSI)

the area. In the middle reaches of Arakawa River, there are mountains and cliffs (terrace cliffs), and the topography varies greatly, with an alluvial fan in Kumagaya City.

Flood damage response in the middle reaches of Tone River and Arakawa River

Before modern times, the Tone River and the Arakawa River joined in the central part of the Kanto Plain and flowed into Tokyo Bay. In the Edo period, projects to control both rivers, which repeatedly overflowed and ran turbulently, and to promote water utilization progressed. For example, the "eastward shift of the Tone River" and "westward shift of the Arakawa River" were carried out to protect against flooding in Edo, develop new paddy fields in the Kanto Plain, and develop boat transportation. After the Meiji period (1868-1912), river improvement projects were carried out on both rivers, and levees were constructed to enclose large areas, including arable land. The low marshy areas in the middle reaches of Tone River and Arakawa River were transformed into the breadbasket areas, and the mass transportation of goods by boat supported the prosperity of the large city of Edo, while the development of Edo improved the lives of the villages in the hinterland.

However, when the water rises above the height of the levees and breaks through them, the above-mentioned communal defenses are not enough to deal with the situation. In areas where floods have frequently occurred, flood damage responses were taken at the residential level, such as flood prevention architecture and premises forests. Flood prevention architecture is a general term for houses, warehouses, and storehouses built on raised and cleared land, such as *Mizuka* and *Mizuya*, which are found in flood-prone areas. In the lowland areas of the middle reaches of Tone River and Arakawa River, flood plains and hinterland wetlands, flood prevention architecture has developed in the form of flood mounds, which are composed of embankments and buildings built

Photo 2: House with *Mizuka* and premises forest in Kitakawabe, Kazo City (May 2022)

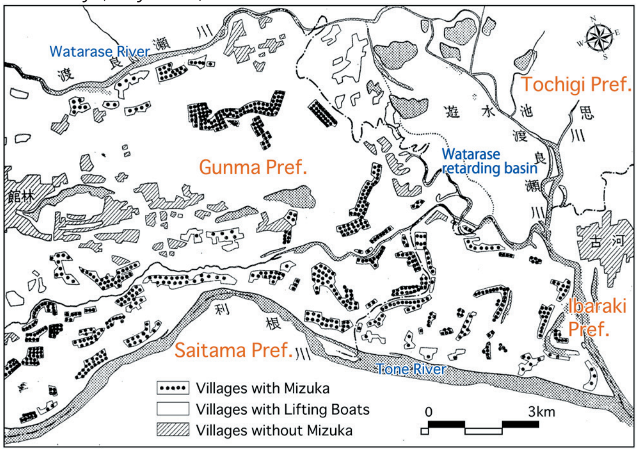


Figure 2 Distribution of *Mizuka* near the confluence of tTone River and Watarase River (Sato 1963)

on top of them. A premises forest is a group of trees that delineates the boundaries of a farmhouse and is arranged in one or more directions around the house. In addition to fulfilling functions such as windbreak, flood prevention, snow protection, and fire prevention, they are closely related to the lives of residents as a source of materials and fuel and are also positioned as an important element of the landscape and habitat for animals and plants. Photo 2 shows a house with a *Mizuka* and a premises forest in Kitakawabe, Kazo City, Saitama Prefecture, located in the middle reaches of Tone River.

Distribution of *Mizuka* and premises forests in the middle reaches of Tone River and Arakawa River

Figure 2 shows the distribution of *Mizuka* near the confluence of Tone River and Watarase River. This area is a plain sandwiched between the main stream of Tone River and Watarase River. There are villages with *Mizuka* not only along the Tone River, but also distribute in the areas a little away from the river, such as Itakura Town, Meiwa Town, Tatebayashi City in Gunma prefecture and Kazo City in Saitama Prefecture. Villages with Lifting Boats are distributed in areas such as the vicinity of the Watarase retarding basin. Figure 3 shows the distribution of *Mizuka* in the middle reaches of the Arakawa River. *Mizuka* are distributed in many cities, towns, and villages from Kumagaya City, Saitama Prefecture in the north to Konosu City, Yoshimi Town, Kawashima Town, Kawagoe City, Shiki City, and the southern part of Kita Ward, Tokyo. In Yoshimi Town, Kawashima Town, and Shiki City, levees were constructed and *Mizuka* were provided to reduce flood control.

When superimposed on the Flood Control Topographic Classification Map (Figure 1), it can be seen that *Mizuka* in the middle reaches of Tone River and Arakawa River are clustered together in the lowland areas. In the lowland areas within Tone River basin and Arakawa River basin, natural levees formed by the former rivers existed in rows, and many residences with *Mizuka* were located on of these natural levees. Traditional settlements are thought to have been formed around natural levees and other lowlands in order to cope with flood damage.

Looking at the distribution of premises forests in the middle reaches of Tone River, in areas such as Itakura Town and Hanyu City, Saitama Prefecture, most premises forests have been located on the north and west sides of houses because of the strong winter pressure pattern and the northwest monsoon that prevails over the Kanto Mountains and onto the plains. In some areas, premises forests were located on the north, west, and east sides of houses. The area is also located in the turbulent waters of the former Tone River and the former Arakawa River, and in order to prevent damage from flooding, the premises forests are composed of a variety of trees, from tall trees to shrubs, and are often combined with hedgerows and stonewalls. In the middle reaches of Tone River, Japanese white

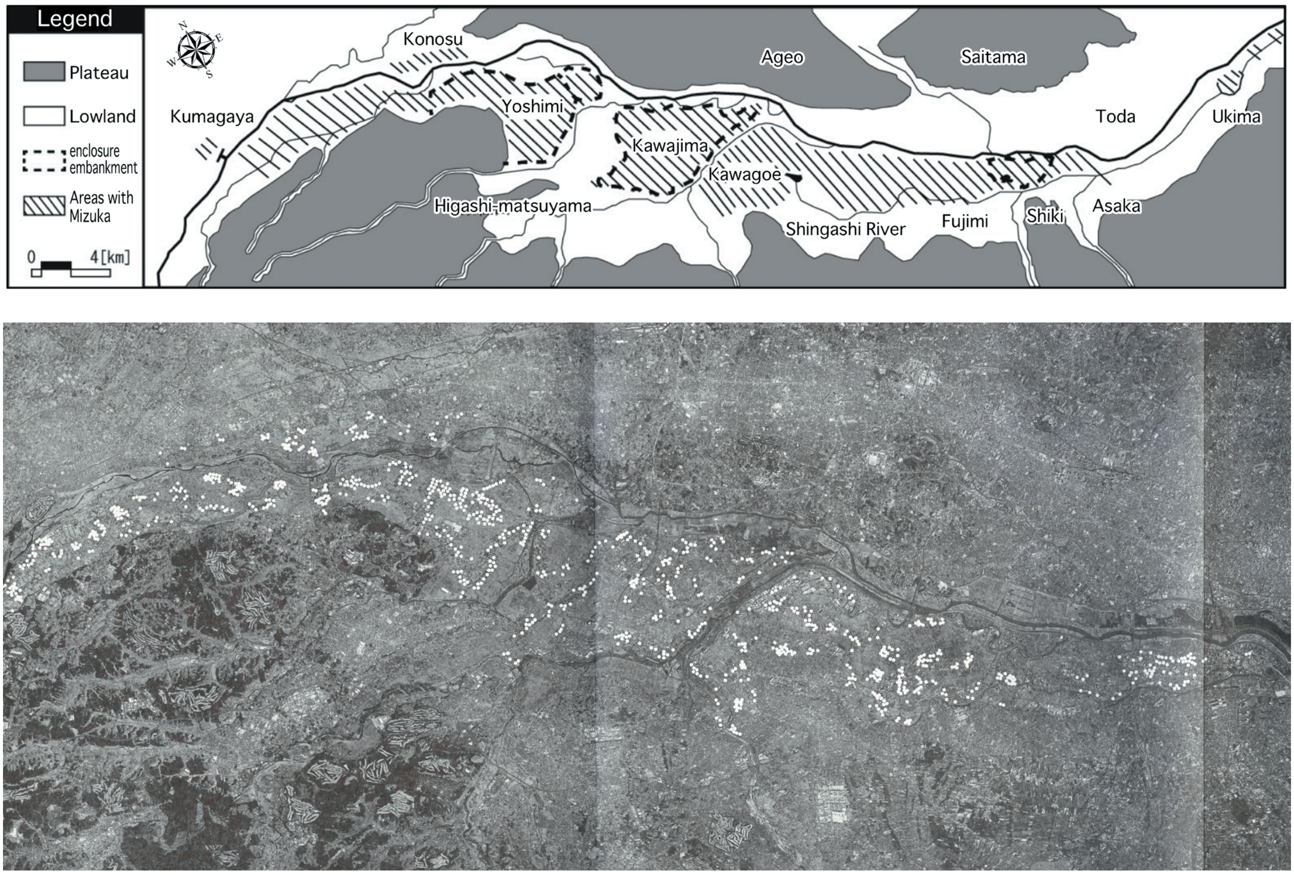


Figure 3: Distribution of *Mizuka* in the middle reaches of the Arakawa River. The white dots in the figure below are *Mizuka*. (Top: Aoki et al. 2015, Bottom: Watanabe et al. 2016)

oak and Japanese zelkova predominate, but the taller trees include *enoki*, muku tree, wild cinnamon, wild camellia, cedar, chestnut, thatch, palm, and bamboo (madake, hachiku, and moso bamboo). Photo 3 shows a premises forest located in Hanyu City and the surrounding farmland.

In the middle reaches of Arakawa River, dry monsoon winds from the northwest or north are strong, and most of the forests are located on the northwest or north side of the houses. Main tree species composition is similar to that of the Tone River basin. Many houses have hedges planted around the perimeter of the forests, including Japanese white oaks, Aomori cypress, Japanese cornel, yellow wood, boxwood, Japanese spindle tree, Japanese cypress, and Japanese redbud cherry. Oak hedges are often built between neighboring houses because of their excellent fire prevention function, and hiba hedges are often placed in front


Photo 3: Premises forests and farmland in Hanyu City (May 2022)


Photo 4: Premises forests and stone wall in Yoshimi Town (December 2022)

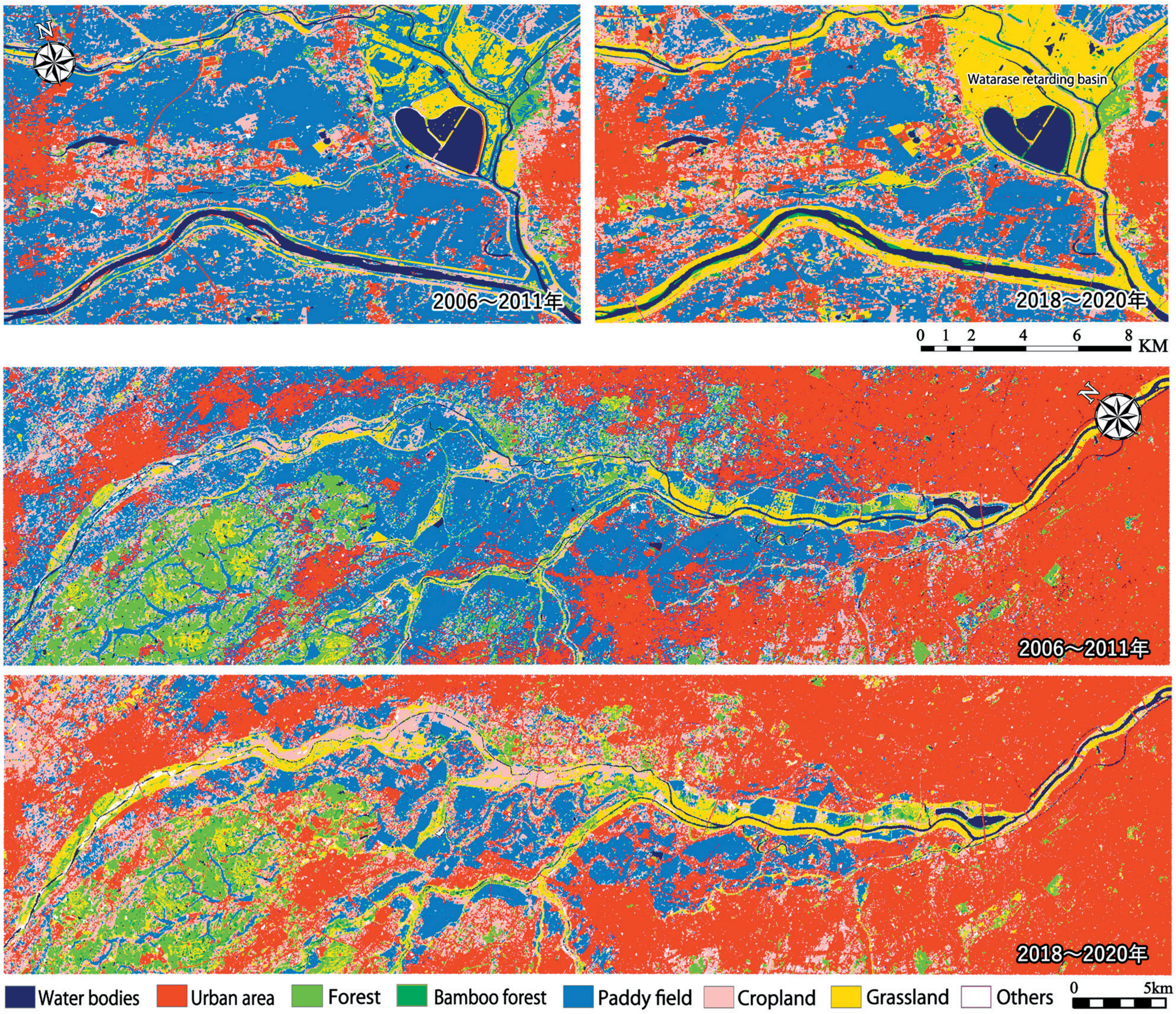


Figure 4: Land use change in the middle reaches of Tone River (top, two side-by-side images) and the middle reaches of Arakawa River (center, bottom) (2006-2011 and 2018-2020, based on the High-Resolution Land Use Land Cover Map (10m resolution) produced by the ALOS/ALOS-2 Analysis Research Project and the Subjective Field Research: Ecosystem Research Group of the Earth Observation Research Center (EORC), Japan Aerospace Exploration Agency (JAXA))

of houses facing the road because of their good appearance. Bamboo, board, and stone fences also exist. Photo 4 shows a house with a premises forest and stone wall in Yoshimi Town. Premises forests have been decreasing due to the cutting down of trees for wartime offerings and the difficulty of maintaining and managing them in recent years.

Land use change in the middle reaches of Tone River and Arakawa River

Figure 4 shows land use changes in the middle reaches of Tone River and Arakawa River from 2006-2011 to 2018-2020. These land use maps are based on the High-Resolution Land Use Land Cover Map (10m resolution) produced by the ALOS/ALOS-2 Analysis Research Project and the Subjective Field Research: Ecosystem Research Group of the Earth Observation Research Center (EORC), Japan Aerospace Exploration Agency (JAXA).

Tables 1 and 2 show the changes in the area for each land use type. In the middle reaches of Tone River, the mainstream of Tone River flows in the south, and its tributaries, Watarase River and Watarase Retarding basin, are located in the north. Urban areas such as Tatebayashi City and Itakura Town in Gunma Prefecture, Tochigi City and Fujioka City in Tochigi Prefecture are distributed on plateaus and terraces, and wooded areas are found around the urban areas, in some areas along rivers, and on a small scale to the east of the Watarase

Table 1: Area by land use type in the middle reaches of Tone River

	Water bodies	Urban area	Forests	Bamboo forests	Paddy field	Cropland	Grassland	Others
2006~2011(㎢)	12.99	28.06	6.33	0.00	110.67	39.94	15.42	2.71
2018~2020(㎢)	12.82	45.09	4.38	4.06	67.99	41.82	38.88	1.08
Area change value(㎢)	-0.17	17.04	-1.96	4.06	-42.68	1.87	23.46	-1.63
Percentage change in area	-1.34%	37.78%	-44.76%	100.00%	-62.77%	4.48%	60.34%	-150.10%

Table 2: Area by land use type in the middle reaches of Arakawa River

	Water bodies	Urban area	Forests	Bamboo forests	Paddy field	Cropland	Grassland	Others
2006~2011(㎢)	12.97	329.42	76.01	0.00	239.46	117.92	30.55	11.00
2018~2020(㎢)	9.13	401.27	53.24	10.55	99.53	165.67	60.15	17.80
Area change value(㎢)	-3.84	71.84	-22.77	10.55	-139.93	47.75	29.60	6.80
Percentage change in area	-42.08%	17.90%	-42.76%	100.00%	-140.59%	28.83%	49.21%	38.19%

Retarding basin. Paddy fields are spread on a large scale in the lowland flood plains, and field areas are distributed adjacent to each urban area and scattered among paddy fields. Looking at the land use change from 2006-2011 to 2018-2020, urban areas, grasslands, bamboo forests, and field areas in order of increasing area, while paddy fields, forested areas, and water bodies decreased significantly. The area of urban area increased by 17.04 ㎢ , representing an increase of 37.78 %. The increase in urban area is mainly due to the expansion of the urban area into the surrounding area from 2006-2011 and the conversion of surrounding agricultural land into urban area. Photo 5 shows the urbanized area of Kazo City. Grassland has increased on both sides of the mainstream of Tone River and Watarase River, and grassland has expanded in the Watarase Retarding Basin as a result of wetland preservation and maintenance activities. The 100 % increase in bamboo forests is because bamboo forests were not classified as such in 2006-2011, but were added to the new land use classification in 2018-2020 due to the increase in bamboo forest area. Grassland increased by 23.46 ㎢ from 2006-2011 (15.42 ㎢) to 2018-2020 (38.88 ㎢), representing an increase of 60.34%. In contrast, the area of paddy fields decreased by 42.68 ㎢ from 2006-2011 (110.67 ㎢) to 2018-2020 (67.998 ㎢), a decrease of 62.77 %. The area of wooded land decreased by 44.76 %.


Photo 5: Urbanized area in Kazo City (May 2022)

Looking at land use in the middle reaches of Arakawa River, it flows from north to south, with many tributary water bodies. Urban areas are widely distributed from the Kumagaya City area in the north to Saitama City and Kita Ward in Tokyo in the south. Urban areas are mainly located on plateaus and terraces, but also extend into lowland fans and flood plains. Woodlands are widely distributed on the mountains and plateaus in the northern part of the city and are dispersed along rivers and within the urban area. Agricultural land is distributed on a large scale between the Arakawa River and the western plateau. looking at land use change from 2006-2011 to 2018-2020, urban areas, farmlands, grasslands, bamboo forests, and others are in order of increasing area, while paddy fields, forested areas, and water bodies are in order of decreasing area. The area of urban areas increased by 17.9 %, indicating that urbanization is progressing in fan-shaped areas and flood plains. Field land increased along rivers and around the urban areas, mainly converted from paddy fields. Grassland is widely distributed along rivers, increasing by 29.6 ㎢ , representing an increase of 49.21 %. Other increases

Photo 6: A private house and its premises forest in Yoshimi Town (December 2022)

are mainly due to the addition of solar panels. On the other hand, paddy fields decreased significantly from 2006-2011 (239.46 ㎢) to 2018-2020 (99.53 ㎢), with many areas having been converted to urban areas and farmland. The wooded area also decreased significantly from 2006-2011 (76.01 ㎢) to 2018-2020 (53.24 ㎢) due to the expansion of urban areas, with a decrease rate of 42.76%. Photo 6 shows a view of houses and premises forests in Yoshimi-machi in the middle reaches of Arakawa River, showing a trend of decrease in premises forests with large trees. Photo 7 shows a residential area along the embankment of Arakawa River flowing through Kumagaya City.

For the future

The middle reaches of Tone River and Arakawa River have been flood-prone areas, and traditional local wisdom such as *Mizuka* and premises forests have been inherited as disaster countermeasures in the lowland areas of flood plains and hinterland wetlands. Traditional disaster countermeasures, such as *Mizuka* and premises forests, have been arranged in response to the topography and climate of each region, and have demonstrated their disaster prevention and mitigation functions, while also creating unique regional cultures and landscapes. However, with the progress of urbanization, changes in lifestyles, and flood control projects, land use within the watershed areas of both rivers has changed *dramatically*, and the need for water *Mizuka* and premises forests and their relationship to people's lives have become less relevant.

Meanwhile, activities and projects to conserve and utilize the rich blessings of nature, such as biodiversity and local culture, while responding to natural disasters, have been implemented in the middle reaches of Tone River and Arakawa River. In the Watarase Retarding Basin (Figure 5), which covers an area of about 3,300 ha in the middle reaches of Tone River, three flood control reservoirs and the heart shaped Watarase Reservoir, which supplies water for domestic use during drought, have been developed so as not to affect the flow of the mainstream of Tone River, creating a rich wetland environment. In 2020, the Watarase Retarding Basin Stork Exchange Center have opened to provide information about Watarase Retarding Basin, promote eco-tourism, and revitalize the area. In addition, the waterfront view of the confluence of Tone River and Watarase River has been highly evaluated as a culture of living and working in harmony with water, and the waterfront

Photo 7: Residential area along the Arakawa River embankment in Kumagaya City (January 2020)

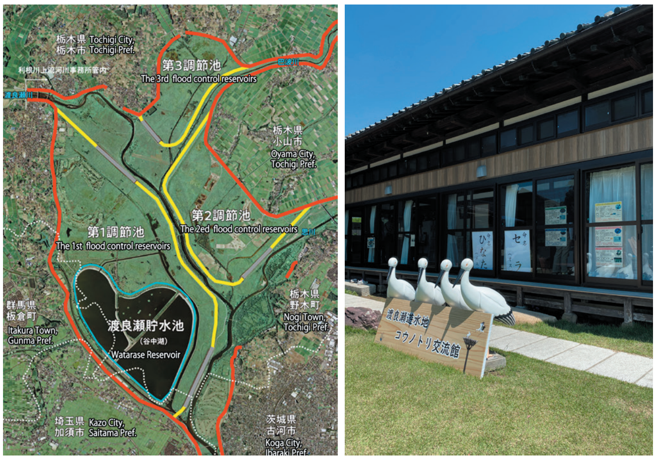


Figure 5: Watarase Retarding Basin (from Tone River Upper Stream Office data) and Watarase Retarding Basin Stork Exchange Center (May 2022)

view of Itakura Town was selected as an "Important Cultural Landscape" by the national government (Figure 6). In Itakura Town, conservation activities and information dissemination are being conducted for local enclosure embankment and *Mizuka*, and a tour course has been established for local enclosure embankment and Mizuka, and a tour course has been established (Photo 8, Figure 7). The Kitakawabe Local History Museum in Kazo City has exhibits on the history of flood damage, the distribution of *Mizuka*, and the industry and lowland lifestyle of the waterfront area (Photo 9). The museum serves as a center for passing on the local culture of the region and is used for social studies field trips to elementary schools and other schools in the city.

In the middle reaches of Arakawa River, there are citizen activities in the "Arakawa River Oaso Park," the "Arakawa River Nature Preservation Association" and the "Arakawa River Tarouemon Area Nature Restoration Council" that aim at disaster response and nature restoration. Arakawa River Oaso Park (Photo 10) is a prefectural park for preserving the ecosystem along the river, where more than 100 species of wild birds and about 400 species of plants have been identified as a "wild bird forest. Arakawa River Nature Preservation Society is a group of local governments, civic groups, businesses, schools, and others working together to preserve the area around Mitsumata-numa Biotope, which spans Ageo City, Kawagoe City, and Kawashima Town in Saitama Prefecture. Arakawa River Tarouemon Area Nature Restoration Council is working to restore nature in a 4 km section downstream of Tarouemon Bridge, where a favorable wetland environment remains in the middle reaches of Arakawa River (Figure 8). The target area includes an area with many *Mizuka* and premises forests, where conservation of the old Arakawa River channel, expansion of wetlands and water stagnation, conservation of riparian forests, environmental education, and monitoring is being conducted. The area is divided into Upper Pond, Middle Pond, and Lower Pond, which function to regulate the amount of water when the water flows out, and also play an important role as a place to conserve plants and animals such as southern killifish, lapwing, Japanese knotweed, and alder.

With the recent increase in unexpected weather and natural disasters, it has become impossible to cope only with hard countermeasures such as embankment. Nowadays, when measures and projects based on the concept of watershed flood control are being promoted, it is important to reaffirm traditional disaster response measures rooted in local nature and culture as one of the measures to promote community-based disaster prevention and disaster mitigation.

Figure 6: Waterhole view and information board in Itakura Town, Gunma Prefecture (May 2022)


Photo 8: A view of the swamp removal dike and its explanatory board (May 2022)

Figure 7: Distribution map of *Mizuka* in Itakura Town and an explanatory board of *Mizuka* (May 2022)

Photo 9: Kitakawabe Local History Museum in Kazo City (March 2022)


Photo 10: Arakawa River Oaso Park "Wild Bird Forest" (March 2022)

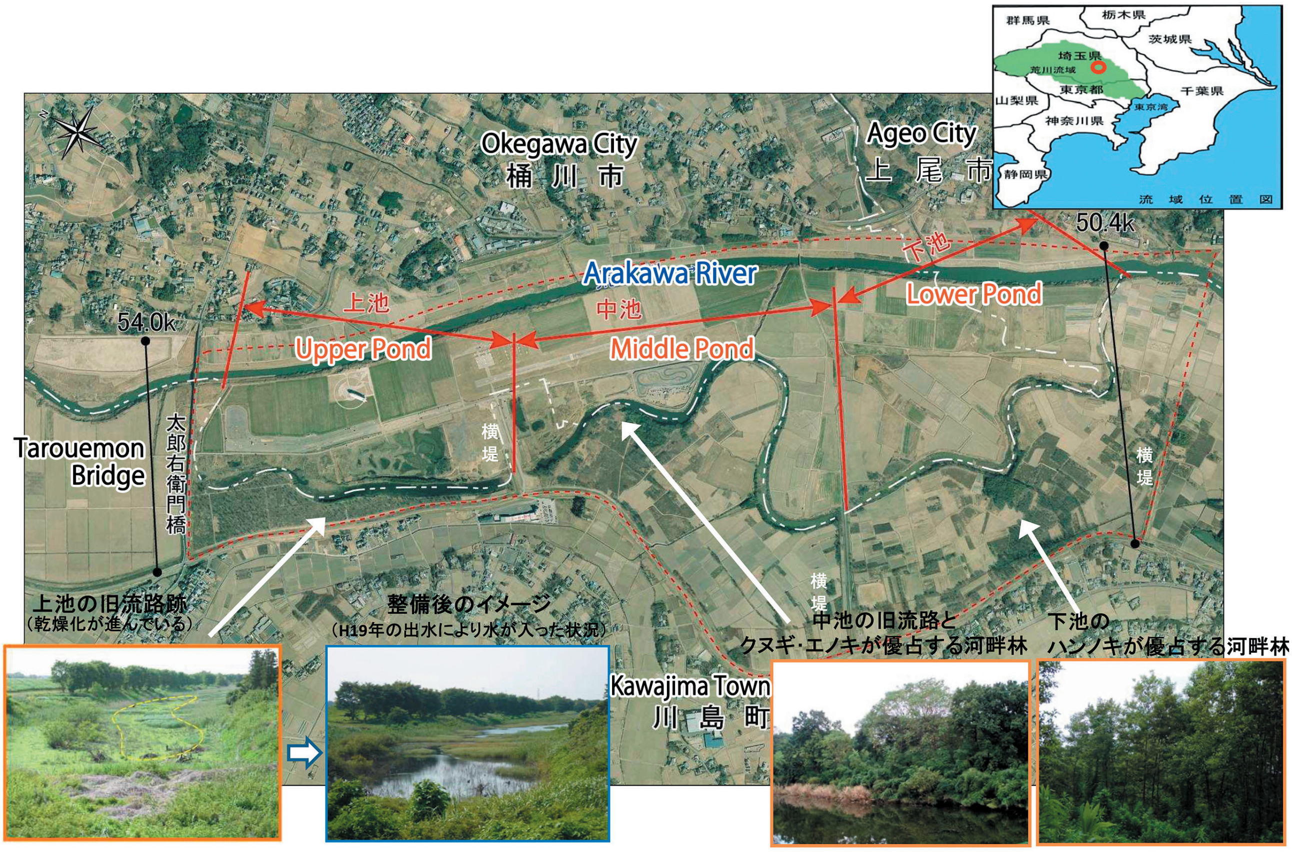


Figure 8: Arakawa River Tarouemon Area Nature Restoration Project Implementation Plan (from Arakawa River Tarouemon Area Nature Restoration Council)

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Mizuka in the middle reaches of Tone River

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Introduction

In areas where floods have frequently occurred, many flood prevention structures have been seen for the purpose of vertical evacuation, and in these areas, the lifestyle and evacuation system based on the assumption that floods will occur has been observed. In the Tone River basin, there is a type of protective mound and structure called *Mizuka,* which has developed especially in the middle reaches of the river. *Mizuka* contains the soil mound below and the upper structure. Photo 1 shows a view of houses with *Mizuka* in the Kitakawabe Town, Saitama Prefecture, located in the middle reaches of Tone River. Photos 2-1, 2-2, and 2-3 show the current of *Mizuka* owned by the house. In 2013, a survey on *Mizuka* in the eastern area of Saitama Prefecture, located in the middle reaches of Tone River, was conducted by the Eastern Area Cultural Property Officers' Association. According to the results of the survey, there were two patterns of the distribution of *Mizuka* in terms of location: Large River Coastal Lowland Pattern and Inland Lake and Marsh Area Pattern. Of these, the Large River Coastal Lowland Pattern was subdivided into three types: Large River Natural Levee Type, Hinterland Wetland Periphery Type, and Dispersed Village Type (Figure 1). Specifically, the Large River Coastal Lowland Pattern is most prominent on and around natural levees developed along the Tone River and its tributary, the Watarase River (including its old channel). Among them, the Large River Natural Levee Type is characterized by the fact that although the natural levee itself is prominent, it is not large in scale and is often only 200 to 300 m in

Photo 1: View from the south front of the house with *Mizuka* and interviews (Kitakawabe Town, Saitama Prefecture: May 2022).

Photo 2-1, 2-2, 2-3: Present condition of *Mizuka* and premises forests (Kitakawabe Town, Saitama Prefecture: May 2022)

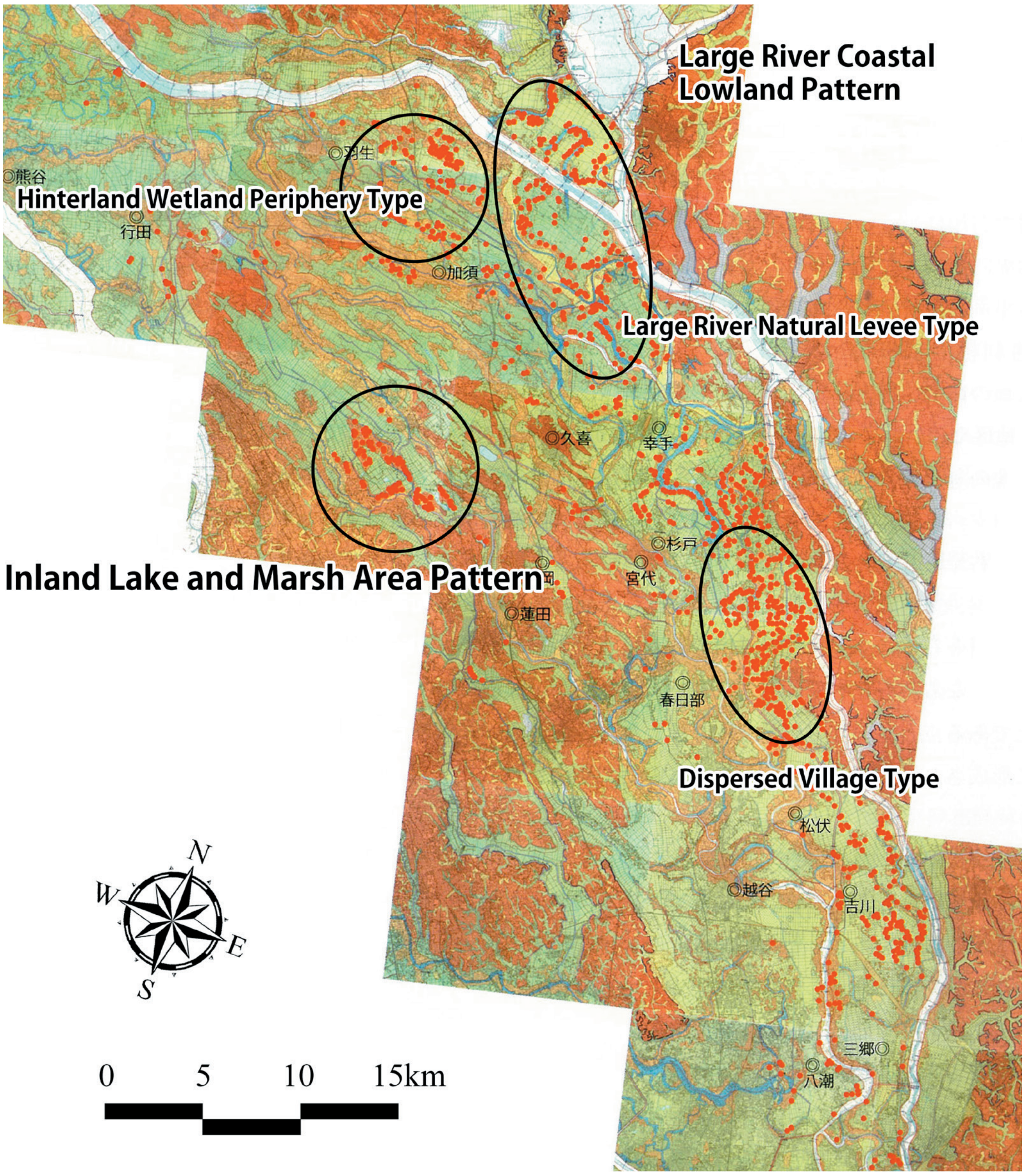

Figure 1: Distribution of *Mizuka* in the eastern Saitama Prefecture area located in the middle reaches of Tone River(cited from "*Mizuka* in Saikatsu, North Saitama")

length. On the other hand, in areas along the coast of large rivers where *Mizuka* have not developed, the length of natural levees is 1-2 km, and the levees are relatively high, making it possible to evacuate and secure supplies along the levees in case of flooding. As for the Hinterland Wetland Periphery Type, the hinterland marsh area is characterized by a certain distance from large rivers, and there is a loam plateau-derived micro-elevation around the marsh area. The marshland was used as arable land during the development of new rice paddies in the early modern period, and the residential area seems to have expanded to the marshland area along with it. Dispersed Village Type is characterized by lowland areas, where dispersed villages were formed with the development of new rice paddies in the Edo period (1603~1868), and large, relatively high *Mizuka* were residential to cope with frequent flood damage. In contrast, Inland Lake and Marsh Area Pattern areas are characterized by the development of long, narrow island-like loam plateaus that tend to be buried, and swamps develop in the open valleys between the loam plateaus. Since the Edo period, these swamps have been developed into new paddy fields by digging drainage channels and the residential areas have expanded into the lowlands. These areas are topographically characterized by the concentration of *Mizuka* in a relatively small area. Compared to the Hinterland Wetland Periphery Type and Dispersed Village Type, which are located

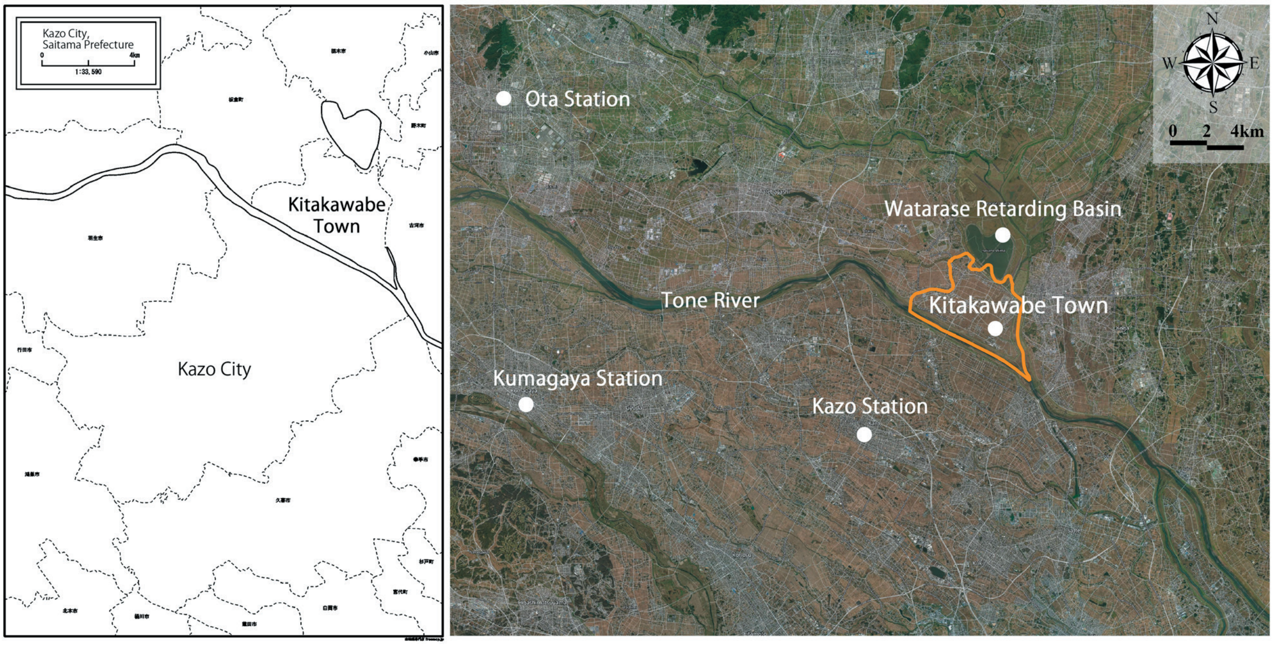

Figure 2: Location of the North Kitakawabe Town (as of 2022, processed from MapTiler)

in the lowlands, these areas have a smaller area of paddy fields with a water recreation function, and have a history of having difficulties in dealing with the stagtant water. As for this situation, the possibility that *Mizuka* may have functioned as a countermeasure against stagnant water should be considered.

Mizuka in the Kitakawabe, Saitama Prefecture

This paper describes *Mizuka* in Kitakawabe Town, Saitama Prefecture, located in the middle reaches of Tone River. The *Mizuka* in Kitakawabe is a representative example of the Large River Natural Levee Type of the Large River Coastal Lowland Pattern, which is distributed in large numbers in the middle reaches of Tone River.

Kitakawabe (Figure 2), with a population of about 13,000 (as of 2019)a total area of about 20.96 ㎢, was located on the northeastern edge of Saitama Prefecture and is now part of Kazo City following a municipal merger in 2010. Kitakawabe, sandwiched between the Tone River and the Watarase River (a tributary of the Tone River), is a low-lying area, with an average elevation of 13 to 15 m. With fertile land, the area was developed as a rice-producing region in the Kanto region, and the endangered plant Onibasu (Euryale ferox) grows wild here. On the other hand, Kitakawabe is a dish-shaped land known as "Wanaka-no-chi," which is surrounded by levees on all sides due to frequent flooding caused by levee breaches. For this reason, there were improvement of the Tone River to overcome flooding and the construction of drainage pump stations to prevent flood damage. In addition, *Mizuka* was constructed as shelters for houses in case of flooding, and usually served as storage areas.

According to the results of a 2013 survey by the Eastern Regional Cultural Heritage Officers' Association, 99 *Mizuka* were identified in the region, mostly on the periphery and in the central area, and were distributed almost entirely on natural levees (Figure 3). Kitakawabe has been formed on natural levees created by flood sediment deposition, and is surrounded by traditional embankment. The embankment is approximately 4 m high and 20 km in circumference. As shown in Figure 4, the spatial composition of Kitakawabe includes a river, an embankment, paddy fields, natural levees, and residences, with the main house, attached house, and *Mizuka*. By arranging rice paddies around the houses, the rice paddies played an important role in mitigating the effects of flooding by acting as reservoirs in the event of flooding. The combination of each of these spatial elements was

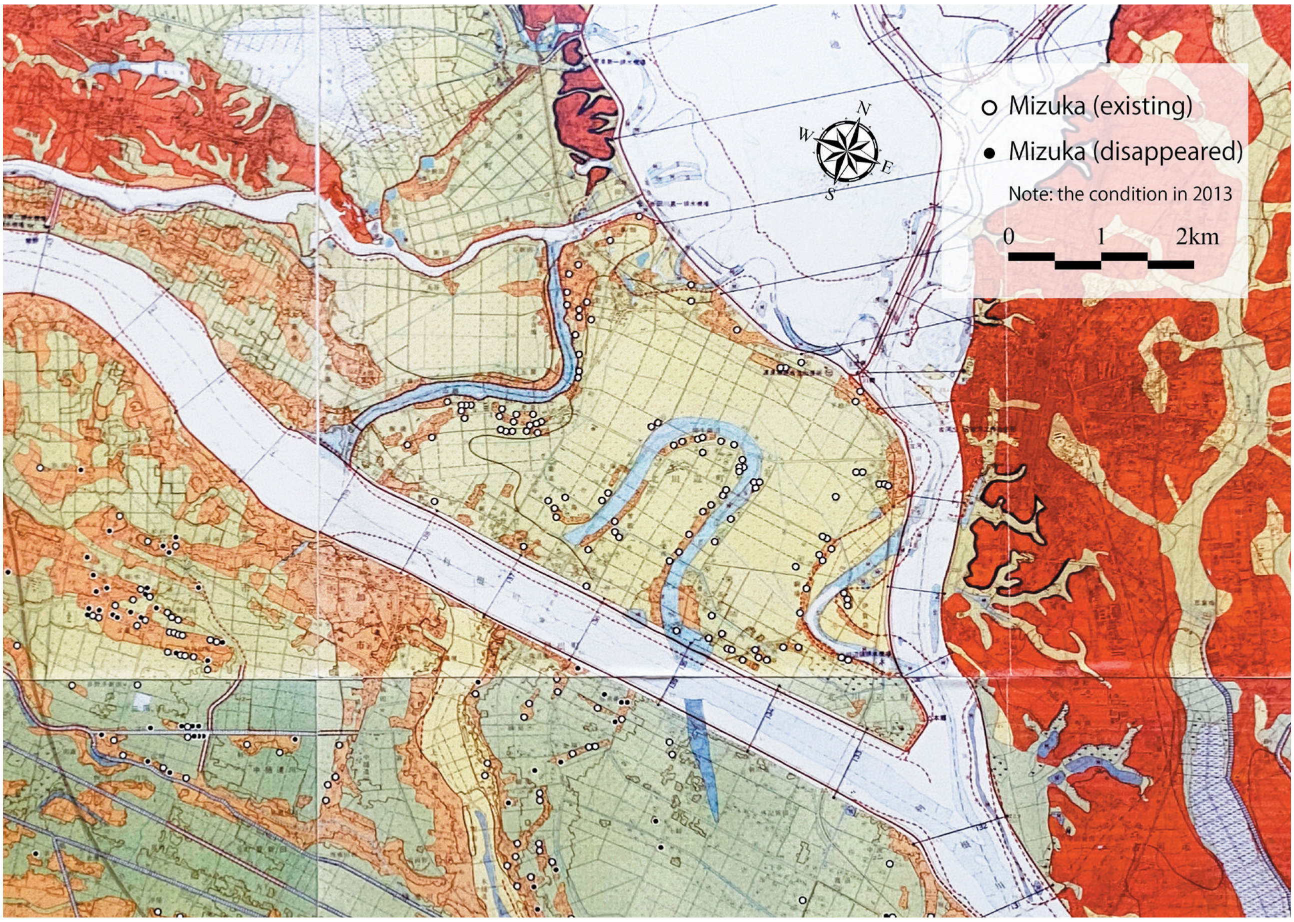

Figure 3 :Distribution of *Mizuka* in Kitakawabe as of 2013 (cited from "*Mizuka* in Saikatsu, North Saitama")

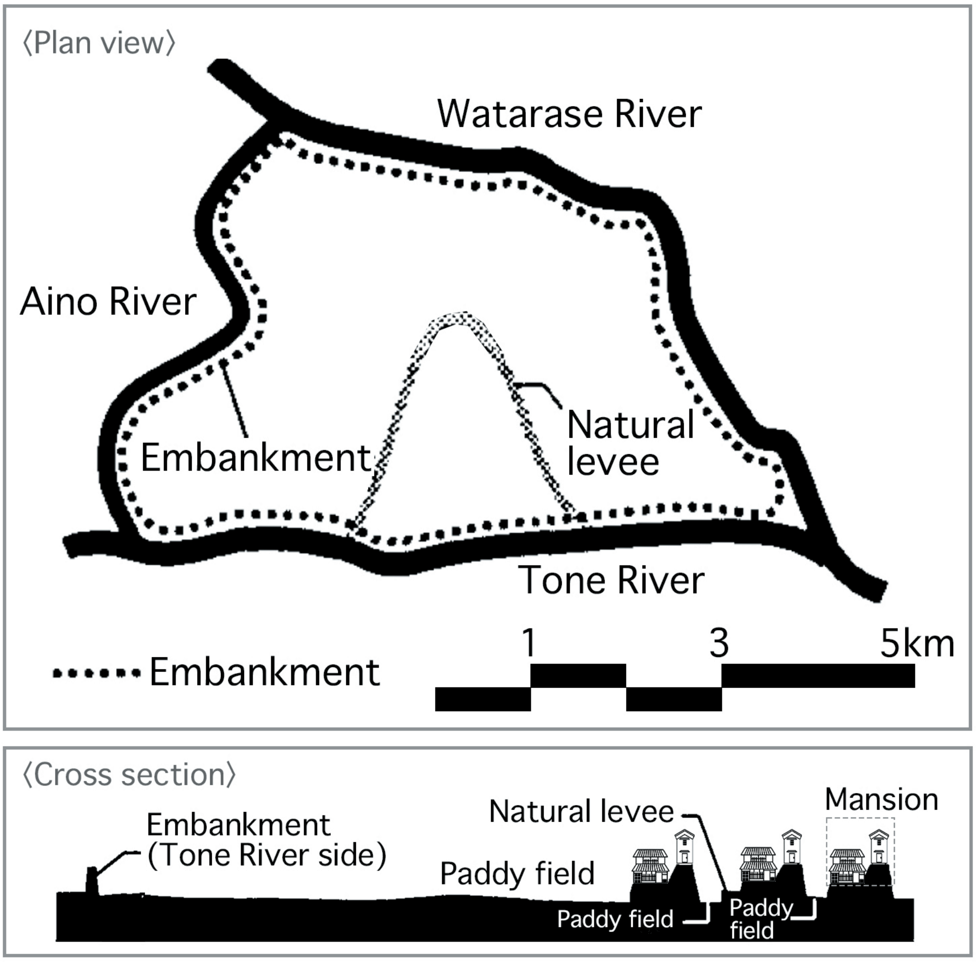

Figure 4: Spatial configuration Kitakawabe (Harima 2003)

effective in preventing and mitigating flood damage, and functioned as a countermeasure against disasters.

Structure of *Mizuka*

Figure 5 shows the typical layout configuration of the plan of a house with *Mizuka* in Kitakawabe. The main house, *Mizuka*, attached house, premises forests, ditch, and a garden existed at each mansion. The entrances to each mansion were

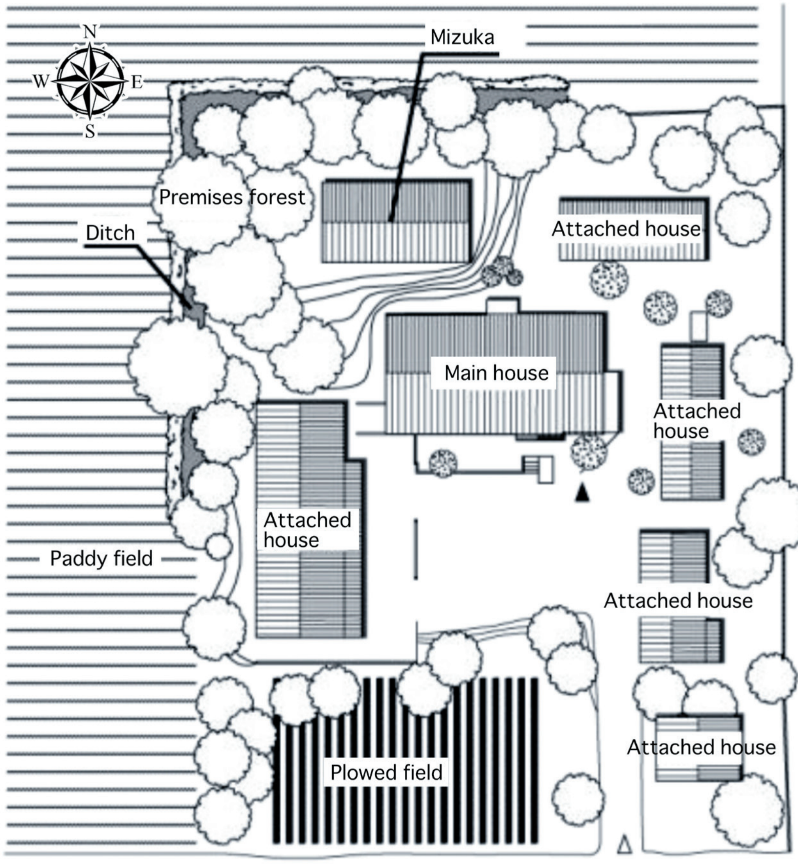

Figure 5: Typical layout configuration of houses with *Mizuka* in Kitakawabe (Yokota et al. 2016)

arranged to be tangential to the road on the south side, and the main house faced south, with a garden and plowed field on its south side.

As for the spatial components of the mansion, such as *Mizuka*, premises forests, and ditch, we can see that Kitakawabe is characterized as a flood-prone area. *Mizuka* was builted by the headman or wealthy farmers in the village, and are not found in all mansions. *Mizuka* is often located on the northwest side of the *Mizuka*. The most common size of *Mizuka* is 2 x 3 *ken* (6 *tsubo*), and some of the larger ones (3 x 8.5 *ken*, 25.5 *tsubo*) and 3.5 x 6 *ken* (21 *tsubo*) were also seen (1 *ken* is converted to approximately 1.82 m, 1 *tsubo* is approximately 3.3 ㎡). In the case where there is a premises forest, it is located on the northwest side surrounding *Mizuka*, and is densely planted to function as a barrier against seasonal winds blowing from the northwest in winter as well as to mitigate flood damage (Photo 3). Many large trees such as zelkova, *enoki*, and oak existed within the premises forest. The ditch was dug to collect fill for *Mizuka*, but its function is to mitigate flooding and as a water supply for firefighting (Photo 4). When *Mizuka* was constructed, soil dug from the ditch and rice paddies was purchased when it was insufficient.

Regarding the cross-sectional structure of *Mizuka*, the relationship between the elevation of *Mizuka*, the main house and the embankment is shown in Figure 6. The elevation of soil mound below the structure of *Mizuka* is approximately 3 to 5 m, and ground level the structure of *Mizuka* is almost equal to the height of main house's 2ed floor (Photo 5). *Mizuka* is located in a position where it hardly suffer disaster even during the flooding. However, the evevation of the main house, is about 2 to 3 m, and the attached house has the same height, but in most cases it is relatively low, with only 1 to 2 m. The elevation of the main house and the attached house was considered to be set at a minimum height so as to eliminate any obstacles caused by the difference in daily life. The elevation of the enclosure embankment is slightly higher than the ground level of *Mizuka*. These different levels were created by dividing the effects of flooding into short, medium, and long term based on the experience of flooding.

Many of the *Mizuka* were two-story structures, which also provided stockpiled food and bedding and protected stored items from flooding. Miso barrel was hung outside the *Mizuka*, and rice, wheat, soy sauce, and other items were stored on the first floor and offered as evacuation supplies. There were also dried pond snails and other items for emergency rations. In addition, Lifting Boats

Photo 3: Premises forest (May 2022)

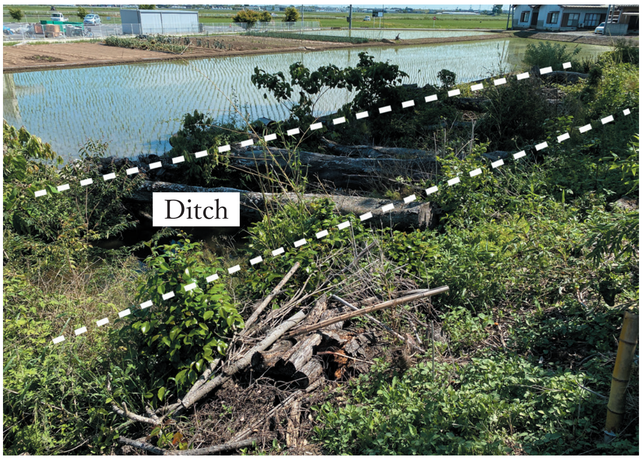

Photo 4: The existing structure moat (May 2022)

were hung and stored under the eaves of the main house and *Mizuka* (Photos 6 and 7), which was used as a means of transportation for evacuation and transporting food in the event of flooding. The above-mentioned *Mizuka* is a typical example, and various types of *Mizuka* can be found in Kitakawabe (Photos 8, 9, and 10). Some were specialized for food storage, while others served not only as shelters but also as residences for daily life. Tile roofing was the most common type of roofing on *Mizuka*, with tin and grass roofing being the other types of roofing. The construction and remodeling dates of the extant *Mizuka* was concentrated immediately after the great flood of 1910 and after Typhoon Kathleen in 1947.

Summary

The middle reaches of Tone River are a flood-prone area, and *Mizuka* has been an important measure to reduce flood damage at the residential level. In Kitakawabe, different spaces such as rivers, enclosure embankment, rice paddies, natural levees, and residences (*Mizuka*, Premises forest) have been used to cope with flood damage. The planar arrangement and cross-sectional structure of *Mizuka* shows the characteristics of flood countermeasures in this area, and their placement on the northwestern side minimizes obstacles to daily life, while at the same time ensuring food storage and evacuation during floods. It has also become a source of wisdom for the community, and has functioned together with the forests, ditch, and surrounding rice paddies on the site.

On the other hand, the decrease in damage caused by floods and the development of the region have brought about significant changes in housing patterns and people's awareness in flood-prone areas. Many of the *Mizuka* in the area were constructed during the Meiji period (1868-

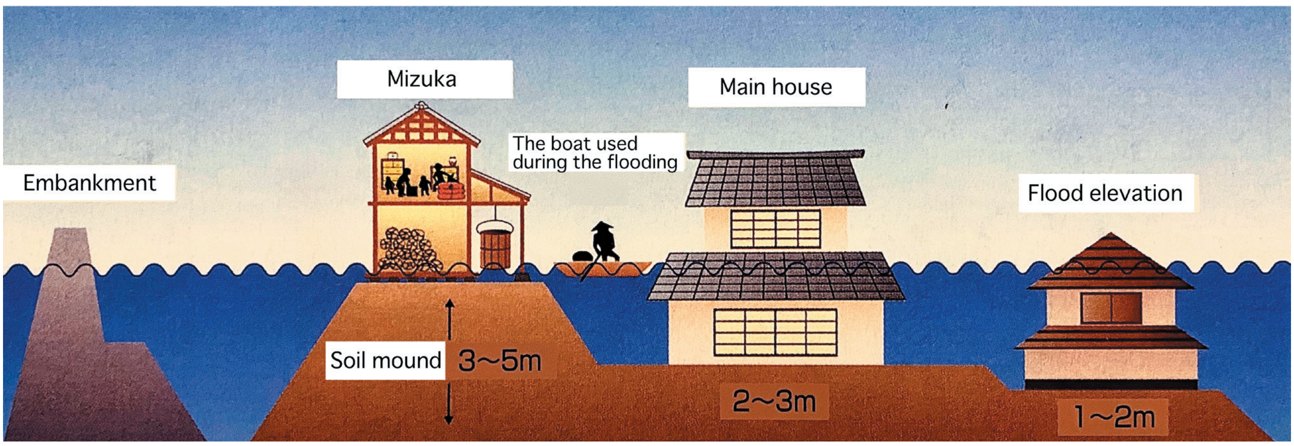

Figure 6: Elevation of *Mizuka*, mansion, and levees (cited from the exhibition materials of Kitakawabe Local History Museum)

1912), However, due to river improvements such as strengthening the levees of the Tone River and Watarase River, the elevation of the embankment is higher than the soil pond of *Mizuka*. As a result, the need for *Mizuka* has decreased, and many of them are either being used as warehouses or have been neglected and torn down due to the aging of the residential area. In Miyamura's research report, the survey was conducted from the perspective that traditional flood prevention architecture could be used in modern times for evacuation, and it is considered significant to preserve and utilize flood prevention architecture as a place of refuge and an example of traditional and local knowledge in the region nowadays. It is pointed out that in order to build a flood-resistant society in the future, preservation measures such as subsidies and tax incentives are needed to maintain and manage these residential area as emergency evacuation sites. It is also considered necessary to consider ways to take multiple spatial disaster prevention and mitigation measures, from the community level to the residential level of preparedness.

Photo 5: Roof height of *Mizuka* and main house in Kitakawabe (Sato 1956)


Photo 6: A Lifting Boat that was active during flood damage in the Showa Period (cited from the exhibition materials at the Kitakawabe Local History Museum)


Photo 7: A Lifting Boat suspended from the existing eaves (May 2022)

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Photo 8: The *Mizuka* near the Kitakawabe Local History Museum and its inside structure (March 2022)

Photo 9: An example of a *Mizuka* in Kitakawabe (cited from the exhibition materials at the Kitakawabe Local History Museum)

Photo 10: An example of a *Mizuka* in Kitakawabe (cited from the exhibition materials at the Kitakawabe Local History Museum)

Traditional and local knowledge to enhance ecosystem services of retarding basins

National Institute for Environmental Studies NISHIHIRO Jun

Figure 1: Overflow levee of the retarding basin. It is lower than the surrounding levees, so that water enters the retarding basin (left side) from the river channel (right side) during a flood.

Figure 2: A controlled burning at the Kokai River

Nature of Floodplains

Retarding basins are areas adjacent to river channels and constructed to reduce the peak flow of rivers by storing water that overflows from the channels during heavy rainfall events. Between the river channel and the basin, an overflow levee, which is lower than the surrounding levee, is constructed, through which the river water flows in (Figure 1). The outer perimeter of the retarding basin is surrounded by a levee called as the perimeter levee, which prevents the water spreading further from the basin. There are approximately 140 retarding basins throughout Japan (Suwa and Nishihiro, 2002).

Since the Meiji era (1868-1912), the standard flood control measures for rivers were building continuous- high-levees and constructing dams to regulate the flow. The construction of retarding basin, which is an approach to secure areas where flooding is allowed to occur, have significant values, since the flooding has positive aspects for society. For example, fertile soils are tended to be formed in flood plains. Before the modernization of agriculture with usage of chemical fertilizers, the nutrients carried by river floods were a valuable resource that supported food production. Flood plains are also important for economically useful fish species such as eels, carp and crucian carp. Early paddy rice cultivation is known to have started on river floodplains, and it is also known that human activities for rice cultivation simultaneously provided habitats for diverse plants and animals (Nishihiro et al. 2009). Thus, flood plains are important places for both biodiversity and culture.

Due to the construction of continuous levees, development of urban or cultivation areas around rivers, and flow control by dams, flood plains have been greatly reduced throughout Japan after the world-war 2. At the same period, rice paddies, which once had flora and fauna in common with natural flood plains, have lost much of their function as habitat due to the conversion of traditional wet rice-paddies to dry rice-fields as a result of field development for improving rice production.

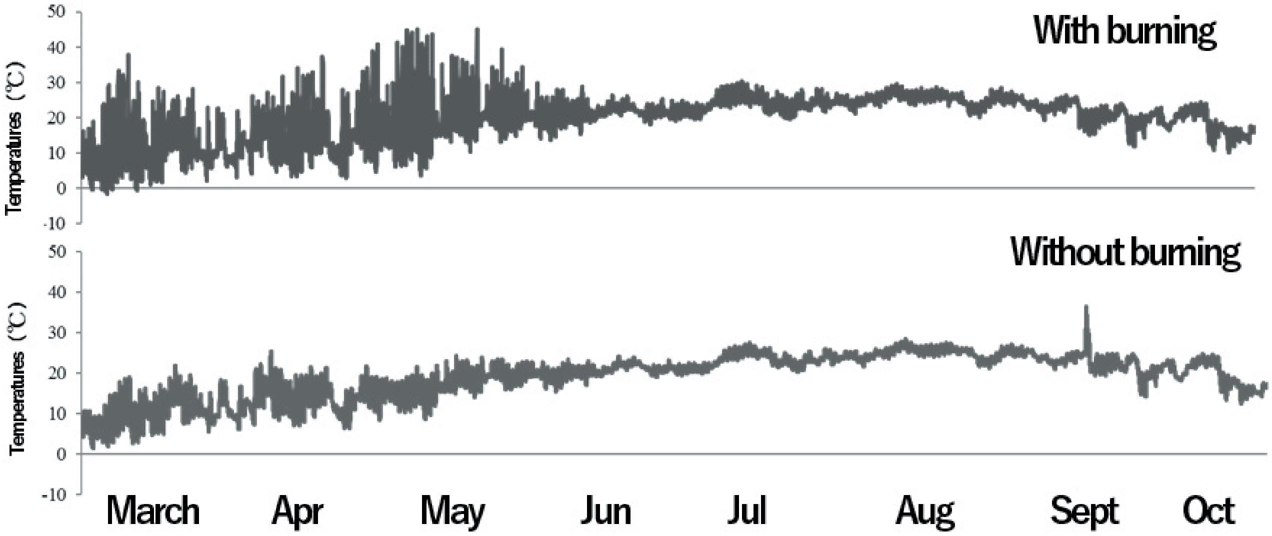

Figure 3-1 Ground surface temperatures in areas with and without burning, the range between day and night temperatures increases by burning

Therefore, retarding basins, which are spaces that are connected to rivers only during heavy rains, are still valuable places with floodplain characteristics.

Utilization of Retarding Basinss and Human Disturbance of Vegetation

Although retarding basins have potential to provide ecosystem services of floodplains, the creation of the facility is not enough. In general, natural floodplains contain diverse types of wetland-ecosystems. Floodplains are complex areas that include sparsely vegetated areas that are strongly disturbed by water, shallowly flooded ponds, and areas that are less disturbed and dense woodland. In addition, dynamic changes in these areas are important feature of floodplain ecosystem. However, areas in retarding basins are less likely to be strongly disturbed because the flood water enter the basins at a slower velocity than in a river channel, and the environment as a whole tends to be more stable. In addition, plant seeds and nutrients are carried into the retarding basin along with sediment transport during each flood. The retarding basins tend to contain the only stable and less disturbed areas left out of the diverse sites included in the floodplain.

In the past, floodplain environments where vegetation grew densely were disturbed by human activities such as using them as paddies, harvesting reeds for thatched roofs, and using trees for fuel, even if they were not disturbed by floods. It can be said that the nature of the floodplain has been supported by both floods and anthropogenic disturbance. Such anthropogenic disturbances can be expected to have a positive effect on biodiversity even when introduced to modern retarding basins. Furthermore, suppression of forestation through disturbance can help maintain the flood control function of floodplains. Too much tree cover risks reducing water storage capacity and causing damage from tree runoff during floods.

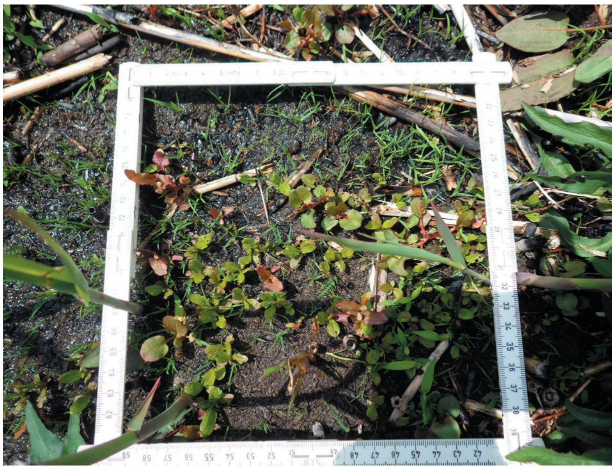

Figure 3-2 Many seedlings emerging after controlled burning

How can we achieve "moderate disturbance of floodplains," which can contribute both biodiversity and flood control? Here, we introduce two types of ideas: the traditional technique of "controlled burning" and the community-based approach of "utilization by various objects".

(1) Merits of Controlled Burning

Fire is one of the factors which disturbs vegetation. The practice of humans burning off vegetation with fire in floodplains has a long history. Analysis of pollen and fine charcoal in the soil suggests that fire was used to suppress trees during the creation of early rice paddies (Zong et al. 2007). Not only that, but controlled burning has been traditionally practiced in many parts of Japan to maintain plants such as reeds, which are useful as materials for roofing and bamboo blinds, in good condition.

In recent years, in some places, the purpose of controlled burning is not only to use reeds but also to conserve endangered plants. For example, in the reed beds along the Kokai River and around Sugo Swamp in Ibaraki Prefecture, control burning is conducted every year for the purpose of preserving endangered plants such as Viola raddeana (Figure 2).

It may seem that burning reeds would be damaging to these small endangered plants. However, this is not a concern with fire burning in reed beds and other grasslands during the winter. The fire that burns the standing litter does not stay in the same place and spreads quickly, so the seeds and roots underground are not damaged because the heat from the fire hardly reaches them. Rather, the loss of standing litter encourages germination and growth of plants with life histories dependent on disturbance. Many plants that thrive in a post-disturbance environment are encouraged to germinate by the increased temperature difference between day and night (Figure 3).

Contrary to burning for the purpose of using or protecting wild plants, burning in slash-and-burn agriculture, where one of the goals is to eliminate weed seeds and underground roots, is controlled so that the rate of spread of the fire is slowed and so that temperatures are transmitted to the ground. The fire is slowed down by mowing the plants down

Figure 4: Person carrying a backpack firefighting water bag, etc. ("Jet Shooter")

to the ground and then lighting the fire, or in the case of slopes, by starting the fire at the top of the slope and allowing it to spread toward the bottom. These skills of utilizing fire for different purposes are valuable traditional knowledge.

Proper knowledge and skills are necessary to safely handle fire in the outdoors. It is essential to prepare a fire belt to prevent the spread of fire to an unnecessary area and a fire-extinguisher to extinguish any unexpected fire (Figure. 4). It is also important to determine the order in which to light and extinguish fires, as well as the assignment of ignition and extinguishing personnel based on wind direction and speed on the day of the fire. In addition, in order to burn grass outdoors on a large scale in today's society, administrativ procedures and local understanding are necessary.

Vegetation management by burning is less expensive,


Figure 5: Watarase retarding basin

and more effective, than mowing in preventing forestation and maintaining the grasslands, as well as in conserving the biodiversity of the floodplain. It is also a suitable method for managing retarding basin, which tend to lack vegetation disturbance. In the Watarase retarding basin, the largest retarding basin in Japan (approximately 330 ha), a controlled burning (reed burning) is conducted every March. More than 1,000 species of plants have been recorded in the Watarase floodplain including more than 60 endangered species such as *Ophioglossum namegatae*, *Apodicarpum* ikenoi, and *Viola raddeana* (Figure. 5). It is also an important habitat for birds such as the Marsh grassbird and the Eastern marsh harrier. The reeds that grow widely in Watarase retarding basin are also used as material for reeds. It is known that around 1960, reeds from the Watarase retarding basin accounted for about 70 % of the nation's production (Fukatsu 201). Today, due to various factors such as increased imports, only a small amount of reeds are produced, but annual burning is meaningful in order to keep the reed fields in good condition for future use.

As mentioned above, the Watarase retarding basin is a vast area and the reeds are large, making controlled burning a very important event. Many photographers visit the site during the fire lighting, giving it the appearance of a "festival" (Figure. 6). A large outdoor fire burn is an attractive resource if it is done safely and correctly. Recognizing the joy and beauty of fire lighting and making good use of it will be important for maintaining biodiversity and cultural diversity.

(2) Utilization of Retarding Basins by Various Stakeholders

Most retarding basins are managed by administrative bodies such as the national or prefectural government. In some of these areas, municipalities are the main players in setting up parks within the area, which are typically open to the general public.

The Asahata retarding basin in Shizuoka City is a place where use by a variety of entities. The retarding basin is managed by Shizuoka Prefecture, and a part of the basin is used as a park managed by Shizuoka City. In 2009, "Asahata Green Park" was opened as an urban green space within the retarding basin. Although it is inaccessible during heavy rains because it becomes a flood control area, it is an urban park that is usually crowded with

Figure 6: People watching (and photographing) the controlled burning at Watarase floodplain (March 2009)

Figure 7: Asahata Green Park, a park established within the Asahata retarding basin

Figure 8: Citizens' wetland creation work at the Asahata retarding basin (Photo by Shohei Koike)


Figure 9: Monochoria korsakowii and Penthorum chinense in the Asahata retarding basin

families (Figure. 7).

In the wetlands along the board walk in Asahata Green Park, "wetland creation" activities are held once a month in principle, cutting the dominant grasses with sickles and creating streams and ponds with hoes and shovels. The main activity is led by citizens who gathered at the invitation of the park's Management, with whom I also consult on wetland creation policies and work together. In particular, many parents who bring their elementary school children to the regularly scheduled nature environment education programs participate in the activities. The work is designed to create a space where a variety of plants and animals can inhabit and where children can play and catch insects (Figure 8).

Since the activities are done without heavy machine, the topography and water flow can be managed in detail, taking into consideration an environment where diverse organisms can easily coexist. For example, since the board walk is wheelchair accessible, and the water surface is designed to be placed close to the path so that dragonflies can be caught even from a wheelchair. In order to prevent the invasion of alien species such as red swamp crayfish and bullfrogs, efforts are being made to manage water depth and flow velocity. As a result of these activities, eight species of dragonflies, six species of birds, and 81 species of plants were confirmed in 2012. Some endangered species that prefer disturbed environments were also identified, such as *Monochoria korsakowii* and *Penthorum chinense* (Figure. 9). It suggests that biodiversity is being conserved due to moderate human disturbance.

Participants in the activity commented, "It was the first time for me to use a sickle, but I enjoyed working with touching soil and plants," "It was good to learn the names of plants from an expert," and "I want to continue the activity next year". This wetland creation activity can be regarded as a service for park users provided by managers rather than volunteers taking on the park management that should be done by the government.

There are several other activities that can be considered moderate human disturbance of vegetation and soil in the Asahata retarding basin. For example, there is a paddy field that focuses on contributing to welfare, where students from a special needs school adjacent to the retarding basin plant and harvest rice with the cooperation of a citizens' group. A local company also participate in activities such as rice planting. This is a collaborative effort among local residents, businesses, schools, and other diverse local groups, and at the same time, it is an activity that also emphasizes vocational training and self-support for the disabled (Figure 10). Vulnerable aquatic plants, such as *Chara braunii* and *Nitella axilliformis*, were also found in this paddy field (Nishihiro et al. 2021). This is an example of how utilization results in the management of a retarding basin and biodiversity conservation. The moderate anthropogenic disturbance of the park has simultaneously realized flood control, biodiversity conservation, and park use. There are both natural and social backgrounds to the realization of this project in the Asahata retarding basin. The natural background is that the area where the floodplain is located was originally a floodplain with swamps and wetlands, where a wide variety of plants and animals grew and lived. Since there are many seeds of wetland plants that grew in the past buried in the soil, they will germinate with moderate disturbance and form the basis of the ecosystem. If the topsoil is removed or reclaimed, it will be difficult to restore the original vegetation, no matter how much disturbance is applied.

The social context is the existence of the Nature Restoration Committee. A number of citizen groups and private companies participating in the council. At the time of its establishment, biodiversity conservation was the main topic of discussion, and participation was limited during that period. But participation rapidly increased from around 2001, when the emphasis shifted to activities with welfare, education, and community revitalization in mind (Nishihiro 2008).

The mere existence of a council does not guarantee the success of various activities. It is also essential for the government to support and permit various proposals in a manner that is consistent with government plans. For example, the above-mentioned "wetland creation" in a park, in which users change the structure of a part of the park, is an exceptional use of a city park. However, it is firmly in line with the original significance of the park, which is to improve the amenity of residents and users. The attitude of the administration to allow such activities based on a relationship of

Figure 10: "Welfare paddy" in Asahata retarding basin

trust with the designated manager is important in extracting multifaceted value from nature. It is also important to have someone who can serve as the hub of a network in order to capture and harmonize the opinions of groups and individuals with different objectives and backgrounds. The Asahata retarding basin is blessed with such human resources, and has realized collaboration among a diverse range of entities. Sustaining this structure and relationships is a challenge for the future.

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Traditional erosion control techniques and valley replacement in the Hanedani Valley, Gifu Prefecture

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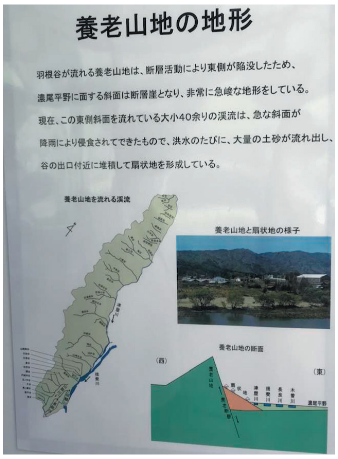

Photo 1:Topography and cross section of the Yoro Mountains

The Yoro Mountains through which Hanedani Valley flows are very steep because the eastern side of the mountains caved in due to fault activity, and the slopes facing the Nobi Plain are fault cliffs. The 40 or so streams of various sizes that currently flow on the eastern slope were formed by rainfall erosion of the steep slopes, and every time there is a flood, a large amount of sediment flows out and accumulates near the valley outlet, forming a fan.

This sediment outflow often interfered with boat transportation, which was an artery for transporting goods on the Ibigawa River and its tributary the Tsuya River, which flowed directly under Hanedani Valley (in the

Figure 1: Hanedani sandstone runout map (Collection of Sabo Yugakukan, Gifu Prefecture)

Yoro Mountains). Records remain of the "Hoei no Daikaki" in 1704 (the first year of the Hoei Era) and the "Teishu Dredging" in 1718 (the third year of the Kyoho Era), in which earth and sand were removed from the river 23 times over 55 years, but no improvement was seen.

In addition, local people were constructing "hillside works" to stop the outflow of earth and sand from the mountains in the upper part of the Hanedani Valley's river channel. Since modern concrete was not available in those days, "soda" (a bundle of hardwoods (so-called *shiba*) with a diameter of 4-5 cm) were buried in layers along the contour line where rocks had been exposed due to soil and sand outflow. This method is expected to have the effect of retaining the slope by allowing underbrush to grow on the hillside and eventually become a forest.

The Hanedani sand and stone run-out map (Figure. 1) is a pictorial map produced between 1871 and 1875 (included in the "Nanno Town" data volume compiled in 1972), which defines the boundaries, names, and territorial limits of the mountains. What is striking is that Hanedani is colored a dull brown that is clearly different from the green of the surrounding forests, and is marked with dots that seem to represent rocks, indicating that earth and sand are protruding from the valley.

Hanedani (Kawara Tachiai) *Sunadome Fushinzu* (Figures. 2 and 3) is estimated to be an illustration from the Edo period (around Koka 3). The west is the sky, the east and west are emphasized as long, and the distance between the north and south is depicted as short. The confluence of the Hanedani and Tsuya Rivers is depicted as a fan-shaped accumulation of earth and sand, and a large amount of earth and sand removed by dredging and construction on both levees was dumped to form a small mountain, commonly known as Koganeyama.

In order to stabilize boat traffic on the Tsuya and Ibigawa Rivers, the Ogaki Clan undertook the "Ansei no Hanedani Repair" ("Replacing the Valley") in 1856, which protected the village by changing the flow path of the central fan to the south and gently merging it with the Tsuya and Ibi Rivers to stabilize the distribution route along the Tokaido Route (from Kuwana to Edo in Kyoto).

It is said that cedar and pine trees in Hanedani were cut down and stones were transported by boat from Tokuyama Village in the uppermost reaches of the Ibigawa River.

Hanedani Valley (Kawara Tachiai) Valley Replacement Transition Map (Old and New) (Figures. 4 and 5) is an illustration drawn in the early Meiji era (1868-1912) that describes sediment disasters and changes in a series of erosion control works from the Ansei Era to the beginning of the Meiji era. The larger drawing depicts the confluence of the Tsuya River and the Ibigawa River (Io

Figure 2: Hanedani *Sunadome Fushinzu* (vally replacement) (Collection of Sabo Yugakukan, Gifu Prefecture)

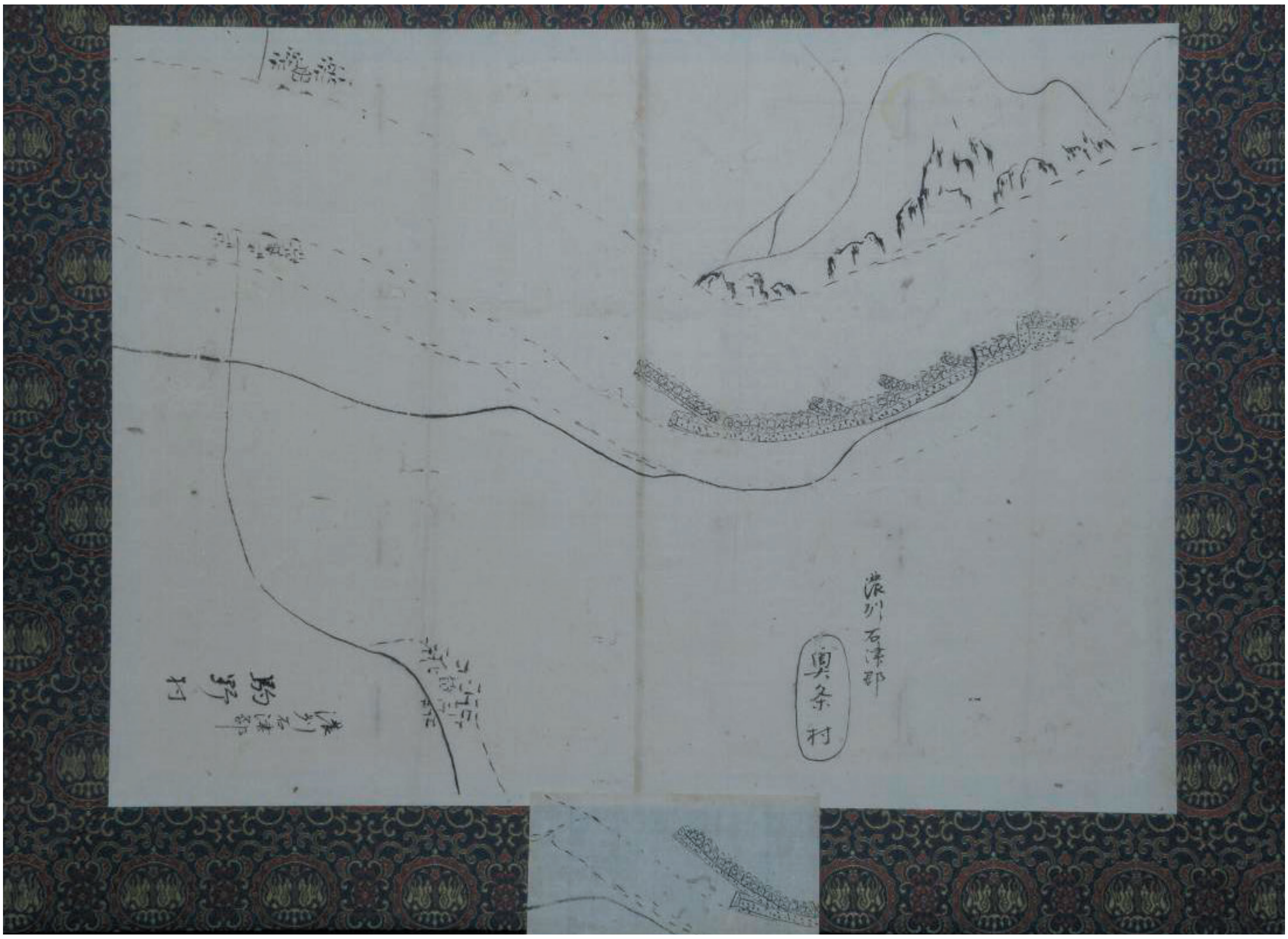

Figure 3: Hanedani Valley Sand Reservoir *Fushinzu* with sticky note (Collection of Sabo Yugakukan, Gifu Prefecture)

River) with the west side facing the sky. It shows the location and number of drainage channels and flumes of the adjacent *Waju* and its drainage channels. The smaller map shows the old name of Tachiai-dani, which was used by the Ibigawa River. The smaller map shows the Tachiai Furudani in the center of the paper, with earth and sand protruding from the Ibigawa River (Io River) and the inscription "Meiji 1-nen Tatsu Haseide" (Meiji 1-nen Tatsu Haseide), and the valley line is curved to the south of the Furudani toward the Hanedani Village area. The valley river section is spaced apart, and is stair-stepped. These are thought to be either banding or low bedding works. In addition, where the valley channel bends to the south and is in close proximity to the Ibigawa River channel, the levee seems to have been collapsed to accumulate sediment.

In the Meiji period (1868-1912), Gifu Prefecture was to carry out the "Hanedani Valley Erosion Control Project" in the Yoro Mountains in accordance with a proposal by Dutch civil engineer Johannes I. Delaecke, and the "Hanedani Valley Gigantic Stone Weir (No. 1 Weir)," designed and supervised by Delaecke, was completed in 1881. The weir was made of clay with a masonry surface, and a channel was attached to allow water to escape. Today, the site is registered as a Tangible Cultural Property of Japan, and is an area where visitors can learn about the history and technology of erosion control and flood control, with the Gifu Sabo Yugakukan (Gifu Prefecture Sabo Education Center) established to convey the technology of early modern civil engineering remains in Japan.

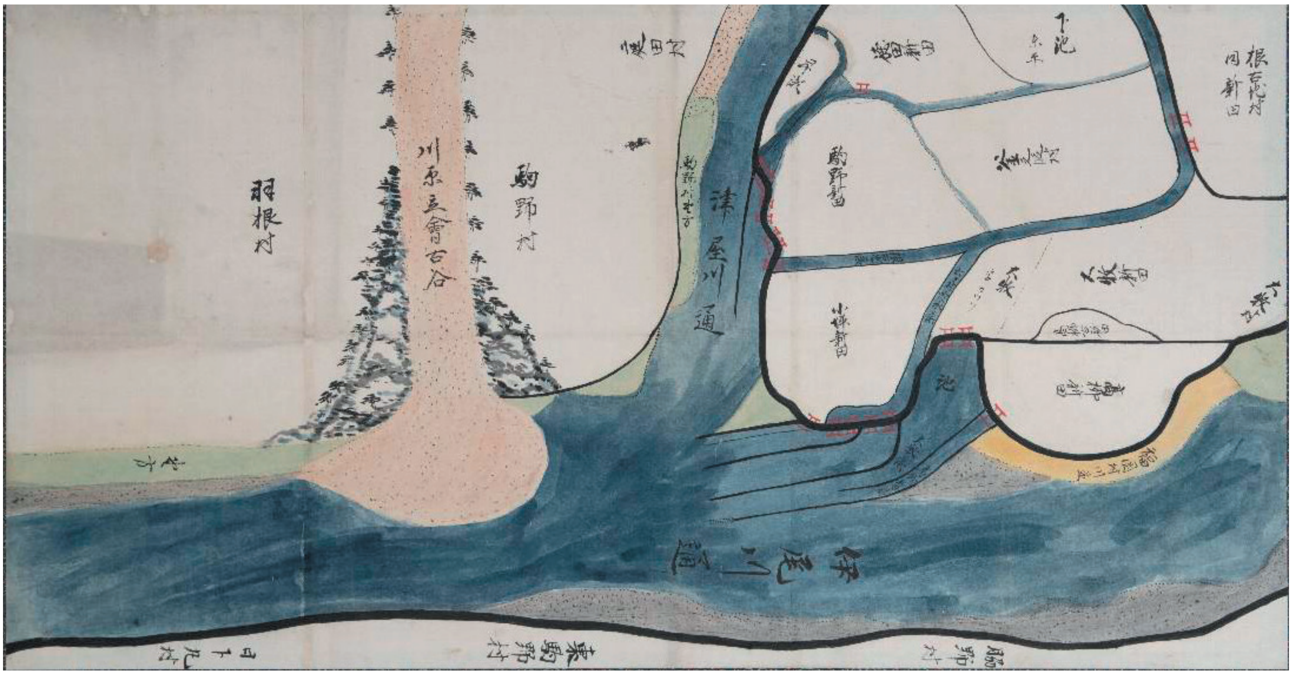

Figure 4: Hanedani Valley Replacement Transition Map (Old)(Collection of Sabo Yugakukan, Gifu Prefecture)

Figure 5: Hanedani Valley Replacement Transition Map (New) (Collection of Sabo Yugakukan, Gifu Prefecture)


Photo 2: View of the Nobi Plain from the erosion control weir

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Gifu Sabo Yugakukan, Gifu Prefecture, Permanent exhibition panel

Nanno Town Hall, "People who challenged erosion control", 1993

Waju levee located in Wanouchi-cho, Gifu Prefecture

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FUKAMACHI Katsue

In the southwestern part of the Nobi Plain, three powerful rivers, the Kiso, Nagara, and Ibi Rivers, known as the three Kiso Rivers, were concentrated in a low marshy area and repeatedly overflowed and changed their flow paths after each heavy rain. The overflowing rivers deposited sediment, and old river channels, natural levees, and hinterland wetlands developed like a web.

Farmers have long residential villages and arable lands on the natural levees and other micro elevations. To protect such lands from flood damage, they surrounded them with levees, which are called *Waju*.

Topography of *Waju* and the Origin of *Waju*

The topography of the *Waju* area is plunging toward the Yoro fault line in the southwestern part of the town. Since ancient times, the three rivers that flowed through the area have been intertwined like a web, overflowing every time there was a heavy rainfall, depositing a large amount of sediment and changing the flow paths. In the process, a number of offshoots such as the Nakamura River and the Ogure River were created, giving birth to "Kawanakajima" (Kawanakajima is the name of the island of rivers). This is the original topography of present-day *Waju*.

It was in the latter half of the Yayoi period (around the 3rd century) that settlements were established in what is now Wanouchi-cho. It is assumed that people cultivated rice in the midst of turbulent rivers in the discovered village of that time (Shigo site). *Waju*, which is located between the Ibigawa and Nagara Rivers and has suffered tremendous

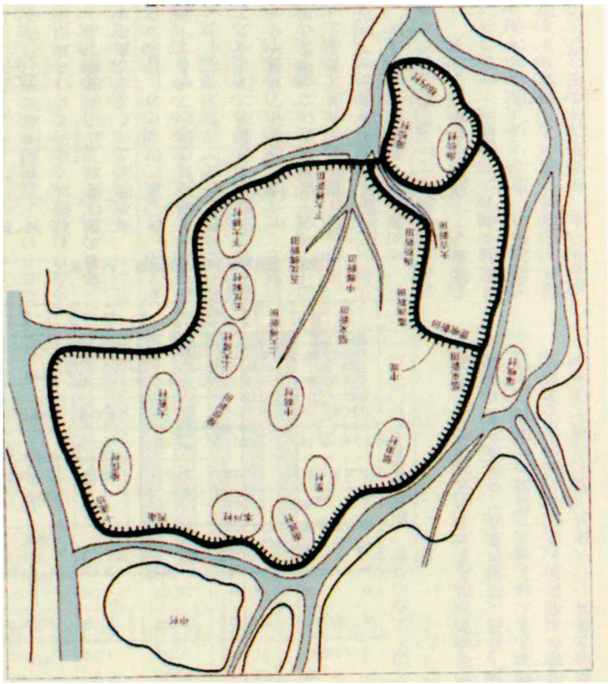

Figure 1: Schematic diagram of Fukuzuka *Waju* in the late Kanbun era (ca. 1670): on p. 7 of *Waju* Gaku Kenkyu No. 5 (Tanaka Kuniaki)

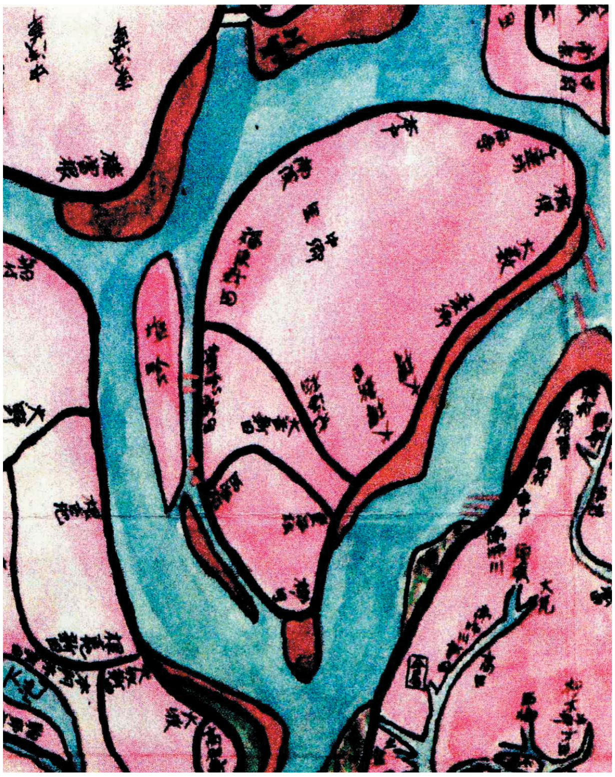

Figure 2: Kanen 3 to 4 years (1750-51) Kawasuji Murata painting: Wakunouchi Studies No. 5 (Tanaka Kuniaki) p 10 of Figure 5

damage from numerous river floods, united in order to fight natural disasters and residential a fortress-like ring of levees around the town. This was the origin of *Waju*.

The Birth of Fukuzuka *Waju*

In the Edo period (1603-1867), as the world settled down, farmers began to focus on developing new rice paddies and expanding their arable land. At this time, the southern part of *Waju* was usually a spacious grassland and marshland. OKADA Syougen-Yoshiatsu, a deputy under the direct control of the Mino *Shogunate*, noticed this and obtained permission from the *Shogunate* in 1615 to develop new rice paddies, which he started seven years later and completed two years later. Two years later, the development of new rice paddies was completed. The development of new rice paddies was also pursued enthusiastically in the surrounding area, and from 1612 to the beginning of the Kan'ei period (1624~), seven new rice paddy villages were developed in addition to Fukuzuka-sinden. The eight new rice paddy villages developed at this time had a stone value of 5,060 *koku*, which translates into an area of 5 km^2.

Along with the development of new rice paddies, the Oguregawa River was repaired and *Tsutsumi* (levees) were constructed, and an "unbroken levee" was residential around the arable land and villages. Compared to Fukuzuka *Waju* (also called Ogure *Waju*), which was the first Waju and where advanced

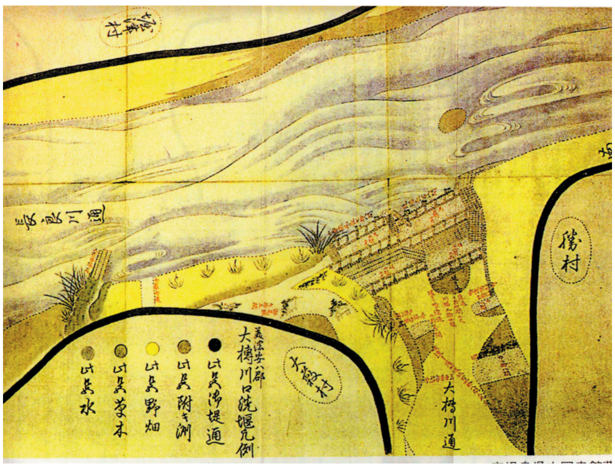

Figure 3: Oguregawa-guchi washing weir illustration (Kagoshima Prefectural Library collection): *Waju* Gaku Kenkyu No. 8 (Tanaka Kuniaki) p 12

flood prevention technology was used due to its status as a *shogunate* domain (directly controlled by the *shogunate*), there was still undeveloped land in the sandbar across the Iogawa River (present-day Ibigawa River) immediately downstream. Here, Nagoya town doctor Yamauchi Shogen and the landowners of Fukutsuka Village developed the land and turned it into *Waju*(Oyoshi-*Waju*). They were named Oyoshi-shinden and Toyokuro-shinden, respectively.

People living in a land surrounded by water with a ring of levees as a shield are of one mind and one heart, even if they belong to different villages. In Fukuzuka *Waju*, 18 villages (10 in the main village and 8 in Shinden) joined together to form the *Waju* Association, a flood control community that was responsible for eliminating bad water (excess water), preserving the levees, and making requests to the *Shogunate* for *gofushin* (measures to be taken when flooding occurs). Although the levees surrounding the area were completed, they were residential of earth, stones, wooden piles, and bamboo baskets. In those days, people had to rely on the power of nature for drainage from within *Waju*. Daily, steady levee repair work, dredging of waterways, and other meticulous conservation work through the solidarity of the people were important.

The *Waju* Dilemma

When we look at the history of flooding in *Waju*, there is no record of flooding in the 20 years since the completion of Wanouchi-cho. This was a period of stability for Fukuzuka *Waju*, where the rice harvest increased *dramatically* after the completion of *Waju* and the area was not subject to flooding.

However, in 1650, the worst flood of the first half of the Edo period, the Great Noshu Flood, occurred, causing extensive damage. The area was then flooded 26 times during the next 226 years until the end of the Edo *shogunate*. One of the main reasons for this was that the development of new rice paddies had closed off grasslands and wetlands that had functioned as recreational areas, and levees had taken away places for water to escape in the event of a powerful flood. In addition, the increase in the number of ronaka also affected the accumulation of sediments naturally transported upstream, making river channel blockages more likely to occur.

These environmental changes would not have been a powerful problem if only 10 rings had been created in the Kiso Sansen. However, in the mid-1700s, the Kiso Sansen area was crowded with more than 100 large and small river channels, and once the water level increased, the river was bound to break a levee at some point. Large-scale disasters caused by excessive modification of nature began to occur along the Kiso Sansen in the early Edo period.

The need to drain bad water out of the levees while preparing for the threat of river water outside the levees" was an issue that remained unchanged for more than 200 years after the completion of *Waju* in the early Edo period and continued through the Meiji era. Life in *Waju* was a history of "fighting against water" to solve the three difficult problems of flood control, drainage (treatment of excess water), and irrigation (water intake while protecting the levees).

Horeki Flood Control, Kiso Sansen Diversion Project, and *Waju*

In 1753, the *Shogunate* decided to carry out the "Horeki Flood Control Project" under its direct control in order to solve the frequent flooding of the Kiso Sansen, which spanned the three provinces of Mino (Gifu), Owari (Aichi), and Ise (Mie). The Satsuma Clan spent a huge amount of money (400,000 ryo) and deployed 947 vassals to complete the powerful works, including the diversion of the Kiso and Ibi Rivers, at the cost of many casualties. In the vicinity of *Waju*, as many as 40 works were carried out, but the most difficult work was the installation of a weir to prevent water from the Nagara River from falling into the Ogure River. These flood control works greatly reduced the threat of water to downstream residents.

In 1873, Dutch civil engineer Johannes I Delaecke came to Japan at the invitation of the Japanese government and conducted a field survey of the Kiso River system improvement work from 1878 to 1881. Katano Mitsuemon, who served as a guide during the survey of the Fukuzuka *Waju* area, strongly appealed to Delaecke about the importance of closing the Oguregawa River and dividing the three rivers based on his own experience in flood control projects, as well as measures to prevent water accumulation in the *Waju* area. This appeal was accepted, and Dereke drew up a renovation plan that incorporated the necessity of complete diversion of the three rivers and drainage of the *Waju*. As part of the national project that took 25 years from 1887, a steam-powered drainage pumping station was installed in Fukuzuka *Waju*, enabling power drainage of bad water (excess water) in the *Waju* area.

The "Modern *Waju*" Remains as a Culture

Although it was not until the Showa period (1926-1989) that Wanouchi-cho flood control, drainage, and irrigation issues were resolved through these cadastrally significant construction projects and modern civil engineering technology, and Wanouch-cho became homogeneous with life on land in general, memories of flood damage and gratitude to predecessors still persist among the residents today.

In *Waju* Town, there still remain *Waju* farmhouses with a *Mizuya*, a separate building from the main house, where people take shelter during floods. Flood prevention warehouses are located around the Fukuzuka *Waju* Levee, and a flood prevention Fighter (fire Fighter) is organized. A monument of gratitude erected by the residents after the flood of 1976 has been placed along the promenade on the levee, and cherry trees and hydrangeas have been planted to provide a place for people to relax. The *Waju* is still protected and handed down as a foundation that protects the lives and livelihood of the residents of *Waju*.

Photo 1: Cutting the Fukuzuka *Waju*

Photo 2: Paddy field scenery within Fukuzuka *Waju*

Photo 3: Walking path on the Fukuzuka *Waju*

Photo 4: Monument of gratitude for the flood control project

Photo 5: Flood prevention warehouse in *Waju* Town

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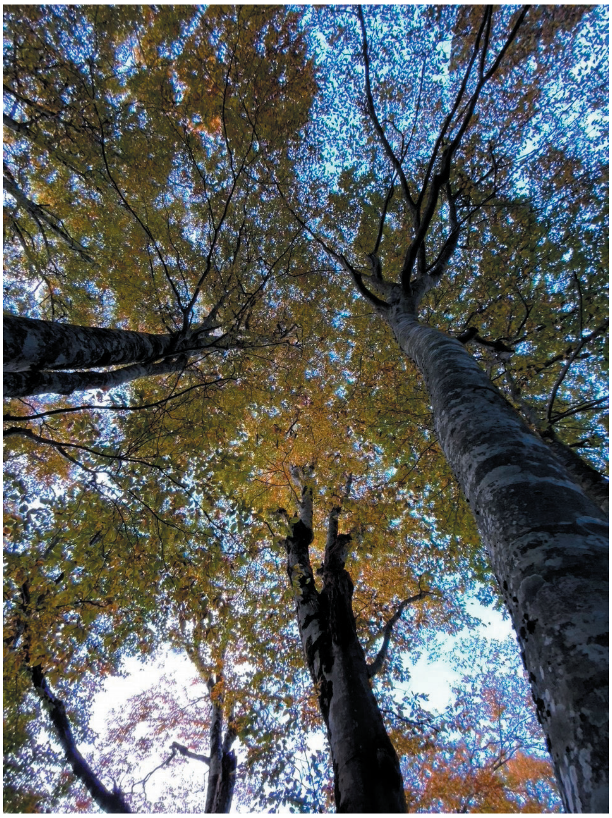
Characteristics and significance of *Yukimochi* Forests in Gokayama area

Former Nanto City Taira Civic Center JODO Tetsuji

Gokayama is the general name for the area located in the southern part of Nanto City, Toyama Prefecture, which used to consist of the former Taira, Kamitaira, and Toga villages.

It extends along the Sho River and its tributary, the Toga River, and consists of five valleys from the south: Akaotani, Kaminashitani, Shimonashitanitani, Ōtani, and Togatani.

Of these, the Kaminashitani valley was divided into the former Taira Village and the former Kamitaira Village in the north and south by the town and village system of the Meiji era. With Akaotani and the southern part of Kaminashitani valley becoming the former Kamitaira Village, the northern part of Kaminashitani, Shimonashitani and Ōtani becoming the former Taira Village, and Togatain valley becoming the former Toga Village.


Yellow leaves of beech dominant *Yukimochi* Forests

Nanto City is roughly equivalent to the area of Lake Biwa in Shiga Prefecture, but Gokayama occupies half of that area, which should give you an idea of its size.

However, the powerfulity of the area is steep mountainous terrain with deciduous broad-leaved forests dominated by beech trees.

Until modern times, Gokayama belonged to the Kaga Clan (now in Toyama and Ishikawa prefectures).

The Kaga Clan strictly protected the forests by establishing a system of seven tree species.

In the former Taira Village, where I was born and raised, there are snow avalanche prevention forest called "Ohai," "Ohobai," "Ohobae," and *Yukimochi*.

These are Snow Avalanche Prevention Forests based on the Preserved Forest System inherited from the enactment of the old Forest Law (1907).

According to Wikipedia, a free encyclopedia, the purpose of these forests is to "prevent the formation of snow laden slopes, which cause avalanches, by stopping snow from releasing on mountainside slopes through the use of trees. When an avalanche does occur, the forest acts as an obstacle to slow it down and direct it in the direction of least damage".

This is a very important point. In the late modern era, the Hokuetsu Snow Record written by Suzuki Makiyuki, a resident of Echigo Shiozawa, states that "Avalanches, along with blizzards, are the most serious problem in snow country," and have long


Nuts of horse chestnut trees that have received protection in *Yukimochi* Forests

been feared.

In Gokayama, too, in March 1934, all five men and one woman of the village were killed by an avalanche on their way back from selling products in Mt. Toga Shinzan, and in January 1940, a weeklong dry powder snowfall in Urushitani, the former Kamitaira Village caused a massive avalanche that destroyed five houses and left 22 people buried alive, along with the tragic loss of 13 lives.

I personally guided the investigators of the "Summary Survey of *Yukimochi* Forests (Snow Avalanche Prevention Forests)" as I was in charge of forestry policy immediately after I was appointed to the municipal office.

According to the Forestry Agency's website, the total area of Snow Avalanche Prevention Forest in Japan is 16,552 hectares, which is only 0.14% of the total area of all forests.

The *Yukimochi* Forests in the former Taira Village


The World Cultural Heritage: Ainokura *Gassho-zukuri* Settlement

cover approximately 98 hectares, which is 0.6% of the total area of all forests in Japan. With this area in just one village, Gokayama as a whole accounts for a small percentage of the nation's total forested area.

Although heavy snowfall and special heavy snowfall zones are widely found on the Sea of Japan coast, *Yukimochi* Forests are quite rare. The Kaga Clan's strict forest protection and regulation system may have been a contributing factor.

Incidentally, the Forestry Agency's website describes the *Yukimochi* Forests of Gokayama as a typical "preserved forest that protects people's lives" as follows.

The Gokayama area in Nanto City, Toyama Prefecture, is a region of heavy snowfall, and since ancient times the forests behind villages have been managed as *Yukimochi* Forests where logging is prohibited, to prevent damage caused by avalanches. The *Yukimochi* Forests are also found in Ainokura and Suganuma villages, which are part of of the Shirakawa-go and Gokayama *Gassho-zukuri* Villages designated as World Cultural Heritage sites, which are highly valued for their landscapes, including the paddy fields and surrounding forests. *Yukimochi* Forests, which are composed of beech, ash, and *mizunara* oak, support the community by preventing mountain disasters such as avalanches and by providing ecosystem services such as the recharging of groundwater supplies for drinking water.

The above excerpts show the characteristics of Gokayama's *Yukimochi* Forests, which are widely distributed in the region.

Gokayama in the narrow sense of the word refers to the former Taira and Kamitaira villages, but they are distributed from Kozo in the southernmost part of the mountains to Soyama in the northernmost part. Not all of them are designated as preserved forests. The fact that they are designated as common forests e.g. the forest of Sugawa settlement may indicate that they avoided designation because they did not want to be regulated.

Being located in the upper part of the village, most of the forest is naturally formed in close proximity to human habitation.

The powerfulity of villages in Gokayama are located on gentle slopes with no valley formations.

This means that there are no mountain streams in the villages, and it is thought that the fear of avalanches was a powerful cause of inconvenience at that time, when people could not rely on pipelines or other means of water-supply.

In villages with clear valley landforms (e.g., Oshima), *Yukimochi* Forests are located in the upper part of the valley.

This is thought to be due to the fact that the valley topography attracts and induces avalanches, and trees on these slopes were the source of Snow Avalanche Prevention Forests s.

Stone walls were piled up on the border between the village and the valley to prevent millet from spreading into the village. These stone walls can be seen at Hososhima of Kamitaira, Tamukai and Kaminashi of Taira Village.

The significance of Gokayama's *Yukimochi* Forests is that they are so close to people's homes. These forests are not rare, virgin forests in deep mountain valleys but natural landscapes, environments with large diameter trees, and precious cultural assets that have been passed down through the cooperation of local residents over a long period of time.

Gokayama has a high percentage of forests under protection, however forestry is not a thriving industry, with only a short history of forestry as a material production industry.

The Forestry Society of Japan has proposed and selected forestry heritage sites, but none exist in Toyama Prefecture.

Forestry heritage is a collection of landscapes, facilities, sites, systematic techniques, characteristic tools, old documents, and other materials that show the history of forestry development. 41 forestry heritage sites have been selected as of FY2019. The forestry heritage has a strong aspect of industrial legacy as a livelihood.

I think we need to reconsider the "*Yukimochi* Forests of Gokayama" as "forest heritage", resulting from humans working and interacting with nature.

Finally, I would like to talk about the wonders of Gokayama.

If *Gassho-zukuri* style architecture, black gunpowder production, and *Yukimochi* Forests are the three elements that characterize Gokayama, I would like to consider whether the establishment of these elements is a coincidence, or whether there is a hypothesis that can explain them in a consistent manner.

In Japan, Gokayama is the only place where potassium nitrate, the raw material for black gunpowder, is produced using the cultivation method, in which hay, soil, and silkworm dung are alternately placed in a pit under the floor to make saltpeter clay, which is then fermented and extracted to produce nitrates. This process required labor, an abundance of wild grasses, and firewood.

The Kaga Clan is said to have controlled Gokayama since 1585 (Tensho year 13), but saltpeter nitrates had been produced in Gokayama long before that, and was supplied to the Ichijo revolt side, including the defense of Ishsoyama Hongan-ji Temple.

As there are still documents related to the Kaga Clan's saltpeter nitrate, Gokayama was not a secret production center, and the *Shogunate* did not suspect the fact that an outlying clan was the number one producer of gunpowder, a strategic material, in Japan.

In fact, as peaceful times continued, the only demand for gunpowder was for fireworks at the manufacturer, and for the extermination of harmful birds and animals. A petition was sent to the Kaga Clan, which was having trouble dealing with the inventory, not to hold back on purchasing.

The *Gassho-zukuri* style in Gokayama was almost completed during the Genroku era (1688-1704), roughly 350 years ago. Prior to the *Gassho-zukuri*, the Gassho-hut was a freestanding structure with hottatebashira (dugout pillars). Okubo carpenters were greatly involved in the establishment of the *Gassho-zukuri* style.

The Okubo carpenters were a group of carpenters brought from their hometown of Owari by Maeda Toshiie, the founder of the Kaga Clan, in 1587. In other words, the first floor was constructed by a group of top-notch carpenters called "Okubo carpenters," and the local villagers residential the hut for the roof, which is called *Gassho-zukuri*.

Listed in order of their establishment, are: *Yukimochi* Forests, gunpowder production, and *Gassho-zukuri*. Of course, it is possible that the later styles may have had an influence on the earlier ones.

Traditionally, gunpowder production, Japanese paper, and raw silk have been counted as the three whites that
supported Gokayama.

I believe that "snow" should be added to these to make them the four whites.

Traditionally, "snow" has been the source of misfortune and has been treated as a nuisance. However, "snow" has restricted the habitable land in Gokayama, and has promoted the advanced use of land and resources.

Because the *Yukimochi* Forests restricted the habitable land to avalanche-protected areas, the houses became taller, and the *Gassho-zukuri* became *Gassho-zukuri*, a style of house construction which utilized the design of the subfloor to the upper floors of the house. The concentration and stratification of the labor force, as seen in the manufacture of gunpowder, led to the development of a product that used enormous amounts of fuel (firewood) resources at the time.

In other words, it can be said that the presence of "snow" promoted "selection" and "concentration". Leaving aside the question of whether the Kaga Clan's rule was a harsh or good policy, if this selection and concentration were the factors that shaped Gokayama, then the hypothesis that the *Yukimochi* Forests were a factor may be worth considering.

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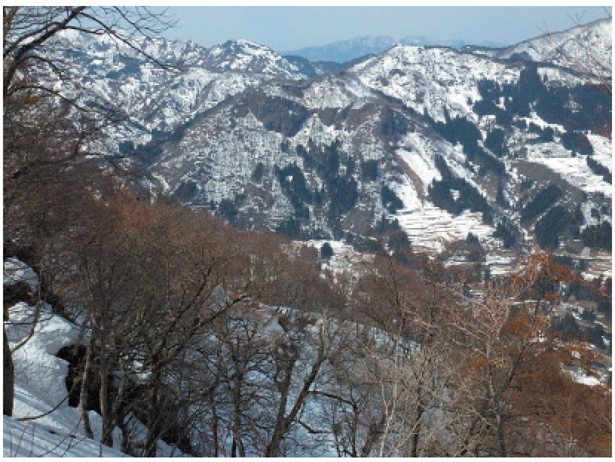

Yukimochi Forest in Ainokura (in the foreground is a forest in Oshima)

Distribution and management of *Yukimochi* Forests in the former Taira Village, Gokayama

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WANG Wen
FUKAMACHI Katsue

Introduction

Gokayama in Toyama Prefecture is located in one of the world's heaviest snowfall areas, the Sho River valley. This area is situated between steep valleys which experience snow accumulation of up to 3 to 4 m in depth and which melts around late May. While this climate has given rise to unique natural landscapes and traditional culture, Gokayama has in the past been frequently hit by destructive surface avalanches. In this area, a total of 57 avalanche events occurred between 1931 and 1990, with a total of 61 deaths and 16 injuries reported. To protect the village from avalanche disasters, local residents conserved "*Yukimochi* Forests" (Photos 1-6) to prevent avalanches, which have been protected for generations since the Edo Period. They serve a public function in preventing mountain disasters such as avalanches and the recharging of water sources, and are also used as building materials and fuel resources. These forests are important in maintaining the environment of Kayaba, a source of building materials. Part of the *Yukimochi* Forests in the World Heritage Site of Ainokura, Suganuma Village are also included in the Preservation District for Groups of Traditional Buildings designated under the Law for the Protection of Cultural Properties.

An existing study on Gokayama's *Yukimochi* Forests, "Summary Survey of *Yukimochi* Forests (Snow Avalanche Prevention Forests)" published in 1987 (hereinafter referred to as the "1987 Summary Survey"), documents the distribution of *Yukimochi* Forests in 1947. In Gokayama, there is no existing data more because there have been no detailed surveys of *Yukimochi* Forests in other villages except the former Taira Village. This paper attempts to understand the distribution and management changes of *Yukimochi* Forests in the former Taira Village of Gokayama since 1947, based on the "1987 Summary Survey," the 2018 Forest Plan Map, and the 1953 topographic map.

In this paper, we have classified the *Yukimochi* Forests in the Gokayama Taira Village into two types: (1) *Yukimochi* Forests (1947): which is identified in the "1987 Summary Survey" and (2) *Yukimochi* Forests (2018): *Yukimochi* Forests that are located within *Yukimochi* Forests (1947) and are designated as Snow Avalanche Prevention Forests as of 2018. In addition, the extent to which the forest is an Snow Avalanche Prevention Forest as of 2018 was labeled as Snow Avalanche Prevention Forests (2018).

Distribution and Change of *Yukimochi* Forests

1) Distribution of *Yukimochi* Forests (1947)

The distribution of *Yukimochi* Forests (1947) is shown in Figure 1, with the extent based on the "1987 Summary Survey". Table 1 lists the *Yukimochi* Forests in the former Taira Village. Of the 22 settlements belonging to the former Taira Village, 17 settlements had *Yukimochi* Forests (1947) Kaminashi, Tamukai, Ainokura, Miza, Shimonashitani, Kokurusu, Nashitani, Oshima, Kagodo, Higashinakae, Shimode, Iritani, Sugawa, Okuzushima, Donohara, Sugio, and Soyama. The total area of *Yukimochi* Forests (1947) was 357.17 ha, and the minimum area per village was 1.24 ha and the maximum 77.85 ha. The overall elevation of *Yukimochi* Forests (1947) ranged from 250m to 1039 m, but most of the forests were located between 300 m and 800 m. The distribution of *Yukimochi* Forests (1947) was different in each settlement, with these forests mainly distributed on steep slopes behind settlement located along the Sho River, while those in Nashitani were located along the Nashitani River, a tributary of the Sho River. In the other 7 settlements,

Photo 1: Natural forest within the *Yukimochi* Forest in Ainokura (photo taken on August 10, 2020)

Photo 2: Artificial forest within the *Yukimochi* Forest in Iritani (photo taken August 11, 2020)

Photo 3: A large horse chestnut tree in the *Yukimochi* forest in Ainokura (photo taken on August 10, 2020)

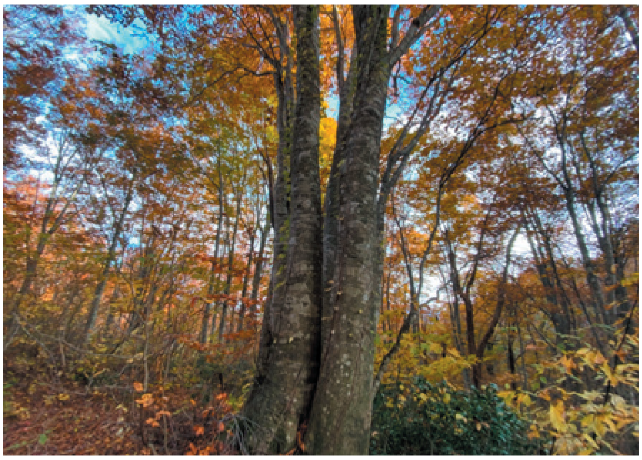

Photo 4: A large beech tree in the *Yukimochi* forest in Oshima (photo taken on November 1, 2020)

Photo 5: Kaminashi and the *Yukimochi* forests behind it. (photo taken on November 8, 2020)

Photo 6: The *Yukimochi* forest behind the settlement, Kagodo (photo taken on November 6, 2020)

the forests were found in multiple locations. There were also differences in the location of the *Yukimochi* Forests in relation to the settlement areas. In Kaminashi, the forests were located between 310 and 1039 m above sea level, and in Oshima between 320 and 1031 m. Compared to other settlements, the location of *Yukimochi* Forests in a wider area and at higher elevations indicates that these settlements have a relatively high risk of avalanche occurrence.

According to the "1987 Summary Survey," the forests near the settlement were used for firewood and coal in addition to *Yukimochi* Forests. Around the 1940s, a large amount of wood was needed as munitions during the war, and the forests were cut down in large numbers. The results of the interview revealed that the majority of the houses in the former Taira Village around 1947 were *Gassho-zukuri* houses, the land near the village was subdivided and used for fields, thatching materials, and wood and coal forests located on steep slopes. Forests other than *Yukimochi*

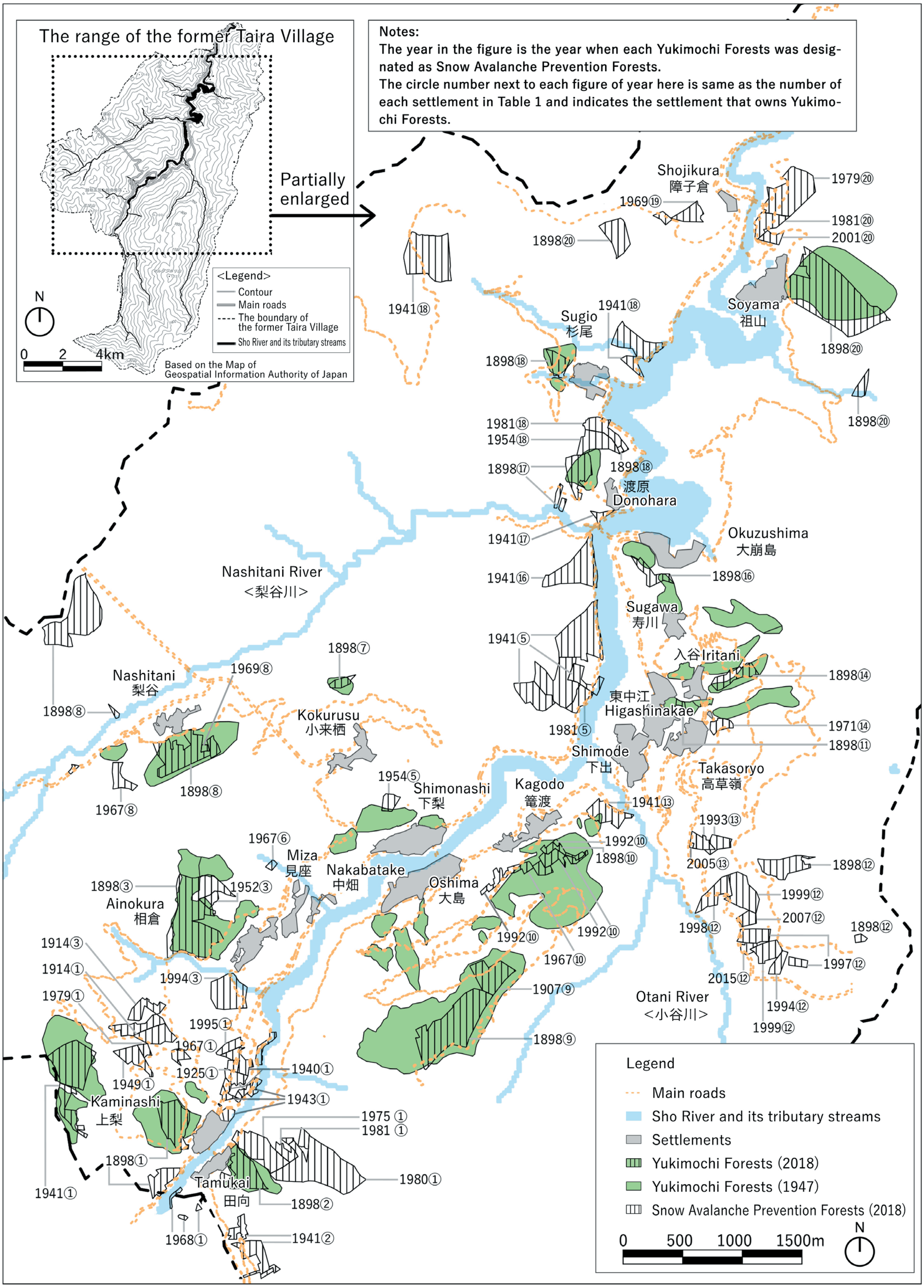

Figure 1: Distribution of *Yukimochi* Forests (1947), *Yukimochi* Forests (2018), and Snow Avalanche Prevention Forests (2018) in the former Taira Village.

Forests were either logged or young forests. During the *Gassho-zukuri* houses reconstruction period from the 1950s onward, each household was allowed to cut down one large tree (beech, zelkova, or chestnut) from its own *Yukimochi* Forest to be used as beams for a new building. In times of food shortages, the seeds of horse chestnut and other trees were an important food source that sustained the livelihood of local residents and are still used for food today.

2) Distribution of Snow Avalanche Prevention Forests (2018)
As of 2018, there were a total of 19 settlements with Snow Avalanche Prevention Forests (Figure 1): Kaminashi, Tamukai, Ainokura, Miza, Shimonashitani, Nakahata, Kokurusu, Nashitani, Oshima, Kagodo, Higashinakae, Takasoryo, Shimode, Iritani, Okuzushima, Donohara, Sugio, Shojikura, and Soyama. The total area of the Snow Avalanche Prevention Forests (2018) was 369.21 ha, with a minimum area of 0.45 ha and a maximum area of 74.89 ha in each settlement (Table 1). The elevation of these forests was distributed between 215 m and 1039 m (Table 1). The distribution of the Snow Avalanche Prevention Forests (2018) overlapped with that of the *Yukimochi* Forests (1947), and some of the forests were located on slopes behind settlement. Compared to the distribution at the elevation of *Yukimochi* Forest (1947), the distribution area was slightly wider and was also located at lower elevations between 215m and 250m. In addition to this, the number of designated Snow Avalanche Prevention Forests areas in the backcountry away from settlement and along the Sho River and its tributaries increased, and there were many scattered cases of such forests.

(3) Distribution of *Yukimochi* Forests (2018)
As of 2018, there were 15 settlements with *Yukimochi* Forests (2018) Kaminashi, Tamukai, Ainokura, Shimonashitani, Kokurusu, Nashitani, Oshima, Kagodo, Higashinakae, Shimode, Iritani, Ookasujima, Donohara, Sugio, and Soyama (Figure 1). The total area of *Yukimochi* Forest (2018) was 123.21 ha, with a minimum area of 0.17 ha and a maximum of 24.93 ha per settlement (Table 1). Overall, the elevation of *Yukimochi* Forest (2018) ranged from 280 m to 1039 m, and was mainly distributed between 300 m and 700 m (Table 1). The area of *Yukimochi* Forest (2018) was about one-third of that of the forest in 1947, and the range of elevations over which it was distributed was also reduced.

Yukimochi Forests (2018) are mainly located on steep slopes behind settlement, and compared to the distribution of *Yukimochi* Forests (1947), Forests near settlements (250 m to 280 m elevation) have decreased significantly. In Kaminashi, several parts of *Yukimochi* Forests were found, but in other areas, only one forest per settlement was distributed.

One of the reasons for the decrease in the number and area of *Yukimochi* Forests is that afforestation centered on the Tateyama cedar was promoted to meet the social and economic needs of each era, such as the restoration of forests devastated by postwar logging and the increased demand for lumber during the period of rapid economic growth. In addition, during times of food scarcity, forests with low avalanche risk were used as fields to sustain the livelihood of local residents.

Management Patterns and Changes in *Yukimochi* Forests

1) History of Designation of *Yukimochi* Forests (2018) as an Snow Avalanche Prevention Forests
Table 1 shows the year when the *Yukimochi* Forest (2018) in the former Taira Village was designated as an Snow Avalanche Prevention Forests under the Forest Law and Security Forest System. The nationwide flood that occurred in 1896 caused unprecedented damage to the former Taira Village. As a countermeasure, in 1898, a portion of the *Yukimochi* Forests (2018) in 13 villages, including Kaminashi, Oshima, and Soyama, were designated as security forests (Snow Avalanche Prevention Forests) under the Forest Law. Subsequently, with the revision of the Forest Law, the area of *Yukimochi* Forest (2018) in the former Taira Village area gradually continued to be designated as Snow Avalanche Prevention Forests, albeit partially, in relation to the occurrence of disasters, etc. Between 1907 and 1992, additional designation occurred in 7 settlements including Kaminashi, Ainokura, Shimonashitani, and Nashitani.

2) Management Patterns of *Yukimochi* Forests (2018)
The Forest Cooperative System was established in 1907 with the revision of the old Forest Law.

Table 1: List of *Yukimochi* forests in the former Taira Village

settlement	Population of settlements (Number of households)	Yukimochi Forests (1947) Area/ha	Snow Avalanche Prevention Forests (2018) Area/ha	Yukimochi Forests (2018) Area/ha	Yukimochi Forests (1947) Elevation/m		Snow Avalanche Prevention Forests (2018) Elevation/m		Yukimochi Forests (2018) Elevation/m		Major tree species (1987)
					Lowest	Highest	Lowest	Highest	Lowest	Highest	
①Kaminashi	95 (29)	48.22	74.89	21.14	310	1,039	250	1,039	330	1,039	beech, horse chestnut, jolcham oak
②Tamukai	40 (13)	10.74	14.06	6.88	310	605	315	635	315	585	horse chestnut, zelkova, katsura
③Ainokura	55 (19)	29.33	36.04	18.54	410	850	340	860	500	850	beech, horse chestnut, zelkova
④Miza	47 (14)	4.28	1.32	–	580	780	475	675	–	–	—
⑤Shimonashi	174 (69)	13.23	32.89	0.17	250	450	250	650	400	440	beech, zelkova, Japanese maple
⑥Nakabatake	37 (12)	—	0.45	–	—	—	415	495	–	–	—
⑦Kokurusu	31 (12)	2.31	1.24	1.24	655	730	675	735	675	730	—
⑧Nashitani	0 (0)	24.24	28.40	7.47	635	870	595	1,030	655	825	horse chestnut, beech, Japanese maple
⑨Oshima	96 (34)	77.85	24.73	23.53	320	1,031	635	1,030	635	1,025	horse chestnut, beech, Japanese white birch
⑩Kagodo	49 (16)	47.49	8.25	6.45	380	785	395	635	440	635	beech, horse chestnut, mizunara oak
⑪Higashinakae	39 (14)	1.92	4.83	0.51	365	460	365	705	365	430	—
⑫Takasoryo	29 (16)	—	22.32	–	—	—	415	965	–	–	—
⑬Shimode	73 (23)	1.24	9.03	0.37	400	600	310	715	410	460	—
⑭Iritani	25 (13)	24.34	4.63	2.9	390	730	450	655	475	655	mizunara oak, horse chestnut, zelkova
⑮Sugawa	24 (8)	16.48	–	–	330	478	—	—	–	–	—
⑯Okuzushima	33 (11)	3.78	12.22	1.05	280	395	250	575	355	395	beech, horse chestnut, jolcham oak
⑰Donohara	2 (1)	6.72	7.27	5.42	320	505	250	540	355	505	mizunara oak, beech, chestnut
⑱Sugio	21 (8)	5.89	36.02	2.61	340	530	250	841	360	530	beech, mizunara oak, horse chestnut
⑲Shojikura	0 (0)	—	3.34	–	—	—	370	655	–	–	—
⑳Soyama	33 (13)	39.11	47.28	24.93	280	775	215	800	280	775	mizunara oak, beech, Koshia japonica

Subsequently, with the enactment of the current Forest Law in 1951, a production forest cooperative was established, and a portion of the *Yukimochi* Forest (2018), which was a community-owned forest, has been managed using the sub sidy system under the production cost project.

In 2018, 15 settlements with *Yukimochi* Forests (2018) had public, private, and state-owned forests. of these, 10 settlements had public forests owned and managed by Forest Cooperative. However, in recent years, the Forest Cooperative have continued to face a difficult business environment, and

since 2010, several settlements in the former Taira Village have been unable to use the subsidies available for the management of Snow Avalanche Prevention Forests. The reasons for this are: the safety of public facilities (in the case of Snow Avalanche Prevention Forests, fallen trees and rocks cause damage to facilities), the alteration of the landscape due to the creation of a protective fence under the Snow Avalanche Prevention Forests (Tamukai), and the loss of large trees in the Snow Avalanche Prevention Forests due to oak wilt damage (Irigaya). In order to improve the situation, the four settlements of Tamukai, Iritani, Okuzushima, and Sugio had reorganized in 2019, and the *Yukimochi* Forests that had been owned and managed by the Forest Cooperatives were changed or planned to be managed by landowner association.

Conclusion

Yukimochi Forests in the former Taira Village in Gokayama were distributed on steep slopes behind settlements that were threatened by surface avalanches. The area, elevation range, and number of locations varied according to the location of each settlements. In Gokayama during this period, repeated logging for firewood and coal use led to the spread of grasslands such as thatch, and there were few older broadleaf forests other than *Yukimochi* Forests in the area around settlements.

After the enactment of the Forest Law in 1897, part of the *Yukimochi* forests (1947) was designated as an Snow Avalanche Prevention Forests. After the revision of the Forest Law in 1951, the area designated as Snow Avalanche Prevention Forests was expanded to include coniferous forests located outside of the *Yukimochi* Forest (1947), due to the construction of roads and the increase of planted forests such as Japanese cedar.

Year designated as Snow Avalanche Prevention Forests	Ownership/management	
	As of 2018	As of 2019 (changes)
1898, 1941	public forests (Forest Cooperative, municipalities) private forests (individuals)	
1898	public forests (Forest Cooperative)	landowner association
1898, 1952	national forest public forests (Forest Cooperative, municipalities) private forests (individuals)	
–	–	
1954	public forests (Forest Cooperative)	
–	–	
1898	private forests (individual)	
1898, 1969	public forests (municipalities) Private forests (individuals)	
1898, 1907	public forests (Forest Cooperative)	
1898, 1967, 1992	public forests (Forest Cooperative, municipalities)	
1898	public forests (Forest Cooperative) private forests (individuals)	
–	–	
1941, 1993, 2005	private forests (individual)	
1898	public forests (Forest Cooperative)	landowner association
–	–	
1898	public forests (Forest Cooperative) private forests (individuals)	landowner association
1898	private forests (individual)	
1898	public forests (Forest Cooperative)	landowner association
–	–	
1898	public forests (municipalities) private forest (individual, company)	

Yukimochi Forests can be positioned as avalanche disaster prevention in a wide range of areas, including not only settlements, but also other areas at high risk of avalanche disasters and public works projects to increase safety against natural disasters.

On the other hand, some forests were recognized as having been transformed into fields or artificial forests, mainly in areas that were not designated as Snow Avalanche Prevention Forests in the *Yukimochi* forests (1947). In particular, natural forests without legal security are thought to have been susceptible to changes in land use and forest types under the influence of social and economic changes, such as food shortages, afforestation policies, and the development of public works projects to prevent avalanches. Along with measures to promote forest conservation and sustainable forestry management, we believe it is also important to reaffirm the use of forests as traditional knowledge, utilizing the ecosystems that have been passed down from generation to generation and for the future.

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Traditional and local knowledge of Mikatagoko, Fukui Prefecture

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Introduction

Elementary school students in Fukui Prefecture learn about disaster recovery work done in the Mikatagoko (Five Lakes of Mikata) region during the Edo period. It was a project work mitigating flooding caused by an earthquake. On May 1, June 16, 1662 year, the Kanbun Omi-Wakasa Earthquake, a powerful earthquake with an estimated magnitude of 7.5 on the Richter scale, hit the northern part of the Kinki region. The crustal deformation caused the ground to rise up to 3.6 m at maximum for several kilom eastward from the eastern shore of the Mikatagoko. As a result, one of the outflow rivers, the Ksoyama River (Figure 1), dried up, causing the lakes upstream to lose their drainage function. As a result, the water levels of Lake Mikata, Lake Suigetsu, and Lake Suga(Figure 1) continued to rise, submerging lakeside villages one after another and eventually forcing 137 families to live in shelters. After the construction of the Urami River (Figure 1), an artificial waterway was completed, and the water level of the lake dropped, thus ending the inundation of the villages. In the process, the shallow waters around the lake were converted to land,

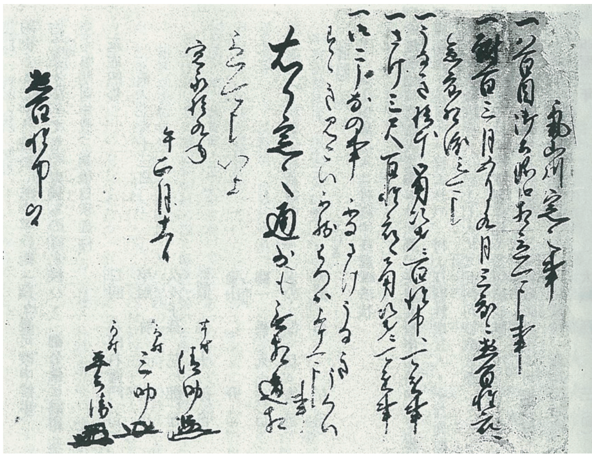

Figure 2: Old document from the Edo period describing what species of fish were caught in the original outflow river (Ksoyama River), Kan'ei 19 (1639) (document from Uwase Shrine)

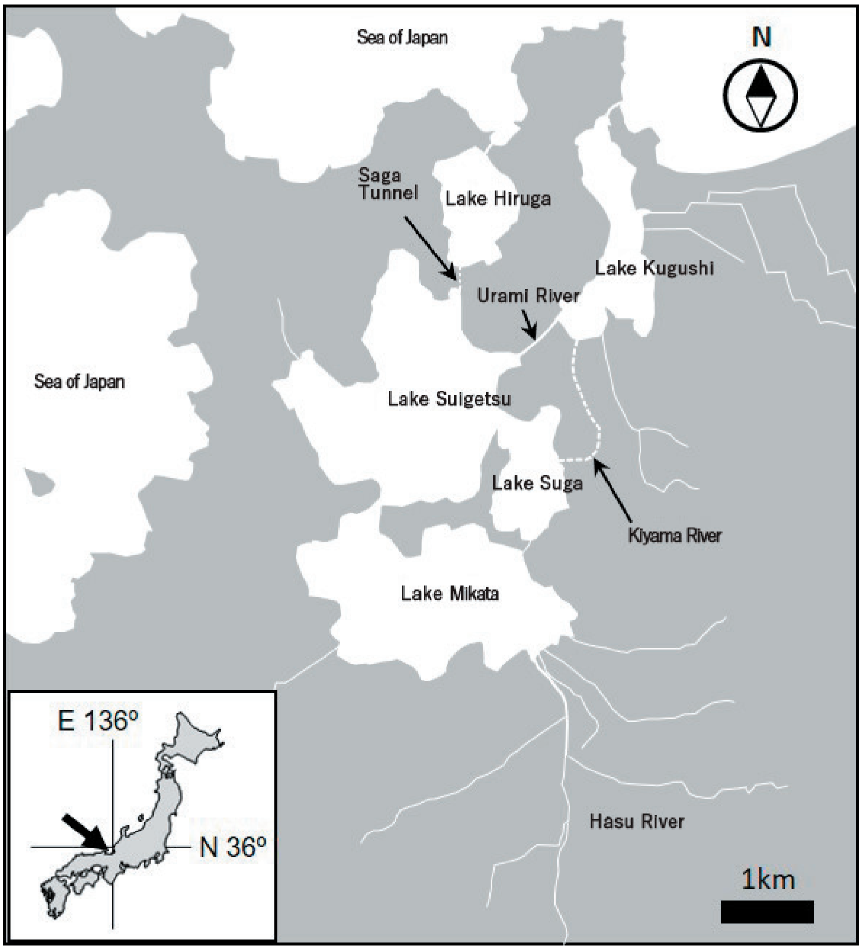

Figure 1: Map of Mikatagoko (Five Lakes of Mikata)

giving rise to two new villages and the development of new rice paddies. At the time, the Obama Clan, which ruled this area, was in the process of recovering from the Kan'ei Famine, and the increase in new rice paddies greatly helped the clan's finances to support the recovery.

The details of this disaster recovery have been passed down to the present day, more than 350 years later, through a variety of media (old documents, stone monuments, etc.), and have even been included in supplementary books on history. On the other hand, the fact that the shallow areas of the dried-up lakeshore and former runoff rivers were actually habitats for a wide variety of fish and shellfish, and were therefore used as fishing grounds (Figure. 2), has rarely been acknowledged. However, there are many historical documents that tell us how our ancestors utilized the bounties of nature, and some of their

Photo 1: The oldest (approximately 13,700 years old) earthenware excavated on the shore of Mikatagoko (top, Wakasa History Museum, Fukui Prefecture) and carp caught in the lake (bottom)

Photo 2: Mikatagoko, brackish lakes surrounded by complex topography (lower side is in the north)

wisdom and techniques are still being utilized today. This chapter introduces examples from Mikatagoko (Five Lakes of Mikata) regarding local wisdom and technology in dealing with these natural resources and disasters, as well as current efforts for nature restoration and disaster prevention/mitigation that are being made by taking advantage of such wisdom and technology.

Lake of Blessing and Healing

The shores of Mikatagoko are where humans first settled in the southern region of Fukui Prefecture. This was about 13,700 years ago, shortly after the end of the last ice age and the beginning of the Jomon period. The abundance of fish and shellfish in the lakes must have been very attractive as a resource for the people who moved here. In fact, when people began to live in the area, they were already using pottery to cook carp species, and this cooking continued for the next 9,000 years until the lakeside settlements came to an end (Photo 1). This was revealed through molecular and isotopic analyses of lipids from earthenware vessels. We know from books on herbology of the time and the autobiographies of the people who brought live eels to Kyoto that eels from Mikatagoko were highly valued in Kyoto and brought great wealth to those involved. Older fishermen still remember that during the Showa period, some fishermen built up a colossal fortune through Shijimi clam fishing, and that the seine fishing for carp species, as well as the mullet drive fishing, also brought great wealth to the community.


Photo 3: Sediment disaster that occurred on a steep slope on the lake shore during heavy rainfall (September 2013)

When we organize the history of the region in this way, we can clearly see that our ancestors have continued to enjoy the bounties of the lakes for more than 10,000 years.

The diverse nature of the Mikatagoko Lakes reflects the diversity of their saline environment. Their area is only one-sixtieth the size of Lake Biwa, but within this limited area, a wide range of saline environments, from nearly freshwater to seawater levels, are squeezed in. Why does this happen? It is because the complex topography intercepts the inflow of freshwater and seawater in places. The five brackish lakes on the Rias coast are the Mikatagoko (see Photo 2).

The complex topography of the Mikatagoko Lakes has also had an impact on the human mind. The rugged topography of the lakes has long been loved by people for its stunning scenery. In the Showa period (1926-1989), the lake was designated as a place of scenic beauty and became part of a national quasi-national park. The Manyoshu (Japan's oldest anthology of poetry) has a poem describing the beautiful scenery of the Mikatagoko. The nature of these lakes has provided people with food, wealth, and healing for a long time.

Disaster-prone Area

The rugged topography also has the distressing aspect of being prone to disasters. The complex topography of the Mikatagoko area has been created by the movement of faults and the occurrence of powerful earthquakes. The flood damage during the Edo period (1603-1868), mentioned at the beginning of this article, was also caused by fault activity. In addition, undulating topography is itself a cause of disasters. In the early Jomon Period (about 5,800 years ago), a Sediment disaster (Photo 3), believed to have been caused by torrential rains, swallowed up the residential areas of the time. As a result, people were forced to leave the place where they had lived for about 8,000 years before the disaster and move to a place where the slope was gentler. Even after the Middle Ages, when written records were kept, records of disasters continued to be recorded. In the great flood of June 1735, many houses and temples were destroyed and swept away, and people and horses were swallowed by the muddy stream. In addition, even the Saga Tunnel (Figure 1), which was dug in preparation for the flood, collapsed, and in the following decades, until it was renovated, even a little rain seemed to cause flooding disasters. In recent years, the loss of property and life due to flooding has been greatly reduced with the development of science and technology, but even so, it has yet to be completely prevented. People living in the area are aware that floods occur every three to five years, causing inundation damage.

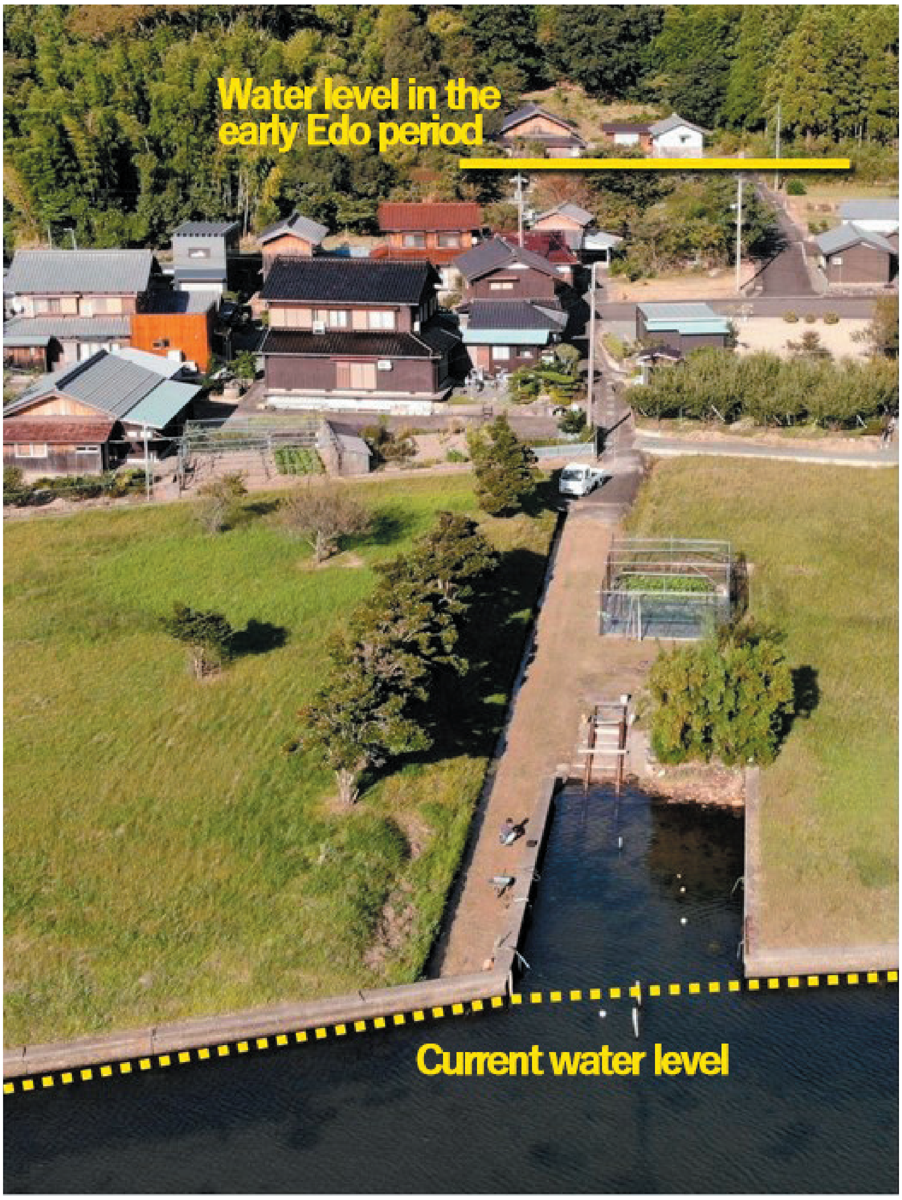

Figure 3: Water level in the early Edo period as passed down orally, and current water level (Lake Suga)

Wisdom and Technology for Survival

However, people have not been immune to the fury of nature. They sought safety by finding places that were less vulnerable to disasters and settling there.One example of this is the Jomon people who, after their village was swallowed by a Sediment disaster, moved to a place with a gentler slope. There are other examples of how

Figure 4: Location of settlements to avoid inundation disasters (during September 2013 flooding)

Photo 4: Sediment carried into the lake by the river during the flood (October 2017). Such sediment was used to develop new rice-fields around the lake.

our ancestors prepared for disasters. On the shores of Lake Suga (Figure 1), during the early Edo period when the water level of the lakes was higher than it is today, settlements were located more than three m above the present level. The water level of the lake at that time and the location of the village have been passed down through oral tradition to this day, more than 300 years later (Figure. 3). Thanks to the wisdom accumulated over the years by

Figure 5: Carp (top) returning to the irrigation channel for spawning and carp (bottom) spawning on the palms used for egg collection

Photo 5: Lake shore where common reeds form a reedbed

Photo 6: Interviews to learn what the lakeshore used to look like (courtesy: Hiroaki Sekioka)

our ancestors to avoid and survive disasters, our residential areas are less likely to be inundated when floods occur today (Figure. 4). On the other hand, many of the areas that are in undated during floods have been used as rice paddies (Figure 4). Located in low-lying areas prone to flooding and connected to lakes, rice paddies and waterways provide important habitats for fish, such as crucian carp, and many other aquatic organisms.

The wisdom of our ancestors was not only to protect us from disasters. They also developed a wisdom and skill to make use of extreme natural phenomena that can cause disasters in their daily lives. For example, when heavy rains cause flooding, large amounts of sediment are carried up stream from the river to the lake (Photo 4). The wisdom and technology to use this sediment to expand rice-fields near the lake and develop new rice paddies existed at least 300 years ago (in the middle of the Edo period). This wisdom and technology was passed down among farmers until the mid-Showa period, when the policy of reducing rice acreage was introduced. This wisdom and technology was applied by fishermen to the restoration of beaches that serve as fishing grounds for Shijimi clam, and has succeeded in increasing the clam abundance.

A Place to Utilize Traditional and Local Knowledge: Mikatagoko Nature Restoration Committee

Local wisdom and skills in dealing with the natural resources and disasters have been passed down to us today in the form of traditional and local knowledge. In recent years, the value of such traditional and local knowledge has been reevaluated and utilized in the practice of nature restoration and disaster response. In the Mikatagoko region, the Nature Restoration Committee is promoting efforts to utilize traditional and local knowledge.

The committee was established in May 2011 to promote nature restoration in the Mikatagoko lakes and surrounding areas. Six Working Groups (WGs) are undertaking nature restoration projects with the goal of "restoring the connection between nature and people surrounding the lakes and their villages," and various traditional and local knowledge is being used in the activities of these WGs. For example, the knowledge that rice paddies and waterways near lakes, which are prone to flooding in the event of a flood, are important places for fish spawning and the growth of young, such as carp species, is widely shared, not only among farmers who cultivate rice paddies, but also among various stakeholders in the community, across generations. This traditional and local knowledge is utilized in efforts to restore fish reproduction and growth in the form of the installation and management of paddy fishways that connect paddy fields and waterways, and the use of palms to collect eggs in waterways and raise fry in the paddy fields (Figure 5).

In addition, the lakeshore, where reeds and other aquatic plants thrive, is not only a habitat and cradle

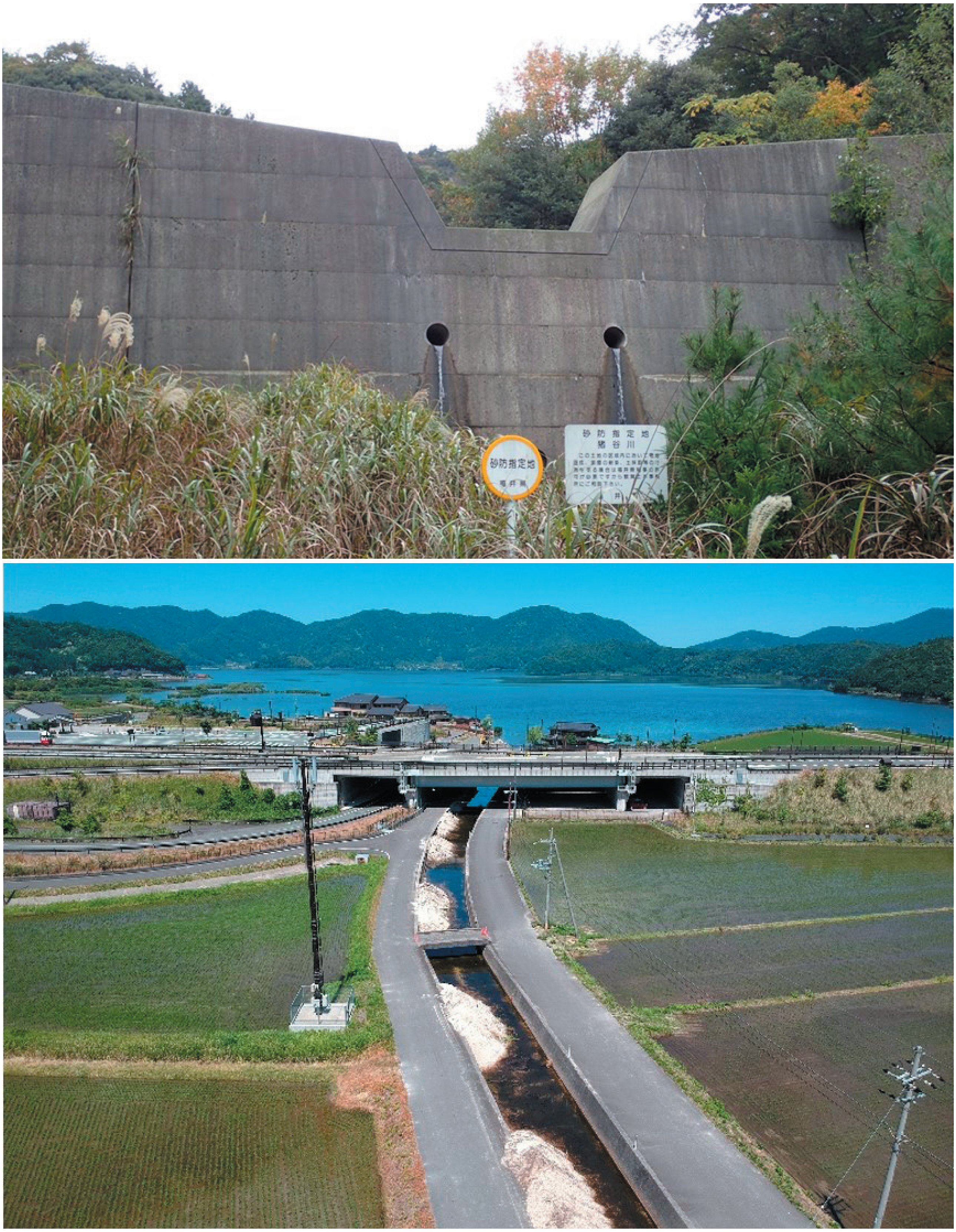

Photo 7: Erosion control weir constructed in the upstream section of the inflowing river (top) and sediment dredged in the downstream section (bottom)

for aquatic organisms, but also a natural shoreline that reduces the risk of land erosion and flooding due to storm surges (Photo 5). The Mikatagoko Nature Restoration Committee established the Lakeshore Restoration WG to work on the restoration of the lakeshore as "Nature-based coastal defense" and began studies on their restoration in 2016. Since the Edo period (1603-1868), much of the shoreline of the lakes has been reclaimed by land reclamation, and in the late Showa period

Figure 6: Sandy beach regenerated using natural forces (area enclosed within white lines)

(1926-1989), approximately 80 % of the shoreline was replaced by concrete embankments. In order to restore the natural habitat, it is necessary to know the previous state of the lakeshore, but scientific report for this purpose was very limited. Therefore, we decided to conduct an interview survey to learn what the lakeshore used to look like. We went out to the lakeshore with fishermen who knew the scenery and the biota of the past before 1975, before the concrete revetment was introduced to the Mikatagoko (Photo 6). Based on the results of this survey, we discussed a policy for the future restoration of the lakeshore. The results were compiled into the "Guide for Lakeshore Restoration in Lakes Kugushi, Suigetsu, Sugako, Mikata, and Hasu River" (hereinafter referred to as the "Guide"), which was published in March 2020.

Restoration of Lakeshores Using Traditional and Local Knowledge

The restoration of lakeshores based on the Guide began in 2020. In developing new rice paddies, the traditional and local knowledge of utilizing sediment washed into lakes during floods was applied to the restoration of lakeshores. In recent years, erosion control weirs have been constructed in the upper reaches of rivers, and regular dredging of sediment has been conducted in the middle to lower reaches where sediment tends to accumulate (Photo 7). As a result, the opportunity for sediment to flow downstream into the lake has been significantly reduced. On the other hand, disposal of the dredged sediment (Photo 7, bottom) has been a considerable burden for river managers. Therefore, we decided to use the sediment dredged from the inflow river as material for beach nourishment on the lakeshore. In this way, we aimed to achieve both disaster prevention and mitigation (river channel dredging and natural revetment in the lake) and nature restoration (habitat restoration through beach nourishment). In accordance with this policy, lakeshores were restored at three locations in the Mikatagoko lakes from FY 2020 to FY 2021.

Lake Kugushi, the lake closest to the sea (Figure 1), was known for its long sandy beaches with shallow waters. There is an oral tradition among the fishermen of this lake that the sediment carried into the lake by rivers expands with the north winds in winter to form sandy beach. An attempt to apply this knowledge to the beach nourishment was started at Lake Kugushi. At the beginning of winter, when the monsoon blows strongly, sediment dredged in the inflowing river was brought to one spot on the south shore of the lake (where the sandy beach used to exist) downwind of the lake, and the beach was then left to the wind and waves to expand (Figure. 6). This approach of making use of natural processes to restore coastal landscape is called "Building with Nature," and has a precedent in the mega-nourishment project in the North Sea coast of South Holland, the Netherlands. In this approach, construction vehicles are not used to redistribute the sand, but rather natural forces such as wind and waves are used over time. This not only reduces the cost of the project, but also helps to curb carbon dioxide emissions. In the beach restored as mentioned above, the population of organisms such as polychaete worms and Shijimit clams, which were conservation targets in the lake, increased significantly compared to other unrestored areas. In this way, the lakeshore restoration practice based on traditional and local knowledge is now steadily advancing in the Mikatagoko region.

Inheritance of local culture and issues

In the Mikatagoko region, fishing was the main source of livelihood until the middle of the Showa period (1926-1989). Seafood caught in the lakes was not only used for subsistence, but also for festivals. At one shrine, crucian carp caught in the lake has been offered as a sacred offering in the ritual of praying for a bountiful harvest since the Middle Ages, according to a prescribed ritual (Photo 8). At other shrines, the lake's catch of Shijimi clams has been used as an offering. However, as the rapid economic growth period came to Japan, people increasingly distanced themselves from the traditional fishery, and in recent years, the aging of workforce and the lack of successors are increasing every year. As a result, the rituals have been simplified, and opportunities to eat lake fish dishes have decreased significantly. The traditional lake fisheries, which has been handed down for a long time, and the local culture rooted in it are now in jeopardy.

Against this backdrop, Fukui Prefecture and the towns of Wakasa and Mihama, where the Mikatagoko lakes are located, have launched a new initiative to pass on the traditional fishing methods of the lakes and the local culture rooted in them, and in February 2019, the lakes were recognized as a Japanese Nationally Important Agricultural Heritage site for their "fishing systems in brackish lakes". This recognition was based on the fact that the traditional fishing method securing the amount of natural resources, which has a history of more than 400 years, has been passed down in the lakes with different salinity levels. The award also recognized the conservation of biodiversity through mutual monitoring and agreement on the amount of fish caught and fishing seasons among lakes (villages), as well as the local shrines and festivals scattered around the lakeside villages, which have created a bond between the community and formed a regional cohesion centered on the raditional fishery. Of course, the fact that the traditional and local knowledge that conveys this information was well preserved in the region, was also highly evaluated. Led by the Mikatagoko World Agricultural Heritage Promotion Council, technical workshops are being held to pass on traditional fishing methods and educational activities on lake fish cuisine are being promoted (Photo 9). Passing on the local culture that has been handed down in daily life is also a goal of the Mikatagoko Nature Restoration Committee, which has been positioned as part of its overall concept. It is expected that the traditional and local knowledge of the Mikatagoko region will be passed on to the next generation through the efforts of the Nature Restoration Committee and the Agricultural Heritage Promotion Council.

Photo 8: Crucian carp caught in Mikatagoko, dedicated at a Shinto ritual (courtesy: Hiroaki Sekioka)

Photo 9: Lake fish dishes with a modern taste

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Open levees and associated retarding basins of Kita River in Fukui and Ado River in Shiga

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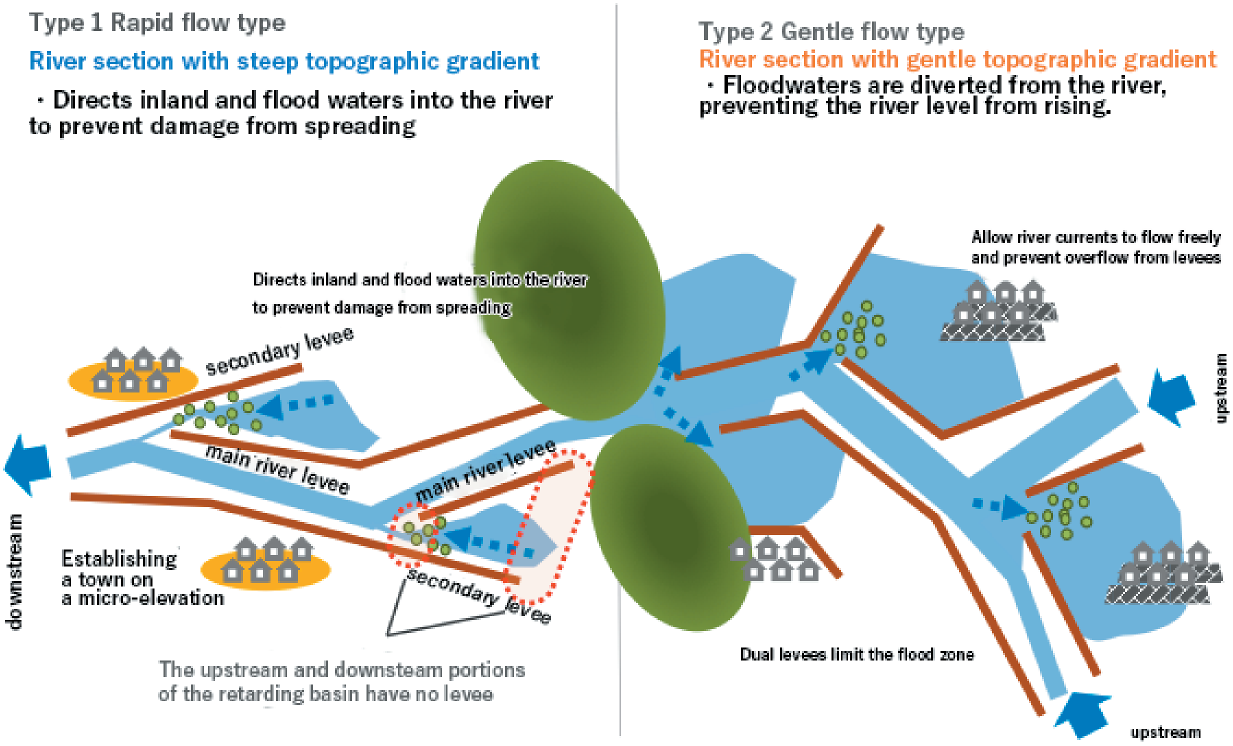

Figure 1: Open levees and their function for disaster prevention and mitigation.

type	A (Duplicate levee)	B (No duplication of levee)	C (No levee, but an embankment with a mountain)	D (tributary inflow)	E (No levee at the confluence of tributaries)
Overview	Waterway, dike control, this dike. Openings can be made with or without a waterway. Some have a channel and some do not. some with and some without	Waterway, levee control, this levee. Openings can be made with or without a waterway. Some have a channel and some do not. Some with and some without	Waterway, Mountains (cliffs), etc., this levee. Openings can be made with or without a waterway. Some have a channel and some do not. Some with and some without	Waterway, Branch river embankment (Role of role of an embankment), this levee, main river. There is only a tributary levee connected to the main levee on the downstream side. There is only a tributary levee that connects to the main levee on the downstream side of the river	affluent, this levee, no levee, main river
Remarks	Classified as a form of open levee				No embankment due to treatment of tributary confluence (in many cases, not the original open levee)

Figure 2: Classification of open levee (Hamaguchi et al. 1987). Tributaries and waterways flow into the main river from discontinuous portions of the levee. (drawing by Tamaho Izumino)

Open levees (kasumitei in Japanese) is a flood control measure used in Japan since old times to build double or triple levees while leaving a discontinuous part where the levees are not connected. By allowing floodwater to gently drift into the retarding basin between the overlapping levees, the floodwater are prevented from becoming too concentrated in the mainstream. The kasumitei retarding basin also serves as a link between the river and the surrounding rice paddies, and is crowded with organisms that come and go between the river and the drainage ditches of rice paddy. During major floods, fish avoiding the torrents of the river use the retarding basin as a refuge. In this way, the open levees are one of the traditional disaster prevention and mitigation infrastructures that utilize the function of ecosystems.

What is open levee (kasumitei)?

The open levee (kasumitei) is one of the traditional Japanese flood control measures, and there are various opinions about its origin and definition (it is said that Shingen Takeda, a warlord, invented it). Here, a multiple-levee system with discontinuous sections, as shown in Figure 1, is referred to as a "open levee (kasumitei)," and the land sandwiched between the multiple levees is called a "kasumitei retarding basin". Open levees have been identified in 54 of the 109 first-class water systems managed by the national government. Until the early Showa period, open levees were newly developed. If small and medium-sized rivers managed by prefectural governments are included, it can be said that many of these open levees still exist today.

According to Okuma (2004), the functions of open levees are generally categorized into (1) the function of eliminating overflow and internal water (i.e., returning overflowing floodwater to the river or channeling floodwater collected from surrounding waterways) and (2) the storage function (temporarily storing floodwater of the river). In general, rivers flowing on an alluvial fan with a steep gradient have (1) a greater flood overflow and internal water elimination function, while rivers flowing on a flat plain with a gentle gradient have (2) a greater storage function. In addition, as shown in Figure 2, most retarding basins have small rivers (or canals) flowing through them and connecting to the main river in order to drain floodwater that collect from the surrounding area.

One feature that distinguishes kasumitei retarding basins from other ones is that there are no levees at the downstream and upstream parts of the basin (i.e., it is levee-free). The levee itself is designated as a river area and its modification is regulated, but the land of the basin is often privately owned. The upstream portion of the kasumitei retarding basin is also levee-free, so even if the river overflows from this area, there is no danger of collapse of levees, although the overflow would spread. When the river water level rises, the retarding basin is gently flooded from the downstream side. Even if the retarding basin becomes full of water, it is possible to narrow down the location of flooded areas, making it easier to make evacuation decisions and manage crises. Compared to a levee break, the destructive force of an inundation flow is weak. Thus, open levees can play an important role as a countermeasure against flood overflows from rivers.

Disaster prevention and mitigation functions

The Kita River, with a basin area of 210.2k m2 and a channel extension of 30.3 km, has its headwaters in Takashima City, Shiga Prefecture, and flows into the Sea of Japan from Obama City, Fukui Prefecture. The flood plain in the middle and lower reaches of the river has a series of 11 open levees (riverbed gradient of 1/750 to 1/390, Figure 3). The flood plain of Kita river is narrow, with mountains on both sides, giving it the appearance of a valley-bottom plain. According to the classification by Hamaguchi et al. (Figure 2), many of the type E open levees are formed at the confluence of tributaries. On the other hand, the Ado river, with a basin area of 300.0 km2 and a channel length of 57.9 km, flows into Lake Biwa. Open levees are continuous in the valley bottom plain in the middle part of the river and in the fan-shaped area in the

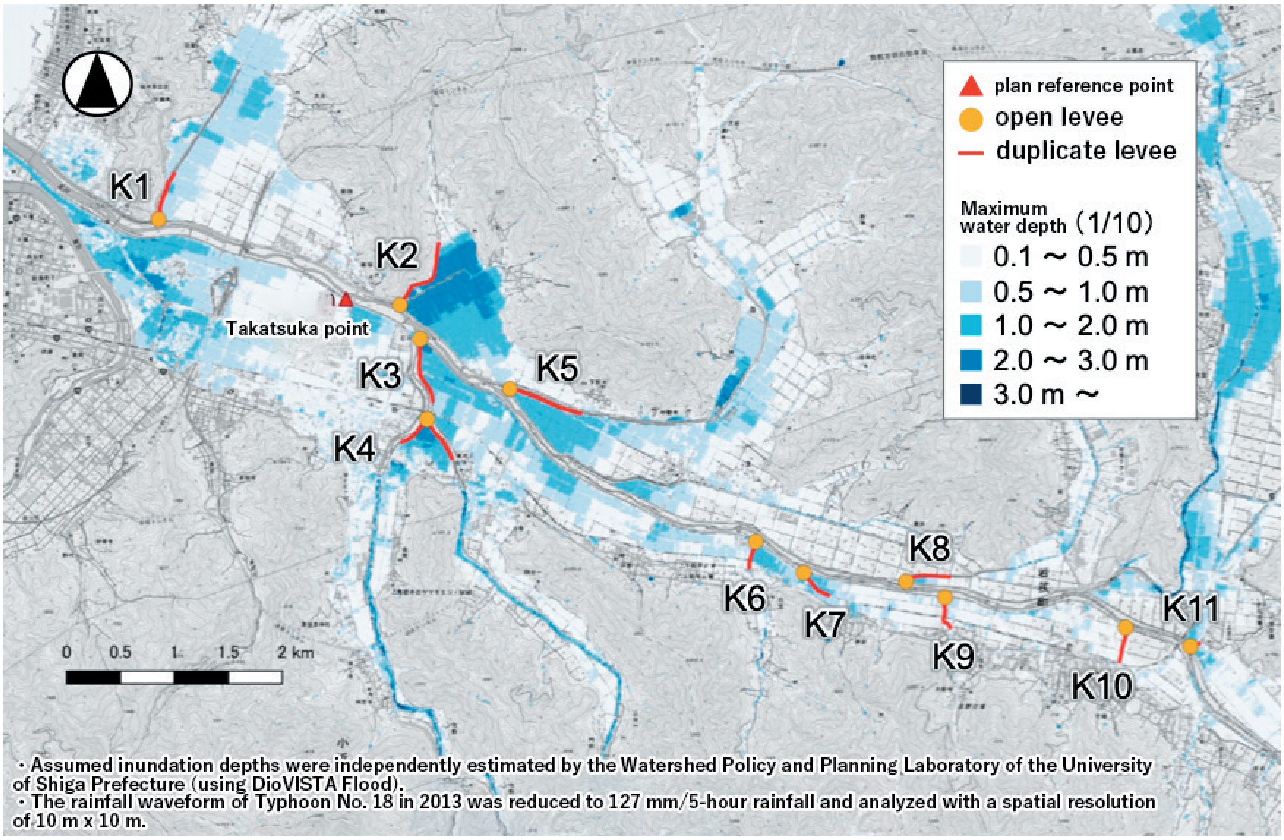

Figure 3: Kita river flooding area. Location of open levee and maximum inundation depth (flooding due to 10-year probable rainfall).

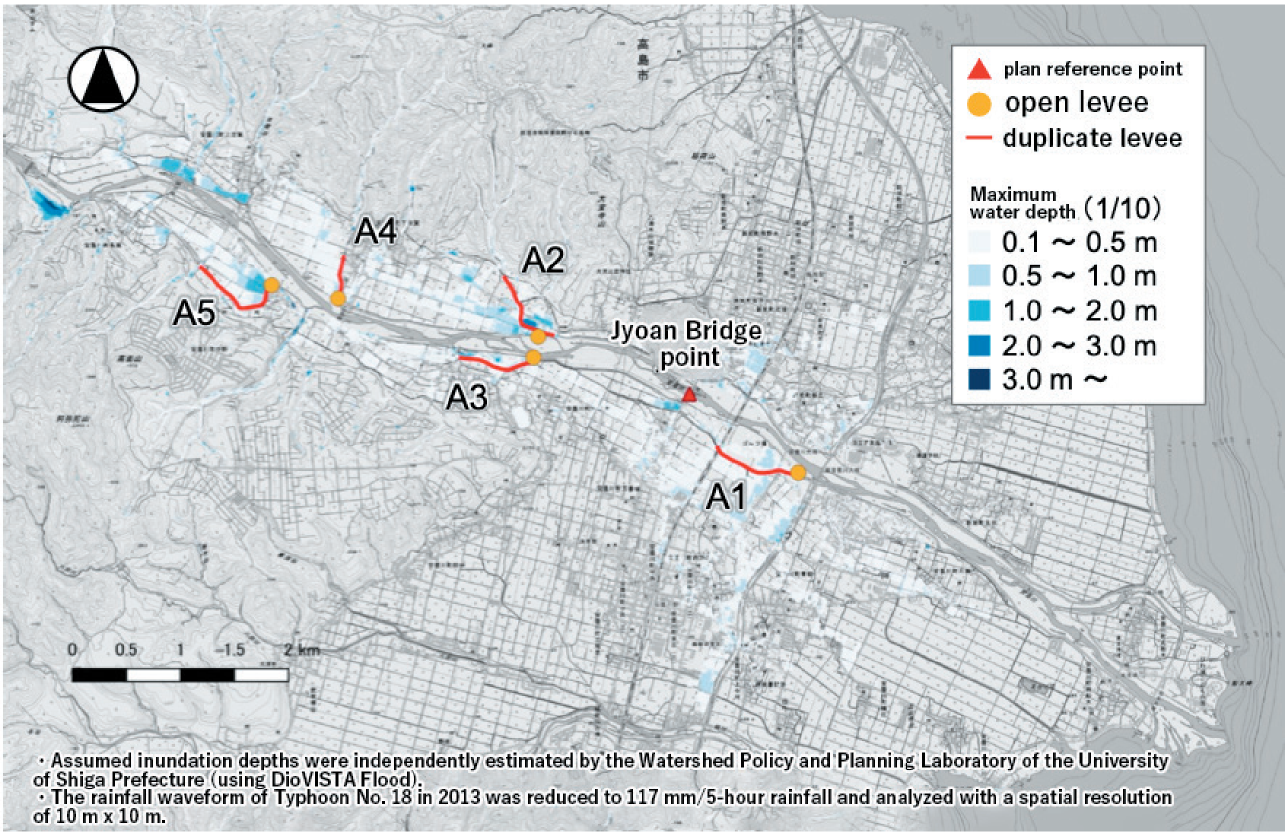

Figure 4: Ado river flooded area. Location of open levee and maximum inundation depth (flooding due to 10-year probable rainfall).

downstream part (the section where the riverbed gradient is 1/400 to 1/250, Figure 4). Type C is more common in the middle part of the river, while Type A is more common in the lower part.

Table 1 shows the results of a computer simulation

Table 1: Disaster Mitigation functions of open levee and its retarding basin. (flooding due to 400-year probability rainfall).

Function (upper row) Indicators (lower row)	Kita river			Ado river		
	status quo	closure	difference	status quo	closure	difference
Reduction of river water level Maximum water level (m)	9.48	9.80	0.32	103.85	104.19	0.34
Levee breakage avoidance Difference between inside and outside water level (m)	1.16	2.23	1.07	1.29	1.04	-0.25
Inland flood water exclusion Waterlogging time (h)	19.67	38.83	19.16	14.67	44.17	29.50
Flood water storage Total storage volume (thousand m^3)	7,869	8,954	1,085	571	599	28

※ The evaluation of breakwater avoidance and internal and floodwater exclusion functions are for Kasumi Levee K-3 (Kita River) and A-3 (Ado River)l

of a hypothetical large flood (flood magnitude is 400-year probability rainfall) (Taki et al. 2021). It can be seen that in the Kita River, which has a relatively gentle flow, the current condition with the open levees lowers the river water level downstream (at the Takatsuka point) compared to the case where the levees are all closed. In addition, the difference between the inner and outer water levels (the difference between the water level of the main river and the retarding basin) is smaller with the existing open levees. When the difference between the inner and outer water levels is small, the levee is supported by water from both sides and the flow that permeates the inside of the levee is suppressed, making it less likely that the levee breaks. It can also be seen that the time required to eliminate internal floodwater is reduced by about 20 hours due to the presence of open levees, and that the retarding basins can store about 1,000,000 m3 of floodwater.

On the other hand, in the Ado river, which has a relatively steep flow, the open levees are effective in lowering the river water level downstream (at the Jyoanbashi point) as well as in eliminating internal floodwater. However, the difference between the inner and outer water levels was mitigated when the open levees were closed and made continuous. This is because internal floodwater is not excluded from the inner area of the levee (outside of the river) and tend to stay there.

As described above, the disaster prevention and mitigation functions of open levees and their retarding basins vary depending on where they are located and how much rainfall they receive. For example, when there is a great deal of internal floodwater (when rainfall in the surrounding area collects), it may cause water levels downstream to rise, so it cannot be said that open levees are generally helpful downstream. However, in the event of a major flood, any open levee will always function to reduce the risk of levee breaks that greatly damage the surrounding areas and to drain internal floodwater quickly.

Function of biodiversity conservation

Flood plains within river channels and river confluences have the ecological function of providing temporary refuge for fish and other organisms during floods (Figure 5). Kasumi retarding basin, which is connected to a river and gently flooded, has the same ecological function as the in-channel floodplain. The openings of kasumitei lack levees, and in many cases, tributaries and waterways flow into them, so that the continuity of water flow is not disrupted even under normal conditions. As a result, the movement of aquatic organisms is guaranteed, and they serve to link river ecosystems with adjacent paddy fields and forest ecosystems. For example, an agricultural drainage ditch (River I and inlet channel) runs through the kasumitei retarding basin located at the confluence of Rivers A and K in Shiga

Prefecture, where a mixture of lotic fish species (e.g., dark chub and *ayu* fish) and lentic fish species (e.g., bitterlings) are found (Figure 6). The agricultural drainage ditch (River I) has no sluice gate or large drop-offs that impede the movement of aquatic organisms, and water connections with the main rivers (Rivers A and K) are maintained even under normal conditions.

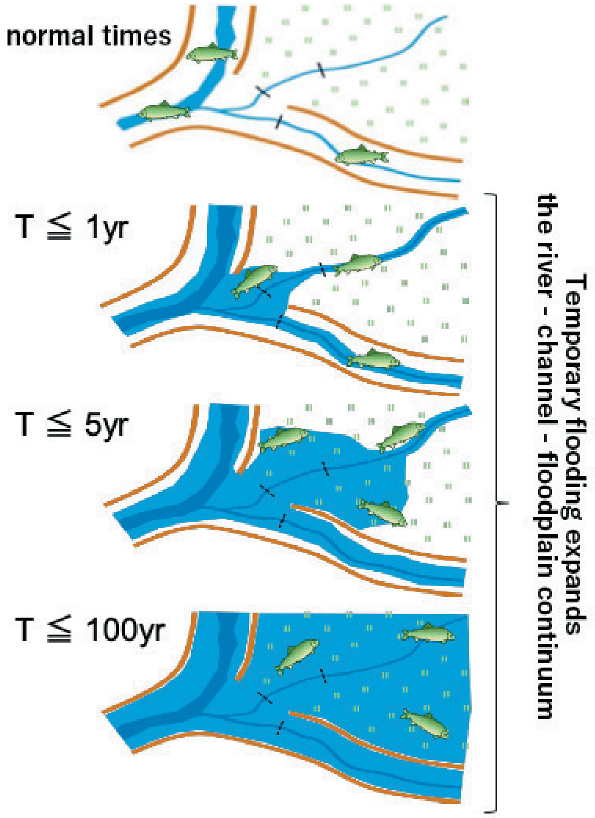

Figure 5: During a flood, the inundation area contiguous to the open levee retarding basin expands.

Thus, when tributaries and drainage ditches of rice paddies flowing through the kasumitei retarding basins are connected to the main river by the open levees, habitat connectivity is established. The paddy field channels in the retarding basins also provide an important habitat for a variety of fish species. In the Kita River, during the spring and fall seasons when there is relatively little rainfall, the volume of water flowing through the channel is reduced and the water connection with the main river is weakened. On the other hand, during the summer season when there is relatively more rainfall, the amount of water flowing through the channel increases and the water connection with the main river becomes stronger. This causes many fish species to migrate from the main river through the tributaries to the drainage ditches of rice paddy, and many fish species can be seen in the drainage ditches where environmental conditions are good. Also, when flooding occurs due to high rainfall, the connection between paddy fields and drainage ditches increases, and loaches that used to live in the paddy fields can be seen in large

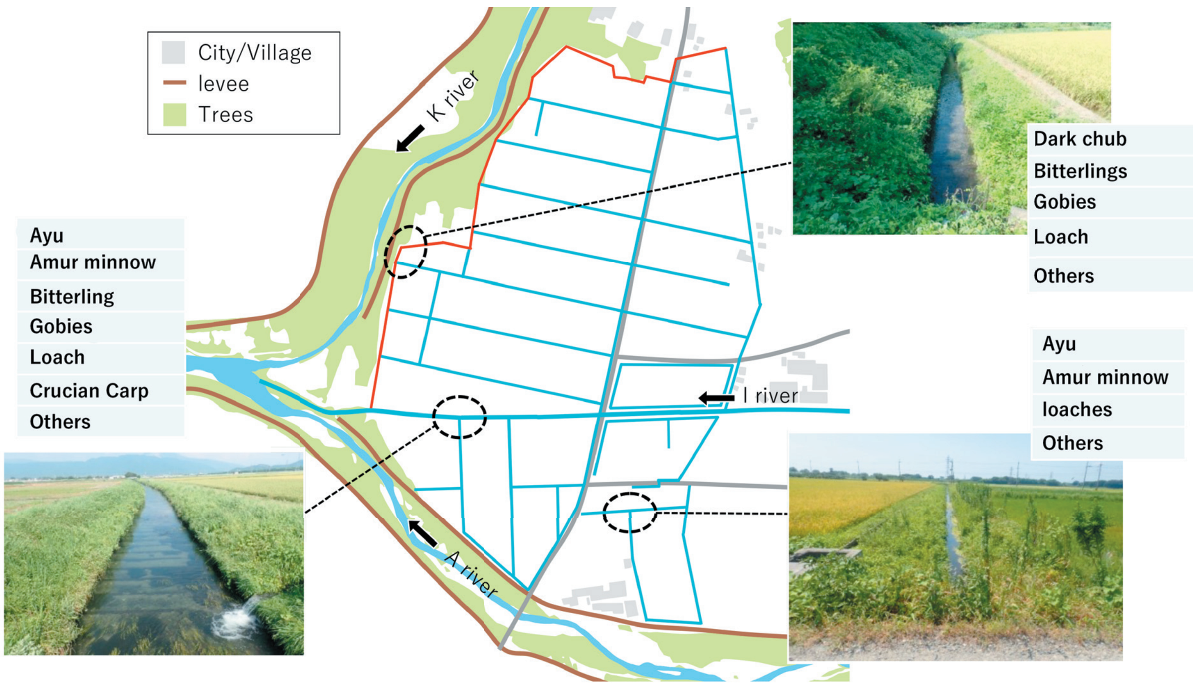

Figure 6: Fish species identified in agricultural drainage ditches around open levee (August 2020). (drawing by Tamaho Izumino)

numbers in the ditches. Drainage ditches of rice paddy play an important role as temporary shelters during floods and as places for spawning and growing loach because the environmental conditions are similar to those of natural canals that existed when the area was once a natural floodplain. The connection between the main river and the drainage ditches by the open levee allows it to fulfill this role.

In the Kita River, the community of organisms that symbolize the connection between the main river and its tributaries and rice paddy ditches by the open levee can be seen. These are the bitterling cyprinids, fish such as dark chub, and mussels such as Pronodularia japanensis, and there is an interesting relationship between the three (Figure 7).

The southern part of Fukui Prefecture, which includes the Kita River basin, is considered the northern and eastern limits of the distribution of Tanakia limbate, a bitterling species in Japan on the Sea of Japan side. In addition, the T. limbate is classified as a threatened species (vulnerable) in the Fukui Prefecture Red Data Book. Bitterling species such as T. limbate are unique in that they reproduce by spawning in the gills of freshwater bivalves, so they can only live in areas where freshwater bivalves are present. On the other hand, the Pronodularia japanensis (matsukasagai), which is a favorite spawning mother shell of the T. limbate , is also found in the Kita River basin and is listed as a threatened species (vulnerable) in the Fukui Prefecture Red Data Book. Mussels such as P. japanensis have a life history in which their larvae float and attach themselves to the gills and fins of various fishes, where they are parasites for a certain period of time. The bivalves need the fish that serve as hosts for the parasites in order to survive. Thus, T. limbate, P. japanensis, and freshwater fishes have a close relationship with each other and live in the Kita River basin.

The open levee creates a water connection between the main river and the tributaries and rice paddy drainage ditches that flow through the retarding basin, allowing fish such as the dark chub to live in the tributaries and drainage ditches as well. This allows the mussels, which use these fish as hosts, to live in the tributaries and drainage ditches. On the other hand, if there is no open levee and the connection between the tributaries or rice paddy drainage ditches and the main river is disconnected, matsukasagai P. japanensis cannot survive. In fact, such differences have been observed in the numerous rice paddy drainage ditches in the Kita River basin.

On the other hand, T. limbate (bitterling) is a small fish with poor swimming ability and prefers areas with slow currents in tributaries and rice paddy drainage ditches. The presence of P. japanensis (mussel) in such areas allows them to spawn and pass on to future generations. The connection to the water secured by the open levee is necessary for the survival of the mussel and the bitterling. In other words, the presence of tributaries and rice paddy drainage ditches that are inhabited by the mussels and the bitterling means that the connection to the main river has been secured.

The environment in which fish and other aquatic organisms can live in abundance in the tributaries and rice paddy drainage ditches that flow through the kasumitei retarding basins supports the survival of other organisms. In recent years, the Oriental white stork, a large bird representative

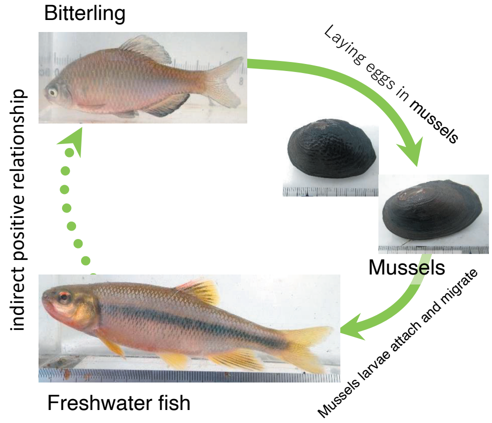

Figure 7: Relationships among mussels, bitterlings and freshwater fish. (photo by Hideyuki Iwamoto)

Photo 1: Storks raising their young near the open levee retarding basin in the Kita River basin. (photo courtesy of the Storks' home town promotion association)

of rice paddies and waterways, is often seen in the Kita river watershed, and is classified as a critically endangered species on the Ministry of the Environment's Red List of Threatened Species. In fact, there is a place in the Kita River basin where juvenile storks left their nests for the last time in Japan in 1961, before they became extinct in the wild. Although storks subsequently became extinct in the wild in Japan, efforts to protect them and artificially breed them were promoted, and in 2005, they were released into the wild. Recently, the number of storks living in the wild has been increasing, and storks are once again flying in the skies of Japan. The day has come when storks once again choose the Kita River basin as their breeding grounds.

In 2021, a pair of storks built a nest and laid eggs in an artificial nest tower standing near the kasumitei retarding basin, and three juveniles left the nest (Figure 8). The next year, 2022, the same pair bred in the same tower, and this time four juveniles left the nest. 3 to 4 juveniles successfully leaving the nest is an excellent breeding record compared to other sites in Japan, but it also means that there is enough food here to support their growth. In fact, parent birds are frequently observed feeding their young in the retarding basin. The storks would not have chosen this area as a breeding ground if it were not for the abundance of fish and other aquatic organisms living in and around the rice paddies that the open levees and associated retarding basins provide. As a symbol of the rich biodiversity being maintained, the storks are teaching us an important lesson.

Before the storks became extinct in the wild in the 1960s, various conservation activities were conducted in the area, such as the establishment of the "Stork watching club" at the Kunitomi elementary school in the area. The storks were once extinct in the wild, but in 2011, with memories of the 1960s lingering in the local people's minds, the storks were confirmed to have flown back to the area, and the local residents established the "Storks' home town promotion association" and resumed protection activities. As a result of these local efforts, the juvenile storks left their nests in 2021 for the first time in 60 years.

Modern utilization and the future of open levees

Much of the retarding basins associated with open levees is still maintained as paddy fields. It is said that during the Edo period, there was a system to conserve such land by classifying it as flooding farmland (ryusakuba) and exempting farmers from various duties. M and S villages, located in the middle reaches of the Amano river that flows through Maibara city, Shiga Prefecture, have retained the open levees upstream and across the river from the village to prevent floodwaters from flowing into the village during floods. The rice paddies in the kasumitei retarding basin are common properties, and are cultivated jointly with the surrounding village (Village I) to prevent urban development and maintain the area as it is.

Although the open levees and associated retarding basins have been historically preserved in this way, during the period of high economic growth, it has been developed for housing, welfare facilities, educational facilities, and waste disposal facilities. Recently, solar panels have also been installed in some cases. If an open levee is closed or the retarding basin is reclaimed, the functions of disaster prevention and mitigation and biodiversity conservation that have been protected for many years will be lost.

There are several policy-based ways to preserve and maintain open levees and associated retarding basins. If a peak cutoff (reduction of river water level) against the planned flood can be expected in the downstream part of a river (planning reference point), it can be placed in the flood protection plan of the river based on the River Law. However, since most of the open levees have a predominant function of eliminating internal and inundation water and have little function of cutting the peak of floods in the downstream part of the river, only a few of them can be placed in the flood protection plan of the river.

Other methods include designating the land as agricultural land in agricultural promotion zones (agricultural land: article 6 of the agricultural land development law) to preserve it as prime agricultural land, or designating it as an urbanization control area based on the urban planning law (article 7 of the urban planning law) to control development. If the land is used for agriculture, it is covered by the agricultural mutual aid, which provides financial relief in the event of flooding. Recently, there is also an option to exclude the land from the residential zone under the appropriate location plan (article 81 of the urban regeneration special measures law). In addition, there is the option of designating areas with significant flood damage as disaster risk zones (article 39 of the building standards law) to regulate development.

Under the revised specified urban river law enacted in 2021, the upstream areas of the confluence of rivers or the constricted part of a river can be designated as "storage function conservation areas" or "flooding damage prevention areas" to ensure the retarding function and avoid flooding risk. The remaining kasumitei retarding basins in various locations are candidates for these areas. The designation of these areas is determined separately, but it is difficult to establish certain criteria for designation because the extent of retarding floodwater and the effectiveness of disaster prevention and mitigation vary depending on the location of the retarding basins and the timing and scale of internal and external floodwater, and the relationship between burdens and benefits is also complex.

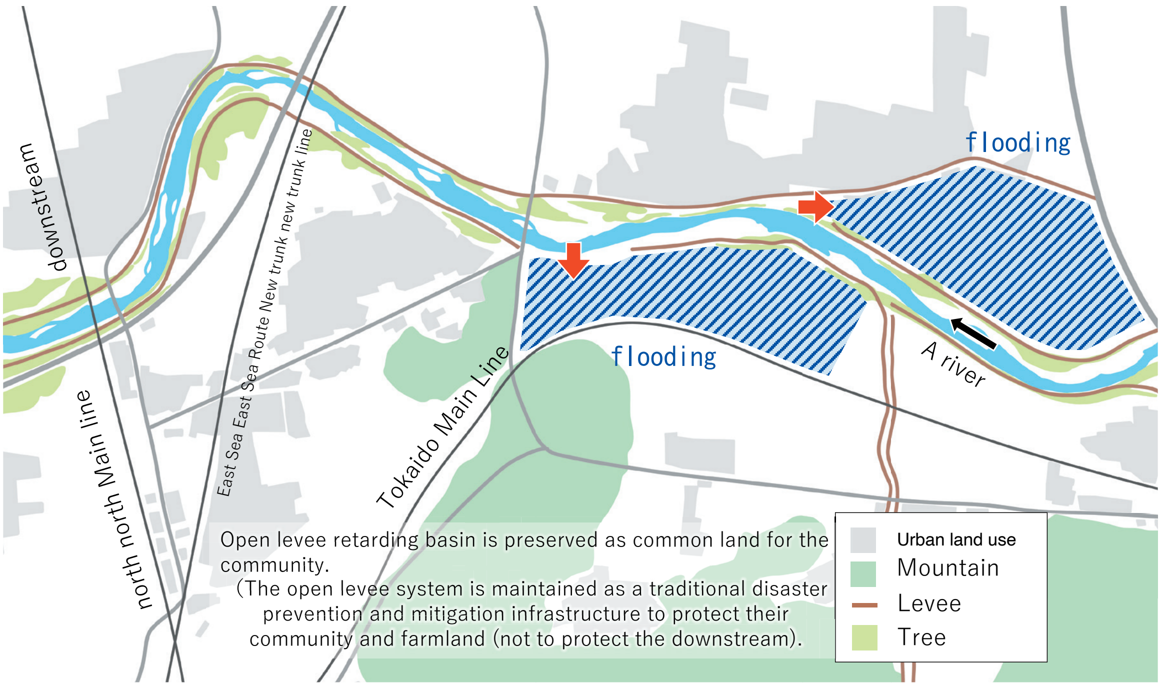

Figure 8: Conditions for the formation of open levee retarding basin. (drawing by Tamaho Izumino)

In addition, the Ministry of the Environment is about to launch a system of OECMs (other effective area-based conservation measures). Under this system, areas where biodiversity conservation is being promoted, including those for private use are designated, and support is provided with a certain level of incentives. This system is also expected to be a way to maintain open levees and associated retarding basins, which has the function of biodiversity conservation.

Even if the open levees and its retarding basins minimize damage by eliminating internal and external floodwater, reducing river water levels, and avoiding levee breakage, paddy fields in the retarding basin will still be flooded. After the flood, farmers are forced to disinfect farmland and remove trash and sediments. In addition, compensation through agricultural mutual aid (yield insurance) does not cover 100 % of losses. Recently, however, mechanisms to reduce the burden on farmers have been enhanced, such as the application of the disaster recovery system to the removal of trash and sediments.

In conclusion, there are a number of ways to preserve the existing open levees and associated retarding basins. Those in charge of flood control, disaster prevention, and environmental policies will be required to have the ability to determine from a broad perspective which combination of ways is the best one to apply to preserve and utilize the open levee system. It is also important to understand the various roles played by the open levees and the retarding basins created and utilized by our predecessors in each local community (Figure 10). It is expected that open levees and the associated retarding basins will be utilized in the future as wisdom to protect local livelihood and nature.

Figure 9: Leaflet explaining the role of open levee and its associated retarding basin (Eco-DRR Project, Research Institute for Humanity and Nature)

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【Hira Mountains Case Study】

Photo：WANG Wen（drone photography）

Natural environment and disasters at the foot of Hira Mountains

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Photo 1: Looking toward Hira Mountains from Lake Biwa

Introduction

The Hira Mountains area, located on the west foot of Lake Biwa in Shiga Prefecture, has experienced many natural disasters in the past, but has also nurtured a lifestyle and rich natural environment that has coexisted with them. From this chapter, we will look back on the history of coping with natural disasters in the Hira Mountains area, and consider the traditional and local knowledge that has been created from various perspectives.

Natural Environment and Disaster Potential Basis

The western side of Lake Biwa is a series of farmlands ranging from a narrow plain along the lake shore to gently sloping land at the foot of the mountains, where a number of villages are located. To avoid flood damage, the villages are located at an elevation slightly higher than the surface of Lake Biwa, avoiding valley outlets and steep slopes so as not to be directly hit by sediment disasters. Heading west from the village, so-called "*satoyama* forests" consisting mainly of broad-leaved trees spread out on the steep slopes that developed as a debris

Photo 2: Collapse of the head of the mountain ridge

Photo 3: Japanese char inhabiting a mountain stream

flow fan. The slopes become steeper and steeper toward the mountain ridges of the Hira Mountains range, where mountains over 1,000 m in elevation stand side by side. Near the mountain ridges, there are cool-temperate vegetations such as beech and grasslands, which are rare in the Kinki region, and steep streams with collapsed headwaters are inhabited by iwana (char). The horizontal distance from this mountain ridge to Lake Biwa is only about 4,000 m. In the narrow area between the mountains and the lake, various landscape elements are distributed in a strip or patch-like pattern. Between the villages, many small rivers run parallel from the mountain ridge to Lake Biwa. The natural environment and natural disaster potential foot of Hira Mountains area are characterized by the concentration of diverse topographic and landscape elements within such a small area.

Natural Threats and Blessings

In this region, sediment disasters frequently occurred near the mountains, and until the Nango washing weir was constructed, flood damage occurred frequently in the low-lying areas leading to Lake Biwa. Also, strong winds called *Hira-oroshi* blow from the Hira Mountains range, causing frequent wind damage. There are very few places that can be said to be safe from natural disasters, and if we only consider the danger of natural


Photo 4: Stone lantern made of granite


Photo 5: *Moriyama-ishi* garden stones and paving stones

disasters, foot of Hira Mountains area may never have been a good place to live. However, this environment that brought many natural disasters was also an environment that provided many natural blessings. Granite, a geological feature prone to debris flow, yields high-quality stone. In addition, chert (*Moriyama-ishi*), which was transported from the mountains to the villages as debris flow, was highly prized as garden stone. The proximity of the mountains to the villages and the lake makes it possible to easily transport nature's bounty from


Photo 6: Japanese *Nourushi* blooming in the marshland


Photo 7: White beach and green pine trees in Omimaiko

the mountains to the consumption areas by boat on Lake Biwa. In addition to stones, woody resources such as firewood and charcoal were also important natural blessings that supported livelihoods and were transported to consumption areas such as Koto. In addition to resources that support livelihoods, areas that are frequently disturbed by sediment disasters and floods are habitat of plants and animals that are unique to the disturbed areas, increasing biodiversity. Sediment runoff from mountains, which is sometimes the cause of disasters, forms wetlands, inland lakes, and beautiful beaches, where precious species such as *Nourushi* and truffle can be found.

Nature and Culture in Response to Disasters

Historically, natural disasters in the region have long been documented in maps and documents, and there are many records of disasters, especially from the Edo period onward. From a geopolitical

Photo 8: Erosion control facilities on the Nohiko River

viewpoint, this area is an important main road connecting Kyoto and Hokuriku, and is considered to be an area with a relatively early cultural development. Stone walls and levees were piled high at points where disasters occurred with high frequency. The areas that were still frequently flooded were used as buffer zones for disasters, without advanced land use. Through repeated disasters and their countermeasures, the wisdom of rational disaster prevention was gained empirically, and at the same time, the technology for efficient use of natural resources was enhanced. The masonry weirs of the Edo period that remain near the Yotsugo river and Ōtani Rivers are not only a reminder of the labor and hardships of the past, but are also valuable as civil engineering heritage.

In the Meiji period (1868-1912), the construction of erosion control weirs and the Nango washing weirs began to be implemented as modern disaster countermeasures. In the Showa period (1926-1989), many erosion control projects, river improvement projects, and lakefront improvements on Lake Biwa were carried out, and the frequency of natural disasters decreased drastically. While the decrease in disasters is a good thing in itself, as the number of residents who have no experience with disasters increases, there is a concern that the wisdom of disaster prevention at the local level will be lost, which in turn will lead to a decline in understanding of the natural environment in the region in general. Fortunately, the Hira Mountains area still has much physical evidence of disaster countermeasures and natural resource utilization. With rapid changes in social conditions and the environment predicted, it is important to examine once again the traditional ways of dealing with disasters and natural resources, and to consider their implications and modern applications.

Topography and geology at the foot of Hira Mountains

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Introduction

The beautiful landscape of the Hira Mountains foothills area has been formed by repeated natural disasters since ancient times, and the nature of these disasters is defined by the topographical and geological characteristics of the area. This section looks at the general topographical and geological characteristics of the Hira foothills area as the basic conditions that have given birth to the wisdom of the many traditional and regional disaster countermeasures in the area.

Topographic Characteristics

The topographical characteristics of this area are typified by the continuity from the mountains to the lake, with steep slopes running eastward from the north-south ridge of the Hira Mountains range, which rises over 1000 m above sea level, to the fan-shaped area of fields beneath it, and then to the 84 m high Lake Biwa across a narrow flat area (Figure. 1). The steep slopes are a source of sediment yield, and the foothills have suffered numerous sediment disasters. In addition, the monsoon from the west in winter brings strong winds called *Hira-oroshi*, and wind damage has often occurred. On the other hand, the water level of Lake Biwa was unstable until the construction of the Nango Weir in the Meiji and Showa periods, and the coastal areas suffered flood damage due to the rising water level of Lake Biwa many times. Figure 2 shows the warning areas for sediment disasters and flood damage in the Hira-Foothills area. Many

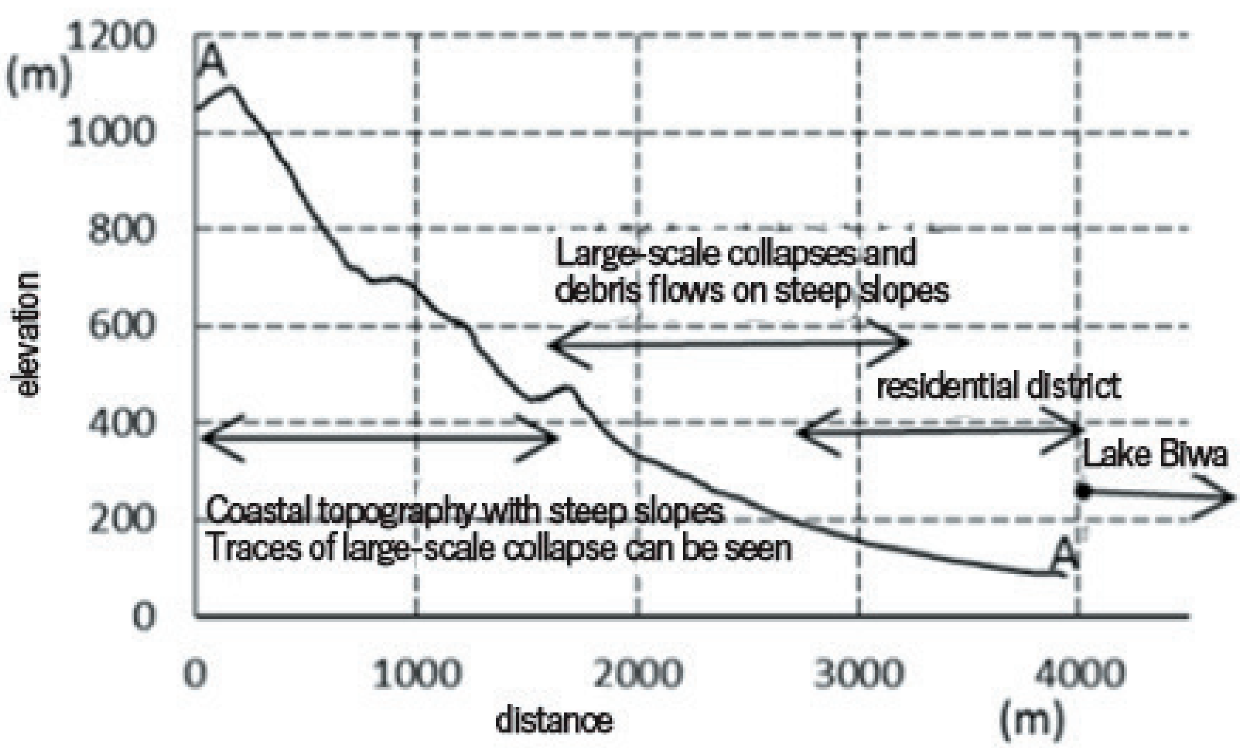

Figure 1: Typical topography from the Hira Mountains to Lake Biwa (near Moriyama)

rivers flow in parallel from the Hira Mountains range toward Lake Biwa, and most of them are designated as debris flow hazards. Sediment disaster hazard warning areas are designated in the middle and lower reaches of each river, overlapping with adjacent warning areas. In addition, the flat lands still have areas that are expected to be inundated in the event of flooding, but historically speaking, the flood hazard areas were much wider before the Nango Weir was constructed, and the land that could avoid both sediment disasters and flooding was a very limited portion of the land. This reduction of disaster risk areas through the construction of disaster prevention structures has also been promoted for sediment disasters. Since the Showa period (1926-1989), erosion control projects have been carried out on most rivers, resulting in a considerable reduction in the sediment disaster hazard areas. However, with the recent concern of large-scale disaster phenomena due to climate change, it is not always possible to prevent all disasters with existing disaster prevention structures alone. When large-scale disaster phenomena occur, comprehensive countermeasures, including land use, etc., are required.

The topographical characteristics that make the area prone to natural disasters are not necessarily disadvantageous to the livelihood of the local residents, but can also work to their advantage. The mountains near the villages provided abundant forest and stone resources, which could be transported by boat on Lake Biwa via shortdistance overland transportation only. In addition, the parallel flow of many rivers from the Hira Mountains range meant that water sources could be sought everywhere, and this gave the area a greater degree of freedom in water use than in the case of many villages seeking water sources from a single large river. Another characteristic of this area is that in the debris flow fans at the foot of the mountains, running water often flows underground, and many springs can be found in the plains. These river waters and springs have been used as water for daily life and agriculture.

Geological Characteristics

The geological features vary from place to place within the Hira Mountains range, and the topography also differs according to the geological features (Figure. 3). In the granitic rocks to the north, small, sharp valleys have developed and the area has suffered from frequent debris flow. In the sedimentary rocks to the south, large scale deep failures have been recorded. Granite weathers at a rapid rate and is converted directly from bed rock into sediment called masa soil. This soil tends to become fluid when it contains water and is a frequent cause of debris flows. The highly fluid soil forms a debris flow fan with a relatively small gradient, and then forms wetlands and sandy beaches along the shore of Lake Biwa. Sandy masa soil supplied to Lake Biwa from rivers rides the lakeshore currents to create the characteristic topography of the inland lake, which is surrounded by wetlands with rich biodiversity. Granite itself has been widely used as a stone material due to its hardness and ease of processing, and stone quarried from the Hira Mountains was transported to the beach, processed, and then shipped to Koto and Kyoto via Lake Biwa. Even within the same granite, the characteristics of the stone materail differed slightly depending on the region of origin, and a variety of products were made based on the color and size, which varied depending on the place of calculation.

In the sedimentary rock areas in the south, accretionary prisms consisting of melange and chert are found as the base rock. These sedimentary rocks tend to weather at a relatively slow rate. Therefore, these sedimentary rocks are prone to large sediment disasters, although the frequency of such disasters is small. In fact, Moriyama village in the lower part of the accretionary complex experienced a sediment disaster during the Genroku era (1688-1704) that washed away the entire village. On the other hand, the chert produced in the area is called *Moriyama-ishi*, which is highly prized as garden stones and paving stones, and has been used in gardens in

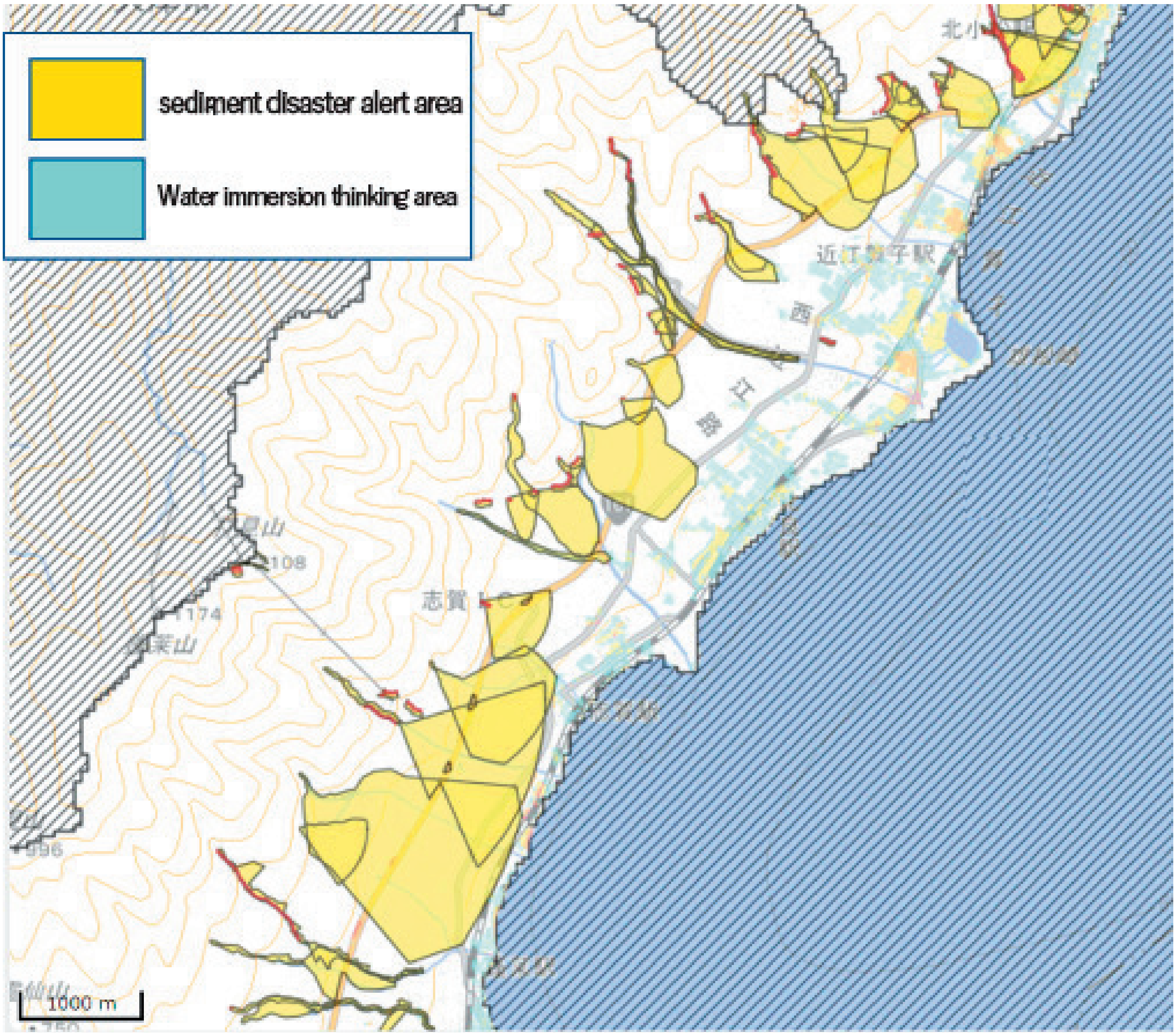

Figure 2: Sediment disaster and flood hazard areas at the foot of Hira Mountains

Kyoto and other places. Sedimentary rocks such as *Moriyama-ishi* are often used in their natural form without processing, and the masonry water ways that have been used for many years have a texture unique to natural stone and add color to the local landscape.

As described above, the unique topography and geological characteristics of the Mt . Hira foothills area are troublesome and cause many natural disasters, but they have also served as the foundation for fostering a rich natural environment, industry, and culture in the area. It is considered important to make the most of such basic natural conditions in future regional development.

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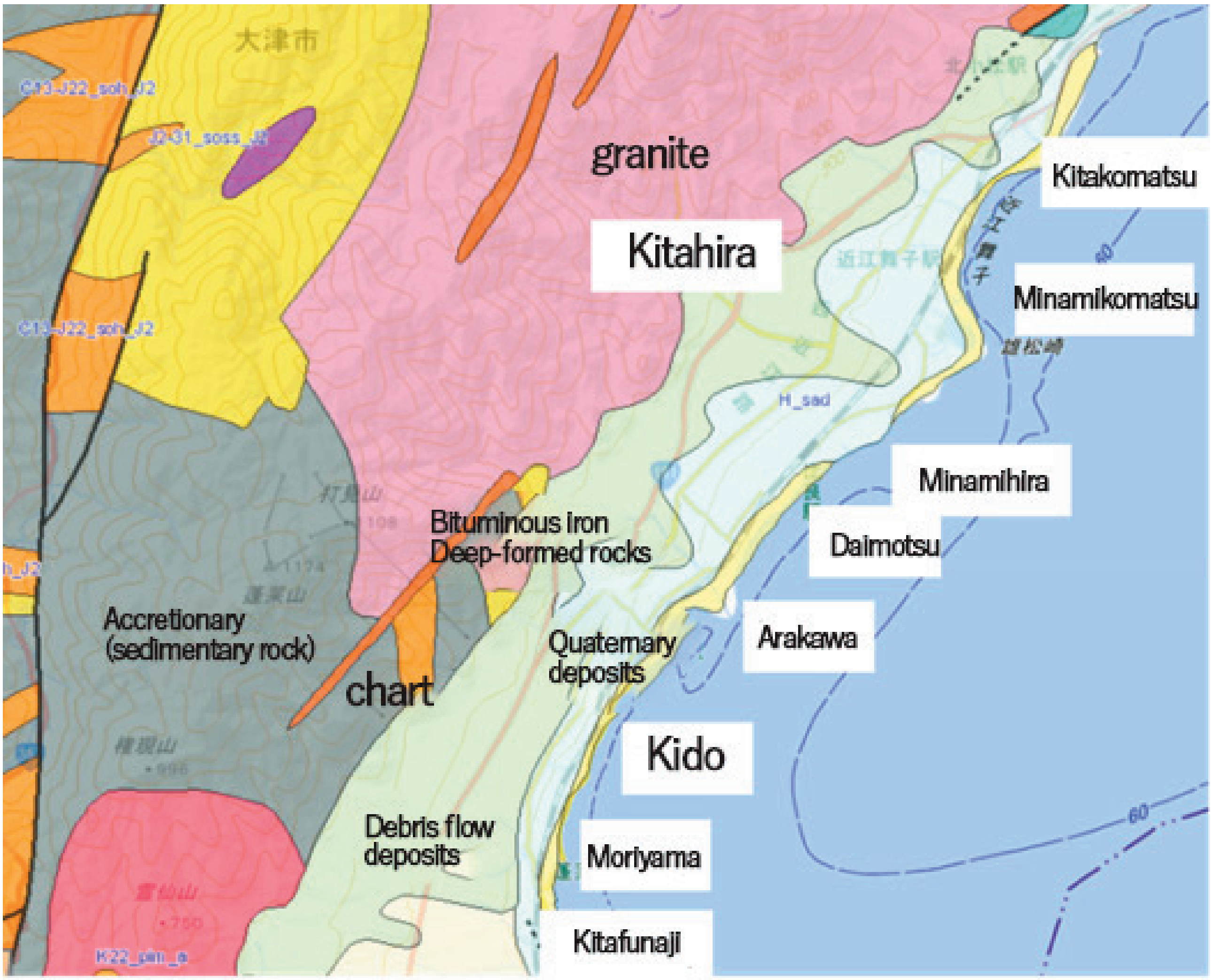

Figure 3: Geology from the Hira Mountains to the shore of Lake Biwa

Vegetation and use of natural resources at the foot of Hira Mountains

Kyoto University

FUKAMACHI Katsue
WANG Wen

Photo 1: *Satoyama* landscape at the foot of Hira Mountains

Introduction

Located in Otsu City, the foot of Hira Mountains is at the junction of the Seto Inland Sea type climate and the Sea of Japan type climate, with rivers of various sizes flowing into Lake Biwa to the east through a fan area. Looking at the *satoyama* landscape today, we can see that farmland, mainly rice paddies, is distributed in the lowlands near Lake Biwa, and large areas of forest spread behind the villages (Photo 1). Traditional villages along the Hokkoku Highway have traditional farm houses (Photo 2) with many local natural resources such as red pine, cedar, and reeds. Shrines and temples have groves containing large trees such as *katsura* and *sudajii* (Photo 3). Since the 1970s, new residential areas have been built along the shores of Lake Biwa and on the mountainside. Secondary forests such as red pine forests (Photo 4), *abemaki* and *konara* oak forests (Photo 5), which have been used as *satoyama* forests, are distributed around villages, but the hillsides are covered with large plantations of Japanese cedar and cypress. At higher elevations, deciduous broadleaf forests of Japanese beech and *mizunara* oak are distributed (Photo 6), and near the summit of Mt.Horai (1,174 m above sea level), there are grasslands (such as *Sasa tsuboiana*) and a pond called Kojorogaike (Photo 7).

Photo 2: A farm house with reed-thatched roof at the foot of Hira Mountains

Photo 3: Grove of trees surrounding Jyuge Shrine in Kido (2018).

At the foot of Hira Mountains, the *satoyama* landscape has undergone significant changes as the natural and social environment has changed. Take the Moriyama in Hachiyado, Otsu City as a case study site, we will examine the characteristics of vegetation and the use of natural resources during the Edo and Meiji periods, when local people's lives and livelihoods were closely connected with the surrounding nature.

Vegetation and land use in the Meiji Period

Based on the late Meiji period topographic maps (the Geographical Survey Institute's 1/20,000 old edition topographic maps of Komatsu Village, Kazuragawa, Wani Village, and Ikadachi Village, 1/20,000), we will examine the topography and land cover characteristics of the Moriyama Village and its surroundings. The villages are clustered in the range of about 95 to 135 m elevation, with houses scattered around the lakeshore. The total area from the shore of Lake Biwa at an elevation of about 85m to the summit of Mt. Horai is about 360ha (about 80% of the total area is mountain forest). The village is located along a highway connecting Kyoto and Hokuriku, etc. At that time, there were about 70 households, and forestry, agriculture, stone production were the main industries. Agricultural land is mainly rice paddies, which are distributed from the village to the lakeshore area, almost as they were in the Edo. There are broadleaf forests around villages, rice paddies, and rivers, and coniferous forests (mainly red pine forests) are clustered at elevations of 135 to 260 meters. The area from the middle of the mountain to the summit of Mt. Horai is a broadleaf forest, but grassland spreads around the ridge at the summit.

The lakeshore was called *hama*, rice paddies were called *ta*, fields for vegetables and tea were called *hatake*, and villages were called *zaisho* in Moriyama. The *hama* was common land for the village, and the cove had a *shima* that served as a landing place for boats. Seafood such as freshwater calm, *ayu* (sweetfish), and eel were gathered from the lakes and their shores, the rivers and rice paddies connected to them, or from springs called *shozu* (spring water). The mountain forests on a fan, mainly private forests up to an elevation of 300 m, were called *jiyama*, and forests on the steep slopes, mainly common forests, from there to Konpira Shrine at an elevation of 500 m, were called *herayama*. The common forest from Konpira Shrine to the summit of the mountain was called *sannai* and the area near the summit was called *dake*. In *sannai*, firewood and red clay for mud walls could be gathered. Water from the Noriko River, which flowed near Konpira Shrine, was used by the village and rice paddies, and flowed into Lake Biwa. Moriyama stone (chert), produced in Moriyama and characterized by its striped pattern, was used for stone walls and waterways.

In Moriyama Village, there is a 1-meter wide *daidoumichi* trunk road that runs along the valley

Photo 4: Red pine forest at the foot of Hira Mountains

Photo 5: *Abemaki* and *konara* oak forest at the foot of Hira Mountains

Photo 6: *Satoyama* secondary forest around the summit of Mt.Horai (2020)

Photo 7: Grassland near the summit of Mt. Horai and Kojorogaike Pond (2019)

from the village to the top of the mountain, along which forest resources and stones were carried out by human power or wooden tools. Ditches were dug in various places along this road, and brushwood and other materials were placed on top of the ditches to prevent the soil and sand from being washed away by rainwater. Above the Konpira Shrine, there was a steep and winding road called *yuri*, and *yurigi* tress were placed at strategic points to prevent the road from collapsing and people from falling down. The *yurigi* were large native deciduous trees such as *mizunara* (*Quercus mongolica var. crispula*), Japanese beech (*Fagus japonica*), and *yamazakura (Cerasus jamasakura)*, and cutting them down was forbidden.

Figure 2 is a schematic diagram of land use in the late Meiji period around Moriyama Village. The fan-shaped area was dominated by *kunugi* (*Quercus acutissima*), *abemaki (Q. variabilis)*, *konara* (*Quercus serrata*), and *akamatsu* (*Pinus densiflora*), from which firewood and brushwood were regularly collected, while Japanese cedar and cypress plantations and bamboo forests were scattered around the foot of the mountains. Pine-split wood (firewood) and brushwood from the red pine forests were sold to tile-producing areas in Shiga or surrounding area, and large-diameter wood was used as lumber and materials for transportation equipment. Various parts of the tree, including leaves, branches, trunks, and roots, were used as natural resources: fallen leaves were used as ignition material, and pine-root oil was extracted from the roots. Matsutake mushroom and a mushroom locally called *abrabon Pholiota lubrica (*chanametake*)* were also abundantly harvested, and were a popular food source. Deciduous broadleaf forests, mainly of *Quercus* species and Japanese hornbeam trees (such as *inushide*), were found on the mountainsides, and forests of Japanese beech and *mizunara*, and

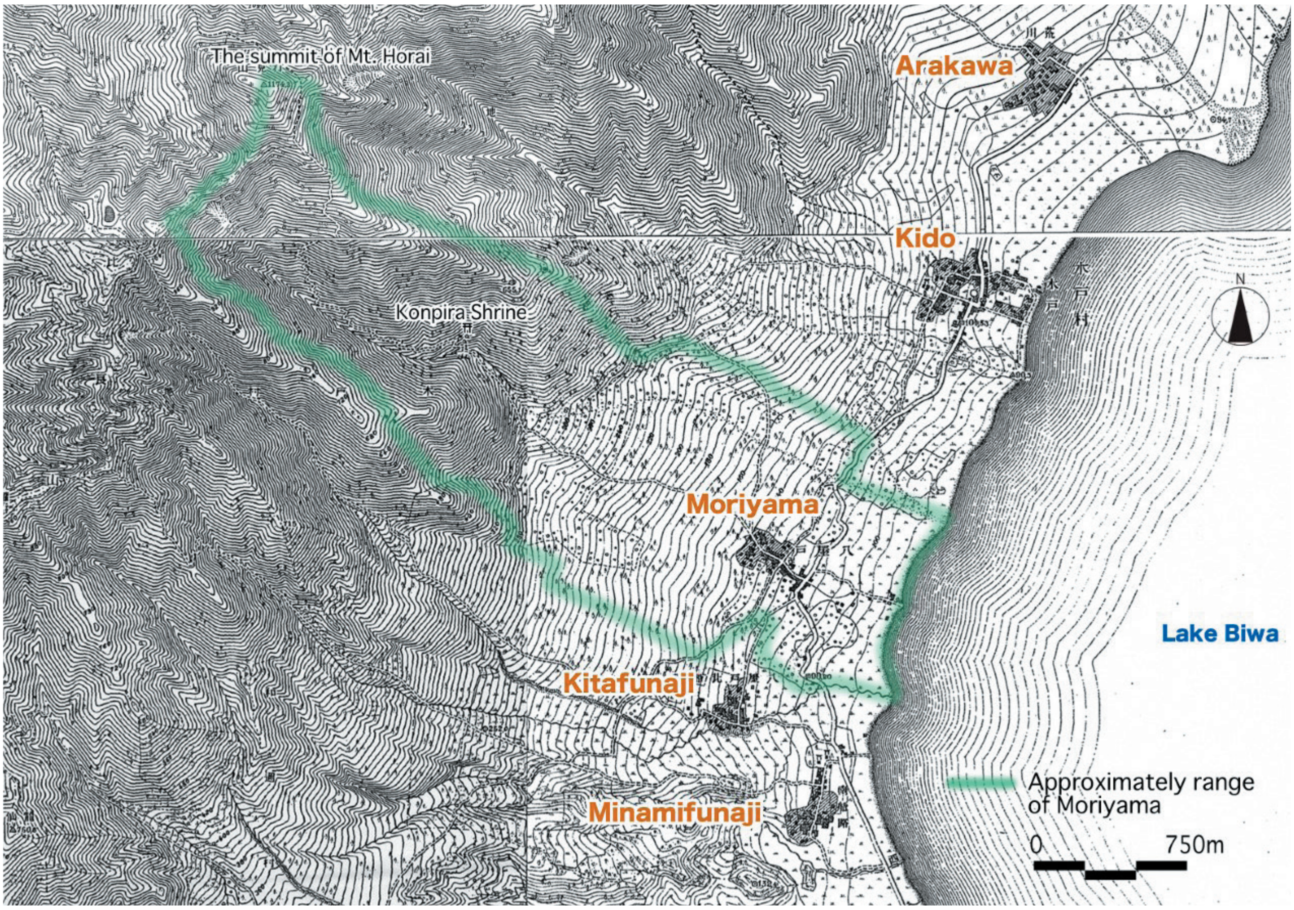

Figure 1: Topography of the Moriyama Village in the Meiji period (from GSI topographic map)

bamboo grass fields were found near the tops of the mountains. Along the riverside, there were grasslands with herbaceous plants, which are used as organic fertilizers, cattle feed, and roofing materials such as Japanese knotweed and silver grass, as well as secondary forests in the *satoyama* immediately after germination.

Vegetation and land use in mountain forests during the Edo

Next, keeping in mind the topography and land cover that can be seen from the topographic maps of the Meiji Period, we will look at the locally preserved "Map of Moriyama Village and Kitafunaji Village Area (Pre to Mid-Edo Period)" (Figure 3). Fields extend along the shore of Lake Biwa and around the village, and behind Moriyama Village there is a *shishigaki* (stone wall to prevent animal damage). The mountains and forests around the village are depicted with the character "field" (grassland) and standing trees (mainly red pine). Red pine forests are concentrated in the areas marked "Moriyama-muramochirin" (common lands) and "Teppo-yama," and it is assumed that forests consisting mainly of shrubs (broad-leaved trees) were distributed from the area around the village to the area indicated by the *shishigaki*. Along the left bank of the Nuruko River (now the Noriko River), downstream from the *shishigaki*, there is a mixture of red pine and shrubs (broad-leaved trees). Such vegetation is thought to reflect not only the natural environment, such as the topography, but also the relationship of the people living in the area, such as ownership patterns and land use.

Figure 4 is a partially enlarged drawing of "Moriyama Village Forest Map" (Mid-Late Edo Period). This figure also shows that vegetation varied according to topography, location, required function, and ownership type. The "Village Forest" and other areas upstream of Moriyama village depict forests dominated by tall red pine trees. Photo 8 shows today's appearance of the mountain forest where tall red pine trees were distributed in Figure

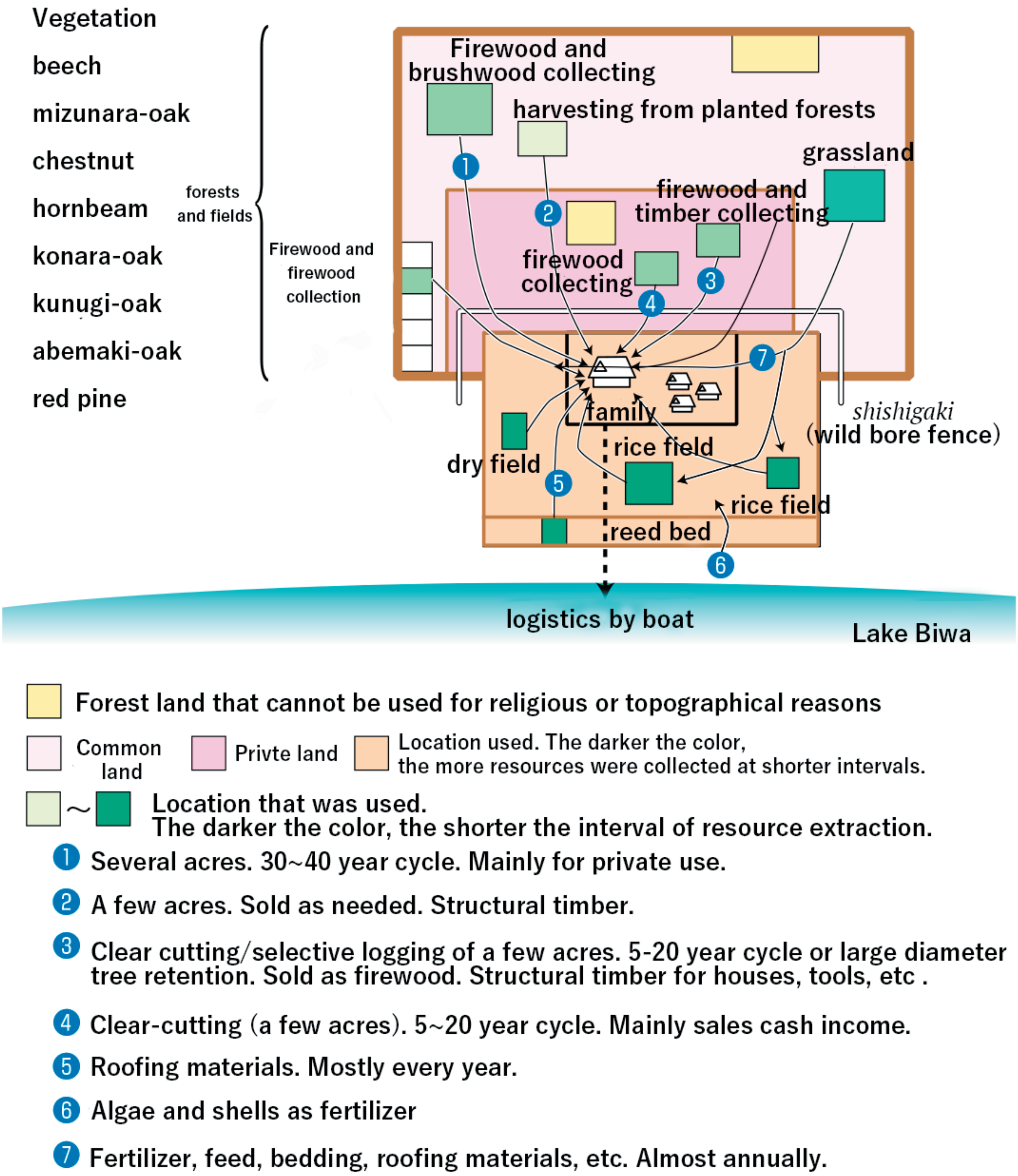

Figure 2: Land Use in Moriyama Village in the Late Meiji Period

4, and disaster prevention facilities are located. Most of the red pine trees have died due to pine dieback, and the forest is now a secondary forest dominated by *konara* and *abemaki*. Tall red pines are distributed mainly in mountain forests with a high risk of landslides, such as the upper reaches of the right bank of the Nuruko River where the village is located and the fan-tops of the fan. These forests were required to function as erosion control forests to slow or catch the movement of sediment to prevent large amounts of sediment from moving all at once onto villages and farmland. Therefore, it is assumed that while resources such as medium to low trees, mushrooms, and stones were used, logging was restricted to maintain the distribution of tall red pine trees for areawide conservation.

It is assumed that the trees depicted were broadleaf trees such as *konara* and shrubs such as azaleas, although there are some red pines in the villages

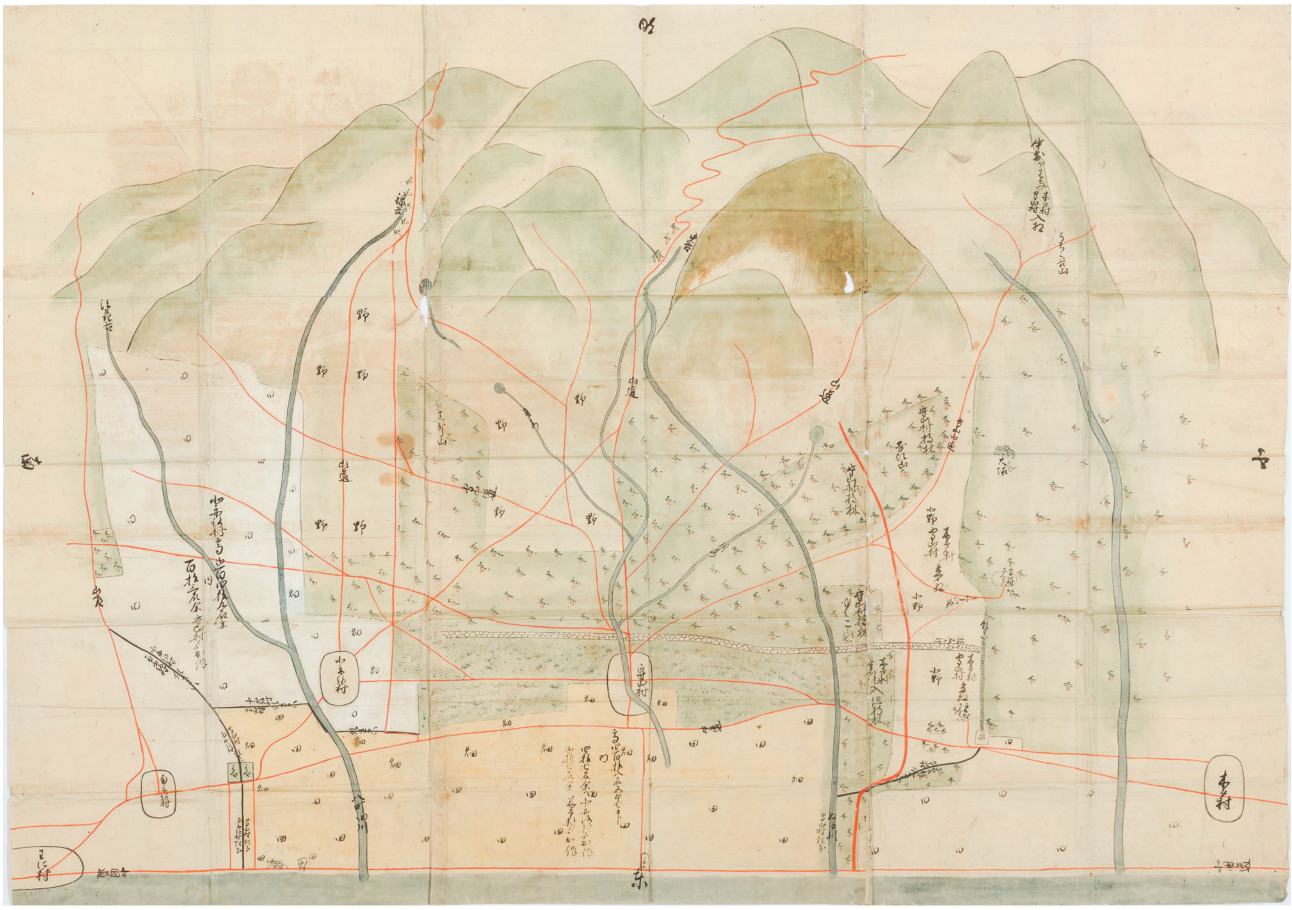

Figure 3: Map of Moriyama Village and Kitafunaji Village area (Early- to mid-Edo)

downstream from the *shishigaki* and on the left bank of Nuruko River. The farmland was distributed in clusters downstream from the village to near the shore of Lake Biwa. The left bank of the Nuruko River near Lake Biwa is depicted as a wooded area with deciduous trees and shrubs, rather than being used as farmland. These areas are prone to high frequency of sediment deposition from upstream, and it is thought that they were not used as farmland, including in response to disasters.

Use of natural resources in the Late Meiji Period

Tables 1-3 show work related to the use of natural resources for mountain forests, as ascertained based on diaries kept in the late Meiji period by residents of Moriyama Village. One diary was recorded (1907-1942) by a forester (I family) born in 1872 who cut trees from the forest to produce lumber and split wood, and the other by a farmer (T family) born in 1881 whose main occupation was farming and blacksmithing (1902-1938). The diaries of the forester and farmer identified 272 types of work

Figure 4: Enlarged view of a portion of the "Moriyama Village Map" (middle to late Edo)

related to the use of forest resources.

Table 1 shows 45 different operations related to pine (primarily red pine). In addition to pine wood, pine wheel wood, pine firewood, pine branches, pine needles (branches with pine leaves still attached), pine pinecone, pine roots, and pine bark were also used. There are a total of 18 types of work related to pine lumber, which can be divided into two categories: "up to felling" and "processing". Before felling, care and management of the pine trees was carried out in the form of pine thinning and pine pile thinning. Marking the pine tree was the process of marking trees to be cut down with ink, and pine root cutting was the process of cutting down the trees from the root base. Pine wheel wood is pine wood with a diameter of 40 centimeters or more, used as wheels for transportation equipment. Pine bark was the bark that remained after sawing.

From interviews with descendants of the T family born in the Meiji, we learned the following about the red pine and *kanagi* (mainly oak species) .

According to the interview about red pines: "In the old days, if you wanted to pine trees and other plants for materials in the mountains, you would cut all the other grasses, leaving the pine trees. Nowadays, pine trees can no longer grow, but in the old days they used to grow a lot. When they were small, they were fine, but when they were tall enough, there were always pine trees in the mountains. Then we would thin out the pines and cut them down, or cut down their branches when they got too big. The pine needles are then gathered into bundles. They are bundled together and called *matsuba-kukuri*.

Table 2 shows 51 types of work related to the use of the main tree species in the *satoyama* secondary forest. The tree species included *kunugi*, *konara*, zelkova, *nezu*, *kashi*, cherry, and camellia. The

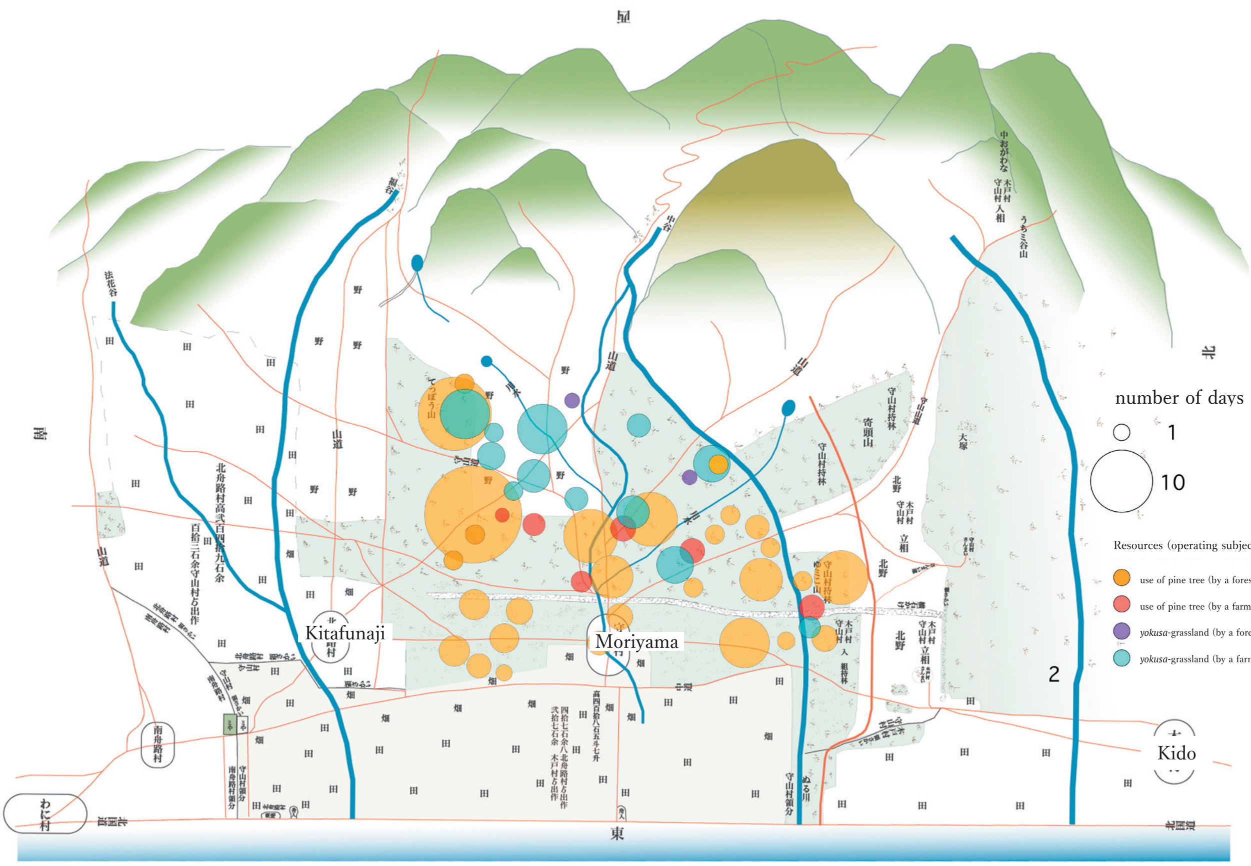

Figure 5: Spatial distribution of work related to pine trees and *yokusa* grassland in the Meiji(work locations superimposed on the tracing of the "Map of Moriyama Village and Kitafunaji Village Area" (Tracing by SHIMAUCHI Risa))

Table 1: Work on the use of pine (red pine and black pine)

Pine-related work (45 types in total)						
Pine Wood (18 types)		Pine Wheel Wood (3 types)	Pine Firewood (3 types)	Pine branches (7 types)	Pine needles (8 types)	Others (6 types)
Work up to logging (12 types)	Processing (6 types)					
Thinning	Sawing wood	Cutting	Spliting	Cutting off poorly growing branches	Cutting	Plant pine
Pile thinning	Sawing wood anything across	Logging	Bundling	Pruning	Bundling	Reap pinecone
Marking	Scraping off	Grinding wood for Wheel Wood	Carrying to the lake shore	Bundling	Bring out mountain	Take pine root
Cutting	*Matsu-tori*			Bring out mountain	Branches with pine needles bring out	Peel a pine tree
Root cutting	Grinding wood for carrel			Picking	Carry it to the lake	Pine bark loggin
Pile cutting	*Mikitori*			Preparing branches for easy carrying	Picking	Pine bark pickin
Root cutting of standing trees				Carrying	Link one's pine needle	
Root logging					Assemble	
Logging						
Carriying						
Carrying out						
Carryung to the lake shore						

Table 2: Work on the use of the main tree species in the satoyama secondary forest

Work related to the use of the main tree species in the satoyama secondary forest (51 types in total)									
Sawtooth oak (7 types)	Houso/Hosu (Quercus serrata) (6 types)	Japanese zelkova (2 types)	Muro (Juniperus rigida) (8 types)	Evergreen oak (5 types)	Japanese chestnut (7 types)	Cherry (3 types)	Camellia japonica (2 types)	Wisteria (3 types)	Others (6types)
Digging up	Plant	Roots cutting	Cutting	Roots cutting	Making piles	Roots cutting	Cutting	Reaping	Cutting k*anagi* (broadleaved tree
Roots cutting	Houso-Kae	Carrying	Digging up	Cutting off poorly growing	Picking	Carring	Carry to the lake shore	Picking	Root cutting of *Muku*
Plant	Cutting		Root cutting	Sawing wood	Carrying	Sawing wood		Pruning	Carring chinkapin
Logging	Sawing wood anything across		Bundling branches	Carry to the lake shore	Cutting				Carrying *Yonomigi* to the lake sho
Digging up seedlings	Roots cutting		Carring branches	Bundling	Sawing				Cutting Japanese star anise
Nae-hiki	Carrying to the lake shore		Picking		Logging				Picking persimmons
Carrying to the lake shore			Carrying		Carrying to the lake shore				*Yabu-kaki* (Bush cutting)
			Carrying to the lake shore						*Yabu-yuki* (Bush work)

Table 3: Work on the use of wild grasses

Mountain plants-related work (15 types in total)				
Hotoro grassland (3 types)	*Yokusa* grassland (2 types)	*Kariboshi* grassland (4 types)	Grassland (3 types)	Others (3 types)
Hotoro cutting	*Yokusa* cutting	*Kariboshi* cutting	Mowing	Pluck the leaves of Japanese arrowroot
Piling of *Hotoro*	*Yokusa* collecting	Picking of *Kariboshi*	weeding	Cutting Miscanthus
Hotoro collecting		Tieing *Kariboshi*	Pulling grass	hay collecting
		Kariboshi collecting		

konara and *kunugi* trees were actively cultivated, as there are descriptions of raising seedlings and planting them in mountain forests. *Nezu* was favored as a timber because of its resistance to decay, and its roots were used as a mosquito repellant. The roots were used to make mosquito repellents. The chestnut was used for stakes and the *shikimi (Japanese star anise)* was used to make offerings before the Buddha. *Kanagi* refers mainly to *konara* (*Quercus serrata*), *kunugi* (Quercus acutissima), and *abemaki (Q. variabilis)*. In Moriyama, split wood means firewood, and the finest firewood in the area was *kunugi* (called *mekunugi*), followed by *abemaki* (*okunugi*) and *konara* (local name: *hosu*). Gathering firewood in the winter on one's own mountain or in the *sannai*, the common forest, was an essential part of the local people's daily life. The *sannai* forests of *mizunara* and *inushide (Carpinus tschonoskii)* were considered good quality firewood because they grew slowly at high elevations and had a tight grain. Some of the split wood and brushwood were transported by boat from the lakeshore to Omi-hachiman and other areas on the other side of the lake, providing a valuable source of cash income.

Table 3 lists 15 types of work related to wildflowers. Wild grasses are mainly grasses such as silver grass and Japanese knotweed, and young shoots of trees such as *konara*. The work was called by different names depending on the time of the year: *hottoragari* for work done during the rice planting season around June 1, *yokusa-gari* for work done in July and August, and *kariboshi* for work done in August and September. The use of the *hotora* was directly used as fertilizer for the rice fields, while the *yokusa* was used as bedding grass or fodder for cattle and then used as fertilizer for the rice fields. *Hotoro-kusa-nyosuru* means piling up mountain grasses. In *kariboshi*, the process of drying wild grasses in the mountains, grasses were carried out from the mountains in October to December after they were dried. *Kariboshiyui* is to bundle dried grass, so that it can be transported. Photo 9 shows a reproduction of *yokusa-kari* in an area that was once used as a grassland.

Characteristics of resource use in the Meji Period

Figure 5 shows a tracing of the diagram in Figure 3 overlaid with the frequency of work done by the forester and farmer on the use of pine trees and *yokusa* as recorded in their diaries. The circles in the figure indicate the locations where the work was done, and the sizes are the total number of days of work done there. The number of days worked per site ranged from 1 to 10 days or more for the forester and 2 to 3 days for the farmers. Looking at the extent of pine forests used, both mountaineers and farmer concentrated their use of pine trees in the *jiyama*, the gently sloping foothills behind villages at elevations of 150 to 300 m. The forester also worked in the forests at elevations of approximately 100 to 600 m, while the farmer used the pine forests at elevations of approximately 160 to 300 m behind the village.

Among the tasks related to wild grasses, *yokusa* was found to have the widest range of locations and the largest number of sites. The number of work sites for forester and farmer was two and 12, respectively. The number of days spent working at one site ranged from 1 to 10 days for farmer and about 1 day for forester. The *yokusa* were used on steep slopes at elevations of 200 to 600 meters, and were concentrated in areas where the "fields" on the Edo map (Figure 3) were distributed. The steep slope of this area, where there are many common forests called *herayama*, and its proximity to the village make it a suitable place to use mountain grasses. In some areas, the *yokusa* and the places where pine trees were used overlapped.

For the future

A look at the vegetation and use of natural resources at the foot of Hira Mountains from the Edo to the Meiji reveals a natural environment different from that of today, and a relationship between people and the nature around them. Land use was carried out in a way that was close to the lifestyles and livelihoods of the time, and it is clear that a variety of natural resources were used with high frequency in various locations in the *satoyama*. In addition, our ancestors devised ways to cope with natural disasters such as landslides throughout the region. It is the arrangement of space and ownership patterns throughout the community, such as the type of land use in any given location, or the use of key locations as common forests, or the placement of shrines. Wisdom and technology were also important for vegetation management, such as intentionally retaining and nurturing tall red pine trees, and for the management of key locations and roads in preventing disasters. The places for disaster prevention and mitigation also overlapped with the places where natural resources were used, and local culture was nurtured through diverse interactions with waterways and forests, providing opportunities to understand and practice disaster risk and coping methods.

Today, most of the pine forests that were once important disaster-response lands have disappeared due to pine dieback and residential land development. In addition, the area of cedar and cypress plantations has increased rapidly since the 1960s, and many of them are poorly managed. On the other hand, traditional and local knowledge as a system to reduce disaster risks and obtain blessings from nature for the entire community is still being carried on today, albeit partially, by local community associations and traditional organizations (Photo 10). More recently, voluntary disaster prevention and education initiatives and citizen activities targeting *satoyama* have been undertaken, including by immigrants. It is important to further consider how to use and manage the land in a way that makes the most of vegetation rooted in the locally unique ecosystem and culture, and to link this to social implementation.

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Photo 8: *Satoyama* secondary forest with landslide prevention facilities (2021)

Photo 9: *Yokusa* cutting in a grassland (2006)

Photo 10: Erosion control forest maintenance by Moriyama Voluntary Disaster Prevention Association (2021)

Changes in land use in the foot of Hira Mountains

Kyoto Prefectural University

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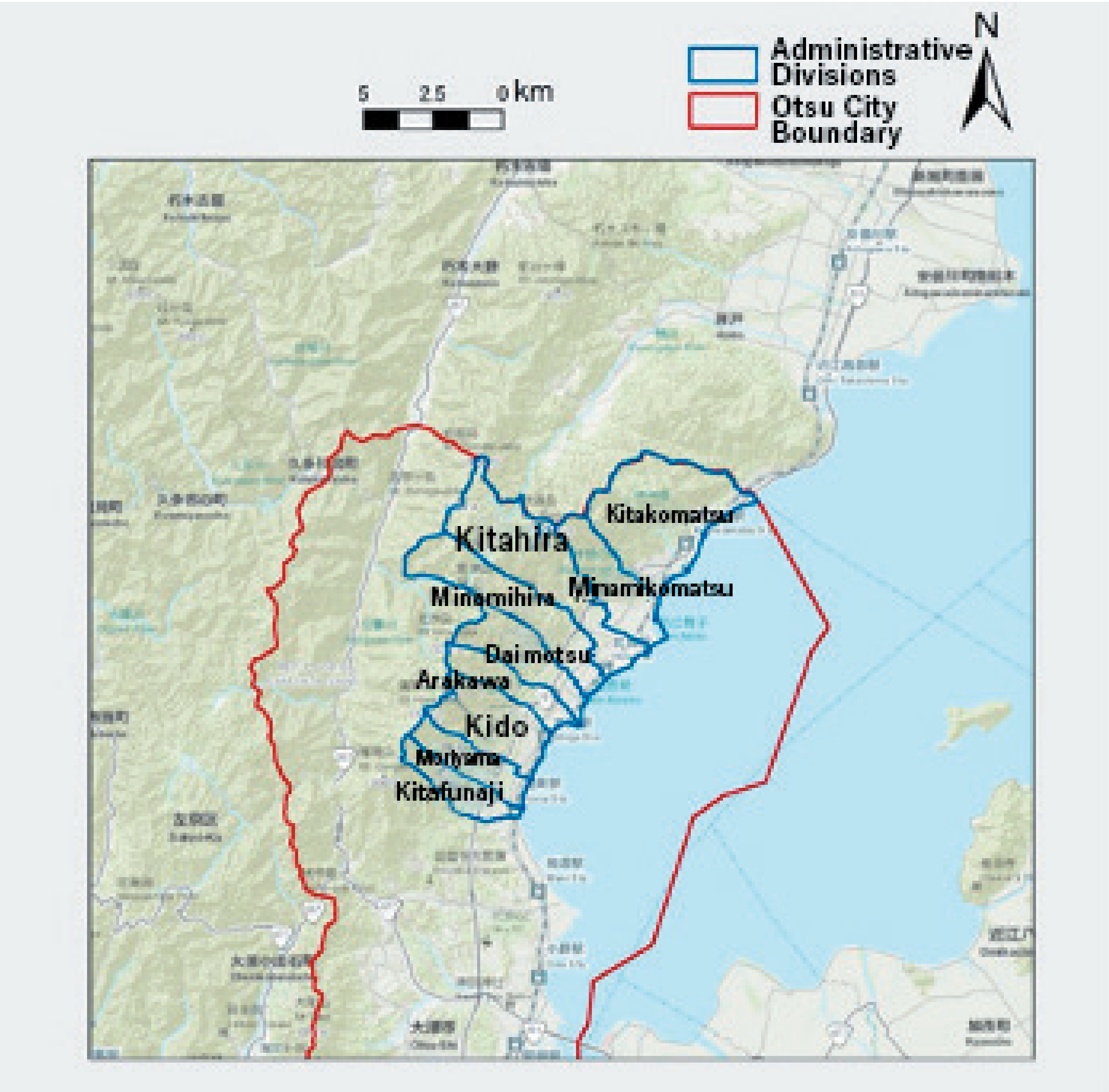

Figure 1: Land to be analyzed

Introduction

Since the 1950s, the system of resource use by local residents has changed against the backdrop of the fuel revolution and the shift in industrial structure, and the spatial elements that make up the *satoyama* landscape have rapidly changed both in quantity and quality (Horiuchi, 2006). In response, residential areas have expanded to higher elevations and areas with higher risk of disasters. In the July 2008 torrential rains, 88 % of the fatalities due to sediment disasters were located in disaster-prone areas (Ministry of Land, Infrastructure, Transport and Tourism, September 2018). Considering the current situation, it is very important to look back at past land use and plan for future land use.

According to the "Approach to Disaster Prevention and Mitigation Using Ecosystems" (2016, Natural Environment Bureau, Ministry of the Environment, Japan), exposure avoidance is a key issue: "Japan is exposed to a wide variety of natural disaster risks, and human lives and property are concentrated in flood-prone areas (lowlands), which account for only a small portion of the country's total land area. In addition, urban areas are expanding in coastal areas that may be affected by tsunamis and storm surges, and in foothill areas that may be affected by sediment disasters. It is important to seize the opportunity of regional restructuring in urban and mountainous areas in view of future population decline and land use change, and to actively promote safe urban and regional development and land use with climate change impacts and disaster risks in mind from the perspective of avoiding exposure." It is important when considering land use to read the land that is inherently vulnerable to natural disasters from the local topography, ecosystem, history of disasters, and local traditions. It also states that in order to reduce vulnerability, "it is important to enhance disaster resilience by integrating land use, ecological, engineering, social, and institutional approaches in accordance with local characteristics". Based on this concept, this paper aims to avoid exposure and reduce vulnerability by analyzing the land use transition in the foothills of Hira Mountains to understand the characteristics of the region and its vulnerable land, and to help improve disaster preparedness by referring to future land use, thereby reducing disaster risk. The project aims to avoid exposure and reduce vulnerability, thereby reducing the risk of disasters.

<Location>
The target area is the Kitafunaji, Moriyama, Kido, Daimotsu, Arakawa, Minamihira, Kitahira, Minamikomatsu, and Kitakomatsu villages in the northern part of Otsu City, Shiga Prefecture. This area is bordered by the Hira Mountains to the west and Lake Biwa to the east. The highest elevation is 1181 m, and the lowest 83 m. The elevation decreases from the west to the east. There are several rivers flowing from the mountain side in the west to Lake Biwa in the east, and Shiga Prefecture has designated many areas along these rivers as areas where sediment disaster hazard warning zones have been established.

Land Use Transition

Figures 2 to 5 show land use for about every 40 years from 1893 to 2016.

In 1893, rice paddies occupied a large area in the lowlands near the lake. Coniferous and broadleaf forests were distributed along the sides of rivers, and coniferous forests were found along the coast. Coniferous forests were distributed at higher elevations between the lowlands and deep in the mountains. At the higher elevations, broadleaf forests were found, and some broadleaf forests were also found in the lowlands. In Moriyama village at this time, the pattern of forest resource use was observed according to distance from residential areas and elevation: residential areas (100~150 m above sea level) - pine, cedar, cypress, and oak (150~300 m) - mountain grass (300~500 m) - bush (500 m and above). The land use patterns in 1932 were as follows: foothills and fan-shaped lowlands - mountainous terrain, and private land - family lots - common forests (Horiuchi et al. 2006).

In 1932, as in 1893, rice paddies were common in the lowlands, coniferous forests were found between the lowlands and the mountains, and broadleaf forests were found at the back of the paddies; compared to 1893, coniferous forests extended to higher elevations in the mountains; broadleaf forests, which were found in the lowlands in 1893, were slightly reduced, but broadleaf forests were still present. The total forest area, which is the sum of broadleaf and coniferous forests, did not change significantly. The distribution area of residential area did not differ significantly from that of 1893. The map symbols for mulberry fields and fruit trees were no longer seen, and those for wasteland were seen. In the Moriyama area at this time, broadleaf trees were distributed in the fan-shaped area with sawtooth oak and *abemaki* forests, and Quercus crispula forests were distributed from about 500 m elevation to the summit of the mountain forest. Conifers accounted for a large proportion of the area of red pine forests, and it was reported that plantation forests were gradually established from this time and artificial forests of cedar and cypress were spread near rivers at the foot of the mountains (Horiuchi et al., 2004).

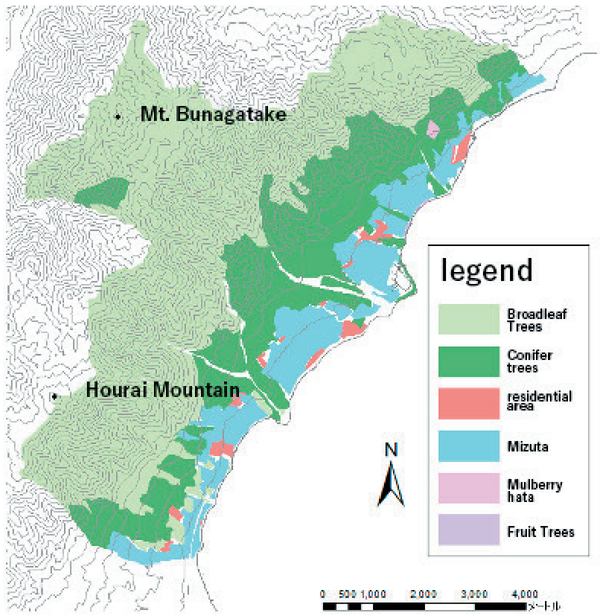

Figure 2: Land Interest in 1893

In 1975, as in 1893, rice paddies were common in the lowlands, coniferous forests were found between the lowlands and deep in the mountains, and broad-leaved forests were found at the back of the paddies. In the topographic map of this period, some of the forests were mixed forests of needle and broadleaf trees, so it was not possible to follow the exact increase or decrease in the area of coniferous and broadleaf forests, but the total area of the forests, including these, did not change significantly. The area of residential area in lowland areas increased, while the area of rice paddies in lowland areas decreased. This is thought to be due to the opening of National Route 161 in 1963, the Lake Biwa Bridge in 1964, and the JR Kosei Line in 1974, which increased the population and thus the residential area.

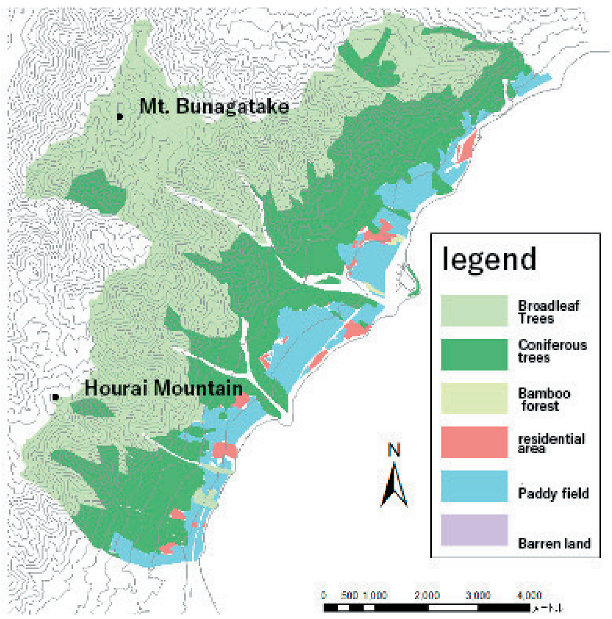

Figure 3: Land Use in 1932

In 2016, as in the previous year, the land use showed rice paddies and residential area in the lowlands, coniferous forests between the lowlands and deep in the mountains, and broadleaf forests or mixed coniferous and broadleaf forests in the backlands. However, compared to the 1975 land use, there was a marked increase in residential areas in the lowlands, a decrease in the area of rice paddies, an expansion of residential areas to higher elevations, and a decrease in the total forest area.

Compared to land use in 1975, there was a considerable decrease in coniferous trees. In the Yanomune river basin in the Minamikomatsu area, it was reported that many of the pine forests had disappeared due to pine die-off and housing development, and in the areas where forest land remained, some renewal of red pine could be observed, but most had transitioned due to neglect and were becoming forests dominated by other yang trees and shade trees (Ando et al., 2020). This may be true in other areas as well.

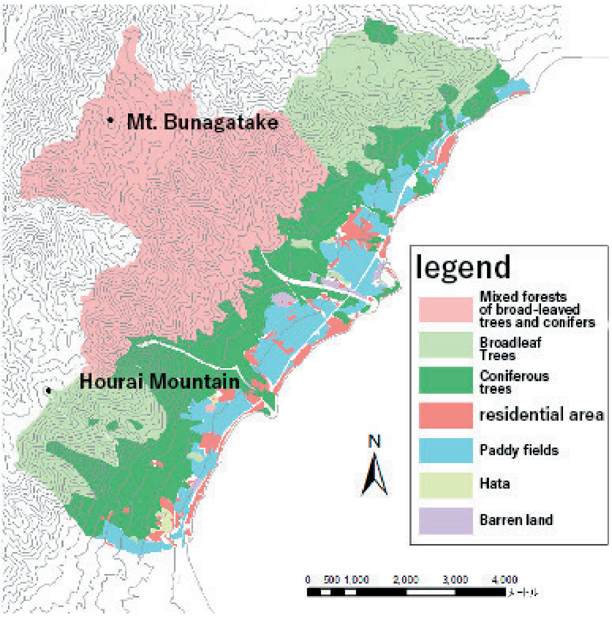

Figure 4: Land Use in 1975

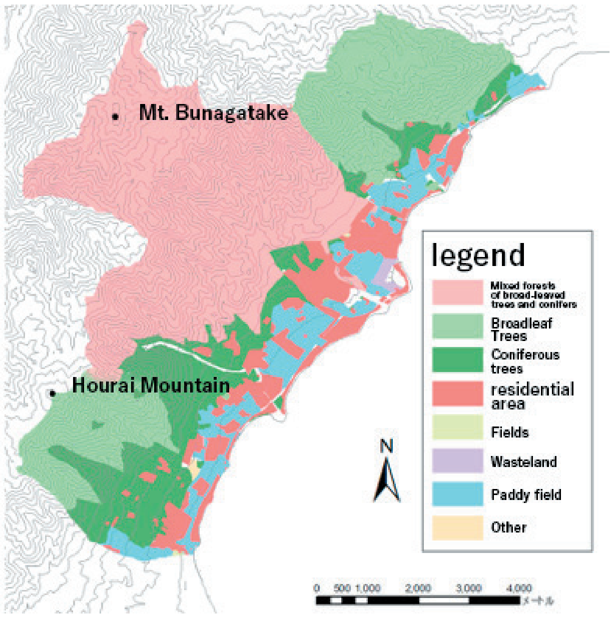

Figure 5: Land Use in 2016

Moriyama and Minamikomatsu areas

In 1961, residential area in the Moriyama area were distributed in low-lying areas with relatively gentle slopes and along the lakeshore, but after 1975, housing lots were residential at higher elevations and houses were constructed one after another. In addition, the river channel of the Jiaredani river was constructed after 1975, and housing lots increased along the river channel. Both of these two areas belong to the sediment disaster hazard warning area. Although it was inevitable that housing lots would be developed as the population increased, the disaster risk must have been taken into consideration when deciding where to build. In particular, the construction of a river channel along the Jiaredani river provided hardware disaster countermeasures, but this in turn led to residential lands being residential within the sediment disaster hazard warning area. This, according to the concept of Eco-DRR, increased the exposure. The land use change survey shows that this land used to be a coniferous forest before the river channel was constructed, and at that time, the coniferous forest zone was considered to be a buffer zone before the debris flow reached the residential area, and this buffer zone reduced the vulnerability. In addition, there were few housing sites, so exposure was low. Therefore, it is considered that the risk of disaster was small because the vulnerability was small and exposure was small even before the hard countermeasures were taken. Now that the river channel has been constructed, the exposure has increased, and the risk of disaster has increased. We need to consider the balance between hard and soft measures, being aware that this land is a dangerous area when disasters occur.

Residential area in the Minamikomatsu area were not included in the sediment disaster hazard warning area as of 1961. However, since 1975, residential land has been developed and houses have increased in the higher elevation areas, the area adjacent to the Kitahira district on the south side of the lowlands of Minamikomatsu, and the wooded area along the river. The housing development in the lowlands does not cover the sediment disaster hazard warning area at all, so it can be said that the area is highly safe. However, the housing sites were not sufficient, and housing sites were residential in high elevation areas with high vulnerability and along rivers, resulting in an increase in houses on land with high vulnerability, high exposure, and high risk of disasters. Compared to the Moriyama area, the Minamikomatsu area is a safer and more livable area because there are fewer sediment disaster hazard areas and the slopes are gentler than in the Moriyama area. In the future, as the population increases or decreases, changes in residential land use are likely to occur. In such cases, it is necessary to review past land use, take into account the sediment disaster hazard warning areas, and consider which land will be used to build safe residential land in the future.

Percentage of Land Use in Residential Area that Increased

Looking at the table for the percentage of land use in residential area that increased from 1975 to 2006, the increase in lowlands was more often converted from rice paddies to residential area, while the increase at higher elevations was more often converted from coniferous forests to residential area. Thus, from 1975 to 2016, when the increase in residential area at higher elevations was greater, a larger proportion of the land was converted from coniferous forests to residential area. There were also many areas along the coast where forests and wastelands were converted to residential area.

Table 1: Original Land Use of Residential areas Increased from 1975 to 2016

Land use	Percentage (%)
Paddy field	27.41
Coniferous	58.081
Broadleaf trees	1.923
Mixed forest	0.676
Wasteland	4.355
Fields	7.515
Along the coast	0.039

Distribution of Residential Area and Sediment Disaster Warning Areas

Figures 6 to 9 show the distribution of residential area and sediment disaster hazard warning areas for approximately every 40 years from 1893 to 2016. From 1893 to 1932, there was no significant change in the area and elevation distribution of the residential area, which was distributed between 84 and 153 m.

From 1932 to 1975, the area of the residential area increased 2.417 times and the elevation distribution expanded from 84 to 331 m. In other words, new residential areas appeared at elevations between 153 and 331 m. The area of the residential area increased 2.64 times from 1975 to 2016. The elevation distribution ranged from 84 m to 328 m. There was no expansion to higher elevations, but there was an increase in the area of residential area at higher elevations. The area of the building zone at lower elevations also expanded, and some of the residential area that appeared scattered in 1975 expanded and became large residential area. The area of residential area at higher elevations is not as large as that at lower elevations, but the probability of being included in a sediment disaster hazard warning area is higher in areas between 130 m and 200 m above sea level. In the Hira-Foothills area, the number of residential area within the sediment disaster hazard warning area has increased since 1975. The expansion of residential area at higher elevations requires caution.

Conclusion

In the late Meiji period (1868-1912), the use pattern of forest resources was observed in the foothills of the Hira Mountains, and the mountains were managed by people. However, today, there is little human intervention in the environment, and it has been reported that many of the red pines, for example, are undergoing succession due to neglect and are becoming forests dominated by other trees.

The transition from 1975 to 2016 shows the expansion of residential areas at higher elevations and the conversion of coniferous forests to residential area. Before the conversion, coniferous forests and other forested areas provided a buffer zone before reaching residential areas in the event of disasters such as debris flow in mountainous areas, and the conversion of forested areas to residential areas indicates that this buffer zone has disappeared. This means that vulnerability has increased. It is important to prioritize these forests

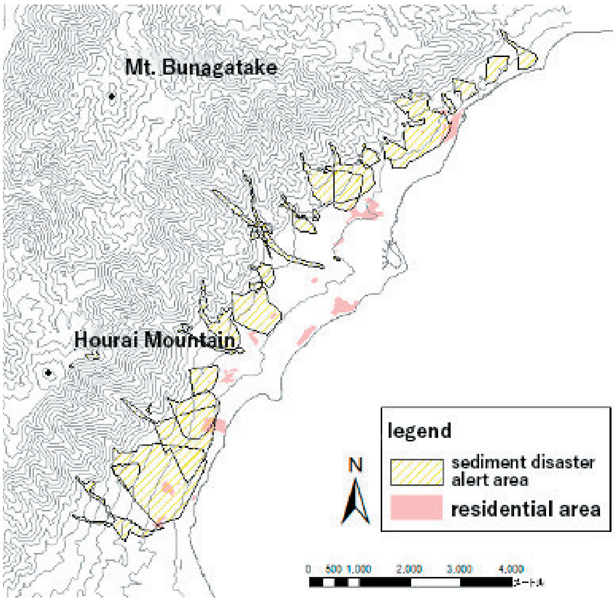

Figure 6: Distribution of residential area and Sediment disaster warnings in 1893

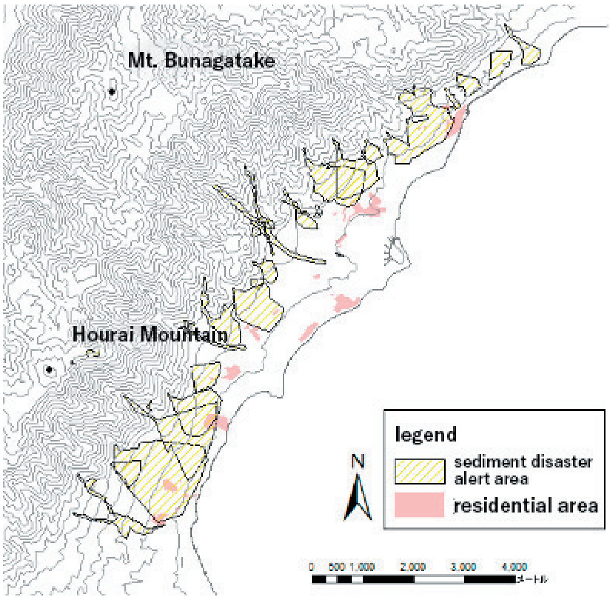

Figure 7: Building distribution and Sediment disaster warnings in 1932

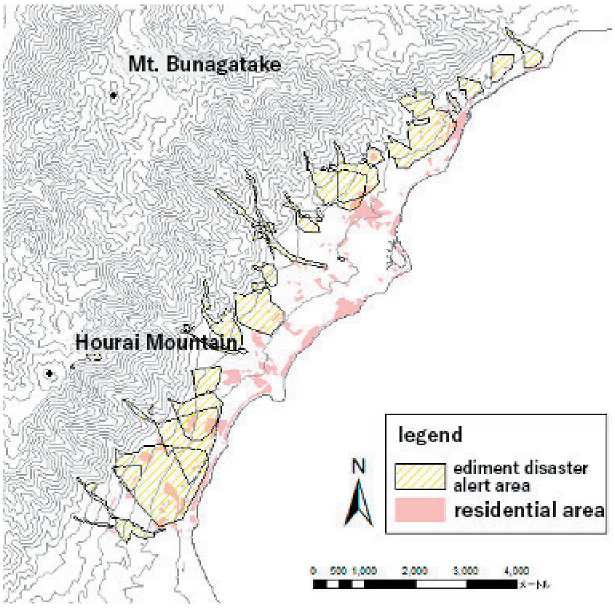

Figure 8: Building distribution and Sediment disaster warning in 1975

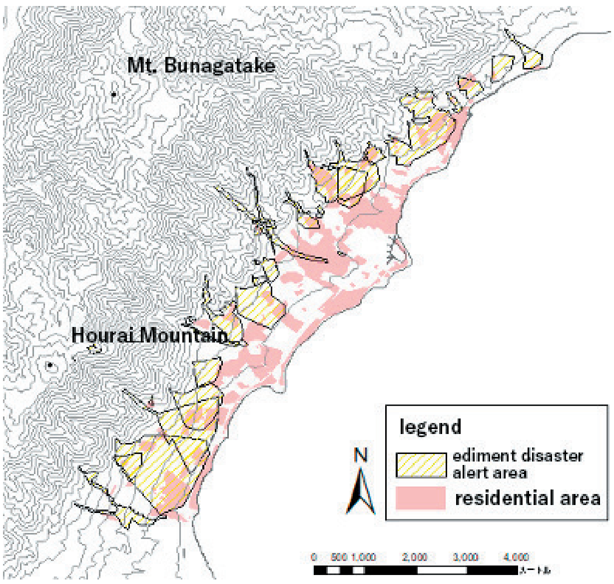

Figure 9: Building distribution and Sediment disaster warnings in 2016

for conservation from the viewpoint of disaster mitigation.

Regarding the relationship between residential area and sediment disaster hazard warning zones, it is known that most of the residential area that have existed for a long time are distributed in lowlands between 90 m and 130 m, and that the proportion of sediment disaster hazard warning zones in lowlands is small. This suggests that land that has functioned as a residential for a long time is safe. On the other hand, since 1975, residential area have appeared and expanded at higher elevations (130 m to 200 m), suggesting that the percentage of sediment disaster areas at these elevations is high. The percentage of built-up areas at elevations between 130 m and 200 m is still small, suggesting that there is room for the residential area up to expand at these elevations in the future. This suggests that the land that functions as residential area in high elevations, which have been increasing in recent years, is unsafe, and that there is a high possibility that residential area will expand on this land in the future. It is important to consider land use with disaster risk in mind and to think about the future of this area.

Sediment disaster response at the foot of Hira Mountains during the Edo Period

University of Shiga Prefecture **AZUMA Sachiyo**

Disasters Around the Base of Hira Mountains

What kind of disasters did the Hira Mountains area face during the Edo period? The "History of Shiga Town" lists four disasters that occurred in the area during the Edo period: (1) shortage of water due to drought, (2) flooding of rice paddies due to the rising waters of Lake Biwa, (3) rivers bursting their levees due to heavy rain, and (4) damage caused by wild boars and deer.

All of these disasters pose a serious threat to the livelihood of the people living in this area, but here we would like to look at the Sediment disaster disaster related to item (3). Rivers in the area used to regularly wash away stones and sediment, as described in ancient documents as "ishigawa," which means "stone river. This is why river bursts often resulted in massive outpourings of earth and sand.

Even today, most of the rivers flowing at the foot of Hira Mountains are considered to pose a risk of debris flow. Of course, erosion control works and river improvement have progressed since the modern era, reducing the risk of such disasters. On the other hand, how did people cope with sediment disasters when only natural materials were available as structures for disaster prevention and mitigation? Let us take Kido Village (Kido Village) as an example.

Prohibition of digging up tree roots and encouragement of planting

First, let's look at the movement of the lords involved in administration.

In 1694, Ono Hannosuke, a local governor of Otsu, issued the following notice to Kido, Arakawa (Arakawa Village), and Daimotsu villages (Daimotsu Village).

> We have long forbidden digging out the roots of trees, earth and sand from the farmers' fields, and forests can interfere with the rice paddies. Please observe this prohibition.

Also, continue.

> Where the planting of bamboos and trees causes sand to accumulate, plant trees and seedlings suited to the land in the village during the farming season to prevent soil and sand from flowing out.

The lord also ordered the planting of tree roots and seedlings. The lords were pinning their hopes on the stabilizing function of plants such as tree roots and seedlings.

Land Use Alteration

In addition to these preventive measures, lords sometimes ordered villages to change their land use as a symptomatic measure. This can be seen in an old document concerning a dispute over a grass field that occurred between Kido and Arakawa/Daimotsu villages in 1674.

The three villages had their own grassland for tachiai (admission). Among them, there was a place called Susumi, which was originally an irrigation wellhead for Kido and Arakawa villages. When this well was cut off by heavy water some 40-50 years ago and the rice-fields of Kido Village were damaged, the lord of the time designated Susumi as a "perpetual forest" and ordered that the grass could be cut by the three villages, but that no bushes in the "kawa-yoke-bayashi" forest could be cut at all. Riverside forests were used as flood control forests. They were trying to transform damaged rice paddies into flood control forests to provide disaster prevention and mitigation functions.

Environment in the late 17th century

Protecting the rice paddies was key to the livelihood of the peasants. The above-mentioned measures taken by the lords ensured the livelihood of the people of Kido Village.

However, behind this was a powerful environmental problem of widespread mountainous land degradation in the latter half of the 17th century. At the time, the Kinai and neighboring provinces (Yamashiro, Yamato, Kawachi, Settsu, and Omi, to be specific) were experiencing mountainous land degradation, and the Yodo and Yamato river systems were experiencing sediment runoff. The sediment was obstructing the flow of water and causing damage in many areas. In order to stop such damage, the Edo *Shogunate* issued several orders, starting in 1684 with the prohibition of digging of tree roots, encouraging the planting of trees, and the change of land use. It can be said that the actions of the feudal lords in the area at the foot of Hira Mountains were also in line with the policies of the Edo *Shogunate*.

Implementation of *gofushin*

Another thing that the feudal lords implemented for disaster prevention and mitigation was kawa-yoke fushin, or river fushin (civil engineering work) for flood prevention. This included river dredging and restoration of levees. Of course, the samurai did not come to Kido Village to carry out the fushin. The feudal lords would pay for the construction work carried out by the villagers.

To the south of Kido Village (to the left in Figure 1), the Uchimidani River (today's Kido River) flows from Uchimidani Mountain (Figure 1). This river is

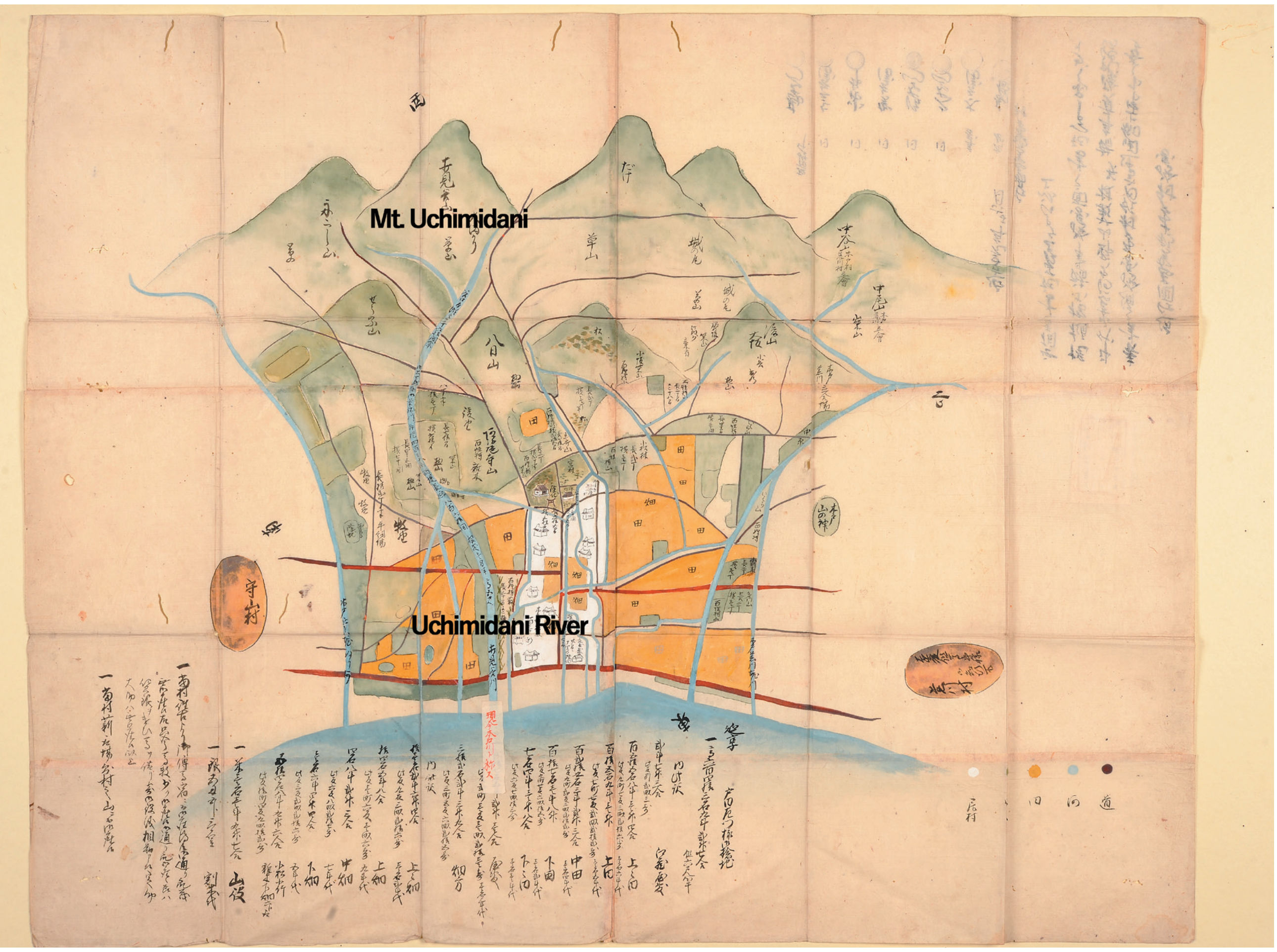

Figure 1: Uchimidani River (present-day Kido River) flowing from Uchimidani Mountain

sometimes described as the "Araishi River" or "Ishi River," and during heavy rains, there was sediment runoff. For this has old documents related to river-removal fushin, such as the "Kido Village Inoharu *Gofushin*-cho" (Kido Village Inoharu Fushin-cho) from 1707. The book lists the expenses for 1,556 laborers needed to dredge the Uchimidani River, indicating that the lord bore the cost of the construction work. This kind of lord-led fushin is called *gofushin*. On the other hand, when the cost is raised by the village, it is called "jifushin," and Kido Village did the river dredging by jifushin in later years. Kido Village was not happy about this, and in 1745 (Enkyo 2), it appealed to the feudal lord, saying that its own fushin was insufficient for dredging the river, and requesting that a *gofushin* be ordered.

The risk of flood and Sediment disaster disasters forced the village to undertake fushin, but the cost created a bottleneck, a situation common not only to Kido but also to villages and hamlets at the foot of the mountain. In addition, river construction is essential not only for disaster countermeasures but also for maintaining the productivity of the village.

Conflict with Livelihood

While the lords were taking measures to prevent and mitigate disasters, Kido Village was also taking measures to prevent and mitigate disasters. These included the maintenance of the aforementioned "Susumi-no-Kawayokebayashi" (river-removal forest) and the implementation of the "Kawayoke Fushin" (river-removal promotion). However, the village's disaster prevention and mitigation measures were sometimes hampered not only by the natural environment, such as heavy rains, but also by various human pressures. The "Susumi" dispute also stems from the fact that Arakawa Village intentionally conducted bush cutting, which, according to Kido Village's argument, should have been prohibited to reduce the disaster prevention function.

In the case of Kido Village, what required special consideration was the existence of the villagers who made a living by extracting stones from the mountains.
In the haikai (haikai) book "Kefukigusa" written in the early Edo period (1624-45), it is written:

> Kidoishi: A stone used as a cut stone.

In addition, the "Omi Yochi Shiryoku" completed in 1734 (Kyoho 19) states:

> The best garden stones are those from Kido Village. Those who love the temporary mountains and springs are very fond of them.

From the beginning of the Edo period, stones from Kido Village were regarded as good stones, and "Kidoishi" became a kind of brand.

This is where the conflict between the business of quarrying stones and disaster prevention/mitigation measures arises.

Stones at the foot of Hira Mountains

In addition to Kido Village, there were many people involved in stone production around the foothills of Hira Mountains. We, the members of the research group, have obtained various information on the stone industry in the Showa period through interviews and surveys. One of the results of our research is that we have found that each village has its own characteristics in terms of the stone material itself, and that the way of working in the stone industry differs from village to village. Some examples are as follows:

Kitahira area...Nagaishi (long stones) were mostly used, and they were processed into nagaishi, shikiishi (paving stones), used to build torii (gateway), and so on.
Minamikomatsu area...many stonemasons specialized in round stones, lanterns, water bowls, and stone mortars.
Moriyama area...Many stonemasons carried out Moriyama stones from the mountains and used

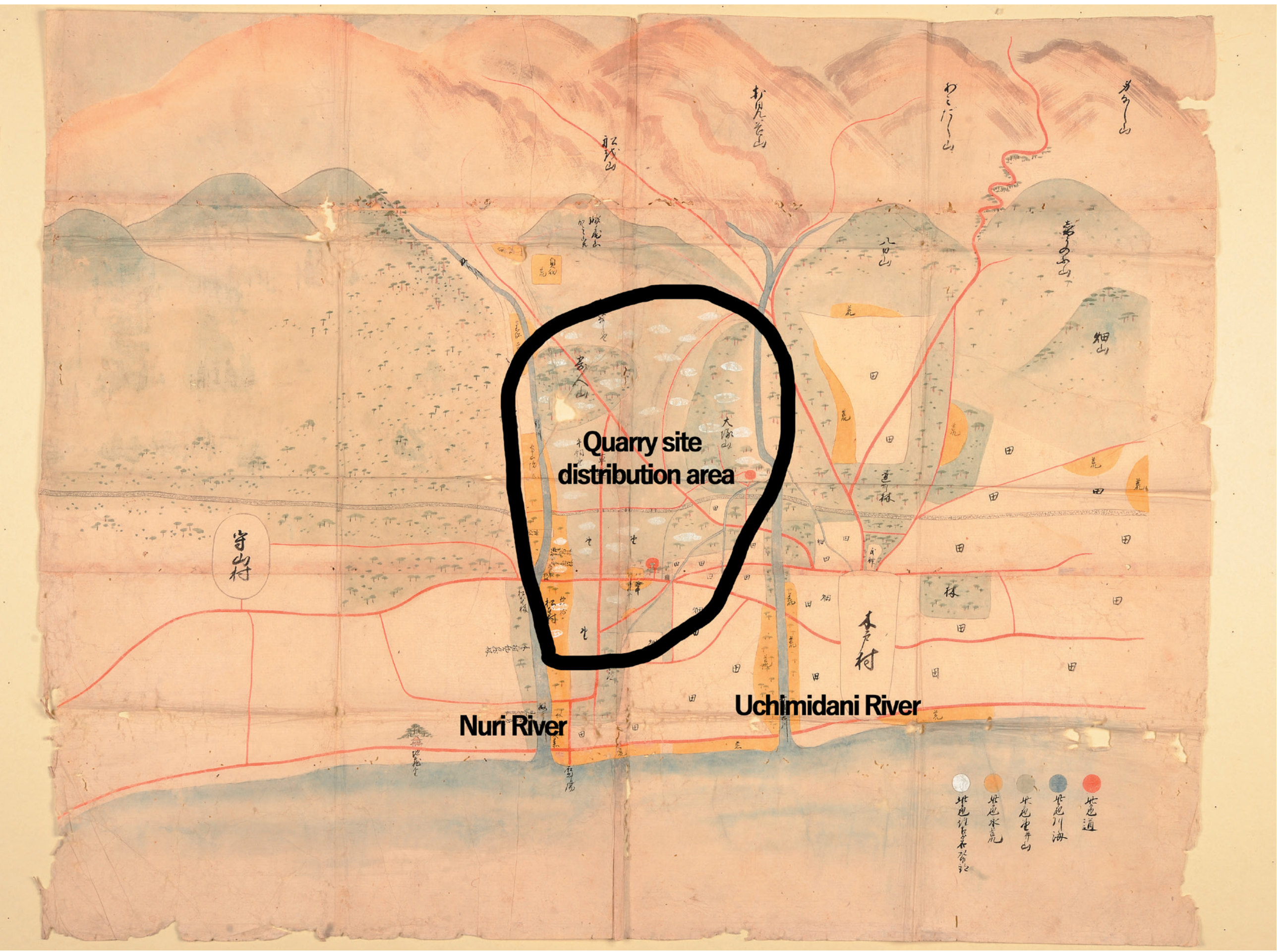

Figure 2: Quarry site (white ovals scattered in the center)

them as stone walls and garden stones without processing them into stone products.

These are only information from the Showa period, but as in the Kitahira village, "nagaishi" (long stones) are found in old documents from the Edo period in Kido Village. People quarried large stones for their livelihood.

Quarry in Kido Village

An ancient document dated 1713 (Shoutoku 3) states that the people of Kido Village, who were engaged in the family business of quarrying stones, used "Sōmurayama" as their quarry. In 1831, it also states that the quarry was "formerly a place that did not interfere with the river course or mountain work" (Figure. 2).

(Figure. 2) is an illustration that, although the date of creation is unknown, is thought to have been made during the Edo period (1603-1868), judging from the expressions and other factors. The legend of the map shows that the white ovals scattered between the Uchimidani River flowing through Kido Village and the Nurigawa River (present-day Noriko River) flowing through Moriyama Village (Moriyama Village) indicate the "remains of stonecutters since ancient times". Indeed, it seems that the stones were quarried in a place relatively close to Lake Biwa, where they did not interfere with the river course and mountain work.

However, in February of Tenpo year 2, a dispute arose between peasants and stonemasons over the location of the quarry. According to the application submitted by the peasants to the lord, the stone masons were gradually increasing in number at that time, and recently they were entering and digging in the "Uchimidani" area. "Uchimidani" probably refers to the valley of "Uchimidani Mountain" located upstream of Uchimidani River. It can be seen that stonemasons were entering the river in search of stones.

Impact on Agriculture

The Uchimidani River was sometimes referred to as the "Araishi River" or the "Ishi River," as mentioned above. Readers will know what happens when quarrying is conducted in the basin of such a river. The river become "red and muddy with every rainfall," and the drinking water was muddy for four or five days. The iron in the granite was probably leached out causing the water to be red. Of course, during heavy rainfall, there was a fear that the rice paddies would collapse. Even without heavy rains, the red water entering the rice paddies could prevent the rice plants from growing, and the river channel could become higher due to sediment accumulation.

According to the peasants, quarrying stones along the Uchimidani River was prohibited by the lords during the Kansei era (1789-1801). After that, stone workers changed the location of the quarry so that it would not affect the downstream area, but they changed the location further because they had run out of "wobby stones". The quarrying there had resulted in a situation where "every summer rainwater pushes out sediment". Therefore, the peasants asked the lord to order the stone workers to follow the peasants' instructions.

Stone Worker's Response

In response to the peasants' petition, it appears that the quarrying of stones by the stonemasons was prohibited. For this reason, the "Ishiya Sodai" submitted a petition in the same month. They claimed that they had no other livelihood besides "stone work" and that their business would be hindered if they could not quarry "nagaishi," which they had been quarrying up to now.

Through this dispute, it is clear that the stonemasons were not free to operate. First of all, until a few years before this dispute, there was a "spring and fall limit" on the number of sections for water used in the rice paddies. Consideration for agricultural water was required. In addition, a fine of 3 monme was paid to the village for "one mallet" and "1 monme 2 bu as hama-yaku." In addition, there were two types of charges: one was "4.5 rin per *tsubo*" and the other was "5 rin per *tsubo*," with the latter being paid according to the location. The "hamayaku" was a payment for the use of a place to carry the stones to the shore of Lake Biwa for processing and shipping, and the "yama-arashi fee" is thought to be an apology for literally destroying the mountains.

At this time, the stone craftsmen said. If necessary, we will assist the "*gofushin*sho" and increase the "yama-arashi-ryo" fee that has been paid in the past. In addition, they said, they would allow the peasants to continue quarrying stones as they wished, depending on their instructions. Quitting quarrying was not an option for them.

Conclusion of the dispute

The dispute ultimately resulted in a "matter settled" (naisai) within Kido Village, and both parties withdrew their applications to the lord. Unfortunately, however, at this point in time, there is no ancient document that shows the specific resolution of the dispute.

It would be interesting to know how the villagers managed to strike a balance between agriculture and quarrying, and between livelihood and disaster prevention and mitigation.

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Masonry work and resource management at the foot of Hira Mountains

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Introduction

The Hira Mountains, located in the northern part of Otsu City, Shiga Prefecture, is the source of a white granite called *Kido-ishi* (Kido stone) (Shiga Town History Editorial Board, ed., 1999), known as the second most famous stone after *shirakawa-ishi* in Kyoto, and widely used for shrine gates, lanterns, building stones, stone walls and garden stones.

The Kido Village Record edited in 1875, mentions granite as a product of Kido Village and says, "Granite is of beautiful quality and is used for lanterns, water bowls, and other masonry work" (Shiga Town History Editorial Association, ed., 1999), indicating the high quality of the lanterns and other products produced in the area. In addition, the Shiga Prefecture Products Record edited in 1880 lists stone lanterns and gravestones as products of Kido Village, and the large percentage of craftmen indicates that the stone industry was thriving (Shiga Prefecture Municipal History Editing Committee, ed., 1962). According to Tainaka, "In Kido and Kitahira villages, the percentage of craftsmen was also high, and the distribution density of masons in this area was outstanding in Shiga Prefecture at the beginning of the Meiji period" (Tainaka, 2007).

The stone materials in the Hira Mountains that supported these craftsmen are all classified as granite, but the characteristics of the stone differ depending on the location. In part of Minamikomatsu, fine-grained stones called *aka-ishi* and *nukame* were quarried. Also in Kitahira, where fine granite was quarried in some parts of the mountain, and brownish fine stone was buried underground.

Another characteristic of granite known to local people is the difference in the size of the stones. In Kitahira and Minamihira, where the valleys are deep and the stones are particularly large, the area was the source of *naga-ishi* (long stones) used for house foundations and shrine torii gates. On the other hand, in Minamikomatsu, where relatively small stones were found, processed products such as stone lanterns and water bowls were produced.

In Moriyama, south of Kido, the stone is not granite, but a blackish chert stone called *Moriyama-ishi*. It is hard and difficult to process, but because of its appearance it was mainly used as a garden stone. In this way, the villages at the foot of Hira Mountains used mountain resources according to the characteristics of the stones.

Tools and Work Processes in the Kitahira Area

There were two types of stonemasons operating in Kitahira. One was the craftsmen who belonged to *oyakata* (master) and was engaged in quarrying, transporting, and processing stone from the mountain, and the other was the craftsmen who was engaged in making *saikumono* (processed goods) on his own. The former was the majority in Kitahira, and they were assigned to a particular master and paid according to the number of days they worked each month. There were two main masters in Kitahira and two in Minamihira.

Let us introduce the management of the Hiraoka family, one of the masters in Kitahira. The Hiraoka family employed 15 to 20 craftsmen to operate the business in the pre-WWII period. Shichiro Hiraoka, who was born in 1926, graduated from high school in March 1941 and started working in the family's stone masonry business, and vividly remembers the thriving masonry business in Kitahira in the prewar period. He says "The heyday of stonemasons must have been during that period (Taisho to prewar Showa periods), and this area must have received a lot of stone-related money."

The Hiraoka family's business site in the 1930s was located at a place commonly called Shiroiwa, which is up a mountain path from Oyamaguchi along a ridge, going up the front valley (southern valley) of the main stream of the Hira River. The elevation is 450 to 650 m above sea level. The quarrying method in Kitahira called *ishi-otoshi* (stone dropping) is to drop huge stones on the slope at once toward the Hira River bed below the slope. These stones are broken little by little over a period of several years and gradually carried out.


Photo 1: A stone with a hole scar from a *teppo-nomi*


Photo 2: Stone with wedge hole marks


Figure 1: Large stone breakage with a *teppo-nomi*


Figure 2: Transporting stones with a *tonbo-guruma*


Figure 3: Processing the products


Figure 4: Lording products to the ship

Craftsmen leave the village at 8:00 a.m. and head for the *choba* (workbase in the mountains), which takes about one to one and a half hours, and work until dusk. Each craftsmen brings a lunch box called a *hiruge*, filled with five to six bowls of rice and two pickled eggplants as a side dish.

The huge stone is first broken into large pieces using gunpowder (Figure. 1). A long chisel called *teppo-nomi*, up to three meters long, was used to make the hole for the gunpowder. At first, a shallow hole was dug with *mau-nomi* (round chisel), and then the hole was gradually deepened with a longer *teppo-nomi*. From the middle of the digging process, it took two people to dig the hole. One person stood and used both hands to hammer down the heavy *gennou* (big hammer), while the other person sat down to support the chisel and rotated it slightly with each stroke.

According to Mr. Hiraoka, it took 20 to 30 days to complete a single hole. In the mountains of Kitahira, stones with *teppo-nomi* marks can be seen, which are thought to be part of the stone material that was broken once but not carried out for some reason (Photo 1). The broken stones were further cut to the required size, and were then carried out along the mountain road by a *tonbo-guruma*.

The *ishi-dashi* (stone transporting) from the mountain to the beach was done with a *tonbo-guruma* (Figure. 2). It is a two-wheeled vehicle with a metal axle attached to a sturdy dolly and a wheel called a *tama*. The wheel is operated by holding the long *kaji* (rudder) stick with one's arms as if to maneuver it down a steep, twisting slope. On a slope, if the rider's center of gravity leans forward, there is a danger of being crushed under the tonbo-guruma, so turn the body sideways like a crab, and sometimes a child was placed on the tail end of the stone as a weight. Once down to the flat terrain, they would change to larger-diameter wheels at the *tamakaeba* (the point where the wheels were changed) to make efficient transportation.


Photo 3: Tools used in lantern making

For Kitahira's stonemasons, the *hama* (lake shore) was another work base along with the mountain quarry. The main work at the beach was to shape the stone into a long, thin foundation stone and make it ready for shipping (Figure 3). A row of holes was drilled into the surface of the stone with a chisel and hammer, wedge-shaped tools called *ya* are inserted into the holes, and the stone is then pounded with a *gennou*. It is important to identify the joints in the granite. The stone is then pounded little by little while listening to the faint sound of the stone cracking. Even today, stones with wedge hole marks can be seen here and there in the village of Kitahira (Photo 2).

As can be seen from the above process, chisels are often used to make holes in stones in the mason's work. At first, a hole is drawn on the surface of the stone with a round chisel, and then the rough shape of the hole is dug with a regular chisel. When the bottom is reached, the hole is completed with a *tekka-nomi* (pointed chisel), and for more careful shaping of the hole, a *sokozuki* (chisel for finishing) is used. Since the chisel tips quickly become dull, during the lunch break, a fire is built in a hut and the tools must be tapped and adjusted. In other words, the stonemason was also a blacksmith.

The final step was loading. The *sendo* (boatmen) who owned *Marukobune* boats were in charge of loading and unloading, and *ganko* boats (boats made of sturdy materials) were especially chosen to carry the stones. *Marukobune* boats could be

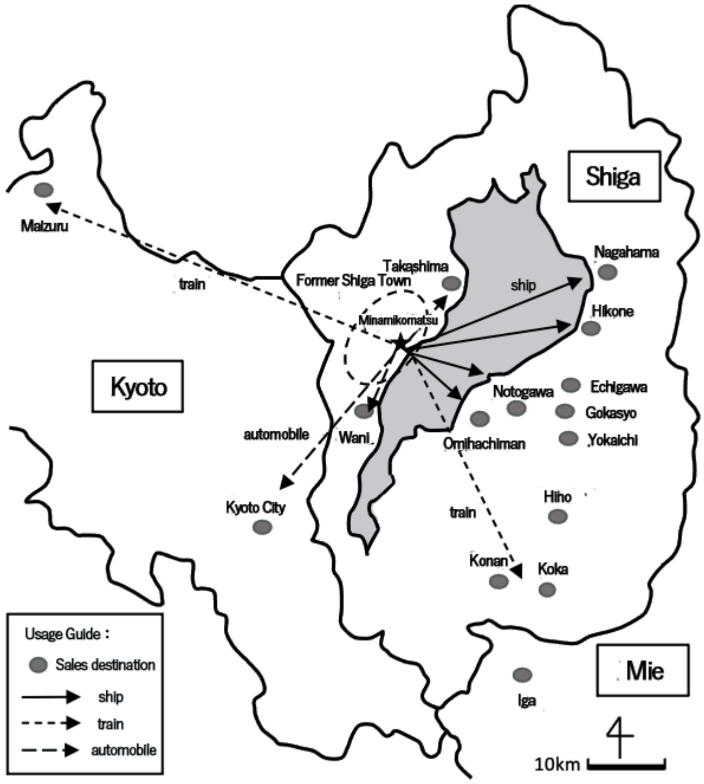


Figure 5: Distribution of Kahei Lanterns

moored on the beach near where the huts were built. Two scaffold boards were placed over the boat, and the middle of the boat was supported by a platform called an *uma*, and stones were pushed on the *koro* (logs) to carry them to the boat (Figure 4). This method of shipping made the most of the wide sandy beach terrain.

The above series of tasks, such as removing the stones, transporting them, and finishing them in a hut on the beach, were carried out by a division of labor among craftsmen specializing in different fields. For example, in the *ishi-dashi* a skilled craftsmen would make two round trips, one in the morning and the other in the afternoon, to transport the stones. The master calculated the monthly wage according to the number of working days and paid it in cash. Mr. Hiraoka still remembers his father using a large sized abacus and flicking the balls with a loud clang as he kept the accounts.

Quarrying and Work Process in Minamikomatsu Area

Although it is known that quarrying, processing, and sales of stones have been conducted in the Minamikomatsu area since the Edo period (1603-1868), where a detailed survey was conducted, the existence of stone masons in Minamikomatsu is not mentioned in the Shiga Prefecture Products Record of the Meiji period. However, in 1932, there were 71 stonemasons living in Minamikomatsu, which indicates that the number of stonemasons was the largest in Komatsu Village (Shiga Town History Editorial Association, ed., 1999). Hachiman Shrine in Minamikomatsu is dedicated to *komainu* (guardian dogs) and lanterns made by master stonemasons in the Meiji era, as well as a giant lantern about three meters high made of *nozura-ishi* (fieldstone) and a stone wall made of giant stones. On the other hand, stone foundations are used for houses in the village, lanterns are placed in some gardens, and folk tools such as pickle stones and stone mortars are piled up and left unused.

According to the local residents (male, 80-90 years old) who had experienced quarrying and carrying out stones around until 1951, a large exposed rock upstream of the river was used as a quarry, a place where granite was dug out. The digging work included stone dropping and stone splitting, each of which was carried out in a division of labor. As in Kitahira, the dug-out stones were carried out of the mountain by a cart called a *tonbo-guruma*.

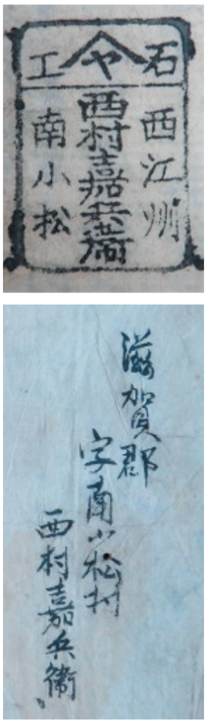
In Minamikomatsu, quarrying was generally conducted on private as well as common lands before World War II, while after the war, quarrying was mainly conducted on privately owned mountains, and continued from a limited number of locations.

However, quarrying ceased in the latter half of the Showa period (1926-1989) due to the decline in demand for stone and the decrease in the number of workers due to the war.

In Minamikomatsu, stone lanterns, water bowls, and stone mortars were actively made from small granite. Field research has revealed that most of the lanterns made were of diff erent sizes, depending on the type, but the proportions of the shade, pole, etc., were almost the same. In addition, when the stone lanterns were made, a wooden frame was used to mark the curved part of the hat with ink, and then worked on it.

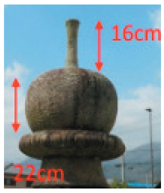
The tools used for making lanterns are also unique. Longer and thinner chisels were used to carve the detailed patterns on the *warabite* (bracken handles), *hibukuro* (fire pouch), and *chudai* (lantern stand) of the lanterns. This is in contrast to Kitahira, where the long chisel was developed to break up huge stones. In addition, a wooden frame used to hold the stone during the making of the lanterns and a wooden compass thought to have been used to process the pole portion of the lanterns were found in Minamikomatsu. These tools are different from those found in Kitahira, where *naga-ishi* was the main product (Photo 3).

One of the representative craftsmen of Minamikomatsu, which specialized in the production of delicate processed products such as lanterns, was Kahei Nishimura. Kahei was the

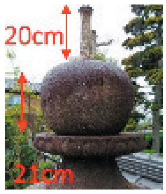

mason's stump and sign


Rengeji lantern


Okunoin lantern



hoju

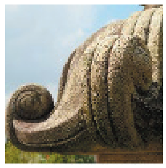


hoju

kasa

kasa

warabite


warabite


Okunoin lantern sculpture (Kyoto City)

Photo 4: Kahei Lantern

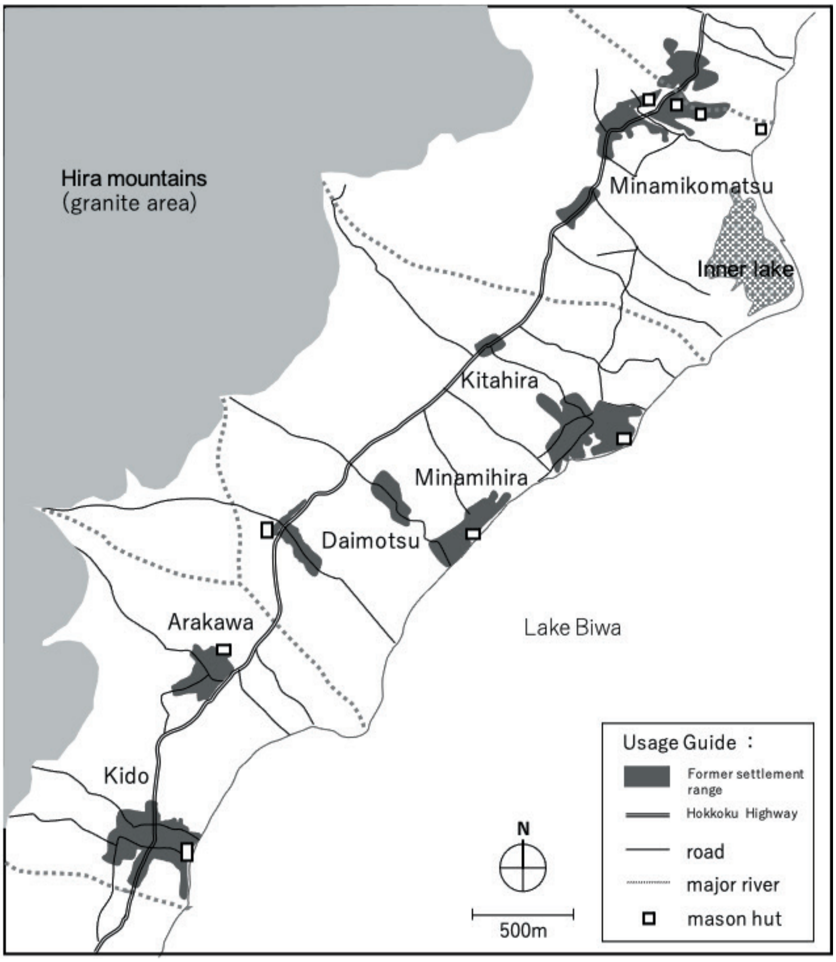


Figure 6: Location of the mason's hut

best known stonemason in Minamikomatsu, and the stone lanterns he produced were so well made that they were called *kahei-toro* (Kahei lantern). His fame spread not only within Shiga Prefecture but also to Kyoto and Mie, and it is known that Omi merchants ordered many of his stone lanterns. Three generations of the Nishimura family took the name Kahei, and it was especially active from the Meiji period (1868-1912) to the beginning of the Showa period (around until 1955).

Kahei's lanterns have three main characteristics (Photo 4). The first is the quality of the stone, which is hard *aka-ishi* with fine grains and less mica than common white coarse-grained granite. The second is the form and technique of the stone. The stone lanterns made by Kahei are meticulously crafted with the tip of *hoju* (top part) and the *warabite* of *kasa* (hat). Detailed work on the fire pouch, flowers and hermits, and beautifully carved designs of the twelve signs of the Chinese zodiac on the base. The third is the high design quality of the lanterns. The carvings of the twelve signs of the Chinese zodiac on the central stand of the *Okunoin* Lantern show Kahei's high design and playful spirit, such as one depicting several mice playing, another depicting a single mouse and a rice bale, and another showing a mother dog suckling her puppies.

Based on the stone sales ledgers kept by the Nishimura family between 1912 and 1960, we have investigated the types of lanterns made and the recipients of the orders, and found that various types of lanterns were made, including *Rengeji* lanterns, *Kasuga* lanterns, *Okunoin* lanterns, *Rikyu* lanterns, and *Yukimi* lanterns.

According to interviews with a local stone mason, his family has a old book printed in the Edo period with pictures of flowers and birds and hermits. One stone dealer's father always kept a notepad under his futon pillow and was always sketching the patterns that came to mind.

From the analysis of the sales ledgers, it has become clear that although the Kahei Lanterns were mainly delivered to Hikone, Notogawa, and the Kosei area (former Shiga Town and Takashima City), they were also delivered to a wide range of areas including Yokaichi, Omihachiman, Gokasyo, Gamo, Konan, Koka, Moriyama, and Kyoto, and that the delivery locations varied with the times (Figure 5).

The method of transportation of the lanterns also varied, with boats, trains, and automobiles being used depending on the location and time period.

Photo 5: Hut (Minamikomatsu) around 1908 (Kimura 1997)

Photo 6: Hut (Kido) around the mid-Showa period (provided by Mr. Kido)

Lanterns can be divided into various parts such as *hoju*, *kasa*, *hibukuro*, *nakadai*, and *sao*, and it seems that each of these parts was fixed in place and carefully transported.

Craftsmen and Huts

Various work huts served as workplaces for the stonemasons introduced up to this point. Generally, around the foot of Hira Mountains, a variety of huts were built, including *shiba-goya* (firewood huts) for storing fuel at home, *kai-goya* (shellfish huts) for burning shellfish ashes for fertilizer, and huts used for Tenporary storage of tools around rice paddies. Among these, the work huts of stonemasons were particularly distinctive.

In Kitahira, for example, stonemasons' huts were located at mountain and lake shore. The hut in mountain called *yama-no-koya* was used for lunch and rest. They were about 3 m x 4 m in size, with simple pillars and roofs. The reason for this was that the hut was only used for a few years during the period when the stonemasons commuted to the workbase. In contrast, the hut on the lake shore called *hama-no-koya* was used for processing stones. More than 10 stonemasons' huts were built on the beach in Kitahira facing Lake Biwa, and four to five of them were owned by the Hiraoka family, while the rest were owned by other masters or other individuals. He said there was a constant banging sound, "kahn-kahn" of splitting and processing the stones. The huts were built with sturdier pillars and more authentic wall and roofi ng materials than mountain huts, and were intended to be used for such a long period of time.

Photo 7: Existing hut (Minamikomatsu)

Based on interviews and the collection of photographs in various villages at the foot of Hira Mountains, it has become clear that mason's work huts similar in construction to the *hama-no-koya* in Kitahira once existed in a wide area from Minamikomatsu to Kido villages (Figure. 6). These huts had straw thatched roofs and open fronts, allowing stonemasons to work out of the rain and wind.

Stonemason's Hut in Minamikomatsu Area

Let's take a closer look at the stonemason's hut based on documents and existing buildings in Minamikomatsu.

According to the floor plan cadastral records from 1887, there were 229 houses recorded in Minamikomatsu village at that time. Thirty-

Photo 8: Mountain road maintenance record in Minamikomatsu (Collection of Minamikomatsu Community Association)

Photo 9: A stone of the same size as the one that was once dropped

five of these houses were described as *shoku-goya* (craftman's hut). Based on interviews, it is almost certain that these workhouses were stone-masons' workhouses. From reading the data, it was confirmed that there were 18 houses with both a main house and a work shed on the premises, while 17 houses had only a stand-alone work shed. The size of the workhouses varied from 1 *tsubo* (1 *tsubo* is equivalent to 3.3 m^2) to 22 *tsubo*, but approximately 70 % of them were between 4 and 7 *tsubo* in size. While most of the artisan huts built only were 4-6 *tsubo* in size, those attached to the main building averaged 6 *tsubo*, and some were over 10 *tsubo*, indicating that they were larger than those built as stand-alone units.

Roofing materials were mostly straw thatch, with some tile roofing, indicating that these were built as more permanent huts. We also found that the work huts were built along the stone outpaths. In particular, many shacks were located along the road that runs along the Yanamune River and the road that extends from Hachiman Shrine to the center of the village and towards Lake Biwa.

Today in Minamikomatsu, these shacks are still used as warehouses and garages. The roof is tiled and the exterior walls are covered with tin, but the walls are earthen, and the structural components are made of wood. The date of construction is unknown, but it was most likely built before 1950. According to the owner, the mason's main job in those days was to make lanterns, and three masons worked side by side facing the stone outcropping road. The stonemason's work began with the care of tools and blacksmithing. This work shed also has a bellows room for blacksmithing. The size of the room is 1.8 m x 3 m, and the height is only 1.8 m at the highest point. The ceiling and side walls were coated with red clay to make it fireproof. A small window has also been installed in the side wall to let out smoke (Photo 7).

Ravage the Mountains, Protect the Mountains

Stonemasons have made the most of the environment surrounding their communities, from the mountains to the beaches, through their stone masonry business. However, this has not always been done in a stable manner. The activity of quarrying large quantities of stone from the mountains is a cause of environmental degradation. Excessive quarrying of stones can lead to sediment runoff from the mountains into rivers, which can immediately affect settlements downstream.

Among the documents from Minamikomatsu, there are a few documents from the Meiji period titled *Yama-are-michi oboe-cho* (record of damage to mountain roads) (Photo 8). The writer was the Minamikomatsu stonemasons association, and reading the contents, the names of local residents who are thought to have been involved in stone quarrying, the location of the target mountain or path, and the amount of money are described. This

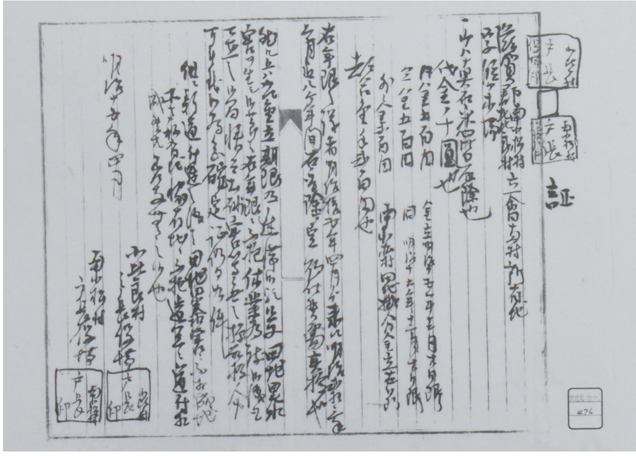


Photo 10: Contract for masonry work in Kitahira (Collection of Kitahira Property Management Association)

suggests that during the Meiji period, stonemasons formed an association and paid money to the association to repair the damage done to the mountains and roads by quarrying and transporting stones. It is said that a lot of soil and sand were produced when stones were quarried from the mountains, and since these materials could lead to disasters, we can read from these documents that the people of the area were maintaining and managing the stones properly while at the same time obtaining the blessings of stones.

In terms of artificially altering the mountains, the quarrying method in Kitahira also had the same problem. As mentioned earlier, the *ishi-otoshi* in Kitahira was a dynamic method of dropping huge stones by rolling them down from above the slope. The size of the stone far exceeded the size of the main house of the home (Photo 9). The stone was dropped by craftsmen specializing in *ishi-otoshi*, who spent several months to a year removing and exposing the earth and sand around the stone, then blasted it with gunpowder to send it tumbling down the slope. "The rock fell down the slope," Mr. Hiraoka said," and it must have been a terrifying fall. When the rocks fell, it must have been like an earthquake." The *ishi-otoshi* was a major alteration of the vegetation and topography of the mountain slopes.

In retrospect, Mr. Hiraoka asserts, "We razed the mountain and took the rocks." The slopes where the stones were rolled down had no trees growing on them, making it easy for earth and sand to flow out. Therefore, when the work was completed, the stonemasons piled up several layers of stone walls on the mountain slope and planted fast-growing trees called *mizu-shide* (a kind of hornbeam) to hold back the earth and sand.

Mr. Hiraoka has many memories of a time when there was a lot of sand in the river. Until the mid 1940's, all households participated in the annual sand dredging in August and September to remove sand from the river's channel, because even a little rainfall would cause sand to accumulate at the mouth of the Hira River. The boatmen had to work together to remove sand from the entrance of *funadamari* (harbor) to make it deeper after typhoons. Some of these joint efforts, such as the sand removal of *shimatsu* (sand deposit pond) continue to this day.

What we notice from our interviews is that the local people were very sensitive to the sand problem. The stonemason's job was to "tear up" the mountain, which inevitably led to sediment runoff. Therefore local people's lives were built around the idea of communal labor to minimize the impact of sand. Furthermore, the work of the masons to "tear up" the mountains was not carried out without limits. There were also agreements in place to curb excessive quarrying.

Among documents from the Kitahira area during the Meiji period (1868-1912), we can find a number of contracts between stonemasons and the Kitahira community regarding the extraction of stone from the shared mountain (Photo 10). Among them are agreements to stop quarrying immediately if earth and sand flowed out during the quarrying process, and to take measures to prevent earth and sand from flowing out. This is not a direct instruction from the government, but a noteworthy example of autonomous erosion control to prevent sediment damage to downstream settlements.

Conclusion

In the Showa period (1926-1989), the production of stone lanterns had already begun to decline due to the depletion of stone materials; from 1941 onward, the production of stone lanterns started to decline as World War II began, workers were taken off to the army, and the number of buyers of lanterns also decreased. After the war, it is said that many stonemasons in the area were involved in the production of *kenchi-ishi* (stones processed into a square pyramid shape and used mainly for masonry) for civil engineering works, indicating that the content of stonemasons' work changed *dramatically* with the times.

After the end of the war, around 1950, the construction of erosion control weirs on the Hira River began to flourish in Kitahira as well, and stone masons were restricted from quarrying stones. On the other hand, local stonemasons were entrusted with the work of creating the *kenchi-ishi* stones needed to construct weirs, and ironically, the stonemasons who were forced out of the mountains received a kind of unemployment relief through this erosion control project.

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Exploring how local communities coped with the sediment transport and deposition at the foot of Hira Mountains by observation of local maps and traditional illustrations

Lake Biwa Museum SHIMAMOTO Kazuyuki

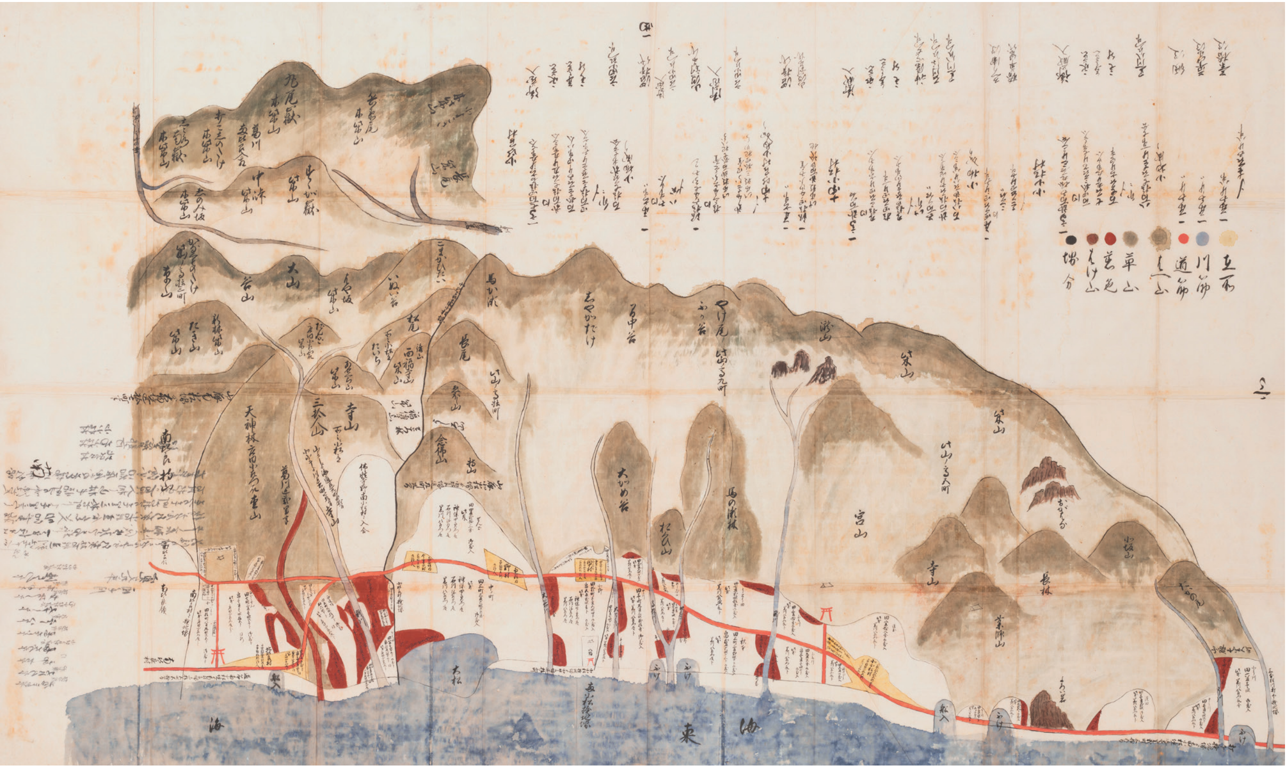

Figure 1-1: Map of Kitakomatsu, Minamikomatsu and Kitahira Village (1669) (owned by Kitahira Property Management Association)

Introduction

In each community of the foot of Hira Mountains, there are a large collection of maps depicting the villages. Most of them were drawn after the mid-17th century, and are copies of maps submitted to the rulers and administrative agencies of the time to grasp the conditions of fields, forests, and rivers in relation to village boundaries, water rights, tax collection, river management, and disasters.

Such maps were basically thematic maps and did not depict all the elements of the region as they were. However, by identifying the subject matter and estimating whether the existing map is the original, a copy, or a rough sketch, we can learn more accurately the history of the land, including the spatial condition of settlements and fields, vegetation

Figure 1-2: Near Kitahira, red paint = wasteland along the Hira River and the *Furukawa*, it's former river course

Figure 2-1: Map of Arakawa and four other villages (1669) (owned by Arakawa Common Property Management Association)

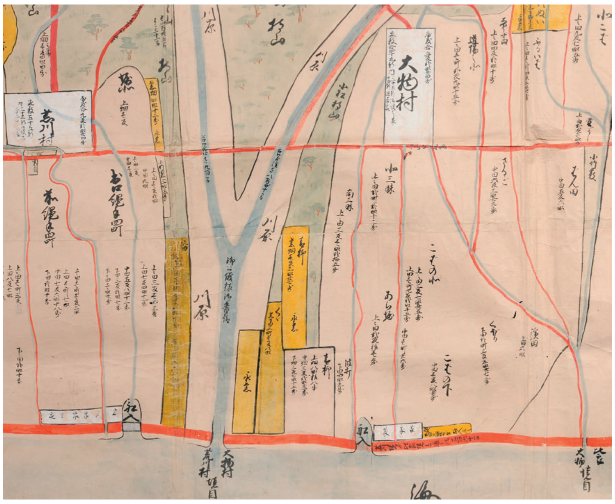

Figure 2-2: Wastelands around Ōtani River (Arakawa Village on the left toward the figure, Daimotsu Village on the right)

on mountains and levees, and the affected area by disasters.

As mentioned in previous chapter in this book, the villages in the foot of Hira Mountains are located behind steep mountains with predominant granite geology, and rivers carry large quantities of sediment from the mountains to the plains. This chapter explores the history of the response of the communities to such sediment transport and deposition through observation of the old local maps.

Wasteland and restoration of farmlands

In the areas located around the foot of Hira Mountains, there are some maps that depict several villages in the region that show detailed information on landuse and other aspects of the villages. While relying on Takahashi (2019) for details review of the maps, further examine the influence of floods and sand deposit that flowed into farmlands.

The legend on the map of Kitakomatsu, Minamikomatsu, and Kitahira Villages (owned by the Kitahira Common Property Management Association, figure 1-1), dated July 1669, depicts wastelands in red. The majority of the wastelands are distributed in a strip alongside rivers such as Hira River and Ōtani River (present-day Yanamune River) (figure 1-2). It is assumed that these are areas where the land along the levees was developed as fields, but the

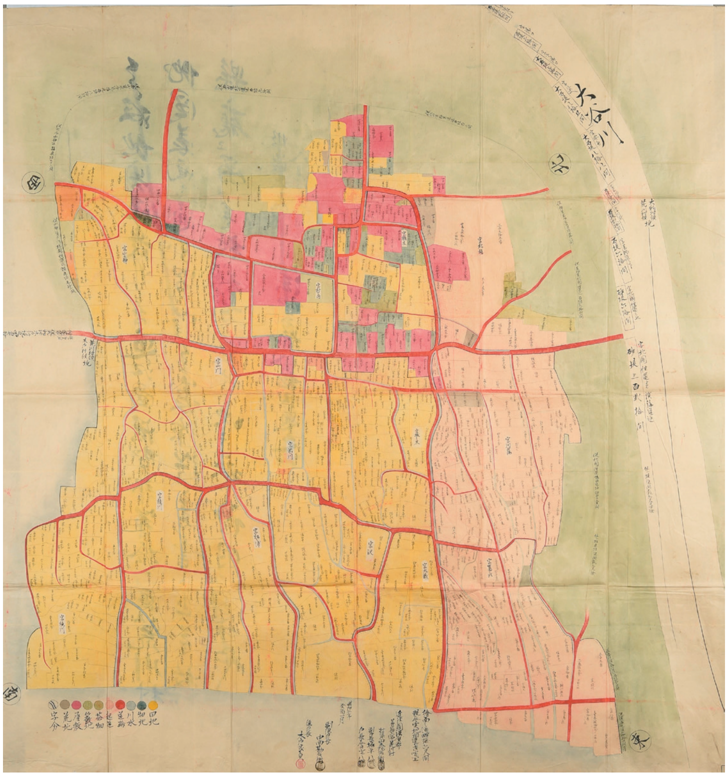

Figure 3-1: Cadastral map of Arakawa (1873) (owned by Arakawa Common Property Management Association)

Figure: 3-2 Legend. Fifth from the right is farmlands under restoration

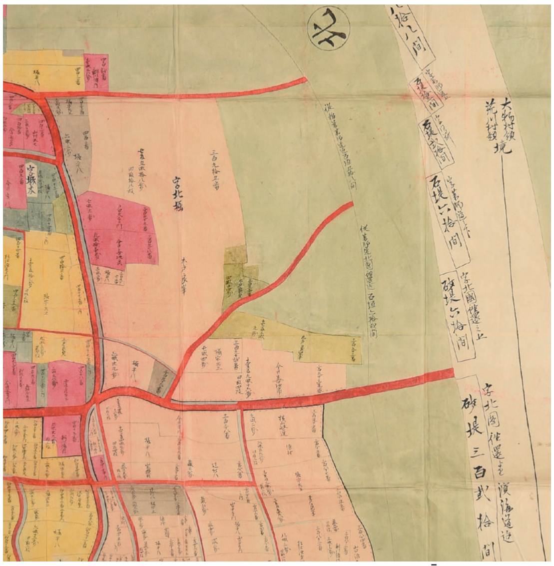

Figure 3-3: Around the right levee of the Ōtani River. From the river at the right end, stone levees, forests, tea plantations and bushland, farmlands under restoration, rice paddies, and houses are distributed in this area

harvest was not sufficient due to flooding and the resulting sand deposit, and tribute was exempted. And along the Hira River, there is a long, narrow red curve marked *Furukawa* (former river course). This expression suggests that the Hira River used to flow close to Kitahira village, and the old river channel was considered wasteland at that time, perhaps because the land was sandy and unsuitable for farmland.

In the Map of Arakawa and Four Other Villages (owned by Arakawa Common Property Management Association, figure 2-1), also made in 1669, *ei-are*, the wastelands are shown in yellow. Excluding fields developed near the foot of mountains or along the beach, *ei-are* are distributed in a strip near rivers (figure 2-2), and are thought to indicate farmland affected by floods and sand deposit, as in the map of Kitakomatsu, Minamikomatsu, and Kitahira Villages. These 17th century maps suggest that villages in the region expanded their farmland at the foot of the mountains and along the rivers, but that harvests were unstable in the mountain valleys and along the river coasts.

Next, we will explore the situation in the period about 200 years later from a map drawn for one village at a time. Cadastral map of Arakawa (owned by Arakawa Common Property Management Association, figure 3-1) is signed and sealed by the three head of Arakawa Village in January 1873, and endorsed by prefectural governor Michiyuki Matsuda in August of the same year, indicating that it was given as a copy to the village. In the legend of this map, the beige colored area is designated as *Okoshi kaeshi*, farmlands under restration (Figure 3-2). *Okoshi kaeshi* refers to rice paddies and fields that was declared a wasteland and was in the process of being restored after a limited number of years of exempted tribute. In the case of Tokai region, for example, the village restored the cultivated land with limited labor and time by working on the highest-grade cultivated land first, requesting an extension of the original period for the exemption of tribute, and changing the landuse from rice paddies to fields. The restoration of farmlands were done while adjusting to the limited labor and time available (Yamashita 2015). In the case of the foot of the Hira Mountains there is

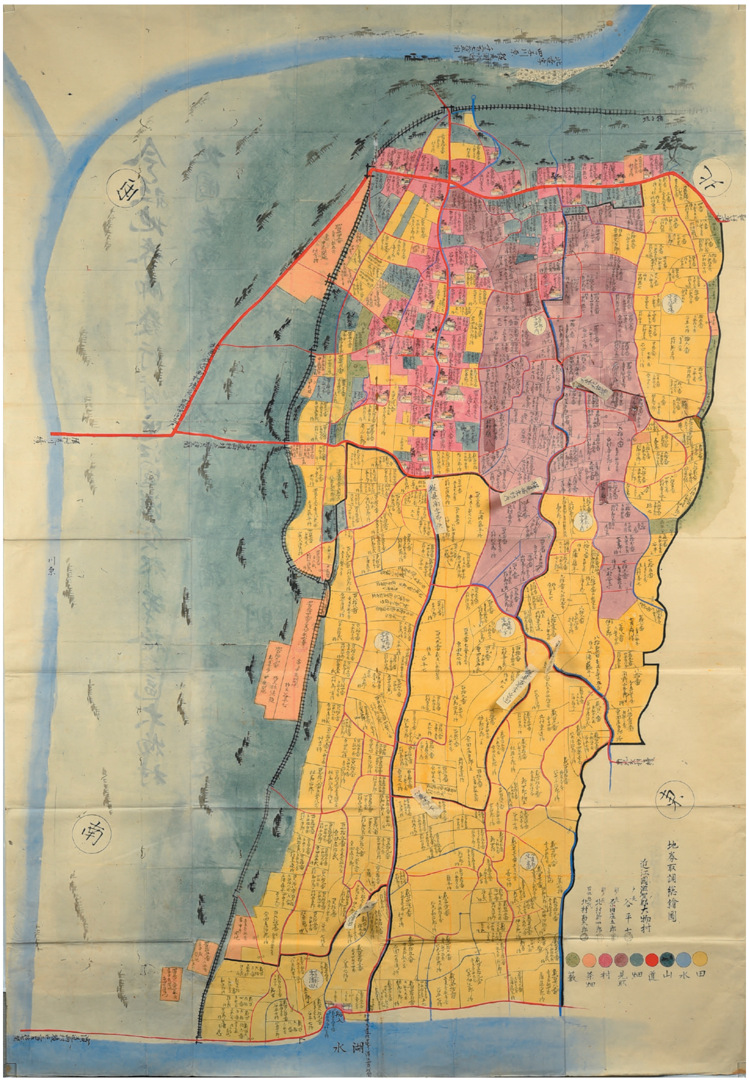

Figure 4: Cadastral map of Daimotsu (1873) (owned by Daimotsu Common Property Management Association)

a map made around 1861 shows restoring farmlands in the location filled with sand in Minamikomatsu Village (Ando and Fukamachi, 2019). In Arakawa Village, a book made in 1869 records that after the flood of 1852, tribute was once again imposed on the restored area in 1855, 1860, and 1869.

In the cadastral map of Arakawa, the areas of *Okoshi kaeshi* are distributed from the northern edge of the village to the beach at the mouth of the Ōtani River, adjacent to the green color representing the mountains and forests along the right levee of the Ōtani River. The legend also includes a separate entry for wasteland, indicating that the area of *Okoshi kaeshi* was not simply wasteland, but land that was to be maintained and restored as farmlands even after being subjected to flooding and sand deposit. Let us look at the situation in Daimotsu Village, which is located across the Ōtani River. Similarly, the cadastral map of Daimotsu (owned by Daimotsu Common Property Management Association), endorsed in August of 1873, shows the farmland north of the village as *mitori* (Figure 4), painted in purple. In general, land called *mitori* in early modern times was land where only the area was known and fixed annual tribute was not set. The lands of *mitori* depicted on this map are located on the extended line where the Yotsugo River bends from the upper right to the left in the figure, and is considered to be the area where floods and mudslides from the Yotsugo River could flow down if they crossed the bend. In fact, in 1852, a stone levee at the bend of the River broke, causing flood damage. It is assumed that the farmland painted in purple were at higher risk of flooding than the area near where the houses were located in the village. The wasteland and farmlands under restoration depicted on the maps are representations of land exposed to flooding. By analyzing their location, extent, and shape, we can reveal how they were affected in the past and how disaster risks were taken into account.

Pictorial depictions of sedimentation basins

Then we take a look at how sand lowed out and deposited from Hira Mountains in normal times, as depicted on maps.

Figure 5-1 is a map submitted to the Shiga Prefectural Government in 1874 by Daimotsu Village, Shiga County. The prefectural government issued a notice to each village in the prefecture in December of the previous year, and had them draw up a map by the following month and submit it with the scale of civil engineering facilities in the village and the division of maintenance costs into government expenses and village expenses. An authenticated copy of the drawing submitted at this time is now

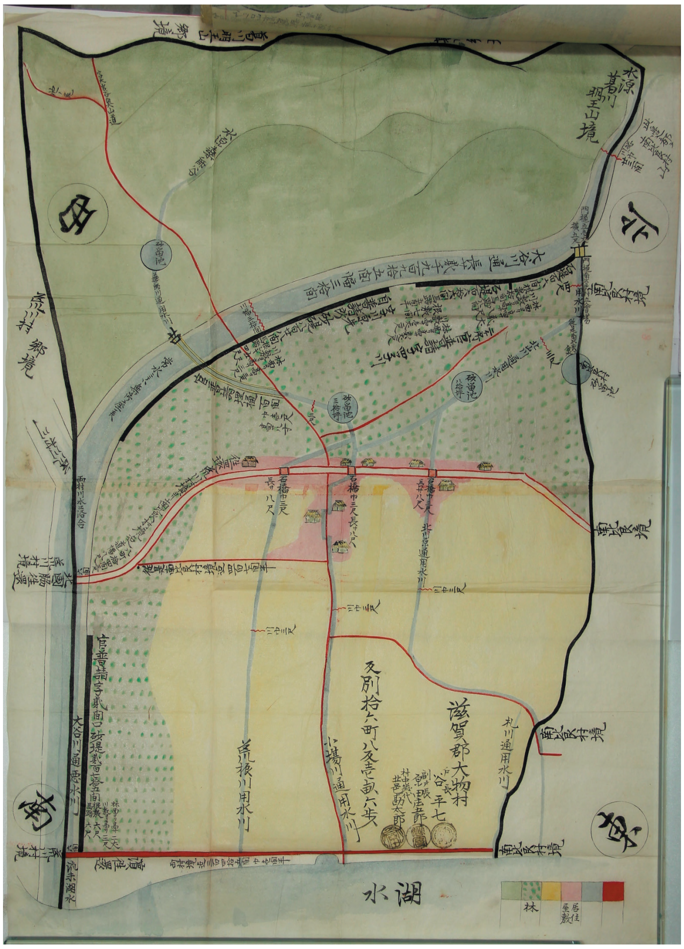

Figure 5-1: Map of Daimotsu(1874) (owned by Shiga Prefectural Archives)

Figure 5-2: Circular basin constructed along the Yotsugo River

Figure 5-3: Circular basin constructed in Yakushidani River

housed in the Shiga Prefectural Archives. Let us focus on a circular basin on the map. One of them is located near the boundary of Daimotsu and Minamihira villages on an irrigation channel diverted from the Yotsugo River, and is identified as the basin of Minamihira Village. The map of Minamihira (figure 6-1), which was submitted to the prefectural government based on the same order, shows a *sunadame*, basin stopping sand in water flow at the same location as in the map of Daimotsu Village, and a total of three *sunadame* can be seen, including one on the irrigation channel that diverted water from the Hira River. Although the names are slightly different, it is clear that these basins were constructed to hold sand on

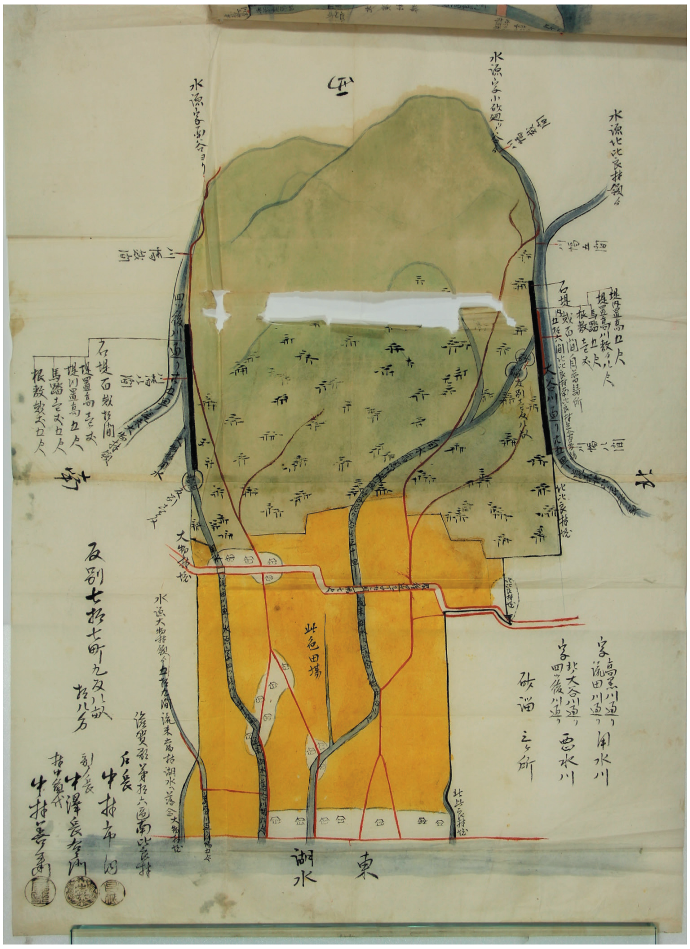

Figure 6-1: Map of Minamihira (1874) (owned by Shiga Prefectural Archives)

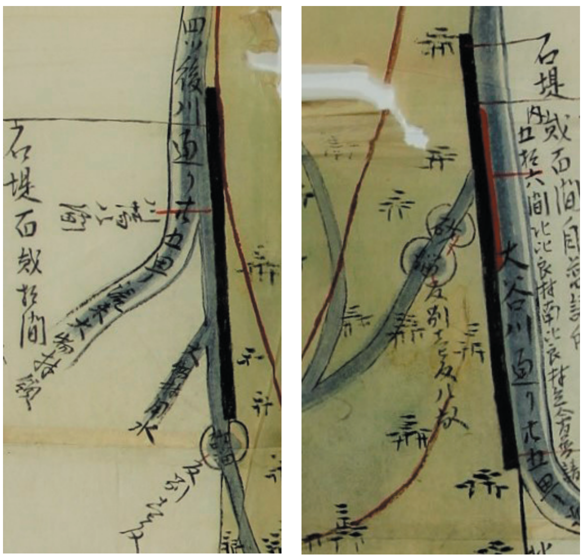

Figure: 6-2 Sand basins depicted on the map of Minamihira (left: channel of the Yotsugo River, right: two sand basins in succession on the channel of the Hira River) the irrigation canals. Similar basins can also be found in the maps of Kitahira (figure 7) and Arakawa (figure 8), which were also submitted to the prefectural government.

Sunamachi, the sand basins, located near the boundary between Daimotsu and Minamihira villages, is depicted in 1709 Boundary Map of Daimotsu and Minamihira Villages (owned by Daimotsu

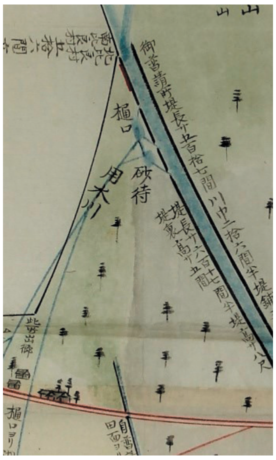

Figure 7: Sand Basins depicted on the map of Kitahira (owned by Shiga Prefectural Archives)

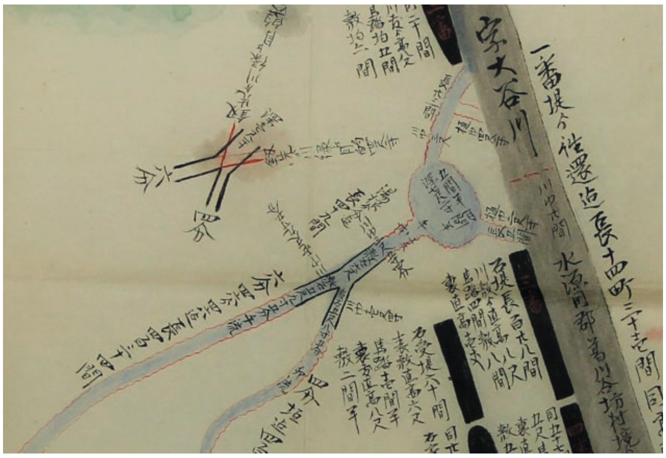

Figure 8: The basin equipped with intake channel from Ōtani River (near present-day Yushima Shrine), illustrated in the map of Arakawa (owned by Shiga Prefectural Archives)

Figure 9-1: Boundary Map of Daimotsu and Minamihira village (1709) (owned by Daimotsu Common Property Management Association)

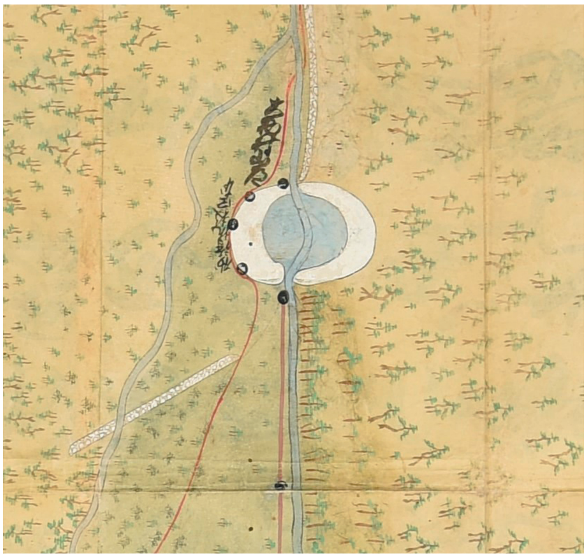

Figure 9-2: Sand basin located near the boundary of Daimotsu and Minamihira Village (not extant)

Figure 9-3: Sand basin in Daimotsu located along the *Hokkoku* highway (not extant)

Common Property Management Association, figure 9-1). This shows two *sunamachi* as landmarks of the village boundary established as a result of a dispute (figure 9-2 and 9-3). As far as we have been able to ascertain, this is the oldest example in the foot of Hira Mountains that is clearly dated and can be presumed to be a sand basin based on its name. It seems that at least as early as the early 18th century, these basins were devised to remove the sand contained in the water when residents used it from the mountains.

The about these devices description is found in a copy of a detailed account book submitted in 1842 included in "Shiga Town History, Vol. 4" (Shiga Town History Editorial Board, ed. 2004, Early Modern Period, I 101). In “Yakushidani" and *Yotsukawa* (Yotsugo River), the two main sources of irrigation water in the present-day Daimotsu area, it is stated that there were two *sunadome* locations in each of these valley drainages. In this cadastral document, *sunadome* was different from a reservoir.

Remaining *Shimatsu* in the present area

We were told that in several areas at the foot of Hira Mountains, there were basins where sand from the mountains was collected to prevent it from depositing downstream, and that these basins were called *shimatsu*. Thinking that these *shimatsu* might be related to the *sunadome* and *sunamachi* depicted on the illustrated map, I walked around the site to confirm this. In Kido, Arakawa, Daimotsu, Minamihira, Kitahira, and Minamikomatsu, where the author investigated, *shimatsu* were confirmed as shown in Figure 10. Some of them are almost identical in location to the depicted sand basin.

When we examine the location of *shimatsu* in relation to rivers, we can divide them into the following three categories: A. those located near the main intake from the main stream of rivers (such as the Ōtani, Yotsugo, Hira, and Yanamune Rivers) (No. 2, 6, 8, and 11 in figure 10), B. those located far from the intake or in mountain valleys, close to the main flow of rivers (No. 1, 4, and 9), and C. those located far from the main stream of rivers (e.g., near villages) (No. 3, 5, 7, and 10). In A and B, when the sluice gate of these basins is opened, water and sand flow out through a ditch and into the mainstream. A, which is located closer to the river intake, reduces the amount of sand and soil that accumulates in the irrigation channel, but B, which is located on a gentle slope slightly downstream, was probably chosen because of the difficulty of constructing a canal in a valley. On the other hand, in case C was constructed far from the river, it is assumed that a place was selected where it was necessary to hold the sand flowing downstream.

Most of the revetments were constructed with concrete or masonry from a relatively recent period, and their shapes are either straight polygons or neat ovals. In irrigation canals where the water is strong, stones are piled up at the inlet of the *shimatsu* to reduce the force of the water (figure 11).

When we spoke with local residents in the Daimotsu and Minamihira areas, they told us that *shimatsu* is used to reduce the velocity of the water and collect sand at the bottom of the basin by letting the water flow into the pond once, and once a year (March in Minamihira and April in Daimotsu), the sedimented sand is removed with the irrigation canals. In *shimatsu*, which is close to the river, it's sluice gate is opened and the sand is discharged into the river using the flow of water. In the basin No.6 in figure 10, which collects water taken from the Yotsugo River, managers of the sluice gate sometimes open it the summer to release sand into the River when it fills up with sand. Even today, when forest resources are no longer used for fuel and other purposes, and vegetation has recovered due to erosion control and flood control work, there is still a considerable amount of sand flowing out of the mountains in normal times in the region. When flooding is expected, they close the gate in front of the *shimatsu* to prevent water and sand from flowing in. The function of the basins are not to stop the sand flowing down not in emergencies, but

No.	Area	Shape	Size (m)	Location type	Discharge gate	Descriptions in the old maps	Reference material	Remarks
1	Kido	Rectangle	6.0 × 6.0	B	○	○	Cadastral map of Kido and Arakawa Villages, (owned by Kido Common Property Management Association)	
2	Arakawa	Oblong	9.7 × 8.0	A	○	○	Map of Arakawa (owned by Shiga Prefectural Archives)	It is located in the area of Yushima Shrine, near the water intake of the Ōtani River.
3	Arakawa	Rectangle	6.8 × 4.0	C	×	×		Northwest part of the settlement
4	Daimotsu	Octagon	6.8 × 6.5	B	○	○	Map of Daimotsu (owned by Shiga Prefectural Archives)	Waterway in Yakushidani
5	Daimotsu	Rectangle	4.1 × 3.8	C	×	○	Map of Daimotsu (owned by Shiga Prefectural Archives)	In front of the *Juge* shrine in Daimotsu
6	Daimotsu · Minamihira	Oblong	10.0 × 5.8	A	○	×		Near the Yotsugo River intake
7	Minamihira	Rectangle	8.2 × 2.1	C	×	×		Waterways in Minamihira area
8	Minamihira · Kitahira	Oblong	12.7 × 11.2	A	○	○	Map of Minamihira (owned by Shiga Prefectural Archives)	It is closer to the water intake from Hira River
9	Kitahira	Oblong	23.0 × 8.0*	B	○	○	Map of Kitahira (owned by Shiga Prefectural Archives)	A canal that draws water from the Hira River.
10	Minami komatsu	triangle	14.3 × 10.9	C	○	×		East side of *Busshoji* field.
11	Minami komatsu	triangle	3.1 × 6.0	A	○	×		Near the Yanamune River Intake

Dimensions were measured at the point with the longest distance in the long and short axis directions and rounded off to the nearest 0.1 m. If the actual site conditions are difficult to measure, measurement device was placed at the closest location to the actual site and actual measurements were taken.
* Values are measured on the map using the Geographical Survey Institute's "GSI Map".
Location type A: located near the intake from the main stream of a river; B: located far from the intake from the river or in a mountain valley, close the main of rivers; C: located far from the main stream of the rivers.

Figure 10: Distribution of *shimatsu* in Kido to Minamikomatsu areas (GSI Map with additions)

in ordinary times.

Through interviews and fieldwork, we learned that all of the sand basins depicted in 1709 were abandoned in later periods, and that *shimatsu* were constructed again when the path of the irrigation channel was changed due to flooding. This time, we were unable to precisely determine the dates of construction or renovation of the individual sand basin listed in Figure 10. In some cases, there are no existing it even though they are depicted on the map, and in other cases, there are *shimatsu* in almost the same location as depicted on the map, but they were moved to a different location in later periods. However, based on their location and role, it can be inferred that sand basins in the early modern period, like the present-day *shimatsu*, functioned as measures for sand transport in normal


No. 1 (Kido) February 25, 2022


No. 2 (Arakawa) April 2, 2022


No. 5 (Daimotsu) July 20, 2022


No. 6 (Daimotsu, Minamihira) March 8, 2022


No.9 (Kithira) February 28, 2021


No.11(Minamikomatsu) February 28, 2021

Fiureg 11: *Shimatsu* in various locations (all photos taken by the author)

Figure 12: Ōtani and Hira River area around 1893 (Topographic maps "Komatsu Village" and "Wani Village", on a scale of 1:20,000, by the Land Survey Department of Japanese Army (surveyed in 1893, made in 1895, from "Formal Topographic Maps of Kansai with a scale of 1:20,000", Kashiwa Shobo, 2001)

time.

Using Sediment on the Lakeshore

Thus, rivers originating in the steep mountains of the Hira have brought sediment from the mountains downstream, not only in times of emergency but also in ordinary time, forming fans and lakeshore land over a long period of time. Especially in the Ōtani and Hira Rivers, the mountains behind them mainly consist granite, so a large amount of weathered white sand flows downstream. As a result, as the topographic map of the Meiji period shows, large sandbars protruded toward the lake at the mouth of the river, and wide sandy beaches extend around it (figure 12). This is different from the Horai beach, consisting of pebbles, and the Wani beach, which was formed at the mouth of the Wani River with the clayey derived from the Kobiwako Group soil (Shiga Town History Editorial board, ed. 1996).

In the cadastral map of Arakawa (figure 3-1). There were rice fields or farmlands under restoration distributed in the lake shore. On the other hand, Figures 1-1, 2-1 and 4 show some beach areas: strips of land with no fields or houses outside of the farmlands or houses.

At the mouth of the Ōtani River, there exist maps depicting the new fields developed on the right levee side (Arakawa Village, figure 13) and on the left levee side (Daimotsu Village, figure 14) in a same rule of drawing. In Figure 13, *tsukisu* is painted in two colors, brown and peach. The term *tsukisu* refers to sediment deposited along the coast and at the mouths of rivers, and it also appears frequently in the early modern historical documents. According to Figure 13, the brown *tsukisu* near the mouth of the river is considered to be a copse. This location is still forested around which lodging facilities are scattered. In contrast, peach-colored area shows a newly developed rice field. In the map of newly developed rice field of Arakawa dated March 1834, (owned by Arakawa Common Property Management Association), the same locations as those painted in pink in Figure 13 are depicted "1" to "5" assigned to them. This indicates that the pink-colored area was one of the new rice paddies developed in several villages along the shore of Lake Biwa after the dredging of the Seta River in 1831. On the reverse side of the map of Figure 13, three headmen of the Arakawa village stamped the inscription, "The drawing on the surface is not different from the original submitted to the rulers. Although the exact date is unknown, it appears to be a copy of a drawing submitted at the request

Figure 13: Map of new fields in Arakawa (owned by Arakawa Common Property Management Association)

Figure 14: Map of new fields in Daimotsu (owned by Daimotsu Common Property Management Association)

of the ruler for the purpose of understanding the lakeshore around the Ōtani River in connection with the development of the new rice field planned in that time.

Figure 14 is similar in wording and legend, and is presumed to have been created for the same purpose as Figure 13. According to the map, the copse was located along the left levee of the mouth of the Ōtani River. It seems that the copse near the riverside forest around the present Aoyagi-hama campsite has been a wooded area since that time.

From these two drawings, we can see that, the area near the river mouth where sediment was deposited for a long time was overgrown with thickets, and that the area away from the river mouth and closer to the village was the subject of development of the farmlands. The picture shows how the sandy beach was spread out outside of the deposited area.

The deposition of sand along the lakeshore can also be found in maps of other areas. In Minamihira Village, there is a copy of a map dated May 11, 1860 (figure 15-1), which was submitted to the lord's official. This depicts the farmalands and residential areas along the lakeshore of Minamihira Village schematically showing the "lack of sand" that occurred along the lakeshore due to the large wave. It is assumed that this is a copy of a map used to show the land washed or covered with sand by the waves of Lake Biwa to the lord's officials who came to inspect the land, and to ask for exemption of annual tribute. On the *shogunate* territory drawn in yellow on the lakeshore, the rice fields near the boundaries of the adjacent villages of Daimotsu or Kitahira are marked as *sunairi* (sand-filled) and those near the center are marked as *namikake* (missing). The tendency for sand deposit on the side closer to Daimotsu or Kitahira is generally in agreement with the recent spread of sandy beaches north of the Ōtani River.

In Minamikomatsu Village, which is famous for the white sand and green pine trees of Omatsuzaki, a copy of a map dated 1650 (figure 16) shows a representation of a pine-type tree next to reeds (Minamikomatsu wetland). Pine trees growing on the spit in the lakeshore are also depicted in a later village map dated 1837 (figure 17). It is clear that at least in the middle of the 17th century, the sandy lakeshore was formed by the sand carried from the mountains by the Hira River and some rivers near Kitakomatsu.

The people of the foot of Hira Mountains have used the land created by sand sediment brought by the rivers as a place of life and livelihood of the residents. The land is also recognized as a scenic spot that is the subject of photo postcards and a place for leisure activities such as swimming by outsiders of this region, and is still used in a variety of ways today.

Coping with sediment transport and Reaping the Water

In the villages at the foot of Hira Mountains, it is said that the farmlands developed in the early modern period on the steep slopes of the alluvial fan was abandoned due to landslides, while the land use was formed along contour lines, resulting in the forests left around the villages to serve as defensive forests against floods and debris

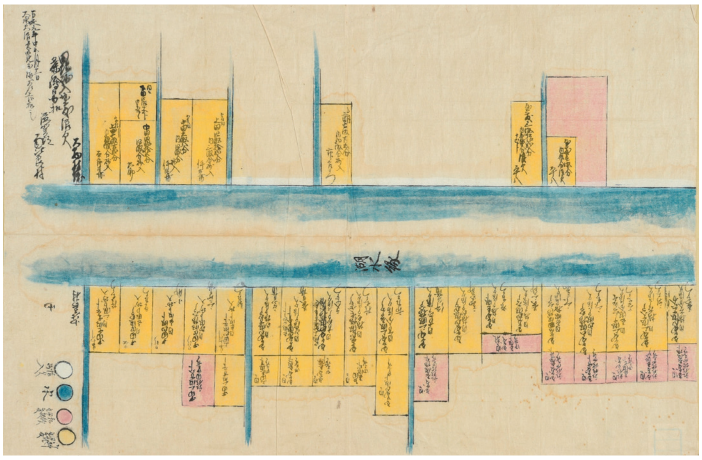

Figure 15-1: Map of lakeshore in Minamihira (1860) (owned by Minamihira Community Property Management Association)

Figure 15-2: Near the boundary with Kitahira Village

flows (Matsuda, 2000). In this chapter, we have confirmed, based on local maps, that people living in the 17th to 19th centuries made their living not only through emergency measures such as defensive forests, but also by restoring farmland that had become a wasteland, and by taking measures against sand contained in water for use in normal times. The presence of the sand basin shows that the measures against sediment transport from normal time have been inherited from the early modern period to today. Furthermore, we have confirmed that the sandy lakeshore, which is made from sediment deposition and is nowadays considered a scenic and recreational area, was formed at least in the mid-17th century and has been used as a place of livelihood in the villages.

Water is controlled not only during emergencies when floods and mudslides occur, but also for sediment transport in normal times. Using the land with this concept since at least early modern times is thought to be one of the factors that have allowed the settlement to persist in its current location regardless of frequent disasters. The driving

Figure 16-1: Map of Minamikomatsu (owned by Minamikomatsu Neighborhood Association)

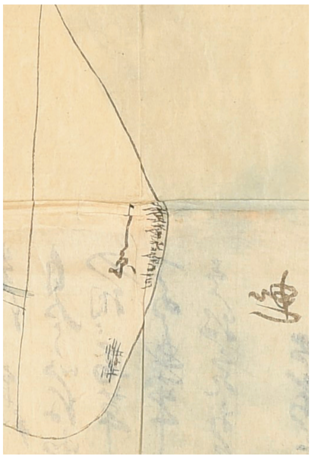

Figure 16-2: Representation of reeds and pine-type trees on the spit of Minamikomatsu wetland

force behind this is thought to have been the "blessings" derived from the geographical conditions of the foot of Hira Mountains, such as the abundant water obtained by establishing a settlement at the edge of the alluvial fan, the natural resources from the forest in the riverside and the mountain behind the villages, and the sandy lakeshore.

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Figure 17: Map of Minamikomatsu (1837) (owned by Minamikomatsu Neighborhood Association)

Wave-removing stones in the Kosei area of Shiga Prefecture

Takashima City Board of Education YAMAMOTO Akiko

Masonry Piles on the Lakeshore

In the northern part of the lake, from the northern edge of the foot of Hira Mountains to the north, there are still masonry piles of 2 to 3 m high made of natural stones of several places including Kaizu and Imazu beaches. Most of these masonry piles were residential in the middle or late Edo period to protect against waves, and are large in scale for inland lakeside masonry piles.

Today, the water level of Lake Biwa is controlled and regulated, so waves from the lake almost never cause damage to houses and people's lives along the lakeshore. However, it is believed that the masonry residential along the lakeshore played an important role during the period when the water level of Lake Biwa rose in each heavy rain and wind.

Kaizu and Nishihama Stone Piles

The masonry piles along the lakeshore at Kaizu and Nishihama in Makino Town, Takashima City, are said to have been residential by Nishi Yoichizaemon, then deputy mayor of Nishihama

Photo 1: Masonry at Nishihama, Kaizu (where many hewn stones are used)

Village, Takashima County, in consultation with Kanamaru Matazaemon, then deputy mayor of Kaizu Higashihama, during the Genroku era (1688-1704). Since then, this masonry has protected lakeside residential areas from the wind and waves, but as the masonry has been repaired each time it has been damaged, it now takes the form of a series of masonry piles of different construction dates.

The size of the stones and the way they are piled vary greatly from place to place, but most of them are piled in random layers, with stones of various sizes. The powerfulity of the stones are granite, with some rhyolite, chert, black sedimentary rock, and limestone mixed in.

The stones are mainly cut from the parent rock using arrows and partially shaped, and there is a mixture of cut stones with fine processing on the stone face. Natural stones are used only in repair areas, although there are areas where relatively big stones are used near the base. Since most of the stones are processed into a nearly rectangular shape, the amount of interstitial filling in the gaps between the stones is small.

The sizes of arrow holes are mixed, ranging from small ones about 4 cm wide to large ones over 9 cm wide. Generally, wider arrow holes with curved bottoms indicate older stoneworking techniques, while smaller, square holes indicate newer techniques.

On the other hand, some parts of the lakeshore surface use "cloth piling" or similar "drop piling" and "random piling" techniques, which use stones


Photo 2: Masonry at Nishihama, Kaizu (from the lake)

with a shape similar to a rectangle. In addition, many corner masonry piles were built as the masonry at this site is broken into sections. the masonry at this site is broken into sections, many corner masonry piles were residential. The corner masonry tends to use larger stones than the facing masonry, and also uses more highly processed stones. The corner masonry technique is basically *sangi-zumi*, but *imo-zumi*, in which stones are piled up with no difference in length between the long and short sides, can also be seen in many cases. It is thought that the masonry did not require much height, so it was not necessary to construct a complete masonry structure. Furthermore, since the residential side requires less height than the Lake Biwa side, there are also many corner treatments consisting of only two or three stones stacked on top of each other.

Dates of Masonry Construction

Records of the construction of masonry in Kaizu and Nishihama appear in several old documents produced in the area. In the "Nishihama-ward Documents," a May 1745 document titled "Gousyu Takashima-gun Ninihama-mura Fushinsho meisaicho" describes the construction of masonry in Nishihama as follows.

> The stone wall on the beach side of the lake was residential in 1688, when large waves were frequently caused, and peasants' houses and traffic routes were dashed by the waves.
> However, the base is 9 shaku
> Height: 9 shaku
> Width: 6 shaku

According to the above, the construction of the masonry was prompted by the frequent large waves in 1702, when residents were troubled by the waves that washed over their houses and the roadway. The residents of the area were troubled by the large waves that swept over their houses and roads in 1702. The completed masonry was approximately 500 m in length, with a base of approximately 2.7 m and a height of approximately 2.5 m. The height is approximately 2.7 m, and the width of the top is approximately 2.7 m. The width of the top surface was approximately 1.8m. The width of the top surface was approximately 1.8m.

On the other hand, although no clear record of the date of construction of the Kaizu masonry has been found, it is mentioned in the "Osaki-ji Document" dated 1682.

In the "Osaki-dera Document" dated 1682, there is a description that "The stone walls of 13 houses and residences on the Dorihama River collapsed, and the houses had difficulty getting into the water due to the wind and waves.


Photo 3: Seine fishing at Nishihama (around the end of the Taisho era); photo by Kanji Ishiida, courtesy of the Takashima City Board of Education.

The wind and waves caused the houses to be swept into the water. This indicates that the stone masonry of Kaizu already existed during the Tenna period (710-794), and was repaired several times

Photo 4: Stone with arrow holes remaining

before being handed down to the present day.

Stone Piles at Imazu Beach

About 10 km south of the masonry piles on Kaizu and Nishihama beaches, masonry piles are also found on the lakeshore of Imazu, said to have been residential in the Edo period to protect the shore from waves. Today, only a small portion of the masonry remains, mainly around the area where the residence of a local government official is believed to have been located, but records indicate that the masonry was less than 1 km long at the time of construction.

The "Old Records of Uchi*oroshi* Village" in Uchi*oroshi* village, located on the north side of Myojinzaki, which protrudes eastward from the northern edge of the Hira Mountains, contains a record of the construction of the stone masonry at Imazuhama. According to this record, in the spring of 1710, the Kanazawa domain, which owned Imazu Village, ordered the village to transport stones from the Ukawa domain adjacent to Uchi*oroshi* in order to build a 500-square meter stone pile on Imazuhama in preparation for a round of inspection tours by an envoy. At this time, Komatsu Village in the neighboring Shiga County voiced an opinion about carrying stones from the Ukawa domain, and a dispute ensued involving the Boat Magistrate of Otsu, but as a result, the stones were carried from the Ukawa domain to Imazu Beach, where a stone pile extending 492 *ken* (about 890 m) is said to have been constructed.

Photo 5: Masonry at Imazu Beach

In addition, a record of the village headman handed down to an old family in Imazu Village indicates that there was already a "hamagaki" between the two villages in 1697, 13 years before the inspection, suggesting that stone piles were constructed on the Imazu lakeshore earlier than on Kaizu and Nishihama.

Imazu Minato, which exclusively collected goods brought from Wakasa Province, was called "Kohoku Yonkaura" together with Kaizu, Shiotsu, and Oura, and prospered as one of the bases for lake transportation of goods from the Sea of Japan region to the upper regions throughout the Edo Period. Considering this, it is thought that the masonry along the lakeshore, in addition to serving as a barrier against waves, also served as a stone wall for the harbor where many ships arrived and departed.

Uchi*oroshi* Stone Piles

Today, masonry piles remain partially preserved on the Lake Biwa side of the old National Route 161, which passes through Uchi*oroshi* village in Katsuno, Takashima City. Like the stone piles in Kaizu, Nishihama, and Imazu, they were residential in the Edo period (1603-1867) as a barrier against waves, and were originally a continuous line of stone piles along the lake shore. Only a small portion of the masonry is now visible, or it is used as a boundary between parking lots and fields.

The masonry is basically residential to the width of

Photo 6: Stacking stones under the hammer

the frontage of each house along the lakeshore, and is broken off at the property boundaries. The space between the masonry piles serves as a passageway down to Lake Biwa, a structure also shared by Kaizu, Nishihama, and Imazu.

The size of the stones and the way they are piled vary from place to place, with some parts made of rectangular stones and others made of roughly shaped stones. There are also many areas where the stones have been newly piled or re-piled in recent years.

Photo 7: Stones and hashish under the strike

Photo 8: Part of the masonry remains in Uchi*oroshi* village today.

The date of construction of the Uchi*oroshi* masonry is not clear. In the Uchi*oroshi*-ward Document, there is a record that Shojiro and two others build a 30-meter stone wall at "Tabishohama" in the 2nd year of Bunka (1805) at a cost of 65 monme per meter, indicating that masonry of a certain scale was also constructed here to protect against waves and flooding.

Uchi*oroshi* Village is close to Ukawa River from which Imazuhama stone was quarried, so it can be imagined that stone was abundantly available in the area. In fact, until recently, there were several families that worked as stonemasons for a living.

In addition, stone was used to build weirs to prevent flooding and stone bridges were constructed in the area.

It is clear that people were making good use of the good quality stone materials that were available in the area for disaster prevention and mitigation.

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Traditional flood control measures at the foot of Hira Mountains: disaster prevention activities by local residents

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Introduction

The area around the foot of Hira Mountains is well known as a source of granite, and in the past, many processed products such as torii gates for shrines, foundation stones for houses and warehouses, and garden lanterns were transported to Omihachiman, Nagahama, and Hikone, as well as Otsu and Takashima in the Kosei area. The granite produced here has also been used to prevent floods, sediment disasters, and wild animal damage. Here, we would like to introduce the traditional levees in Daimotsu and Arakawa, as well as Kitahira, to show the disaster prevention measures taken by local residents in each area.

We hope that you will visit the sites and see for yourselves the hardships and wisdom of the people of those days, and the importance of the levees that remain today.

Hyakken-Tsutsumi in the Daimotsu Village

The Yotsugo River, which flows from the foot of Hira Mountains, makes a sharp turn to the south at its midstream. A review of old documents and maps stored in the Daimotsu village reveals that the Daimotsu community, located downstream on the left levee, has been repeatedly damaged by flooding. Figure 1 shows an old map drawn in 1677 (Empo 5), which is stored in the Daimotsu village. The river overflowed, The description of "Nagareta" indicates

Photo 1: *Hyakken-Tsutsumi* levee (right: top of levee) (left: channel crossing the levee)

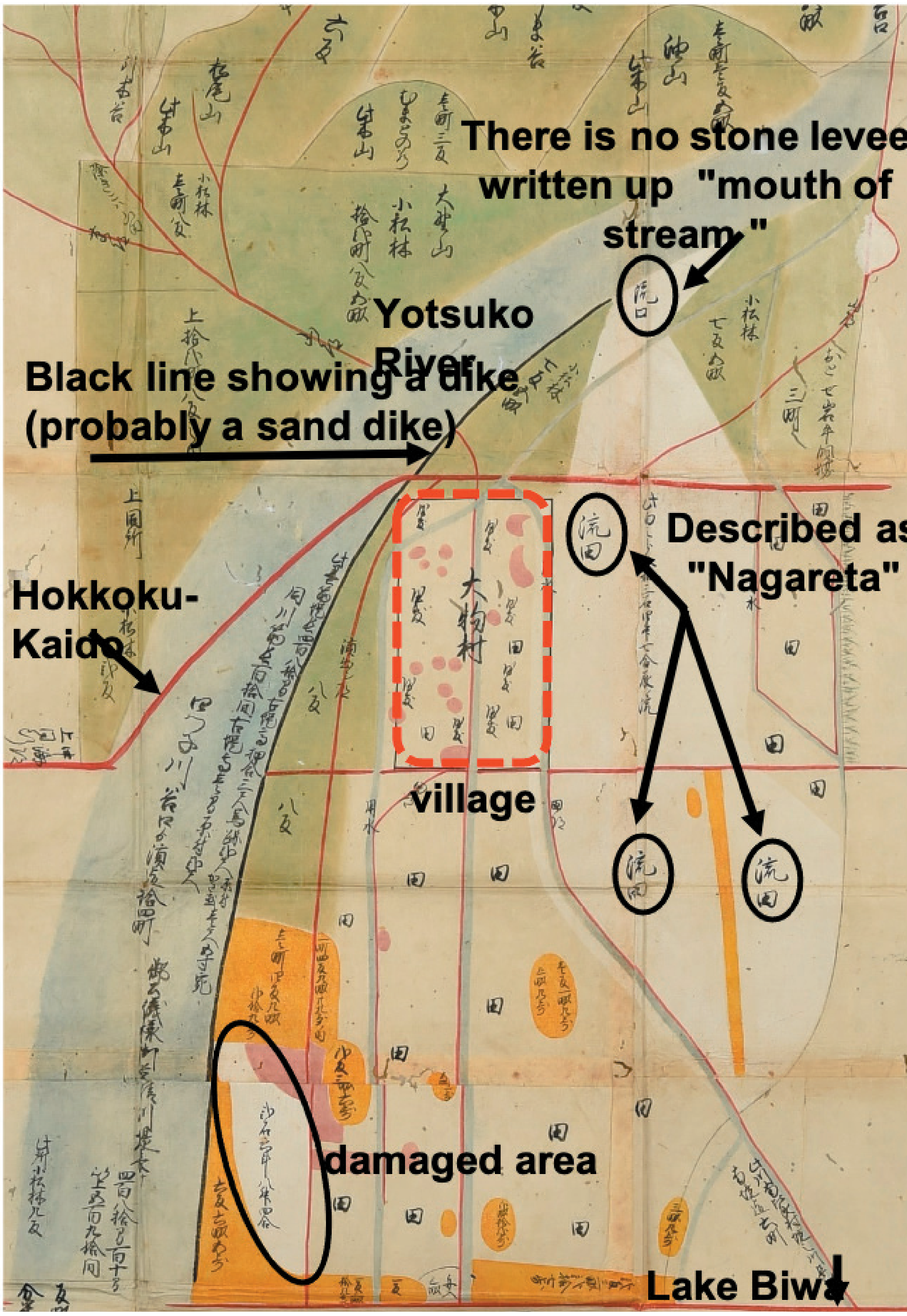

Figure. 1 Daimotsu Village map(1677)(Daimotsu Common Property Management Association)


Photo 2: Woman's levee

that a paddy fields, reaching almost to the shore of Lake Biwa, were damaged. According to the repair record of 1681, there was a stone levee of 410 *ken* (approx. 750 m) and a sand levee of 2410 *ken* (approx. 3900 m), and every year petitions for repair were received from the village headman of Daimotsu.

In 1852, a storm caused a massive overflow of the river, which washed away Washed away the fields downstream and several houses in the Daimotsu

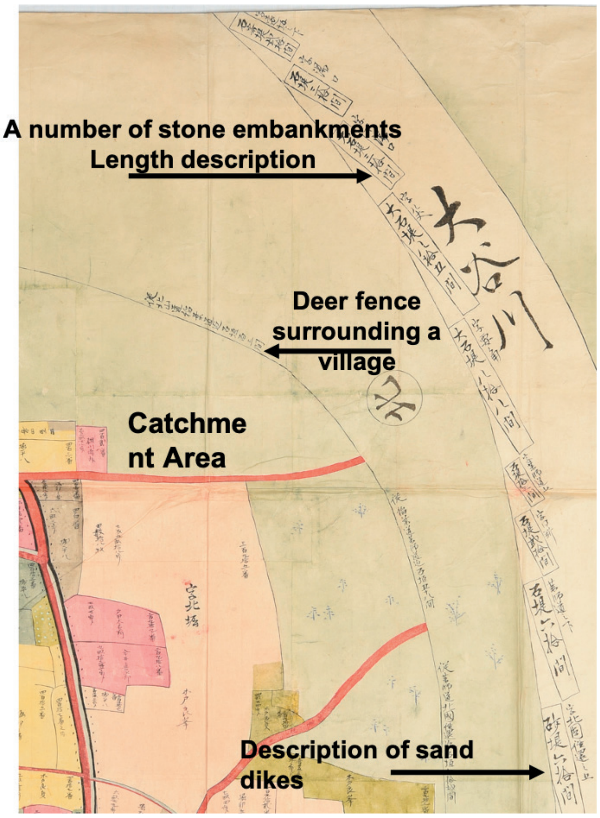

Figure 2: Stone levees and wild boar fence in the Arakawa village(Arakawa Village land registry map, Arakawa Common Property Management Association)

village, causing extensive damage. It is said that as a result of this flooding, two thirds of the residents changed their occupation from farming to masonry. In response to the villagers' petition, Masanari Hotta, then lord of the Miyagawa domain, decided to carry out a powerful repair work to prevent flood damage. The villagers spent five years and eight months to complete the *Hyakken-Tsutsumi*, which extended about 180 m, was about 18 m wide at the top, about 9 m high facing the river, and about 5.5 m high at the back. In "Shiga no mukashi banashi" ("Old Tale of Shiga"), the "Daimotsu no *Hyakken-Tsutsumi*" tells a story that, "A master mason named Sakichi was invited from Wakasa (Fukui Prefecture) to serve as the masonry master, and men and women from nearby villages were hired as laborers, with the men receiving 1.5 kg of rice per day and women half of it."

The stones that make up the levees are over 3 m high and 5 m wide, and there are wedge marks left on the stones where they were cut. The *Hyakken-Tsutsumi* is made of local granite, but in addition

Photo 3: The *Hyakken-Tsutsumi* sand basin

to the typical white to light pink color, it also includes a bluish stone called *aogare*, which is hard and difficult to work. The masonry was made with a slope of three to five degree, and it still retains its perfect shape today, showing the high level of technology of the time (Photo 1).

Downstream of the *Hyakken-Tsutsumi* (stone levee), there is a part called *Onna-zutsumi*, made of stones that even a woman could carry, followed by an sandy levee called *Suna-zutsumi* (Photo 2). These differences are thought to be due to the slope of the land, the speed of the river and the velocity of the current. At several places on the sand levees, there were flume gates called *hi* and stone pillars with ditches dug into them. When returning home after mountain work or when it rained heavily, people would insert boards into these *hi* to prevent water or animals from entering.

At the top of the *Hyakken-Tsutsumi* is a sedimentation sand basin called *shimatsu*, from which water channels were residential that flow into the Daimotsu and Minamihira villages. The sand that accumulates in these sand basin is periodically cleaned and discharged into the river, Even today, it serves as important water utilization facilities (Photo 3).

Measures Taken by Residents of the Daimotsu villages

According to interviews with the older residents

Photo 4: Stone levee in Arakawa village

Photo 5: Stone levee restored in 1935 in Arakawa village

living in the area, until after World War II, pine trees were planted on top of sand levees, and when it was about to rain hard, the adults of the village

Photo 6: Yushima Shrine

would cut several of these pine trees and fell them toward the river, using the driftwood method to prevent the sand levees from being washed away. The roots of the cut-down pine trees were left in place, and the "pine resin" hardened into a fuel called *jin* that could hold a fire in rain. The community center and private residences stored the *jin* along with a tool called a *taimatsu* made of a therr meterlong iron rod and plate to carry the *jin* in case of heavy rain.

In addition, since the houses along the road stretching from the Nishi-Omi Road (*Hokkoku* Kaido) to the lakeshore in the Daimotsu community are on gently sloping, many of them had stone walls residential on both the mountain and road sides where water and sand would flow. This was a measure taken by individuals to prevent flooding, as noted in "Kido no Sato: A Tour of History," and a good example of the wisdom and ingenuity of the local residents.

Although the *Hyakken-Tsutsumi* had protected this area for a long time, there was a time when people did not pay attention to it because of the progress of river works by modern technology. However, a teacher assigned to a local elementary school learned about *Hyakken-Tsutsumi* and wrote a song about it, which has now been incorporated into the fourth-grade community education class. The local residents association also regularly performs cleanup work, such as weeding, and it plays an important role in conveying the history of flood damage in the area.

Ōtani River stone levee remaining in Arakawa village

The Arakawa village is located to the south of the Daimotsu village, which has the *Hyakken-Tsutsumi*. To the northwest of the Arakawa community flows the Oya River, which joins the Yotsugo River, a river which also used to cause much damage. According to old documents kept in the Arakawa, there were at least three "Arakawa floods" in the 1600s: 1615, 1643, and 1695.

According to old documents and cadastral maps, two or three rows of levees were residential along the Ōtani River. It is not clear when these levees were constructed, but the earliest known record is a copy
of an application for a stone levee construction project from Arakawa village to Munekiyo Ono, a *shogunate* deputy (Otsu deputy), in 1694. other documents also indicate that the levee was frequently damaged by flooding, and that it was repaired or extended each time.

A number of cadastral maps stored in the Arakawa village show details of the levee and *shishigaki* (used to keep out deer and boar) fences. Figure 2 is an Arakawa Village cadastral map dated 1873, which depicts a number of levees along the Ōtani River to the north of the village. For example, there is about 160 m of large stone levee, a about 36 m of stone levee, and a about 109 m of sand levee.

Most of the remaining stone levees in the area are piled using the random masonry or *nozura-zumi* masonry method, but the masonry method and form differ depending on the date of construction. The stone levees that can be seen today mainly extend from the mountain side of Kosei Road (Kosei Bypass) along the Ōtani River for approximately 860m (including the 280m mentioned above) to the vicinity of Yushima Shrine. In addition, a levee called *Uke-zutsumi* (receiving levee) still remains on

Photo 7: *Shishigaki* in Arakawa

Photo 8: *moko*

the south side, and the high stone walls can be seen from the side road of the bypass. This old stone levee has two or three layers, depending on the location, and varies in height from 2 m to 8 m and in width from 1 m to 5 m, (Photo 4).

In 1935, there was a lange flood that caused extensive damage to this area. During that flood, a part of this levee was damaged, causing earth and sand to flow out to the downstream village, destroying the *shishigaki* surrounding the Arakawa

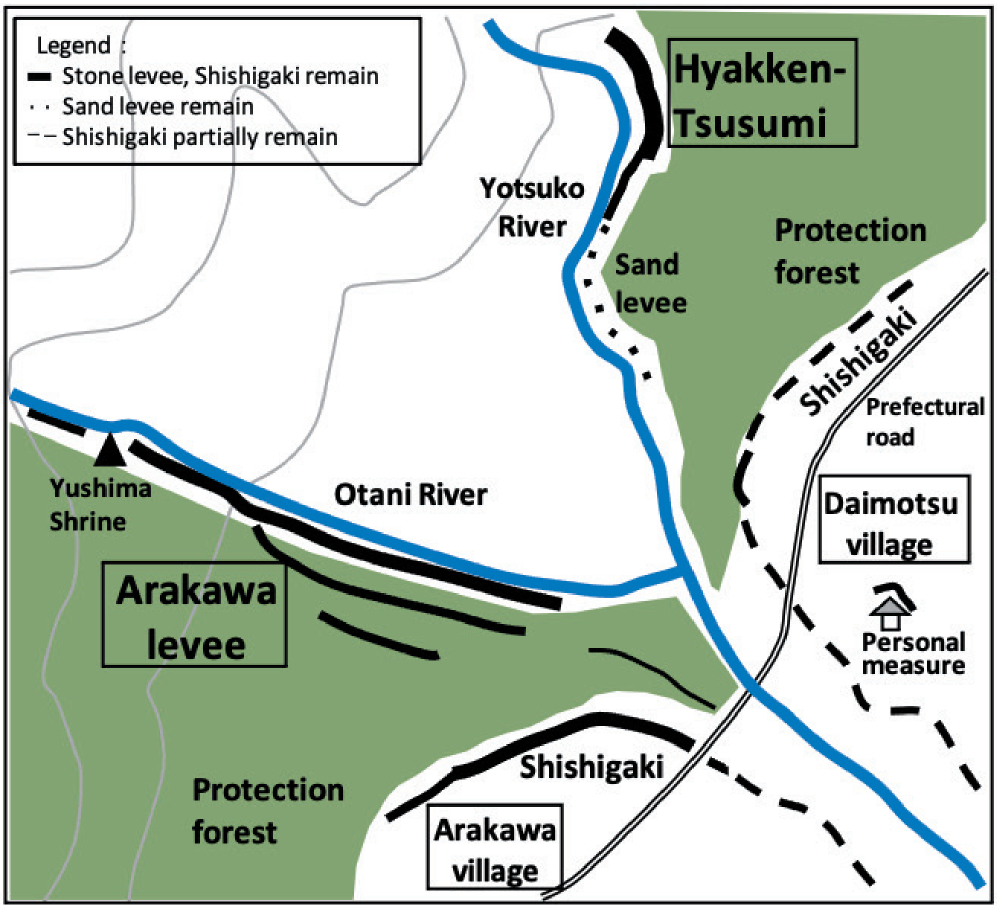

Figure 3: Relationship between traditional levees, *shishigaki*, and protectrom forest (Drawn by Ochiai)

village, and causing fields to be washed away by the earth and sand. In the same year, 75 villagers participated in the restoration of the levee, and photographs of the restoration work from that time are kept at the Arakawa Community Center. The levee reconstructed in 1935 has different shape than others, it has rounded-top with 6 m high which stretches about 280 m. This is believed to be a construction method introduced after the Meiji period (Photo 5).

In 1875, yushima shrine was residential because the Ōtani River was severely damaged by flooding between 1855 and 1860, and the sacred tree that was enshrined to protect the well weir was washed away. A festival is held there once a year in this shrine (Photo 6).

The shrine also has a sand basin and diversion called *shimatsu*, which is still maintained by the local people today. When heavy rains are expected, a duty called *mizuban* (water guard) is still in place to close the *shimatsu* and several flume gates connected fo the river.

Shishigaki to prevent the sediment Disaster

In the Arakawa village, a stone fence called *shishigaki* that surrounds the village and protects it from wild boars and deer still remains in almost perfect condition. At the same time as the re construction of the levee in 1935, the fence was reresidential to a height of approximately 2 m and a width of 1 m to 1.5 m to withstand sediment disaster using local stones. (Photo 7).

In the past, a *shishigaki* separated the mountains and villages in this area, but most of them have been destroyed by road expansion and housing development, or are quietly hidden in the mountains and forests. In the Arakawa village, on the other hand, *shishigaki* stone wall with, a wire mesh fence on top of it securely surrounds the village and serves as a modern-day protection against wild boars and deer. The *shishigaki* in Arakawa village is

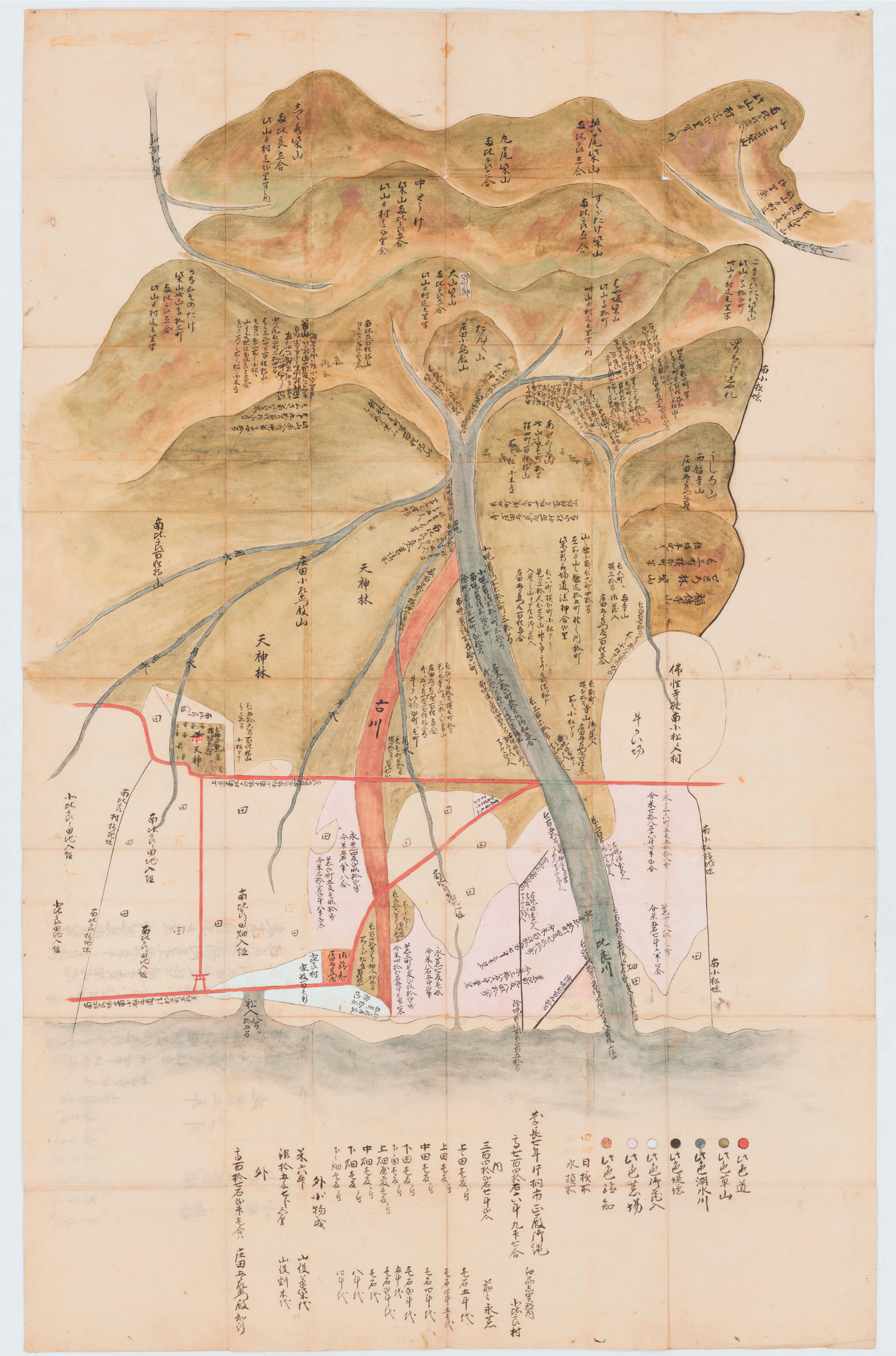

Figure 4: Kitahira common property management association

well known by residents of other.

Between the stone levee and the *shishigaki* along the Ōtani River, a flood-protection forest extends, where pine trees and Japanese oak can be found.

Traditional measures taken by residents of the Arakawa village

According to interviews with older residents living in the area, in the past when there was a large rainfall, men would go to check on the levees, called *kawara-iki*. Women and children were told to evacuate immediately to the south side where is higher ground. In addition, the bell tower at the temple still has a plaque showing how to ring the bell in the event of flooding, which was used to warn villagers. In addition, there was a custom called *mokko*, (stone carrying tool) in which each small neighborhood groups made a stone *mokko* or sand *mokko*, a flat surface made of straw with two suspension ropes attached to its four corners, and the condition and *Mokkoshi* was the event to check the total number of *mokko* on the third day of new year. This was done as a preparation for transporting stones and sand after a disaster (Photo 8).

Trees had grown over the traditional levee, which had not been taken cane. In the past few years,

Photo 9: Remains of what appears to be levee masonry

trees have been cut down in stages by the people in resident's association, and these levees can be seen by walking along the Ōtani River.

Multi-Layered Defense Mechanisms

In the Daimotsu and Arakawa villages, a multi-layered defense system has been constructed to protect communities from flood and sediment disasters, including levees along rivers, protection forests, *shishigaki*, and stone walls around houses. Local residents have kept records of these measures, and various nou-structural measures reflecting the geography, geology, and social characteristics of the area have also been taken to build a multi-layered defense system (Figure. 3).

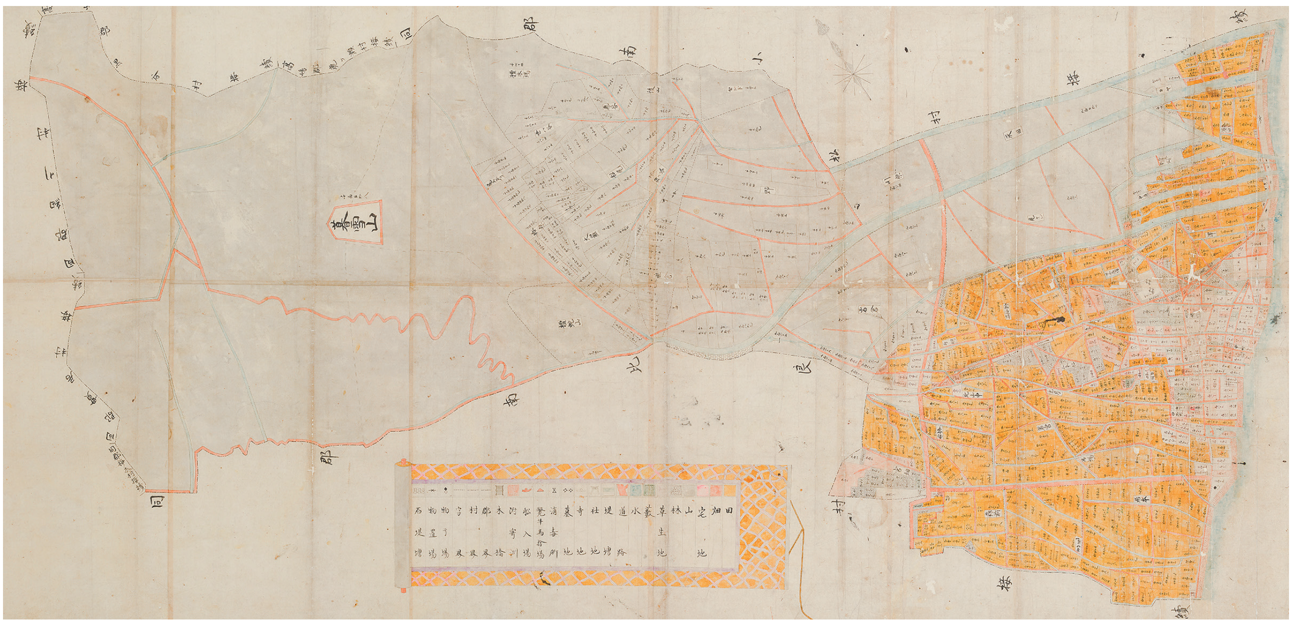

Figure 5 Kitahira village cadastral map (Kitahira Property Management Association)

The difference in countermeasures between the two villages can be attributed to various factors, such as the geographical relationship between the river and the settlements, the size of the stones that could be guarried, and the processing techniques used.

According to the questionnaire survey on stone culture, flood and sediment control measures conducted in the Daimotsu and Arakawa villages in December 2020, 94 % and 70 % of local residents were aware of the *Hyakken-Tsutsumi* and Arakawa levees, respectively.

Although both rivers have sabo control facilities and levees, it is believed that these traditional structures may play some role in the event of unexpected rainfall in the future. The community also shared a common understanding that these levees would play a role in disaster prevention and disaster education. On the other hand, we have also found that the recent development of housing has brought in new residents; they are unaware of past disaster experiences and traditional disaster prevention measures.

Kitahira and Hira River

The source of the Hira River is located near the foot of the *Kanakuso path* in the Hira Mountains, and from there the river flows down the steep slope of the *Shoen dani* (southern valley) that separates Kitahira and Minamihira. It joins the *Inn-dani* (northern valley) that originates near *Shaka-dake* (1,060 m) on the way, turning slightly to the north and flowing into Lake Biwa around the Kitahira Swimming Beach. It is one of the rivers that form a relatively large fan among the inflowing rivers on the western shore of Lake Biwa. Like other rivers at the foot of Hira Mountains, it is characterized by the fact that its flow from its headwaters to its mouth is completed within the area of one village, Kitahira. Looking at the current topographical map, the downstream of the Hira River flows near the border with Minamikomatsu, as if to avoid the village of Kitahira. In connection with this, among local Kitahira people, it is known as *Furugawara* (Old river) and *Shingawara* (New river). The present-day Hira River flows through *Shingawara*, and the current location of the village is *Furugawara*, meaning that the river used to flow through the settlement area.

Looking for references to the river on cadastral maps of the Edo period, for example, *shinkawa* and *Furukawa*are mentioned on a map of Kitahira Village dated 1650, and later the word *Furukawa*appears on a map of the same village dated April 1677 (Figure 4) (an irrigation channel was constructed to intersect with the *Furukawa* River). The word *Furukawa* is also found in a map of the same village (Figure. 4). At the early Edo period, current river route alas to be fixed, and it is known among local residents that Hira River used to flow through the current settlement.

If we are imaginative, we can envision a cadastral composition in which the original diverted flow of the Hira River was gradually shifted to the north, near the present border with Minamikomatsu, to enhance the safety of the village, while the old south channel was converted to an irrigation channel for use, but this remains a matter of conjecture. Nevertheless, it is certain that there used to be a considerable stream here, since a sandbar-like landform can be seen beyond *Furugawara* on the current topographical map. In addition, the land registry map of the Meiji period shows the name of a place called *Kawasaki-cho* in the channel of *Furugawara*, which is reminiscent of a river.

Among the villages at the foot of Hira Mountains, Kita- Hira's settlement is characterized by its location on the flat land near the lakeshore, rather than on the slope leading to the mountain or along the road. The rows of houses not only near *Furugawara* but also along the lakeshore extend in a southwesterly direction, and two Jodo-Shinshu temples in Kitahira, Saifuku-ji and Fukuden-ji, are located side by side here. The area around these temples are lower than *Furugawara*, and water tended to accumulate in this area. Naturally, the topography of the area would have been affected by water overflowing from Lake Biwa.

Hira River Levee and Flood Damage

According to interviews with the Kitahira elderlies, one of the characteristics of the Hira River was its rapid flow. The headwaters in the mountains and the downstream near the settlement are so close together that people said, "The water comes in a rush. The water flows fast. The water comes all at once." Another reason was that the sand from the mountains had accumulated and formed the topography of a ceiling river with a high riverbed. When the water level was high, the sound of the flowing river water seemed to echo from above, adding to the fear of the people.

A solid levee had been residential along the main stream, and there is remains of stone levee that can be seen it now (photo 9). According to the so-called *Fushinsho-chosa-ezu* of 1874 (the Shiga Prefectural Archives), the levee was 1,124 m on the right levee (village side) and 940 m on the left levee (Minamikomatsu side). The levee bed is described as 5.5 m, with a horse tread of 4.5 m. The height of the levee (right levee) is 2.4 m (the height from the riverbed) and 9 m (the height from the ground), indicating that the river has a remarkable ceiling river shape.

The Meiji era cadastral map (Figure. 5) shows two rivers (Ichibei River and Moroko River) running parallel to the main stream in the lower part of the Hira River, and many narrow rivers are drawn like the teeth of a comb in the lowest part of the river. Local elderlies call these "reserve levees," and say that although there is no normal water flow, they serve to channel water overflowing from the main stream in the event of an emergency. Even today, the trace of the river can barely be seen (Photo 10). This has a long history that, in addition to the "north levee" on the left levee there are the "south levee" on the right levee of the Hira River, two rows of *narrow* are depicted near the mouth of the river in the cadastral map of the village from 1677.

Photo 10: Remains of a small river in the past

Photo 11: Marker recording a height of rising water at the entrance to Fukuden-ji Temple

Photo 12: Water level mark in 1868 (first year of Meiji era)

Photo 13: Marker on the stone wall of the bell tower at Seifukuji Temple when the water level rose (wedge)

One of the most locally remembered flood disasters is the Hira River levee failure in the prewar period of the 1930s. Along with the water, a large amount of sand and soil flowed into paddy field, burying rice paddies in sand as deep as 1 m. The sand that was removed was carried to the levee of the Hira River (where Seikei Gakuen is now located) or piled high in some of the rice-fields. It was said that when five rice paddy fields were damaged, one of them was sacrificed and piled up the sond to a height of 6 to 7 m. Until the land was cleared, it was not possible to determine which rice-fields had been destroyed.

People Protecting the Levees

Heavy rains were frequent from summer to autumn, and typhoons in September were especially threatening. When the rainy day continued, several local people were assigned to "guard the river," and they walked along the levees and patrolled the area. If the levee was in danger, the fire Fighter organized in Kitahira would come into action. In Kitahira, there were two fire fighters the volunteer firefighter (for school graduates aged 14-15 to 20 years old) and the Fire Fighter (for those aged 20 to 34-35 years old), whose members went out to protect the levee from the torrent. In particular, it was necessary to prevent the torrent from hitting the levee and gouging the bottom of the revetment.

The methods were as follows. (1) Cut off the branches (3 to 5 m long) of the red pine trees growing on the levee from the trunk. (2) Tie the branch to the end of a rope that people had brought with them. (3) Tie the end of the rope to the roots of the red pine. (4) From a little upstream of the point where the water current is particularly strong, hang the branch with the rope attached in the water. This was intended to reduce the water's impact on the levee. The red pines that grew abundantly along the levees were well suited for this work because of their long branches and dense foliage.

When the work was particularly urgent, not only the firefighters but also one person from each household would come out to work. In such cases, the bell of the village temple was struck in place of a siren, and a drum hung in the temple's main hall was also struck continuously to call people to come out to work on disaster. Shichiro Hiraoka (born in 1926), an elderly in Kitahira who shared this story with us, said that he once or twice went to work on the Hira River when he was a member of the volunteer firefighter. He remembers the strange sound of the constant drumming, and the sense of urgency he felt when he heard it. Now almost no one remembers a sense of crisis, but people could not sit down still when something like that bell rang. Remembers a sense of crisis that they can not sit still when something like that rings.

Memory of the highest water level

While the center of the village was located on a slight elevation along the *Furugawara*, the terrain to the south of the village was slightly lower.

The area where Saifuku-ji Temple and Fukuden-ji Temple are located is one of the lowest areas in the village. According to Mr. Hiraoka's memory, there was a time before the war in which the outside toilet was inundated by 50 cm of water. It is thought that rainwater probably collected in these low-lying areas via irrigation canals, and that the inability to drain the water was so severe that it caused damage to houses.

At the entrance to Fukuden-ji Temple, there is a stone wall on the left side of the staircase made of beautiful long stones from Hira, where a mark is engraved showing how high the water came when the water level rose in the past (Photos 11 and 12). A horizontal line engraved at about neck level bears the inscription *Meiji Gan Tatsudoshi Mizu (the water level, great flood of 1868)* (there is another line below it, shaped like a frame to engrave an inscription, but strangely enough, there is no inscription). There is one line slightly lower than that, where it reads *Manen Gan Sarudoshi Mizu (the water level, great flood of 1860).*

In addition, a part of the stone wall of the bell tower of Saifuku-ji Temple is also inscribed with a water level mark as shown in Photo 13, although there is no inscription. The stone wall of the temple is a monument to the damage caused by the water. The process of flooding in Kitahira from the end of the Edo period to the Meiji period has not been fully understood, but it is thought that water overflowing from Lake Biwa probably joined the floodwaters and stagnated in the lowlands of the village.

Toward Conservation

In the old days, people used to sit around the irori (fireplace) and listen to their grandfathers tell them over and over again about floods and community life. In recent years, lifestyles and residential patterns have changed, making it difficult to create opportunities to tell these stories to the next generation, even if they wanted to. Therefore, it is necessary to create a system to conserve and utilize the remaining traditional/ local knowledge in villages so that the generation that has not experienced flood damage can learn about the local flood damage history and acquire traditional knowledge about it in a tangible and experiential way.

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Variety of dry stone walls to protect from wild boar *Shishigaki* at the foot of Hira Mountains

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Introduction

Villages at the foot of Hira Mountains have used stones quarried from the local mountains to deal with disasters and damage from wild animals for a long time. Here, based on the results of a survey of wild boar defense walls called *shishigaki* remaining in each village, we would like to discuss the differences between each village and the current condition of *shishigaki* that many of them still remain in this area.

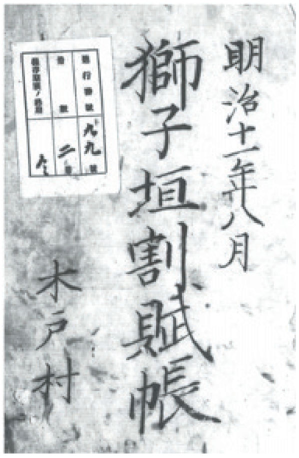
Shishigaki is stone walls constructed by local villagers under the farmland landscape to prevent damage from deer or wild boars to paddy fields. In Japanese, "Shishi" means "wild boar" and "gaki" means "walls." *shishigaki* is described variously as boar- walls, deer- walls, boar, and deer walls in cadastral documents. There are two types of *shishigaki* morphologies categorized into a "linear type," which represents a straightforward fence located between the forest and the settlement area to cut down wild animals' accessibility to the village. Another one is "surrounding type," which is located at the village border between forests and settlements area by surrounding shape (Takahashi, 2010). Although most of existing ones were made with stones, *shishigaki* have been built with other materials such as clay, bamboo, or wood, with an average height of 1 m to 1.5 m and about 2 m around the Shrine area. In the case of stone walls, the height is surprisingly low, and the reason for this is that wild boars do not have the strength to jump up, so a low fence was sufficient (Takahashi, 2010). It is said that a bamboo fence was added to the stone wall to prevent deer (Yagasaki 2001).

History of *Shishigaki*

There are many cadastral documents and maps stored in this region, among which there are documents related to the construction and restoration of *shishigaki*, and those maps depicting *shishigaki* on the borders of villages. It is not sure when *shishigaki* began to be residential, but there are several records from 1700 to late 1800 in Shiga Prefecture. We confirmed the records of *shishigaki* in this area exist in eight villages (Note 1), except Kitakomatsu. The oldest record is a petition submitted to the *shogunate* regarding the construction of a *shishigaki* written in 1735 in Moriyama. After that, it is unknown when the *shishigaki* was actually residential, but it is known that there was already a *shishigaki* as there is a record of the distribution of the *shishigaki* construction in 1793. On the other hand, according to the existing research, there is a document written in 1604 that stipulates that Moriyama and Kido villages work together to restore the *shishigaki* called *Ishikake*, therefore, *shishigaki* is believed to have already been constructed in the 17th century (Matsuda, 2000).

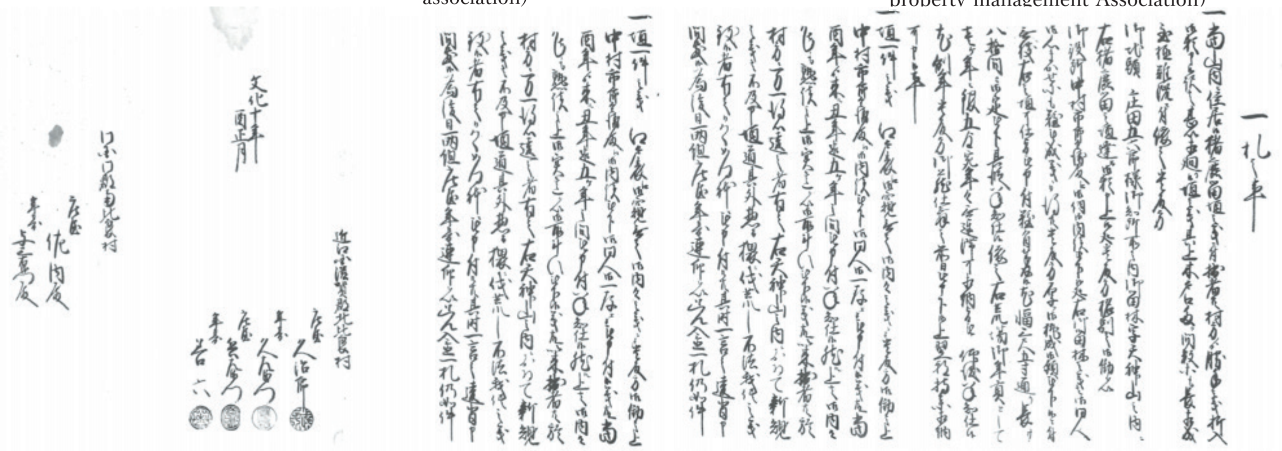
From the latter half of the 1780s to the early 1800s, we confirmed that there are records like "Assignment record of *shishigaki* construction work" and "Installment record" in villages like Minamikomatsu in 1788, Kitahira in 1791, Kitafunaji in 1801, Daimotsu in 1807, Minamihira in 1813, Arakawa Village in 1816, and Kido Village in 1878. Figure 1 shows examples of cadastral documents stored in each village. From these records, *shishigaki*

Moriyama village "*Shishigaki* common assignment record" (1793) (Moriyama common property management association)



Kido village "*Shishigaki* assignment record" (1878) (Kido resident's association)

Daimotsu village "*Shishigaki* inheritance record" (1835) (Daimotsu common property management Association)

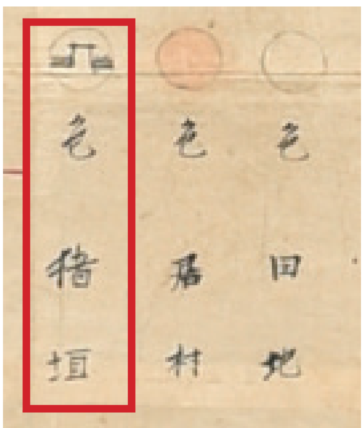


Minamihira "Note (regarding the *Shishigaki*)" (1813) (Minamihira common property management Association)

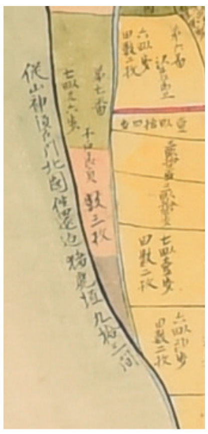
Old document regarding the *shishigaki* in Minamikomatsu (Left: 1788), (Right:1886) (Minamikomatsu resident's association)

Figure 1: Old documents related to *Shishigaki*

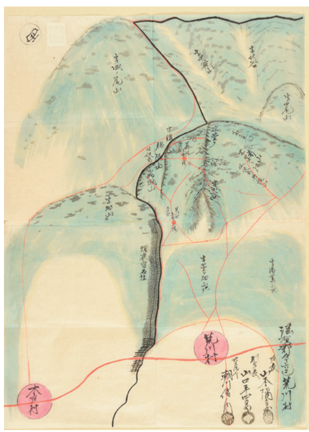
Gates are drawn (Minamihira common property management association)



Shishigaki is shown in Legend (Minamihira common property management association)



Length is shown in the map (Arakawa common property management association)



Shishigaki is drawn between Kido and Arakawa villages (Arakawa common property management association)

Figure 2: *Shishigaki* and legend on the cadastral map

were residential in each village during the Edo period (the late 1700s to 1800s), and restorations were carried out several times. Also, in some villages, it can be seen that the *shishigaki* were not necessarily built all at once, but were built in stages. In the case of the Minamikomatsu village, the tasks (distance) of construction and restoration of the local residents is allocated according to the size of the paddy field owned.

Shishigaki drawn on cadastral maps

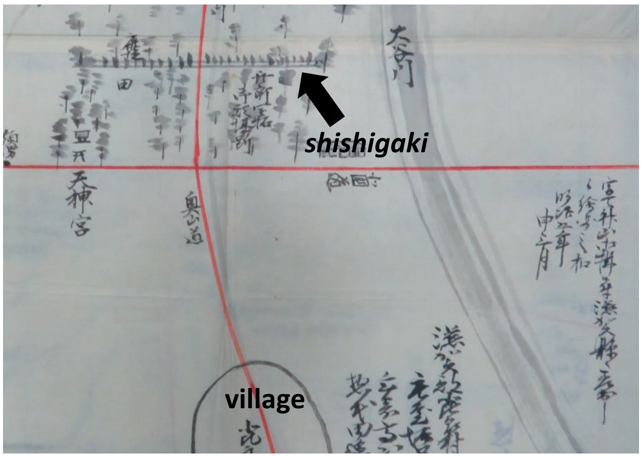
The research found that eight villages stored several cadastral maps depicting *shishigaki* (Note 1), excluding the Kitakomatsu village. Mainly maps from the early Meiji era, we can learn about the appearance and location of *shishigaki* and its relationship with the villages. Some of these maps have legends written as "Deer defense wooden wall" or "Deer defense stone wall." By deciphering those maps, we learned that in this area had both "linear type" that extended straight and "surrounding type" that surrounded and connected the villages. The way of drawing varies depending on the village, but wooden or stone walls are indicated by black lines. A wooden doorway is set up at the boundary or the road. In some villages, a spiky expression (Is this showing bamboo joints?) was used. The location and length of the walls were written alongside the lines.

Figure 2 shows examples of *shishigaki* drawn on cadastral maps stored in each village. In the Moriyama, the linear type is depicted in which the *shishigaki* extends almost straight to the north and south on the mountainside of the village that is circled on the map. In the north, it extends to the Kido village, before the Kido River, and in the south, it extends to near the border with the Kitafunaji. In Kido, Arakawa, Daimotsu, Minamihira, Kitahira, and Minamikomatsu villages, the *shishigaki* extends to surround the village, with the boundary between the village and the forest at the top (surrounding type). Since rivers often located at the boundaries between villages in the north-south direction, we can see that the two rivers extend from the boundary between villages, fields, and forests to the *Hokkoku-Kaido* (main road) or the lakeshore in the east-west direction. In addition, we found that there are cases where *shishigaki* is built for each village, or three villages are connected to form a surrounding type, such as Daimotsu, Minamihira, and Kitahira. Kitafunaji is different from others, and the straight stone walls lined up between the two rivers divided the field from the mountains. As it will be mentioned later, there are no *shishigaki* relics in the Kitafunaji, it is not certain but it can be said that this was the *shishigaki* because this measures using stones and their placement.

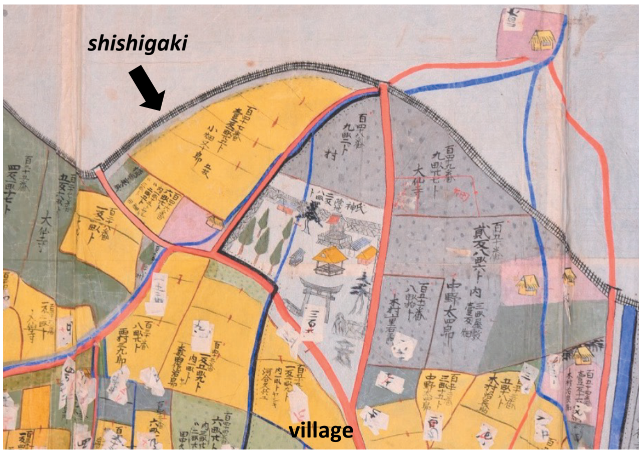
Shishigaki examined in the field survey

Many of the *shishigaki* were demolished during the turmoil after the war and due to housing development after the 1960s, but some of them can still be seen in each village. Figure 4 and Table 1 show the locations shown on the cadastral maps and the results of the field measurement survey.

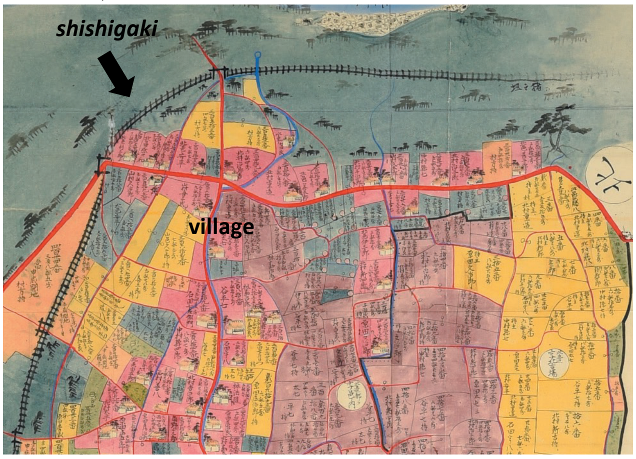

Photo 1: *Shishigaki* located on a steep slope (Left: Kitakomatsu, Right: Kido)



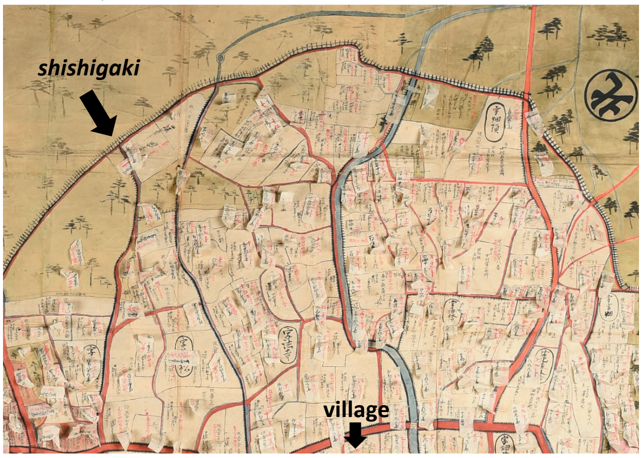
Kitahira "Map (1872)" (Kitahira common property management association)



Minamikomatsu "Village Map (1873)" (Minamikomatsu resident's association)

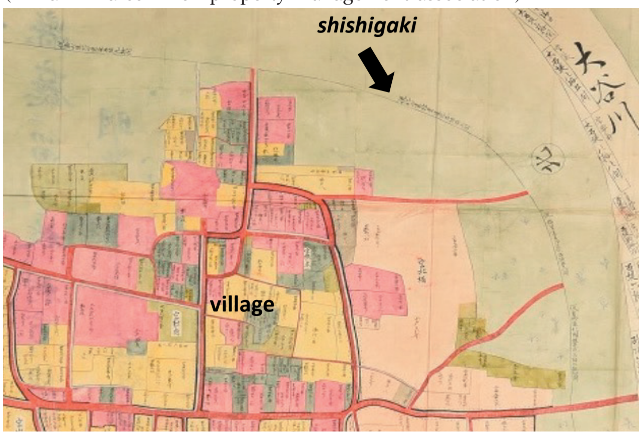


Daimotsu "Cadastral Map (1873)" (Daimotsu common property management association)

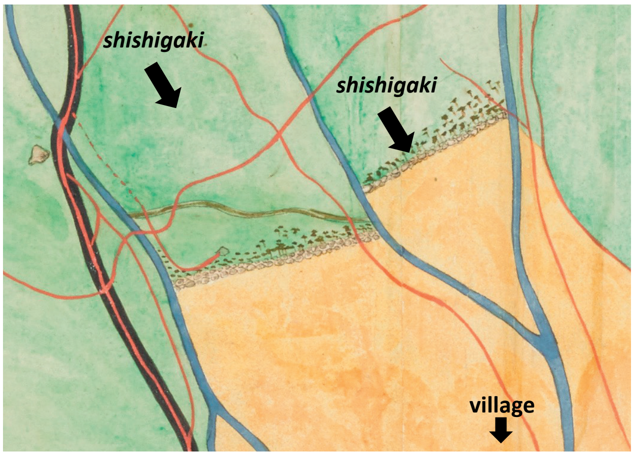


Minamihira "Land ownership research map (Edo period)" (Minamihira common property management association)

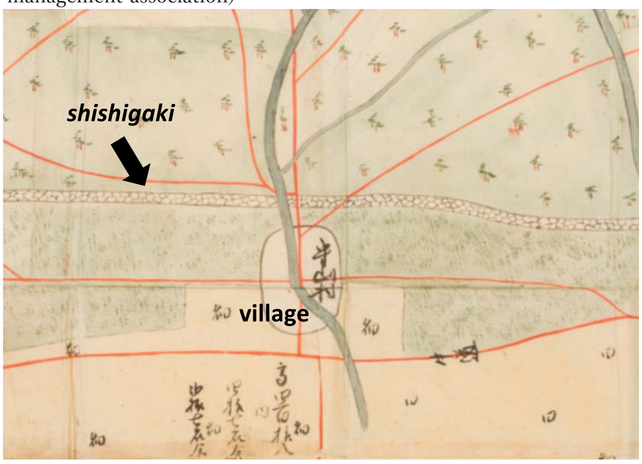
Kido "Cadastral Map (1873)" (Kido resident's association)



Arakawa "Cadastral Map (1873)" (Arakawa common property management association)



Kitafunaji "Map around Moriyama and Kitafunaji (Edo period)" (Moriyama common property management association)



Moriyama "Moriyama village map (Edo period)" (Moriyama common property management association)

Figure 3: *Shishigaki*s drawn on the cadastral maps

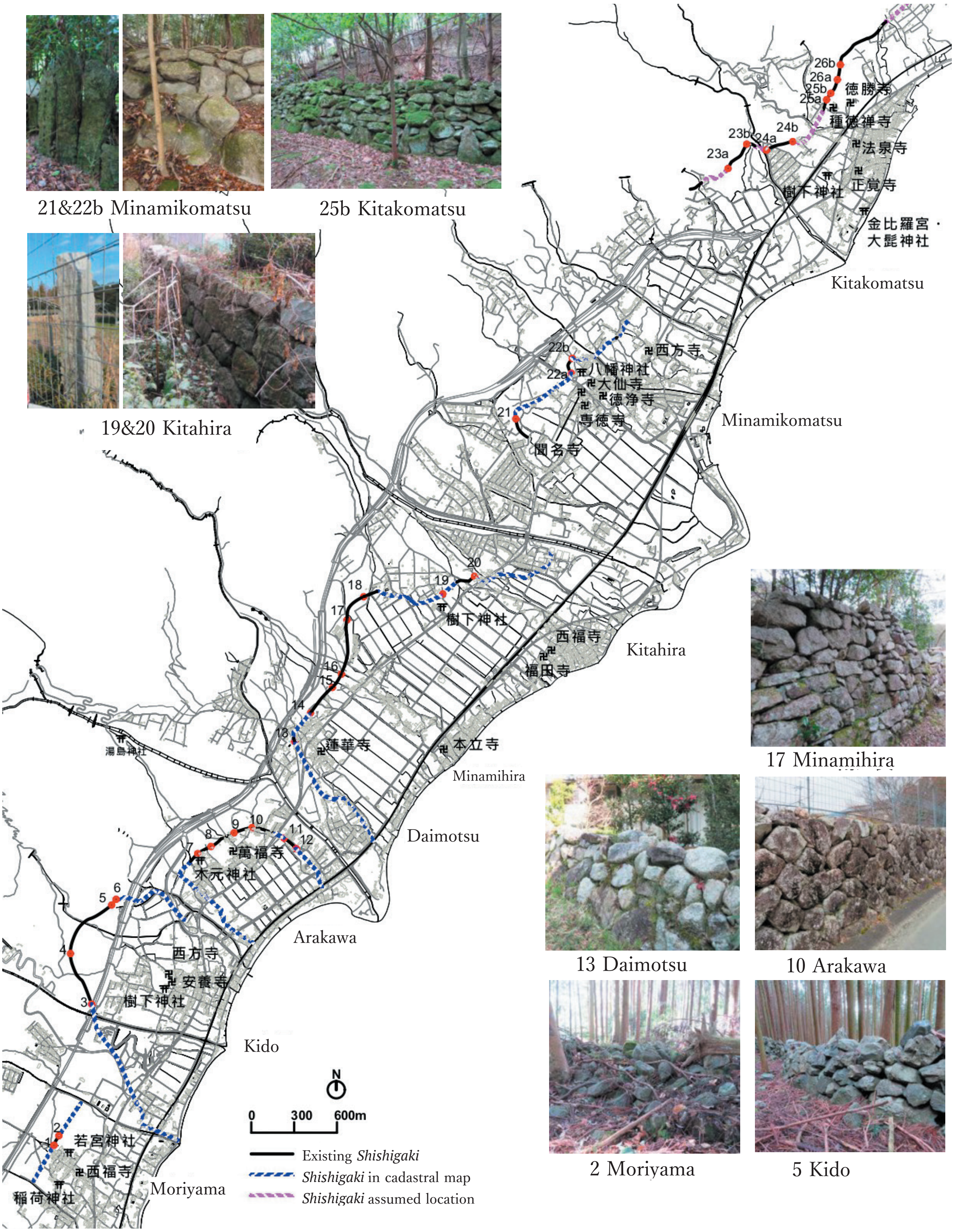


Figure 4: Locations of *Shishigaki* shown on the cadastral maps and existing in areas at foot of Hira Mountains

Photo 2: *Shishigaki* with stone pillars (Left: Minamikomatsu, Right: Kitahira)

The total length of the *shishigaki* was estimated about 13 km, and approximately 4.6 km of relics were observed. The length of the *shishigaki* in each village varied, around 40 % of *shishigaki* walls (approximately 1.3 km) were found in Kitakomatsu, around 40% (approximately 1.1 km) in Kido, around 40 % (approximately 0.78 km) in Arakawa, around 40 % (approximately 0.56 km) in Minamihira, and around 20 % (approximately 0.18 km) in Kitahira, while only around 15 % (approximately 0.20 km) in Daimotsu, around 20 % (approximately 0.30 km) in Minamikomatsu, and around 10 % (approximately 0.075 km) in Moriyama. However, as for Moriyama, there are almost no large stones used for the surface, and only traces of stones that are thought to have been packed inside can be confirmed. Unfortunately, we were not able to confirm the *shishigaki* in the Kitafunaji. On the other hand, in Kitakomatsu, where there were no materials related to *shishigaki*, we found that there are *shishigaki* in good condition along the mountain behind the temple and along the hiking course.

The overall elevation of the *shishigaki* ranged from 100m near the shore of Lake Biwa to 230m in the forests of the Hira Mountains, indicating their wide distribution spanning over the different zones of settlement, farmland, and forest. In particular, *shishigaki* relics that remained in Kido and Kitakomatsu have experienced relatively large elevations from 180 m to 230 m, and 120 m to 194 m, respectively.

This is thought to be due to the fact that many of the *shishigaki* in residential areas were removed for housing and paddy field development, while the *shishigaki* in forests remained because they were difficult for human development.

The height of *shishigaki* varies from 0.4 m to 1.9 m in general, but the average height of those in good condition was about 1.0 m to 1.5 m. In addition, many of the stone walls were constructed in a trapezoidal shape with the bottom section (approximately 1.0 m to 2.0 m) wider than the top section (approximately 0.8 m to 1.5 m). In addition, while masonry construction was the most common technique for building *shishigaki* among villages, stone pillars with a height of 1.0 m to 1.4 m, which have been erected vertically next to each other, were also utilized in Kitahira and Minamikomatsu Villages.

Characteristics of stone use and structure

Although wooden walls were also seen in the drawing on the cadastral maps, all *shishigaki* that could be confirmed in the field survey were made by stone. It is known that local stones have been used as materials for *shishigaki* where stones are abundantly produced. In this region, chert stone is used in Moriyama, and granite is used in other areas. While the characteristic white and gray stones of the same type of granite were often used, there were also some granites with a bluish tinge that was hard and difficult to process, called *aogare* in

Japanese. In this way, we can see that the local stones used in this region were used effectively. The stones used are about 15 cm to 50 cm in height, and depending on the location, 80 cm and 100 cm stones are used. The average stone size was 10 cm x 15 cm and 20 cm x 30 cm. In addition, depending on the village and location, both naturally rounded shapes and squared shapes with marks of artificial processing are used.

The masonry construction method mainly uses Nozura-zumi. Nozura-zumi is a method of stacking natural stones as they are. Of course, technology is required so that the masonry is stable. Some of them are *Tani-zumi* (stones are piled up at a specific angle) and *Ran-zumi* (random rubble masonry (shown in Figure 5). *Tani-zumi* can therefore create a more stable structure than *Nuno-zumi* because of the interactive pressure of stones on each other. On the other hand, *Nuno-zumi* is a method in which relatively large stones are piled up side by side, and the strength is slightly inferior. Ran-zumi, on the other hand, means that stones of different shapes are piled irregularly. Even in each village, different forms of stone masonry were adopted.

Ran-zumi and *Nuno-zumi* masonry were the common techniques used in the villages, whereas *Tani-zumi* masonry was only utilized in Arakawa and Minamihira Villages. According to an interview with a local stone mason, *shishigaki* is so called "an empty pile" containing smaller stones and crushed stones in the middle to prevent plants from growing and improve drainage. Residents of each village shared responsibility for stacking the stones, so it seems that there was a difference in individual skill when looking at the slight differences in the stacking method every few m.

Table 1: Types, uses, and masonry construction methods of existing *Shishigaki* in each village

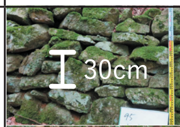
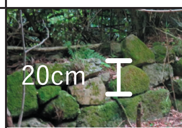
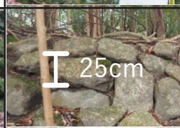
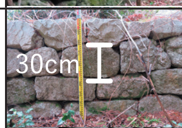
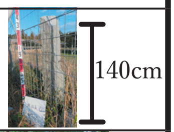
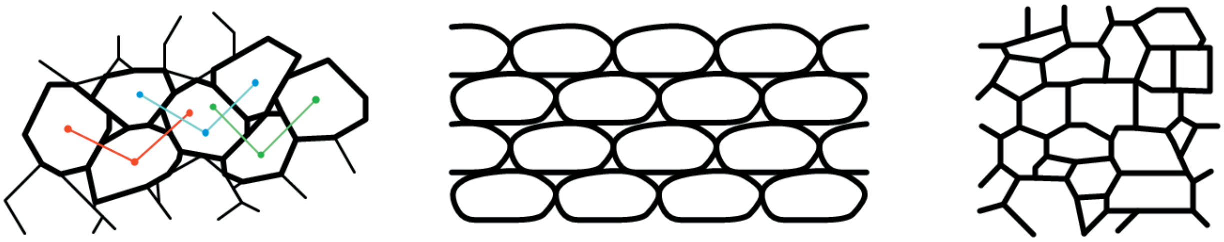
Village	cadastral map	old document	types	uses	steep slope	Tani-zumi	Nuno-zumi	Ran-zumi	Pillar
Kitakomatsu	not confirmed	not confirmed	linear	wild boar defense	yes	-	-		-
Minamikomatsu	yes	yes	linear	wild boar defense	-	-			-
Kitahira	yes	yes	linear	wild boar defense	-	-			
Minamihira	yes	yes	linear	wild boar defense	-				
Daimotsu	yes	yes	surrounding	wild boar defense	-	-			-
Arakawa	yes	yes	surrounding	wild boar defense Sediment disaster	-				-
Kido	yes	yes	surrounding	wild boar defense	yes	-			-
Moriyama	yes	yes	linear	wild boar defense	-	-	-	-	-
Kitafunaji	yes	yes	linear	wild boar defense	unknown				

Photo 3: *Shishigaki* using chart stone (Moriyama)

Photo 4: *Shishigaki* located in the boarder of house (Daimotsu)



Tani-zumi masonry

Nuno-zumi masonry

Ran-zumi masonry

Figure 5: Masonry method

Responding to sediment disasters

Arakawa village has a particularly large *shishigaki* among the remaining *shishigaki* in this region. A sediment disaster that occurred in 1935 damaged the *shishigaki* that surrounded the village, causing the damage that earth, sand and water flowed into the village. In the Arakawa, immediately after the disaster, the *shishigaki* was rebuilt using the stones that flowed into the area. As a result, *shishigaki* here came to have the characteristic of being used not only as a countermeasure against wild animals, but also against sediment disaster. The rebuilt *shishigaki* is mainly in the area damaged by the sediment disaster on the north side of the village, like 1.9 m high, 2 to 2.4 m wide at the bottom, and 2 m wide at the top, and it has a stronger structure compared to other villages (see Photo 6).

Possibility of conservation

An old man over 70 years old in the Minamikomatsu area said, "There is a *shishigaki* around the back of Hachiman Shrine. It was already there when I was a child. I used to play around there. At that time,

Photo: 5: Cut stone is used (Minamihira)

Photo: 6: *Tani-zumi* masonry is used (Arakawa) we have no memory of doing maintenance work for the *shishigaki*." From the beginning of the Showa period, the repair costs of *shishigaki* were no longer listed in the village accounting record from the Meiji period that remains in the Minamikomatsu. In other villages as well, there were stories such as, "Some people sold the stones they used for *shishigaki* during the difficult times during after the war. That's how hard life was. " From this, it is thought that the maintenance of *shishigaki* had already ceased to be carried out around 1935 to 1945.

The *shishigaki* that once protected the village from wild animals is now forgotten, and the remains of the crumbled *shishigaki* sit in the forest. It is largely due to the fact that the land with *shishigaki* has been handed over to people outside the village, and that the *shishigaki* have been demolished for road expansion work since the 1960s.

There are many *shishigaki* remains in this area, but with the exception in Arakawa village, they are not well known by residents, and no village has continued conservation activities. These *shishigaki* still exist today in places surrounding the residential area, and these *shishigaki* were stacked up, maintained, and managed with residents' cooperation. The *shishigaki* is a record of the lives of the local people who have overcome hardships, and is one of the relics that should be protected as a local asset by raising the awareness of the people. Please check where those *shishigaki* are and talk with your family and community.

Photo 7: *Shishigaki* having a function to protect from debris flow in Arakawa

Citations and References

Note:1

For old documents and cadastral maps, photos taken by the Otsu City Museum of History and stored in each village are used. At the same time, we conducted additional surveys of existing *shishigaki*. In addition, anything related to *shishigaki* in the old documents and cadastral maps owned by the Kitakomatsu village were found, therefore, it was excluded from the study this time.

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Yazaki Takao, "*Shishigaki*nimiru Inoshishi tono koubou-Kinsei nihon niokeru shosou", edited by Takahashi Shunsho "InoshishitoNingentomoniikiru", Fight with wild-boar with *shishigaki*: Modern era situation in Japan, Kokinshoin, 2001

Traditional flood prevention measures *Hyakken-Tsutsumi* to be inherited to children

Kyoto University OHARA Ayumi

Introduction

We have suffered many disasters in the past and experienced the horror of nature. However, as time passes and we return to our daily lives, the memory of the disaster tends to fade. It is not easy to think and realize disaster prevention and mitigation in our daily lives. Moreover, in order to face the coming disasters, it is essential to learn from the lessons of the past. Therefore, we need to make various efforts to keep the memories of disasters from fading away and pass them on to the future. It will be necessary to devise ways to convey the message to various generations, from children to adults.

This paper reports on a case in which the author created a "picture-story show" to tell the story of his predecessors as part of a "program to discover and think about natural disasters and blessings handed down in the community through experience" undertaken by Shiga Kita Kindergarten in the former Shiga Town, Otsu City, and linked to learning for the children.

Initiatives at Shiga Kita Kindergarten in Otsu City
Otsu Municipal Shiga Kita Kindergarten is located in the northern part of Otsu City, Shiga Prefecture, in the former Shiga Town's Omono district. The kindergarten is located near the Lake Biwa Matsunoura Swimming Pool, and looking up to the west, the majestic mountains of Hira stretch close by, allowing students to experience the changing nature of the four seasons with all their senses.

Shiga Kita Kindergarten has been implementing a unique curriculum called "Furusato Shiga" in order to make the most of its regional characteristics and rich natural environment in childcare. The program is based on the concept that "the town where we live has landscapes and lifestyles that we cherish," and provides children with opportunities to experience, feel, and think about the landscapes and lifestyles of the area.

involvement begins

As part of the "Furusato Shiga" program, five-year-old children (senior class) went to see the Hyakumen-Tsutsumi, a stone masonry flood prevention measure built in the Edo period at the foot of Hira Mountains, to learn about the history of local people working together to protect their village from disasters. The children were asked to give an explanation of the Hyakumen Dike.

To communicate in a way that a five-year-old child can understand the history of the granite that is the resource of Hira Mountains and the Hyakumen Dike that was built to utilize it, as well as the two sides of nature, disaster and blessing, the technology used and utilized, and the lives of people who have faced nature. I have a five-year-old daughter who knows by ear, but cannot visualize, time such as a week or a year, or even language that represents units such as five m. I strongly felt the need to devise a way to convey the meaning of words in a way that is easy to understand, so I decided to create a "picture-story show" to help people empathize with historical events and convey images visually.

The Big One's Hundred Meter Dike

The huge stone dyke, Hyakumattei, is located upstream from the Yotsuso River in Oomono, Shiga Prefecture. The Yotsuso River meanders along the side of the village of Omono, causing flooding every time a large storm hits, repeatedly damaging Omono and the neighboring village of Minamihira, as well as their fields. Since the late Edo period (1603-1867), stone levees were built to keep out the floodwaters, and repairs have been made after each flood to prevent disasters. According to local legend, Toyozenomori Miyagawa, the feudal lord of the domain, called Sakichi, a master stone mason, from Wakasa (Fukui Prefecture), and mobilized local farmers and women to participate in the construction work. They completed a large dike called Hyakuman-dike, which was called Hyakuman-dike because of its length of one hundred m (about 180m). It is also said that the water channel was built to secure water for residential use and water source. (Shiga Town Folktales, "Daimotsu no Hyakumen Tsutsumi")

Production of a picture-story show "Omono no Hyakumenzutsumi" (The One Hundred Meter Bank of Big Fish)

(1) Production process

① Gather information (literature, research books, exhibition catalogs, books, local books, picture books)

② Plan content for your target audience.

Since the subject is a 5-year-old child, the following three points should be considered

. Considering the time it takes to concentrate on the conversation, it should take about 10 to 15 minutes.

The storyboards will need to be developed to generate interest and attention.

Line ① Line ② Line ③

Production of a *KAMISHIBAI*(picture story show) "Daimotsu-no-*Hyakken-Tsutsumi* "(For ages 5 years old)
Created and drawn by Ayumi Ohara

Photo 1: Let's go.

Photo 2: Is this the *Hyakken-Tsutsumi*?

Photo 3: We are going further and further into the mountain.

・Since we cannot use pro-technical vocabulary, we choose the language that children can understand.

③ Select the content *KAMISHIBAI* (picture-story show). The story can be developed with movement.

④ Thinking about the story

⑤ Think about the story's development points and

Photo 4: *Hyakken-Tsutsumi* is big!


Photo 5: We saw a "*KAMISHIBAI*(picture story show)" about *Hyakken-Tsutsumi*. Photo provided by Shigakita Kindergarten.

structure. Skip the part about the blessing of water as there is too much information and focus on the "why it was made" and "it took a lot of people and a long time to make it".

⑥ Creating a storyboard

⑦ Confirmation of contents to the researcher

⑧ Creation of a temporary picture-story show

⑨ Write the work in book form and complete the work.

(2) Points of ingenuity

Introduce the children to the story as if they were watching a picture-story show as if it were their own.

Photo 6: How did they cut the stones?

Photo 7: Is it heavy? Can you hold it?


Photo 8: The principal broke the stone and showed us.

Draw the characters. Create features such as hairstyles, clothing colors, etc., to clarify roles.

Make it a picture story show that children can participate in. Create a place where children can chant the lines of the picture story together.

The representation of the six years of time spent building the dike is felt through the repetition

Photo 9: The surface of the broken stone is flat! Photo provided by Shigakita Kindergarten


Photo 10: I spoke about the blessings and uses of water.


Photo 11: Children looking at the illegal dumping site

peculiar to picture story shows.
Pointing to the picture, tell them specifically what the picture is about.

Children visit Hyakumattei

In November 2022, we visited Hyakumen Dike with the children of Shiga Kita Kindergarten's 5-year-old "dolphin group". Two parents also participated.

① From the vicinity of Route 161, the school children will walk to Hyakumattei.

② You will be able to see the Hyakumenzutsumi in person, touch the stone walls, and confirm its size and existence.

Photo 12: Children discovering the waterway in front of the kindergarten

③ What is Hyakumen-Tsutsumi?" Through the picture-story show, we learned the story of why Hyakumen-Tsutsumi was built. We were able to perform the picture-story show when the children were surprised to see Hyakumen-Tsutsumi. The children listened to the story in front of Hyakuman-Tsutsumi and concentrated on the story. They were able to get more and more into the story as they shouted together, creating an atmosphere as if they had built the Hyakumen-Tsutsumi together.

Photo 13: We have arrived at the Lake Biwa Matsunoura Swimming Beach.

Photo 14: Looking at the white sand beach where granite has flowed in

④ After the picture-story show, the audience was asked, "How did you make the masonry?" "How did you cut the black?" The children asked, "How did you make the masonry? In response, the teacher asked, "How do you think the stones were cut? The teacher asked, "How do you think the stone was cut? The headmaster showed us a small piece of granite that he had broken with a crowbar and a cane. While looking at the cracked stone, he told the children that the stone used to make Hyakumen-dike was granite, which is easily broken, and that the granite has an "eye of stone," and that a craftsman called a mason was able to recognize the eye of stone. Then, the children said, "I found the eye of the stone! Is this the eye of the stone? and the "stone eye search" began.

⑤ Afterwards, everyone gathered in front of the diversion pond. We talked about the fact that rain and water are necessary for life, not only bringing disasters but also important blessings, and that the Hyakumen-tei not only prevents water but also has water channels built to safely use the water and has the technology and wisdom of "water utilization". How do the stones of Hyakumen-Tsutsumi stand? Where are the stones? How do trees grow? Where does the river water come from? I was overwhelmed by the children's natural questioning.

⑥ Where does this water flow to?" On the way back from Hyakumen Dike, we found an irrigation channel leading from the diversion pond and observed the water flowing down the mountain.

⑦ You can't dump trash in the mountains, can you?" There was a sign for illegal dumping near the foot of the mountain path. The teacher asked the children, "What happens if we dump trash in the mountains? I asked the children. The children stopped and said, "The water will become dirty. The water would become polluted, the mountain


Photo 15: Comparing grains of white sand and those of stones

would become dirty, and so on. They felt that this was a problem.

⑧ As the children were returning to the kindergarten by bus, they found water flowing in the canal in front of the school. Is the water flowing from Hyakumattei? Is the water flowing from the mountain? and the teacher asked, "Shall we follow the waterway to Lake Biwa to see it?" "I want to go there!

⑨ Connected to Lake Biwa!" The irrigation channel was connected to Lake Biwa. The children were overjoyed.

⑩ While looking at the white sandy beach at the Matsunoura swimming hole, I told them that this beach was made up of finely granite that I had seen on the mountain and deposited. Then one of the girls named the granite stone grains she had picked up next to the Hyakuma Dike as "sparkling stone" and "rice stone" and brought them back home. As we all compared the grains of sand and stones together, we thought, "They're the same! and we could feel the connection between the mountains and the lake.

To children's awareness and discovery

Shiga Kita Kindergarten's program has revealed many messages to the children through their experience at Hyakumen-Tsutsumi. (1) That we are alive because of the water, stones, soil, plants, and trees that come from the nature of the region in which we live. (2) In order to maintain nature in good health, it is necessary to pass on the skills of our predecessors. (iii) In order to obtain the natural resources and to prevent disasters, waterways and masonry have been built. (4) That we have a role to play for the community and nature in order to continue to live in safety and in the abundance of nature. The teachers, while attending to each child's experience and awareness, took the "questions" from the children's words and created time for them to think and share their discoveries with their friends and teachers. I was surprised at how much the children absorbed and understood the experiences and words, and at the same time, I realized how important it was for the teachers to encourage and support the children to become aware of their experiences and words.

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Water and life in Moriyama village - Kawato and Ike

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Moriyama village (elevation: approx. 120 m) in Otsu City, Shiga Prefecture, is located in the central part of the eastern foot of the Hira Mountains and encompasses the catchment area of the Noriko River. It covers an area of about 360 hectares, which includes the top of Mount Horai (1174 m above sea level) and other mountains to the shore of Lake Biwa (about 80 m above sea level), and is characterized by the extremely close distance between the mountains, the village, and the lake.

In order to understand the various forms of water use in daily life and their mechanisms, we have conducted interviews, field surveys, and observation of local community activities such as festivals and traditional events, in order to understand the events and joint management of water use. We will look at the characteristics of mountain water and spring water in Moriyama village through "Kawato" and "Ike".

Understanding the water environment of Moriyama village

Figure 1 shows the network of the water environment in Moriyama village and points related to water blessings and beliefs. Moriyama village has an irrigation canal called "Daidou River Irrigation Canal" originating from the Daidou River, which has an intake at an altitude of 500m upstream from the Noriko River. The "Daidou River Irrigation" has 10 irrigation channels, all of which have names such as "Kaitouda River," "Hatakeda River," and

Photo 1: Intake from the Noriko River to the Daidou River

Photo 2: An irrigation channel of the Daidou River flowing through the mountains

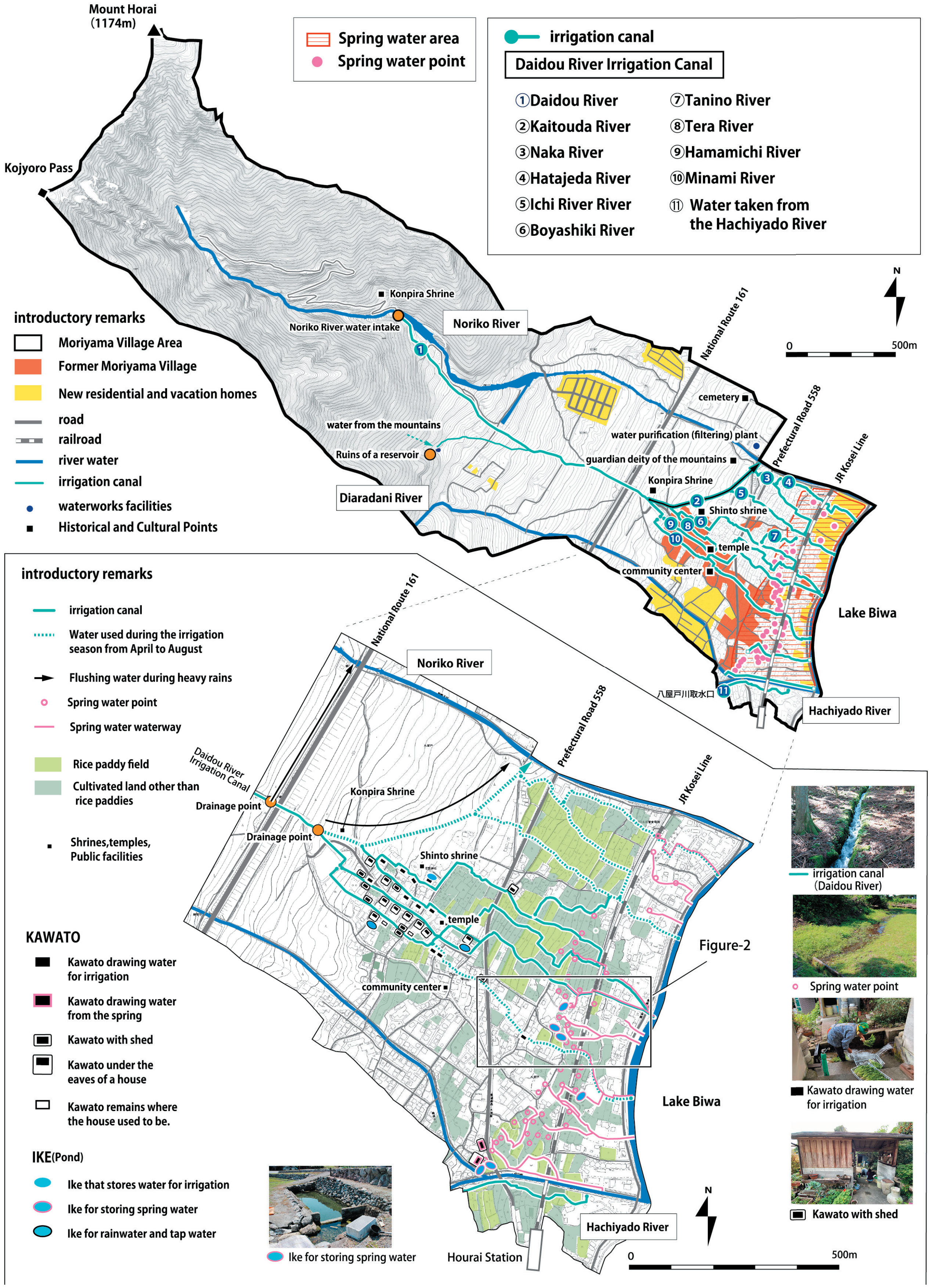

Figure 1. Moriyama village 's water environment


Photo 3: Branch of irrigation channel .

"Hamamichi River". Mountain water from the Noriko River flows down the approximately 30-cm wide irrigation channel along a steep mountain path. From an elevation of around 150 m above sea level, in front of the village where the slope becomes more gentle from the undulating mountainous area to the foothill area, the water is diverted in turn and leads to a total of nine irrigation channels.

The irrigation channel that runs through the village is used as domestic water at the "Kawato" located in each house. From the lower reaches, the water is used for agriculture and finally flows to Lake Biwa. Every spring, there is an event to clean the waterway for the Daidou River, and in the summer, the residents of the village work to maintain the waterway and the area around the waterway for agricultural use in the downstream area. In addition, on the Lake Biwa side of the prefectural road at the foot of Hira Mountains (especially near the Kosei Line), there is a belt of spring water overflowing from the subterranean waters of the Hira Mountains. The amount of spring water increases from May to September, and the spring water that


Photo 4: Water used for agricultural purposes


Photo 5: Water intake to rice field


Photo 6: Water flowing into Lake Biwa

Photo 7: Outdoor Kawato

Photo 8: Outdoor Kawato. There are stairs to go down, a watering hole, and a Jizo statue.

Photo 9: Kawato shared with neighbors

Photo 10: Kawato (interior) shared with neighbors

Photo 11: Kawato inside a half house

Photo 12: Kawato (interior) of a half house. There is a pickle hut in the back.

seeps out is used for domestic and agricultural water, etc., and flows into the irrigation canal and pours into Lake Biwa. The local people call the spring water *Shozu*. In this paper, we use *Shozu* as it is written in the testimonies by local residents.

Life with Kawato

Kawato is a form of water use deeply related to the lifestyle and livelihood of the Moriyama community. Kawato have a function as a washing place, with a device to dam water with a board to raise the water level and collect water, and a jar to collect spring water once it has been collected. There are a total of 31 existing Kawato in Moriyama village. Twenty-six of them are located along the Daidou River irrigation channel. Of these, there are two Kawato that can be shared with neighboring houses and are used as communal watering holes. In addition, there are two Kawatos with spring water in two private houses along the prefectural road that are within the area where the spring water seeps from the ground. In terms of spatial information, 19 Kawatos have semi-outdoor spaces that are both outdoor and personal spaces, as evidenced by the eaves of private houses and huts built on top of the Kawato. Before the water supply system was built, Kawatos were used for drinking, washing rice, washing faces, washing dishes, washing vegetables, cooling vegetables, and bathing. There are also examples of pickle huts and pickle barrels by the Kawat, indicating that water-intensive tasks related to food, clothing, and shelter have been carried out in Kawat. The act of polluting the water was forbidden, and families, especially those living in upstream areas, were strictly told from childhood how to handle the water. The custom was to wash soiled items such as diapers in the Kaitouda River, which was used only for agricultural purposes, and not to discharge them into the irrigation canals that flowed through the village, thus protecting the clean water.

Today, it is no longer used as drinking water, but is instead used to wash vegetables with soil, to wash farm equipment and farming implements, and to awaken the heat by soaking hands, feet, and other parts of the body in water. It is also used to water plants in adjacent gardens. It is thought that the many semi-outdoor spaces are used to avoid rainfall because the work related to food, clothing, and shelter that requires water is carried out in Kawatos. It has been about 60 years since the water supply system was established, and although there have been some changes in the use of the Kawato, the daily connection with water still remains.

They may also use the condition of the Kawatos as a guide to determine when to respond to a disaster, such as going upstream to check on the irrigation canal when the amount of water from the mountains increases during a series of rains. Then, we also saw ingenious ways to control the overall flow of water in the canal, such as channeling the increased water in the upstream Kawatos toward the adjacent fields.

Below is the testimony of Mr.Asatsugu Ishizuka, whose home is located upstream of the Minami River, about the river water and Kawato.

"This is the South River. It used to be paved with cobblestones, but it was replaced by a concrete U-shaped ditch. Before that, it was all cobblestone pavement, and it was beautiful. Kawato stops the water with a board. Then, the depth of the water would accumulate to about 12 cm. With this amount of water, even vegetables could be washed. This is where we wash vegetables, pots, etc. In the old days, we also used to put rice in the pot. Before there was running water, we washed rice in Kawato. It was also used as drinking water. On sunny days, when the water is clean, there is a large pot at the kitchen. We would store it there. That way, when it rains and the water is muddy, we can use the clean water. When it rains, the rain on the road falls into the river, which inevitably becomes muddy. So they fetch water on a sunny day. When it rained, I did not boil the bath very much. For the water for the bath, we used to draw water into a bucket and fill it in through the window of the Goemon bath, which was located near the front door of the house

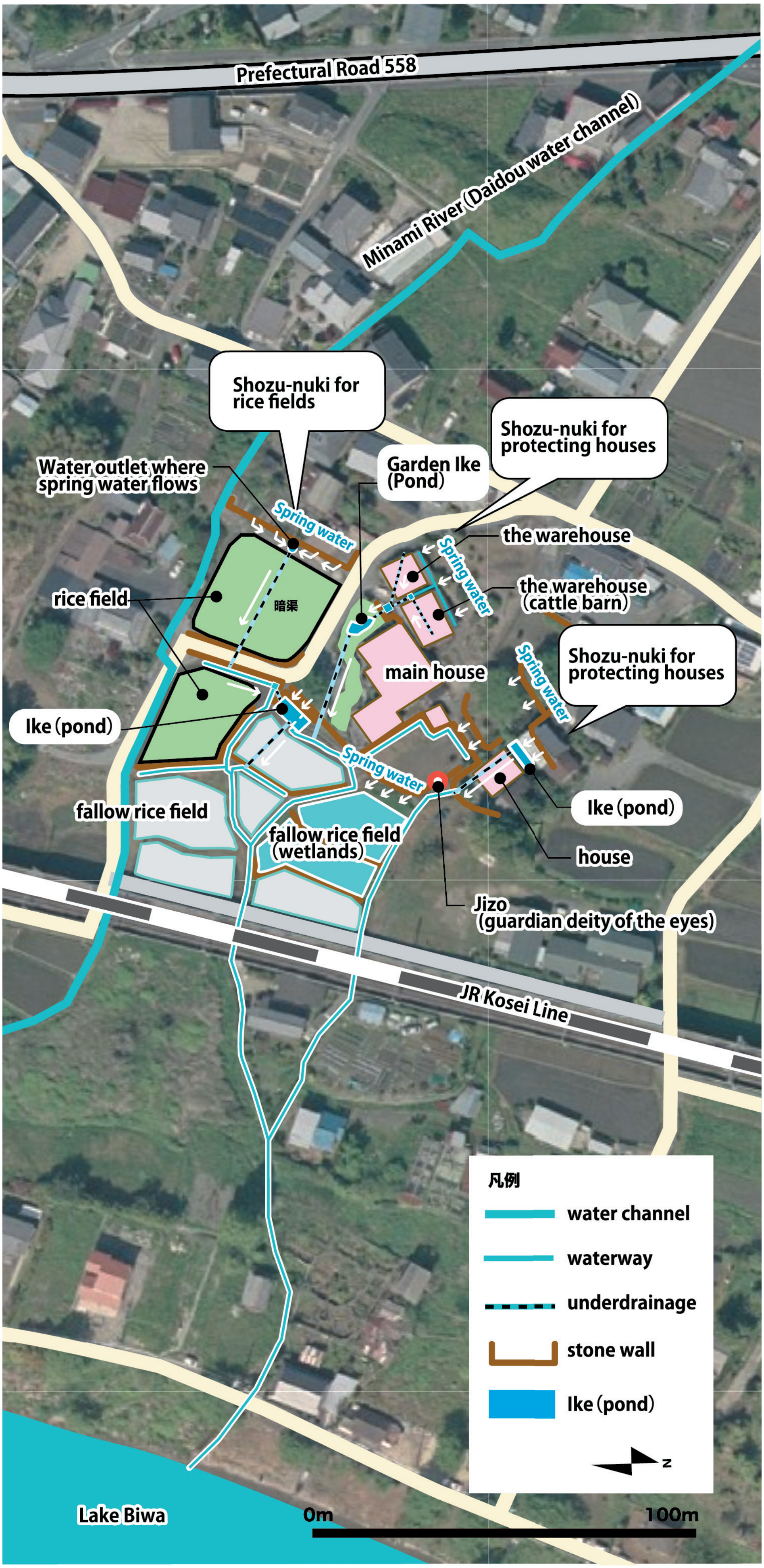

Figure 2: Shozu-nuki drawing of Mr.Yoshiteru Ishizuka's property

where we live today. We used this river water for eating, bathing, and cooking. If the water was dirty, there was a "dumping river" on the other side of the river. There was a river that did not flow toward the houses. It was a river that flowed toward the rice paddies. There was a washing place to wash diapers and so on, and everyone washed their dirty things separately".

Use of Ike to Miss Spring Water (*Shozu*) - A Case Study of Mr.Yoshiteru Ishizuka

In Moriyama village, there is a small artificial pond called "Ike," which serves as a device to utilize water for irrigation and spring water (Figure-1). Water sources include irrigation water, spring water, and rainwater. Here, we will look at the Ike that are located near private residences and are related to spring water. From the Lake Biwa side of the prefectural road to the Kosei Line, there is a strip of spring water points where subsoil water from the Hira Mountains overflows, The amount of spring water increases from

May to September. There is an ike for collecting spring water, which is also used as a place for domestic water.

Mr.Yoshiteru Ishizuka, who lives in the spring area between the prefectural road and Lake Biwa in Moriyama village, has an Ike on his property and uses the water to feed his fields, wash farm tools, cool vegetables and fruits, and as a place to keep pine trees for New Year's decorations. The water from the spring is a constant temperature of about 14 degrees throughout the year, and feels cool in the summer and warm in the winter. On a hot summer day, when the farmers return home after a hard day's work, they dip their bare feet in the spring water, and the sweat instantly disappears. It is very cool and comfortable. Until Mr.Yoshiteru was a child, he used the water to cook rice and wash vegetables. When there was no water in the garden, he used a pump to pump up water to fill the garden's Ike. Also, the rice-fields downstream used to use the water for agriculture, but they do not use it now because the fields are fallow. When he was a child, he caught fish from Lake Biwa and tried to keep them in Ike, but the water was too cold and the fish stayed still and did not grow big, so they are not there now.

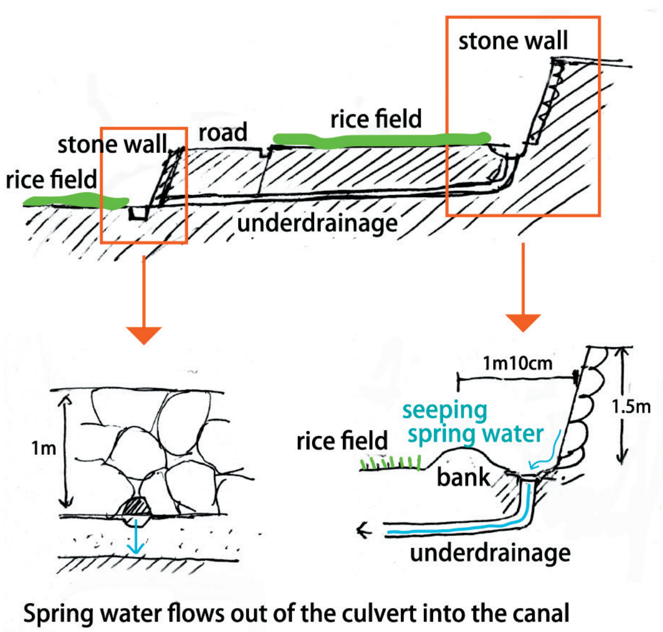

Figure 3: Shozu-nuki in rice field (Sketch from interview)

Spring water is a blessing of nature, but too much of it can lead to natural disasters. In Moriyama village, "Shozu-nuki" is a method of managing water by letting the rising spring water escape. The spring water overflows out of nowhere, so the "Shozu-nuki" is used as an ingenious way to drain the water.

In Mr.Yoshiteru Ishizuka's rice-fields and residence, there are two types of Shozu-nuki: Shozu-nuki for protecting houses and that for rice-fields (Figure-2). In years when there is a lot of snow in winter, water begins to seep out from around May to September. The most common time is during the rainy season in June. The warehouse on the mountain side of my mother's house was once filled with water up to its ankles, and the cattle shed next to the warehouse was filled with water up to the cows' bellies, so we asked the house above the prefectural road to evacuate the cows for about two weeks until the water receded.

Water is necessary for rice cultivation, but even when water is not needed, many springs spring up, so there are devices to collect the spring water and release it into waterways. A ditch is dug along the upstream of the rice field, and water is channeled downstream from the ditch through a culvert under the rice field using an earthen pipe (currently a pipe) (Figure 3). The water that flows into the canal is connected to the Ike next to the farmland. The Ike next to the farmland also has a spring that gushes out from a gap in the stone wall, and water accumulates there throughout the year. The storage shed on the mountain side of the main house has a ditch around it and a culvert in the ground. Spring water that seeps out from around the house is collected in a garden Ike next to the main house. When the amount of water in the garden exceeds a certain level, it is piped down to a waterway downstream, where it is used for farmland and flows into Lake Biwa.

There is also a "Shozu-nuki" on the one-story house to the north of Mr.Yoshiteru's

Photo 13: Farmland with seeping spring water along the JR Kosei Line

Photo 14: Mr. Yoshiteru Ishizuka

Photo 15: A rice field with a Shozu-nuki culvert

main house. An Ike has been built to store spring water that gushes out from the stone wall that is the foundation of the adjacent house. To prevent the spring water from flowing into the one-story house, a culvert drains the water from the Ike into a canal. The water is so pure that it is said to cure eye diseases if you wash your eyes with it. Jizo (guardian deity of the eyes) is enshrined by the outlet of the spring, and is well known and loved as Jizo-san (guardian deity of the eyes). Flowers and a drooling hanging scroll are always offered to him. Children from the neighborhood come to visit during the Bon Festival.

The following is Mr.Yoshiteru's testimony.

"Shozu had enough water when I was little to wash my face in the ditch next to the warehouse," he said. Water also comes out from inside the hut. There is a pipe in here that drains the water, and if you don't remove the water, the water will accumulate. One I forget to remove water and found everything floating in the water next morning. 20 cm of water was in the hut, and I had to wear boots to go out. Even in the rice paddies, water comes up from the base of the stone walls, so we have to dump this water somewhere. We have to keep releasing the water. There is nothing above the prefectural road, but water comes out from this area. It's a tough place."

"The reason for this is that in the rice paddies around here, there are not so many *Shozu* above the prefectural road, but there is a road for Shozu about 70 to 80 cm below the rice paddies. There is a road, or rather, a place where all the *Shozu* come to, and there is a road. We put a pipe under there. They are all at the bottom of the rice paddies. The point is, when it rains, when it rains during the rainy season, it already overflows with a thud. If you don't do the Shozu-nuki, the inside of the rice paddies won't dry out when the rice paddies are harvested in the fall. The current machines are large, so if you want to put them in, you have to make sure the rice paddies are dry. In large paddies, there are two pipes. My rice field has one."

"During the rainy season, when there is a lot of water, it comes pouring out of the shed above the house, so much so that it floods the area under the porch of the main house. Therefore, the shed is equipped with drainage pipes to drain the water out of the shed, and the water gradually accumulates in the garden Ike through the earthen pipes. Water also drains from the garden ponds to the waterway below through a drainage pipe. When the *shozu* starts to spring up, the garden Ike fills up and cannot keep up, so we have to use a big pump to pump the water into the waterway below, or else it will go down to the bottom of the garden. If there are too mach water, it will come that far. The house gets damp and damages the tatami. It happens once or twice a year. There are also years when there is nothing. It depends on the amount of snow and rain. "

"In the old days, we didn't have machines like we do now, so we had to dig by hand, put in the earthen pipe, fill it with gravel, and cover it with dirt dug from the top. If we left the mud in the pipe, it would get stuck inside the pipe, so we put gravel on both sides of the pipe. Gravel was also used to cover everything around the joints of the earthen pipes. The tool used to harden the ground was a log with four branches to hold it, and two people would pound it into the ground. The tool was called an "Octopus “. The logs were about 30 to 40 centimeters thick. If it was too big, it would be too heavy, and I think they used materials like oak and cypress, which were, heavy, strong, and would not rot."

Photo 16: The mouth of the pipe that collects water from the *Shozu* and releases it under the rice paddies.

Photo 17: Water in the canal collects to Ike

Conclusion

Thus, Kawato and Ike have a history of nurturing a close and diverse relationship between people and water, and have produced experiences and customs for handling water in a manner that does not pollute the living environment, as well as wisdom and technology for meticulous disaster prevention and mitigation. Even today, we can see the ingenuity of people who have enjoyed clean water as a blessing and linked it to local structures and beliefs. Predicting changes in the natural environment is not easy, and in some respects it is difficult to maintain houses and rice paddies. Large amounts of mountain water or spring water overflowing can lead to disasters and must be managed for domestic and agricultural use. While valuing the water use patterns and water awareness that shape local cultures, it is expected to review the familiar water environment as a place to practice disaster response rooted in daily life, and devise ways to make the

Photo 18: Ike, where water from the canal collects. *Shozu* is springing up in the Ike. The water flows from here to the rice paddies downstream and to Lake Biwa.

most of it in the future.

Photo 19: Ike in the garden next to the main house. Water collected in the warehouse and in the culvert collects.

Photo 20: *Shozu* springs all year round.

Photo 21: Washing eyes with this shouzu is said to cure eye diseases.

Photo 22: Jizo (guardian deity of the eyes)by the irrigation canal in Shaw's

Hira-oroshi and premises forests at the foot of Hira Mountains

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Kyoto University FUKAMACHI Katsue

Photo 1: View of Kitakomatsu, Otsu City(2020)

Introduction

Hira-oroshi is the name given to the strong wind that originates in the Wakasa Bay area and runs down the southeastern slope of the Hira Mountains (1,000 meters high), creating the strong wind which blows down through the Hira foothills on Lake Biwa . This wind appears throughout the year, but the *Hira-oroshi* occurs most frequently in March, and the strong *Hira-oroshi* at this time is called *Sangatsu* (March)-*hayate* or *Hira-hakko*. The strong winds of the *Hira-oroshi* can cause the JR Kosei Line and ships on the lake to suspend operations, and they have a significant impact on the growth of crops and the fishing industry. They have also derailed cargoes and capsized ships. When strong winds blow into the village, houses and other structures suffer wind damage. Therefore, since ancient times, people have taken measures to protect their houses and create a comfortable living environment, such as planting *yakagi* trees, or premises forests, around their properties. *Yakagi* trees were especially designed on the windward side to cope with the prevailing winter winds, and also played an important role as a place to supply materials necessary for daily life.

Occurrence of *Hira-oroshi* and atmospheric pressure pattern

The occurrence of *Hira-oroshi* is deeply related to the atmospheric pressure pattern and often occurs when the pressure is high on the northwest side of the Hira Mountains and the ground isobar line flows from the northeast to the southwest. " Biwakodas" is a wind observation system run by the Lake Biwa Regional Environmental Education Study Group to investigate local winds in Shiga Prefecture, and the real-time wind observation network system was initially set up at 10 observation points around Lake Biwa with the support of the Lake Biwa Museum. Currently, 12 stations have been set up by the research group itself, and data is being collected on an ongoing basis. According to the Biwakodas

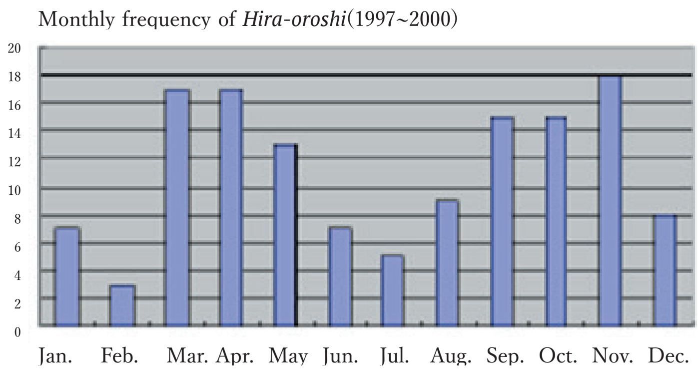

Figure 1: Monthly frequency of *Hira-oroshi* in Kitakomatsu

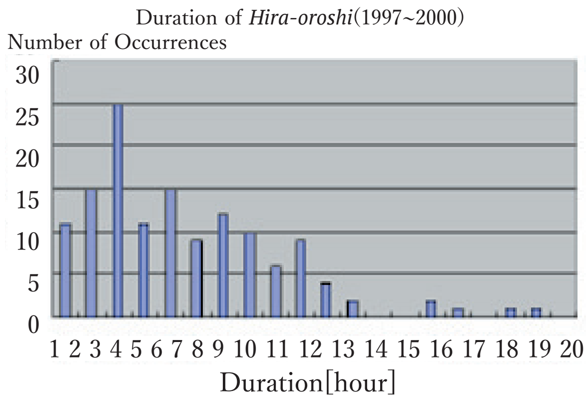

Figure 2: Duration of *Hira-oroshi* in Kitakomatsu

wind observations to date, it is known that *Hira-oroshi* occurs more frequently in the area from Minamifunaji in Otsu City in the southern part of the Hira Mountains foothills to the Komatsu district in the northern part. If we define *Hira-oroshi* as "when northwest winds averaging 7 m/s or more per 10 minutes blow for more than one hour," a total of 134 *Hira-oroshi* events were confirmed in Kitakomatsu during the four-year observation period from 1997 to 2000. Figure 1 shows the monthly frequency of *Hira-oroshi* at Kitakomatsu, with two peaks observed from March to May and from September to November, indicating that the number of occurrences is low in midwinter and midsummer when the season is stable. In spring and autumn, when the atmospheric flow from east to west is active, low-pressure systems and cold fronts pass through, or typhoons are frequent, and *Hira-oroshi* are more likely to occur. The wind direction of *Hira-oroshi* in Kitakomatsu (Photo 1) is generally northwest, heading toward Chomeiji on the opposite shore. In the area, *Hira-oroshi* has become an integral part of daily life, and it occurs only several times a year when the winds become so severe. Figure 2 shows the relationship between the duration and the number of occurrences of

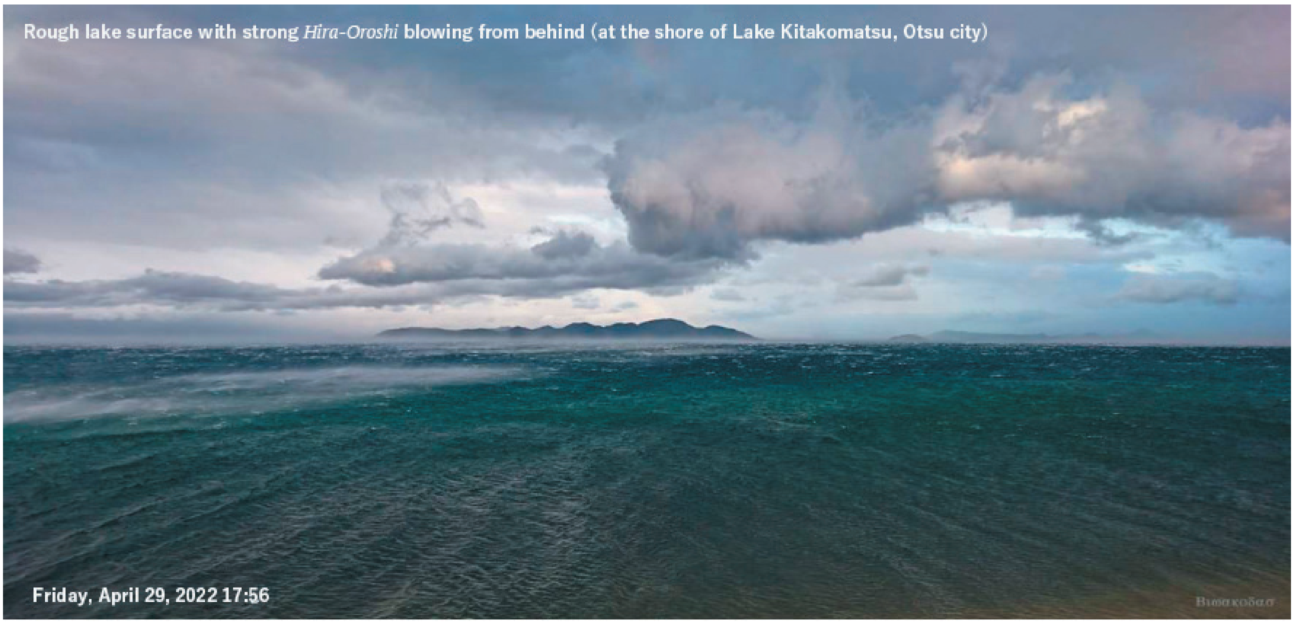

Photo 2: View of Lake Biwa from the shore of Kitakomatsu.

Photo 3: Wind pillows appearing near the top of the Hira Mountains range during strong winds and stratocumulus clouds caused by downwind waves

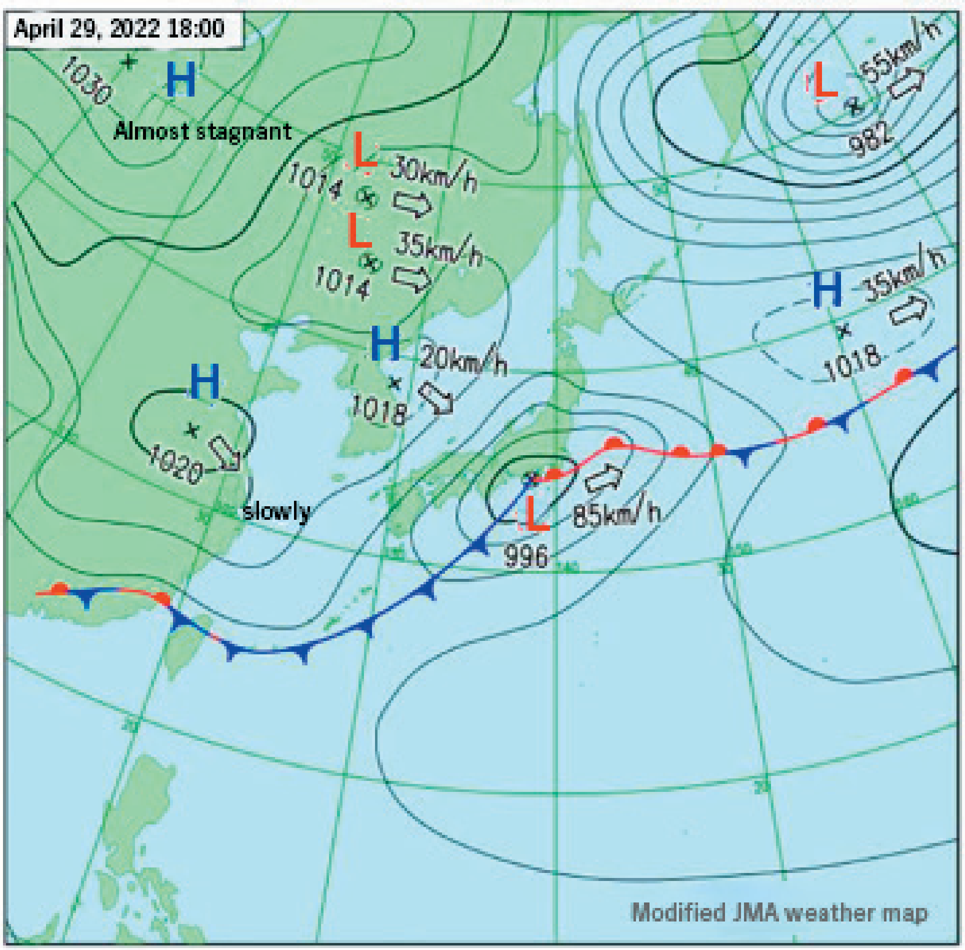

Figure 3:Surface weather map during high winds

Hira-oroshi with an average wind speed of 7 m/s or higher over the course of 10 minutes. The peak duration is 3 hours, and *Hira-oroshi* lasting more than 10 hours has occurred 20 times in 4 years.

On April 29, 2022, the strongest class Hira-oroshi occurred. As shown in Photo 2, the view from the shore of Kitakomatsu was very rough with *tsumaki* and spray coming off the lake surface. As shown in Photo 3, the Hira Mountains range (with Mt. Domandake in the center)and the area around the summit, was covered with a "wind pillow" bank of clouds. This wind pillow is formed when air currents coming from the Wakasa direction hit the Hira Mountains range and clouds from the Kutsuki (Takashima City) direction begin to rise and form. The clouds disappear once they run down the southeast slope, but when they rise again, they reappear downwind, generating stratocumulus clouds. These are the clouds floating above the left side of the photo 3. There is a legend which tells that fishermen in the old days, upon seeing wind pillows begin to form on the top of the mountain, would predict strong winds and abandon their nets, rushing back to their fishing ports.

Figure 3 is a surface weather map at the time of the strong *Hira-oroshi*. The *Hira-oroshi* intensified and peaked around 6:00 p.m. as the low pressure system developed and passed over Kyushu and Shikoku, and then from the Kii Peninsula to Tokai. The peak time was around 6:00 p.m.

Komatsu's *Sangatsu-hayate*

The *Sangatsu-hayate* is the most feared *Hira-oroshi* in the Kosei region around March. Even though during the morning it is clear and the lake is calm, in the afternoon, it can suddenly and without warning become a gale force wind known as the *Sangatsu-hayate*. It is usually warm and windless until noon, but the clouds in the sky are flowing unusually fast from west to east and disappear when they leave Hira Mountains and reach the sky over Komatsu. These clouds are called *Teppo-dama* which means gun balls. Gradually, waves begin to swell on the surface of the lake near Komatsu, but the winds from above have not yet arrived. As time goes by and the winds reach Komatsu, the direction of the wind shifts to the northwest and the weather suddenly changes, with the strong winds of *Sangatsu-hayate* blowing, bringing rain or snow.

It is very dangerous to be on the lake when strong wind gusts occur. In the western part of the lake, if a boat is carried out onto the lake by the wind and capsizes when hit from the side by a wave, rescue can become difficult. Locally, there are fishermen who have lost their lives in the *Sangatsu-hayate* and others who miraculously made it to the other shore. For these reasons the *Sangatsu-hayate* is the most feared wind locally.

The following is a description of the characteristics of *Sangatsu-hayate* as revealed in the interview with Toshio Ikeda. Mr.Ikeda was born in February of 1926 in Kitakomatsu, and was the third generation of the "Shinjiro" shipping business family in Kitakomatsu. He was involved in transporting stones quarried and processed in Minamikomatsu to the Nagahama area as a shipping agent. His many years of experience as a maritime transport operator and sailor carrying stones and sand has given him a wealth of knowledge about the wind, waves, and weather on Lake Biwa. Observing the way clouds move like Mr. Ikeda does, and predicting how the wind blows is called *keshikimi*

Kazuyuki Matsui: Mr. Ikeda, you have been in the shipping business, and if you have ever had an extraordinary experience, please share your story.

Toshio Ikeda: Well, I have witnessed many times when a ship was on the verge of being lost or wrecked, even after it became a steam-powered ship. We have heard many stories about the time when these ships were under sail. There are people who had died in the *Sangatsu-hayate* that we are talking about now, and fishermen in Komatsu who also died. I vaguely remember when I was a child that the parents of those who died in shipwrecks held memorial services at the beach. I don't know how many generations before the current Owasa (house name), but of course it was during the time of oar making that 2 people died in the *Sangatsu-hayate*. I also heard stories including people who died when they were working on the oars and sails of the Maruko ship. I remember when we went from Nagahama to Takeshima Island, the southwesterly wind started to blow, and we had to run away to Chikubu Island with the waves behind us because we could not fight against the waves. We had to pull a hired boat. I was on the boat behind the hired boat and we both started our engines and ran, but we couldn't fight the waves, so we evacuated to Chikubu Island with the waves behind us. In that case, I thought of fleeing to the

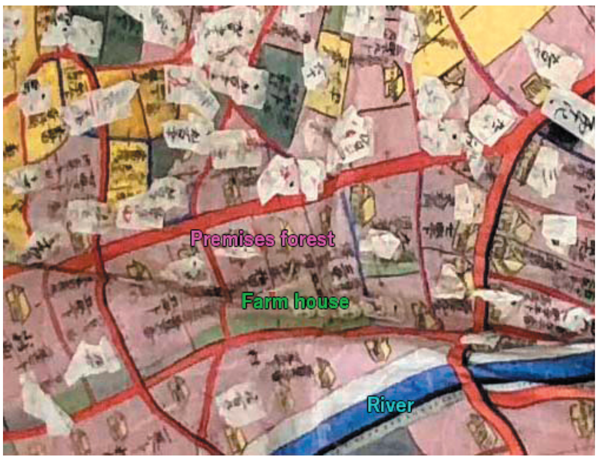

Figure 4: Minamikomatsu village and its premises forests in the Meiji period (Enlarged part of the general picture map of Minamikomatsu Village, owned by the Minamikomatsu Community Association).


Photo 4: View of Minamikomatsu with premises forests (c. 1955, Collection of Mr. Kiyotsugu Kimura)

Photo: 5 Premises forests along Yanomune river (2023)

shady Funaki-no-saki. However, the side waves were too strong, so I tried to run toward this side as much as possible, but the rolling was too severe, so I took shelter toward this side. Because the wind was strong, I sometimes climbed onto the shore of the sandy beach to endure the wind. But if it was a rocky beach, it was not possible to do so. Then there were cases where we ran into the sandy beach.

Tomoyuki Aoyagi: Even in the same Lake Biwa, there are places where the mountains are close to the lake, and there are places like Funaki and Warasono, where there are mountains set back from the rice paddies. Is there a difference in the way the wind hits the lake depending on where you are?

Ikeda: Of course there is.

Aoyagi: Is it that much stronger if there is a mountain in front of you?

Ikeda: The closer you are, the stronger the wind will be.

Photo 6: A View of Moriyama with premises forests (2020)

Aoyagi: Avoid mountainous areas when fleeing, and use beaches instead.

Ikeda: No matter how big the waves are, the wind is too strong, and it is not good to be caught in a crosswind anyways.

Aoyagi: That's because you get hit on the side of the head.

Ikeda: In that case, if the ship falters, we may run into the wind. Well, to avoid such a situation, I look at the clouds and say, If this wind is blowing this way, it won't blow until around what time? Anyway, the flow of clouds is a good indicator of the weather.

Matsui: Can you tell me about the *Sangatsu-hayate* again?

Ikeda: It's been really sunny in the morning. But every once in a while, a small cloud would pop up and then drift away at a very fast speed. Then they would quickly disappear in the midstream. In the morning, there is little increase in cloud cover, but in the afternoon, the amount of cloud cover increases. And the wind changes from around 3PM. The weather was unbelievably nice that morning and I couldn't believe it was going to be such a gorgeous day. And if you don't know *Sangatsu-hayate*, you might say, "What are you talking about, it's going to be nice today?" One day, 37 years ago, I built a new sand boat and brought it to Nakanishi Gumi (Association), a sand company in Ono, Wani, where I was doing some work. The president of the company told me that on such days in March, he would go out in the morning and would not even think about not working. Anyway, when I see such a cloud in the morning, I don't think about working. When I went there in the morning and said, "Today is a day like that, so I'm going to stop now," he replied, "What are you talking about?" If I don't work on a day like today, when will I work? The employees of the Nakanishi-gumi had to work because their boss said so. They almost sank the boat that day. I had no choice to go out. Then he told me, "How wonderful, you people have been living in Lake Biwa for a long time." The difference was that he could not imagine that such a good day would turn into such a bad day. Indeed, even people around here who are not fishermen or boat people would say, "What are you talking about? On such a beautiful day." That, too, would depend on how fast the clouds were moving. Oh, if it's this fast, it'll be fine for the rest of the day, or we have to come back by noon today. You have to judge it by the speed of the morning clouds.

Aoyagi：For example, if you do *keshikimi* in the middle of the night and the wind dies down by midnight, it is called *yoiochi*, meaning

Photo 7: Residential area with premises forests in Kitafunaji (2020)

Photo 8: Large ever green trees making up the premises forest(2023)

Photo 9: A premises forest and a hedgerow(2022)

Photo 10: Winter premises forest and view of Lake Biwa(2023)

that the wind will not blow much the next day. However, if the wind is still blowing after midnight, it is called akaochi, which means that it will definitely be rough in the afternoon.

Ikeda:, but I have no idea about the science behind this, but I often hear in weather forecasts that there is a low-pressure system nearby when northerly winds blow even after evening, or until midnight. So, in general, a northerly wind is an omen of a good day. But in the case of the rainy season, it is sometimes said that the next day will be rainy even though the north wind is blowing. Even experts are sometimes unable to determine the next day.

Premises forests at the foot of Hira Mountains

Some of the post-Edo period illustrations that remain at the foot of Hira Mountains show a small area of wooded land near the residence. Figure 4 is a map depicting Minamikomatsu in the early Meiji period (an enlarged part of the general map of Minamikomatsu Village, District No.16, Shiga County, Omi Province (estimated to have been created in 1873)). You can see that a wooded area is depicted in green in the northwest direction of the residence located near the present-day Yanomune River shown in blue (a private house is depicted in light red). Photo 4 shows Minamikomatsu around 1955. Lake Biwa and an inland lake are located in the upper part of the photo (east side), and private houses in the village adjacent to rice paddies are dotted with premises forests. Until this time, many private residences had their forests located mainly in the northwestern direction for wind protection and other purposes. Today, premises forests can still be seen near the Yanomune River (Photo 5), and they serve as windbreaks against the *Hira-oroshi* and to reduce flood damage from the Yanomune River.

Since the 1960s, the number of premises forests at the foot of Hira Mountains has decreased as modernization and urbanization progressed, but some premises forests still remain today (Photos 6 and 7). Many of the trees that make up the forests are large evergreen trees such as *tabunoki*, Japanese oak, and cedar (Photo 8), and these provide sufficient windproofing against the winter *Hira-oroshi* winds. There are also many private houses with stone walls and hedgerows around the houses with a mixture of trees such as Camellia japonica, *kaya*, Japanese cedar, Japanese *enoki*, Japanese oaks (Photos 9, 10). This is an example of traditional and local knowledge that makes good use of trees, mainly native species, that are suited to the local climate as a disaster prevention and mitigation measure against *Hira-oroshi*.

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Wetlands around the inner lake and *Euphorbia adenochlora* as a disturbance-dependent species

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Photo 1: A colonies of *Nourushi (E. adenochlora)*

Introduction

Around the inner lake, wetlands are formed by the fluctuation of the water level of the inner lake and by the disturbance caused by running water and sediment from the incoming river. In wetlands, ecotones (transition zones) are formed by slight differences in elevation (microtopography) from the water's edge.

This ecotone is inhabited by a variety of plant species, depending on the microtopography and sunlight conditions. Many of these species are called disturbance-dependent species, which are able to grow because the ecotone is dynamically maintained by disturbance. Disturbance, however, can also unexpectedly threaten human life by causing disasters. Therefore, humans have controlled nature to reduce disturbance, for example, by fortifying levees to confine running water within the river channel and by controlling fluctuations in lake levels with weirs. As a result, many disturbancedependent species that grow in wetlands have lost their habitat and are in danger of extinction.

Nourushi (*Euphorbia adenochlora*)

Nourushi is one of the disturbance-dependent species that grows in the wetlands around the inner lake of Omimaiko. It is a plant that grows in bright, moist areas, such as riverbeds, ponds and swamps, and marshlands, where it develops enlarged rhizomes and grows in groups (Kurosawa 2015). In the Kinki region, shoots (above-ground parts) can be seen from April to June, and it is a dormant spring plant outside of this period (Yamasaki 1999; Kurosawa 2015). It is declining nationwide, mainly due to the loss of its habitat, and is listed as a semi-threatened species by the Ministry of the Environment. In the wetlands around the inland lake of Omimaiko a magnificent colony of this plant can be seen (Photo 1).

Growing Environment of Nourushi

With many of the disturbance-dependent species that grow in wetlands threatened with extinction, why do we see colonies of nourushi in the wetlands around Omimaiko, as shown in Photo 1?

Let me digress for a moment. In general, wetlands are often difficult to survey because they are muddy and densely overgrown with herbaceous plants. Drones have been attracting attention in recent years as a means of surveying such areas. Drones can be used to fly over wetlands from outside the wetland and acquire a variety of environmental information. In addition, because human intrusion does not invade the environment, it can reduce the risk of environmental modification by the researcher himself, for example, by unintentionally introducing non-native species.

The drone was equipped with various sensors and surveyed the wetlands around the inland lake for about a year (Niwa 2022). As a result, we found that the nourushi growing around Omimaiko has a natural population (hereafter referred to as "natural"), a population distributed in areas where local people mow the grass (hereafter referred to as "mowing"), a population transplanted in conjunction with the development of glamping facilities (hereafter referred to as "transplanting"), and a population distributed in abandoned farmland, along canals and in parking lots (hereafter referred to as "Other"). The "natural" population is a mixture of large and small above-ground clumps (patches) of nourushi, suggesting that individuals of different ages are growing in this area Japanese society is faced with a declining birthrate and an aging population, but for a society to sustain itself, it is important to have an unbiased population of people of various ages. The same is true for nourushi. Places with a mix of individuals of different ages are more likely to be sustainable. "Mowing" is also likely to persist where patches of nourushi, large and small, are growing in a naturalistic manner. "Other" is considered less likely to persist due to the lack of small patches of nourushi and the lack of next generation growth.

We have already mentioned the importance of microtopography in ecotone. The microtopography can be surveyed with a laser instrument mounted on a drone. Using the results of the drone survey, we analyzed the relationship between elevation and nourushi growing in the area around Omimaiko (Figure 2). "Natural" was found to be distributed

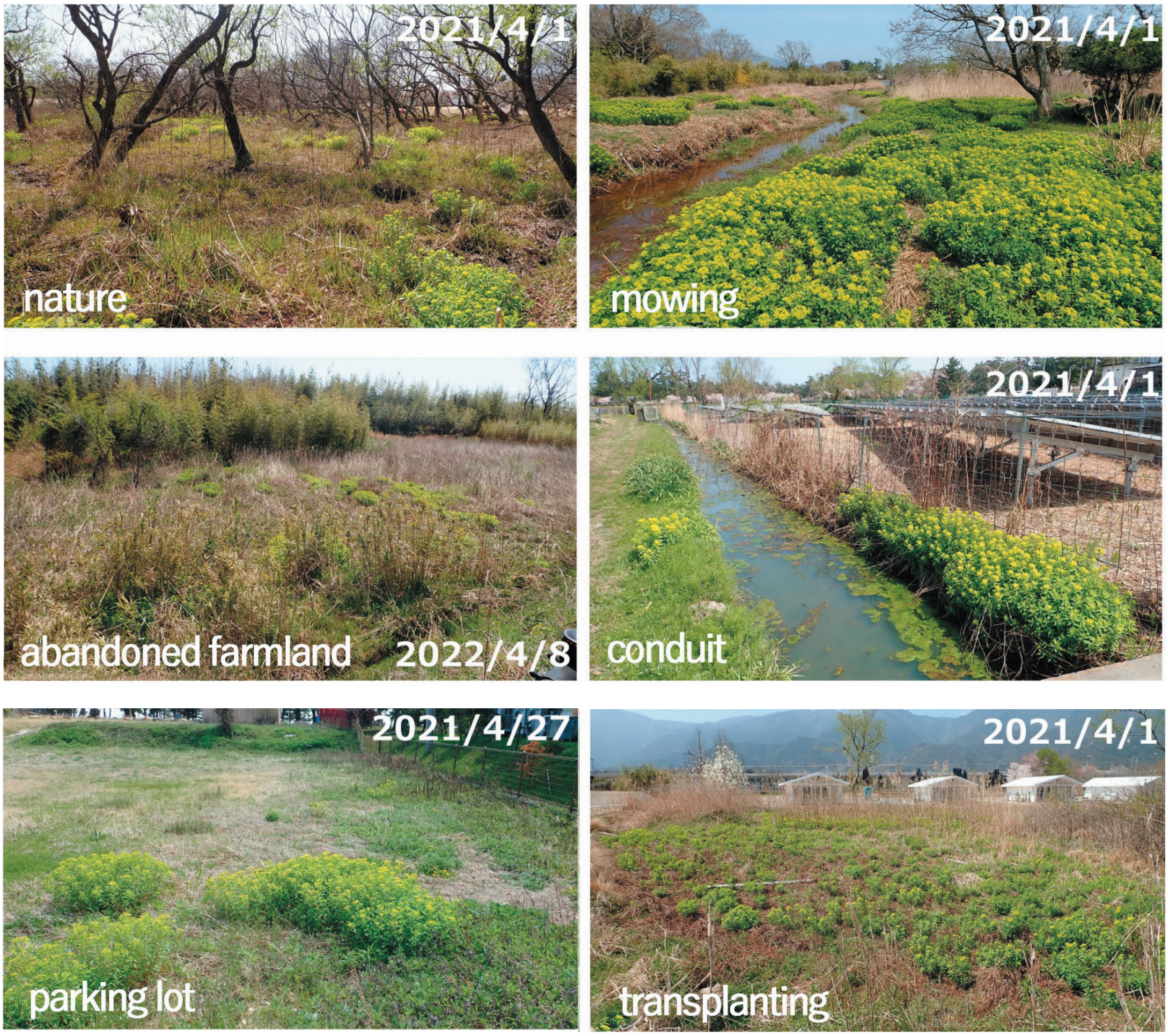

Figure 1: Six types of nourusi populations.

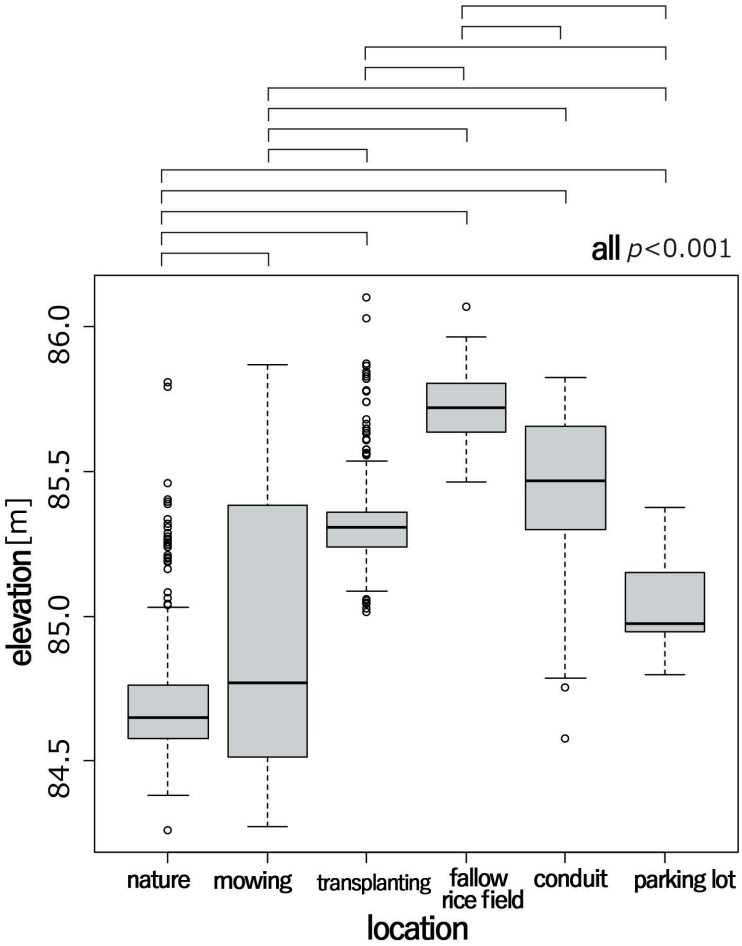

Figure 2: Relationship between six types of nourushi growing and elevation.


Photo 2: Reed cutting (mowing)

at the lowest elevation. The "mowing" species was found to be distributed at elevations similar to those of the "natural" species, but also at higher elevations. "Transplanting" and "Other" were found to be distributed at higher elevations than "Natural". Considering that the elevation where "Natural" is distributed is the most suitable for nourushi, it can be said that "Mowing" grows in a wider range of elevations, while "Transplanting" and "Other" are not suitable for higher elevations.

In summary, "natural" is a population that persists due to natural disturbances. "Mowing" is a population that is sustained by human disturbance through mowing, which allows it to grow in a wider range of sites than "Natural". "Transplanting" and "other" are vulnerable populations that will not persist without continued mowing at least. Around the inner lake of Omimaiko, wetlands with ecotone formation are found, and disturbance-dependent species symbolized by nourushi are growing. While natural disturbances caused by water level fluctuations and rivers are decreasing due to human control, we found that the human disturbance of reed cutting (mowing) has a positive impact on the survival of nourushi. It can be said that the wetlands around Omimaiko have the function of mitigating natural disasters and serving as a base for connecting the region and the ecosystem, by dealing with natural disturbances and passing on the traditional human disturbance of reed cutting.

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【Traditional and Local knowledge of Eco-DRR from different locations of Japan】

Photo：WANG Wen

Concluding Discussion

by editors of the series.

How do we pass on traditional and local knowledge?

In what kind of society can traditional and local knowledge be utilized?

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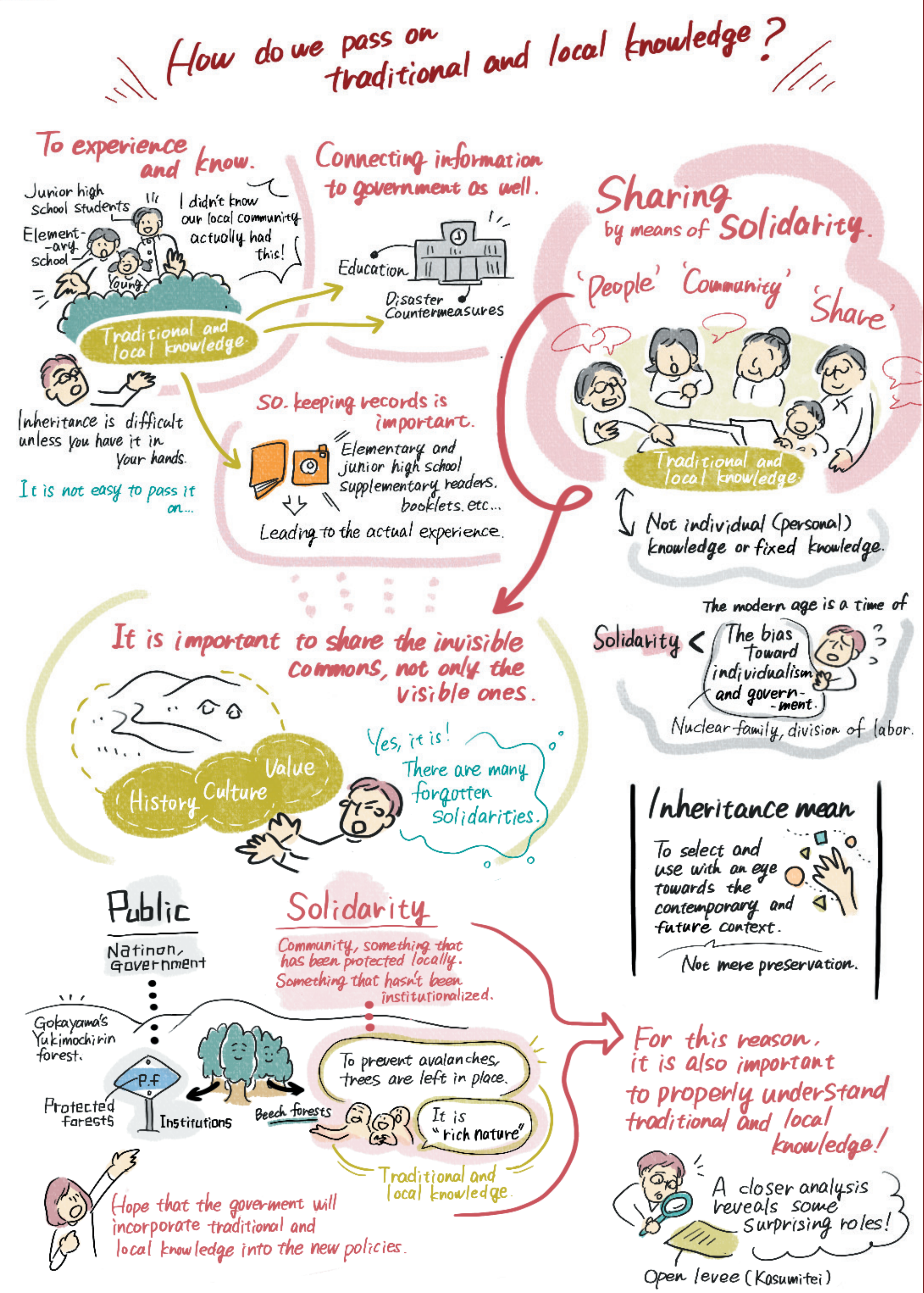
Graphic : Yu Aruga



How do we pass on traditional and local knowledge?
To experience and know.
Junior high school students
Element-ary school
Young
I didn't know our local community actually had this!
Traditional and local knowledge
Inheritance is difficult unless you have it in your hands.
It is not easy to pass it on...
Connecting information to government as well.
Education
Disaster Countermeasures
So, keeping records is important.
Elementary and junior high school supplementary readers, booklets, etc...
Leading to the actual experience.
Sharing by means of Solidarity.
'People' 'Community' 'Share'
Traditional and local knowledge
Not individual (personal) knowledge or fixed knowledge.
The modern age is a time of
Solidarity < The bias toward individualism and govern-ment.
Nuclear family, division of labor.
It is important to share the invisible commons, not only the visible ones.
History
Culture
Value
Yes, it is!
There are many forgotten solidarities.
Inheritance mean
To select and use with an eye towards the contemporary and future context.
Not mere preservation.
Public
Natinon, Government
Gokayama's Yukimochirin forest.
P.F
Protected forests
Institutions
Beech forests
Solidarity
Community, something that has been protected locally.
Something that hasn't been institutionalized.
To prevent avalanches, trees are left in place.
It is "rich nature"
Traditional and local knowledge.
Hope that the government will incorporate traditional and local knowledge into the new policies.
For this reason, it is also important to properly understand traditional and local knowledge!
A closer analysis reveals some surprising roles!
Open levee (Kasumitei)

Because
local production for
local consumption produces
various blessings through
synergy.
Examples
Finding and using firewood.
Going into the mountains so they will be cared for ...
Encountering the blessings of the mountains.
wild vegetables
Connecting to food culture.
From an economic point of view, the result is efficient, isn't it?
The community is made up of many connections!!
Using wisdom to make good use of the blessings in front of us, like local production for local consumption.
Local goods
How to make the best use of resources?
I hope this will be appreciated!
It's important!
On the other hand,
exchanges would cause environmental burdens due to transportation.
Do you have the sensitivity to accept that?
Sensitivity is ...
Experience
Time
Created by the accumulation of Experience and Time reading one's feelings.
The sense of feeling and thinking.
To feel the blessings and disasters of nature, we must experience nature!
Feeling the blessings of nature.
It's cold!!
A calming sound~!
Fish!
When our senses are enriched, we gain pseudo-experience through imagination.
This leads to the power to create anew.
It's frightening...
If the current is too fast, my feet will get scooped up...
If the current gets stronger, it will flood, and people and houses will be swept away?
Feeling the presence of disasters.

In what kind of society can traditional and local knowledge be utilized?
Do we have the sensitivity to feel "Nature's blessings!"?
There are two sides to what nature brings.
Blessings
Disasters
Can we make decisions based on the long-term perspectives?
Not just short-term outcomes.
It will be difficult to pass on this concept to the next generation unless the society can understand the value of this...
Disasters
We need to be able to cope with disasters without incurring too much cost.
Are you ready to engage in the risks?
With these things in place, we will have a society that accept the importance of tradition and local knowledge
Which is great!
We need to cherish this!
If all we need is to stop disasters,
We can simply do it with hard infrastructure.
But there are many problems associated with this...
We need to go back to traditional and local knowledge!
Otherwise, we won't make it.
The time has come to foster "Cooperation"!!
Instead of the too much "competition and efficiency"
Traditional and local knowledge
Commons
Community
It will be necessary at the root of society.
From now on, Engineering will be used in combination with traditional and local knowledge.

Editorial postscript

YOSHIDA Takehito　　Eco-DRR Project, project leader

Nature's blessings and disasters are two sides of the same coin. Each local community is expected to make wise use of these blessings while flexibly avoiding disasters in order to realize a sustainable society. At this time, there is much knowledge, wisdom and technology (traditional knowledge and local knowledge) that our ancestors accumulated in their respective communities that we, the people of today, should utilize and pass on. Unfortunately, however, this traditional and local knowledge is being lost at an alarming rate. The five booklets in the series "Eco-DRR as Learned from Local History" contain many such traditional and local knowledge. With climate change bringing more frequent and severer disasters, and regions facing many challenges such as population decline and biodiversity degradation, the utilization of traditional and local knowledge is expected to lead to the simultaneous resolution of local issues. We hope that traditional and local knowledge will be utilized to answer the important question of how people should connect with nature, which brings both blessings and disasters.

FUKAMACHI Katsue　　Traditional and Local knowledge group, leader

In reviewing various case studies from across Japan, we found that traditional and local knowledge for reducing disaster risks and obtaining blessings from nature for the entire community is still being passed on today, albeit partially, by local community associations and traditional organizations. In some areas, interest in traditional and local knowledge is growing through voluntary disaster prevention and education efforts, as well as citizen activities targeting *satoyama*. On the other hand, modernization and other factors have drastically changed land use and the way natural resources are used and managed, and local people have become less involved, and traditional and local knowledge is rarely taken into account in disaster prevention and mitigation policies and public works projects. It is time to reexamine a new path for disaster prevention and mitigation that takes advantage of the region's unique history and culture, and to utilize the healthy and abundant nature and ecosystems of the region while regenerating them. We would like to further deepen our collaboration to realize land use and disaster prevention planning that combines disaster prevention and mitigation functions found in traditional and local knowledge that can be applied today.

TERAMURA Jun　　Traditional and Local Knowledge group (Matsuura River edition)

Although I had visited the Matsuura River frequently for research and personal enjoyment, this time I had an opportunity to understand what the Matsuura River is and how local residents have interacted with the river and nature. I visited the area many times to learn more about it and as a result, I discovered the Funagata Yashiki, stone weirs, etc. It was a great pleasure to unravel the wisdom and history of the residents of the basin, who have been dealing with disasters.

I was suddenly appointed to create and edit the Matsuura River Local Knowledge and Traditional Knowledge, and having no experience in editing, I took the plunge and got to work. It was as if I was running as fast as I could without knowing where my feet were. Under these circumstances, the authors, Dr. Fukamachi, Dr. Yoshida, and Dr. Shimatani who gave me the opportunity, Ms. Shimauchi who edited and designed the book, and many other collaborators managed to complete "Traditional and local knowledge of Eco-DRR in and around the Matsuura River". We would like to express our deepest gratitude to all.

KOBAYASHI Hirohide　　Traditional and Local Knowledge group (Tonami Plain edition)

In Tonami City, Toyama Prefecture, urbanization has been progressing since the 1960s, and various urban structures have significantly changed the traditional rural landscape, but a bird's-eye view from the observatory still reveals a unique scattered village landscape. A closer look at the traditional houses and forests, which are the main elements of the landscape, reveals people's traditional and local knowledge of how to live in harmony with nature. We can also see that these are deeply related to the local landscape. It is said that in the process of developing the fan-shaped area of the Tonami Plain, dwellings were residential on the slight elevation between groups of small rivers, forming scattered villages, and the foundations of the houses are heaped high to prevent flood disasters. The forests of the mansions are planted with tall trees in that direction to protect them from strong winds blowing from the southwest. In addition to wind protection, they also serve as heat and cold protection, provide privacy, use fallen leaves and dead branches as fuel, and are used as building materials for the next generation. I feel that the role of this project is to explore these significant elements of traditional and local knowledge once again, and to create an opportunity to pass them on to the future.

SHIMADA Kazuhisa　Traditional and Local Knowledge group (Sanriku Coasta edition)

The Sanriku Coast consists of a number of intricate inlets. In addition, it is characterized by its steep terrain, which drops sharply into the Pacific Ocean from the Kitakami Highlands, and by the presence of forests, villages, and oceans within a single municipality, as well as by the inclusion of entire river basins from their headwaters to their mouths. As a result, the region has suffered from a variety of disasters, including sediment disasters, floods, and tsunamis.

On the other hand, the region has also enjoyed the bounty of the sea and mountains, and people in the region have a strong sense of "living together with nature. In this region, which experienced the Great East Japan Earthquake, we were able to gather many examples that differ from other surveyed areas in that traditional and local knowledge also had a significant impact on the recovery process. As the population continues to decline in this region, and traditional and local knowledge cannot be passed on to the next generation, we hope that the examples presented in this booklet will provide hints for solutions.

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Eco-DRR as Learned from Local History

Traditional and Local knowledge of Eco-DRR from different locations of Japan

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