10

Agricultural Crises Due to Flood, Drought, and Lack of Sunshine in the East Asian Monsoon Region: An Environmental History of Takahama in the Amakusa Islands, Kyushu, Japan, 1793–1818

Satoshi Murayama
Kagawa University, Japan

Noboru Higashi
Kyoto Prefectural University, Japan

Hiroko Nakamura
Kagawa University, Japan

Toru Terao
Kagawa University, Japan

https://doi.org/10.26493/978-961-293-399-9.217-252

A New Horizon in Comparing Economic and Environmental Histories

The approach of this chapter was originally rooted in Sheilagh Ogilvie's institutional studies (Dennison and Ogilvie 2007; Ogilvie 2007, 2010) of the interrelationship between social capital and power, as well as in gender studies focused on consumer activities, especially those of women, dating back in part to Jean de Vries' discussion of the 'industrious revolution' (Murayama and Nakamura 2021). However, we present a new area of discussion: the diversity of economic development in early modern Japan. We have focused on the environmental system unique to Asian monsoon regions. For the maintenance of the early modern 'subsistence economy', especially in Japan in East Asia, the sustainability of agricultural production depends primarily on resilience to seasonal disasters.

Murayama, S., Ž. Lazarević, and A. Panjek, eds. 2024. *Changing Living Spaces: Subsistence and Sustenance in Eurasian Economies from Early Modern Times to the Present*. Koper: University of Primorska Press.

The main objective of this chapter was to show new ways of comparing Japan and pre-modern Europe by drawing on Fernand Braudel's three layers of economic life. This was done to broaden our understanding of this phenomenon and its influences on early modern societies. In Braudel's words:

I wish, in particular, to stress that material life can be divided into three levels. I see the market to be the equator. South of the equator is the southern hemisphere, that is, bartering, and it is above the equator, in the northern hemisphere, that we find capitalism. The southern hemisphere, that is, the level embracing bartering, is what is called '*economia sommersa*' (submerged economy) in Italian.[1]

Consistent with this comparative scheme, Saito Osamu (2005, 2015a; 2015b) extended comparative studies of pre-modern Europe and Japan based on similarities observed in the 'market' layer and significant differences in the lower and upper layers, or at the level of household economy and capitalism. This chapter focuses on this lower layer, which Braudel referred to as the 'underground' economy, and highlights the existence of locally oriented ecological and climatological conditions that could determine the upper layers of the market economy and capitalism in the early modern period.

European economic historians have long debated the origins of the Industrial Revolution. Jan de Vries and others attempted to explain economic development in terms of changes on the demand side (Hayami 2003; Vries 2008; Muldrew 2011; Vries 2013). Early technological development in England and the Netherlands was stimulated by market demand driven by people seeking to improve their standard of living. European economic history is also characterized by a tremendous development of 'capital', such as mercantile capital and state capital. Neither could develop in Japan because international trade did not exist due to a political decision by the Tokugawa shogunate that isolated Japan from the rest of the world, and the economy was sustained by a 'rice-oriented' local village economy. In the absence of international trade, Japan achieved a level of early modern agricultural development, including market-oriented production comparable to that of England. However, 'Japan's upper- and middle-class layers were much thinner than those of its English counterparts', and 'the "extent of the market" was smaller than in England'

1 Braudel (1986, 94) (translated from the original French text by Hiroko Nakamura).

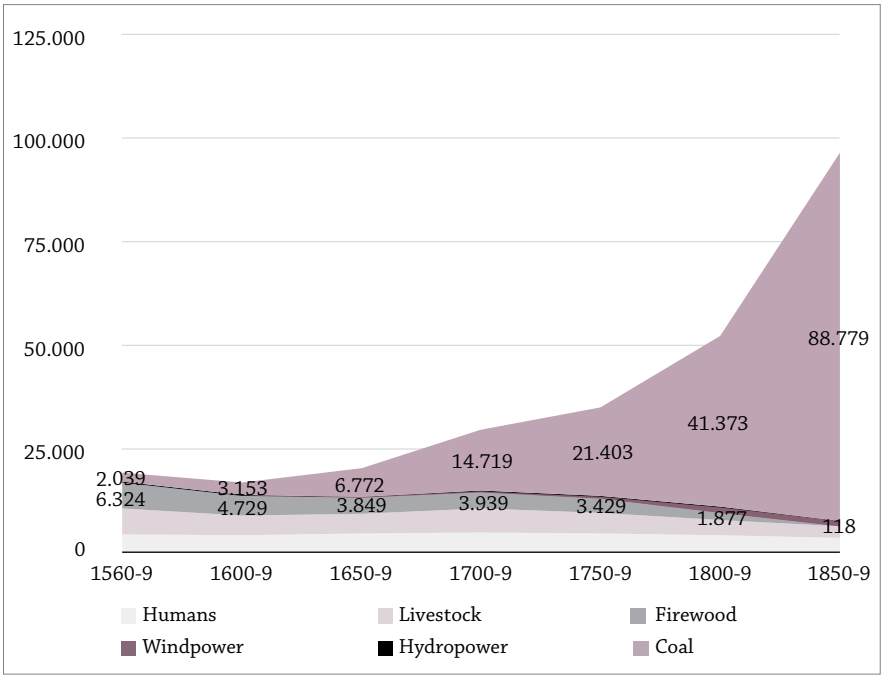

Figure 1 Annual Energy Consumption per Head in England and Wales (MJ)

Note Numerical values in figure 1 relate to coal and firewood.
Source Wrigley (2016, 34), table 3.2.

(Saito 2005, 42). This was Osamu Saito's main argument for the crucial difference between Japan and Europe in the early modern period in the context of economic development. However, the process by which the Industrial Revolution occurred was not a simple economic process, but rather a combination of segmented processes that were particularly evident in the transformation of organic economies in a geographic context (Wrigley 2016, 95–100).

Figure 1 shows that the increase in coal consumption had already begun in the sixteenth century in the United Kingdom, which was the first country to enter the Industrial Revolution. The turning point occurred in the seventeenth century (Wrigley 2016, 30–44). In the Industrial Revolution era, the amount of coal consumed actually increased rapidly. The petroleum era came soon after. On the other hand, the United Kingdom was freed from the shackles (Wrigley 2016, 204–5) of forest resources, such as firewood, which were necessary for heat supply. The use of coal marked the beginning of the move away from an organic economy,

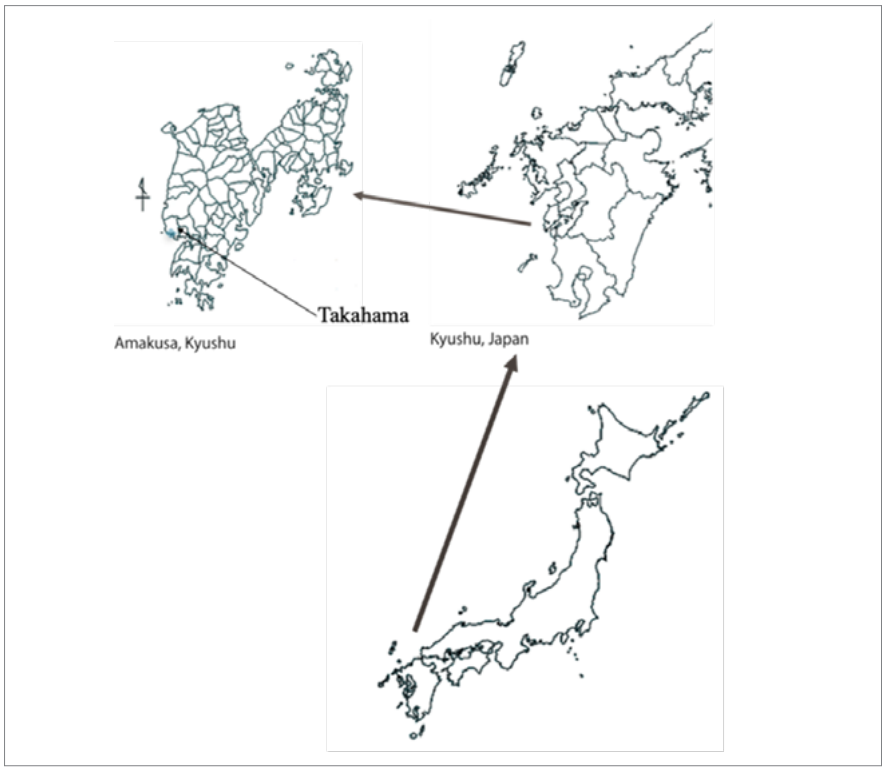

Figure 2 Amakusa in Japan and Takahama

and this fundamental change in the environmental history of Britain occurred much earlier than the Industrial Revolution. E. A. Wrigley argued that this change enabled sustainable economic growth in Britain. In other words, the liberation from natural constraints meant the end of the era of the organic economy, which was to be affected by hydro-climatic conditions and climate change.

Takahama, a village in the Amakusa Islands, Kyushu, Japan (figure 2), is located in a relatively warm region of Japan. Therefore, even in the diary of Ueda Yoshiuzu, one of the most important historical sources we used for our research (as explained later in the text), there is no mention of the use of firewood for heating, although fuel resources were needed for daily life.

The environmental history presented in this chapter focuses on the village of Takahama and covers the period from the late eighteenth to the early nineteenth century. When comparing to the local or regional history

of the United Kingdom, it was necessary to determine which time period was optimal. Using energy consumption as an indicator for periodization, the relevant period in Takahama was before the seventeenth century in the United Kingdom, which paved the way for the Industrial Revolution. As part of the Asian monsoon region, Takahama struggled with the constraints of the organic economy (figure 3). To clarify the characteristics of this Asian monsoon region and contrast the crop constraints of an organic economy in Takahama, we focused on monsoonal climate events with clear seasonal patterns that significantly affected agricultural production from spring to autumn. Large areas of South, Southeast, and East Asia are characterized by abundant annual rainfall (figure 3a).

On the other hand, monsoon systems provide a dry winter and a humid summer climate (figure 3c, d), although the geographic distribution of precipitation varies greatly and is related to topographic complexity. On the north and northwest sides of Japan, it is humid during the winter season because much moisture evaporates from the sea surface of the back-arc basins of the Japanese islands. This is also one of the results of the monsoon climate caused by the spectacular seasonal reversal of the thermal contrast between land and ocean. Monsoon systems result in dry, wet, hot, and cold periods, and their contrasting geographical and seasonal characteristics are influenced by tropical cyclones and storms (figure 3b), extreme weather conditions, and a lack of sunshine.

Population Changes in Takahama

Arthur E. Imhof, a German historical demographer, said the following:[2]

> Today it makes sense to talk about a life expectancy of—for example—seventy or eighty years, since the vast majority of us can really count on living that long. To count on any number of years—however few—would have been folly for our forebears up until but a few generations ago. On the contrary, one of the most pronounced characteristics of their time was the omnipresent danger to every human existence. Extended periods without at least one of the three scourges, 'plague, hunger and war', were unknown.

The major disasters in early modern Japan during the Tokugawa shogunate were rainstorms, floods, earthquakes, tsunamis, the spread of epidemics (especially smallpox), and fires. However, there were no mortality

2 Imhof (1990, 37). Historical demography revealed that the early modern mortality factors were chiefly epidemics, starvation and war. See also Imhof (1988, 92–102).

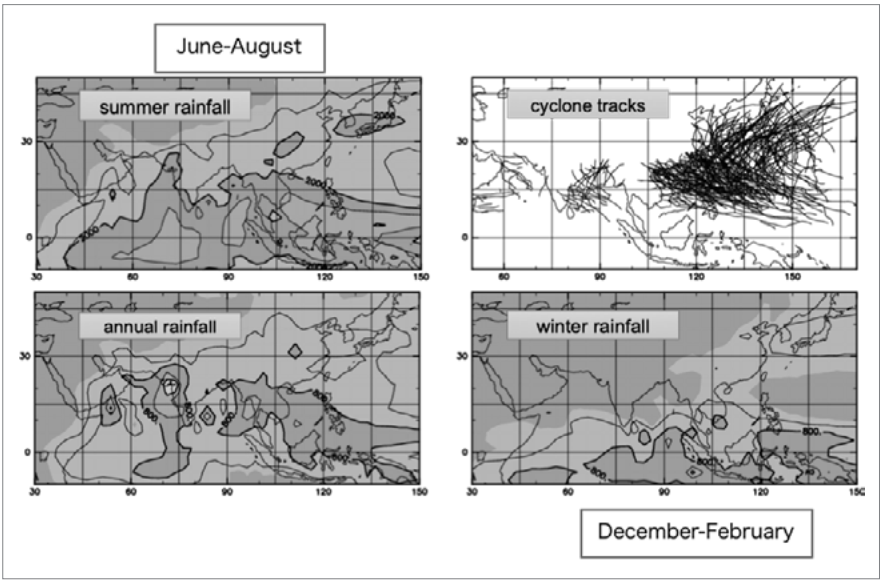

Figure 3 Rainfall in Asian Monsoon Areas

Sources and notes (a) annual, (c) summer (June to August), and (d) winter (December to February) precipitation amounts were based on the CPC Merged Analysis of Precipitation (CMAP in Xie and Arkin 1997), averaged from 2007 to 2016. Units are millimetres. (b) Tracks of tropical cyclones were based on the best track data from the Joint Typhoon Warning Center (JTWC), US Naval (Chu et al. 2002).

crises due to war during the Tokugawa period. Japan had no army during the two and a half centuries of Tokugawa rule, and this shaped the major mortality trends of traditional Japan. In stark contrast, early modern Europe experienced a population decline triggered by countless wars such as the Thirty Years' War, the Seven Years' War, the Great Northern War, the Napoleonic Wars and Wars of Independence, and the Franco-Prussian War. However, these wars were not the main cause of mortality, for even more threatening were 'the major epidemics that even small armies spread in their wake. The plague marched alongside the armies in the Thirty Years' War, together with typhus carried by lice in their clothing. More victims fell to these epidemics than to the small bands of soldiers with their primitive cut and thrust weapons, their unreliable and complicated guns, or even their actions of burning everything in sight' (Imhof 1990, 39).

Not war, but epidemics – especially smallpox – and famine were the major mortality factors in early modern Japan. Takahama in the Amakusa Islands is located directly on the sea and does not have sufficient arable

land for rice paddies. Takahama had a population of 3,413 in 1816 (Bunka 13), and the village *kokudaka* was only 611 *koku* in size, which was equivalent to 0.18 *koku* per capita.[3] The population of Takahama[4] went from a stagnant phase to a gradual growth phase, increasing from 3,086 in 1785 (Tenmei 3) to 3,470 in 1818 (Bunka 15). To examine how the disasters affected the population of the village, we need to look separately at the three periods of population decline: the first period from 1807 (Bunka 4) to 1809 (Bunka 6), when the population decreased by 63 people; the second period from 1813 (Bunka 10) to 1814 (Bunka 11), when it decreased by 41 people; and the third period from 1815 (Bunka 12) to 1816 (Bunka 13), when it decreased by 35 people (figure 4).

In contrast to Takahama, Sakitsu, a village near Takahama, suffered a dramatic loss of population as a result of three smallpox outbreaks in 1801, 1813, and 1834. As a fishing and trading port whose continued existence depended on its market network, Sakitsu experienced changes in its population: in 1690 it was 850, it rose to 2,466 in 1808, declined to 1,252 in 1864, and rose again to 1,414 in 1872 (figure 3). Studies on the effects of smallpox outbreaks shed light on the vulnerability of isolated early modern villages such as Sakitsu (Murayama and Higashi 2012), which suffered from repeated smallpox outbreaks. Isolation due to quarantine destroyed the economic interactions on which Sakitsu depended, and thus smallpox outbreaks led to rapid population decline. This observation shows that livelihoods during the Tokugawa era were primarily based on rice paddies

3 In the Tokugawa period, it was widely held that 1 *koku* (=150 kg of rice volume or capacity) was enough to feed one person for one year. According to Nakamura's calculation (1968, 168–74), the production of farm products in the benchmark year 1700 was 169 kg, exceeding the level of 150 kg (or 1 *koku*/person), and it increased over time to 201 kg in 1872. In many Japanese villages, land tax and other taxes were static or even slightly reduced, although the productivity of land was generally on the rise, and thus, an increasing amount of 'surplus' was a general phenomenon. The widely held notion that the land tax imposed during the Tokugawa period was cruelly oppressive is unsupported. While *kokudaka* did not reflect the actual productivity of a village, it served as a criterion that is commonly used within a region, and due to the ecological and climatic conditions of each village, the *kokudaka* per capita in a village differed enormously, not only regionally but even locally within neighbouring villages. According to our provisional study, the difference in village *kokudaka* per capita could have fluctuated from under 0.2 to more than 3.0 *koku*. See: Smith (1988) and also Alfani and Tullio (2019), especially regarding information on economic inequality in early modern fiscal states.

4 See the sources shown in figure 3.

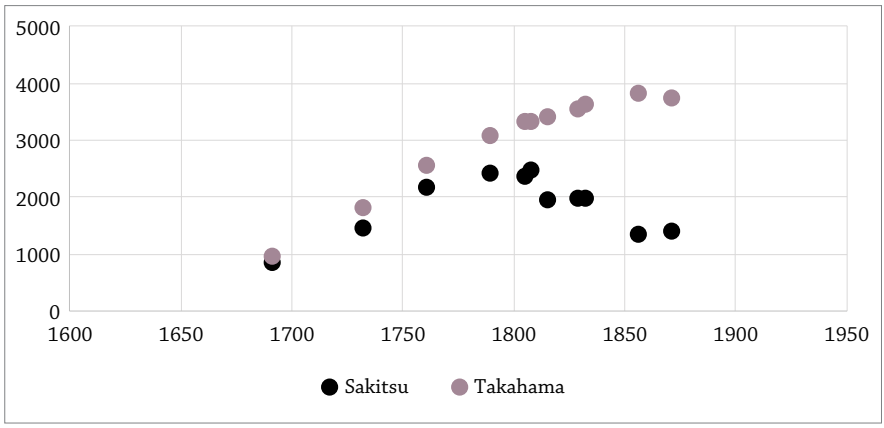

Figure 4 Population Changes in Takahama and Sakitsu, 1690–1879

Sources Amakusa Komonjyo-kai (1988–1993). II/III, 239–405; Amakusa-cho Kyoiku-iinkai (1985–1998); UkM, *Ueda Yoshiuzu Diaries*; UkM, *Village Records*; UkM, *Population Register of Amakusa Islands in 1692*]; Morinaga (1986).

and fields, but were simultaneously supported by village and commercial networks (Murayama et al. 2017, 238).

In societies that suffered from frequent disasters and epidemics, mortality crises were a social premise, and therefore economic societies and individual families were doomed to be challenged by sudden failure. On the one hand, economic historians can wonder how 'markets' sustained economic growth in such societies. On the other hand, environmental historians can examine the resilience of the land and the ability of people and natural conditions to recover.

Historical Sources for the Local Analysis

The administrative diaries of a village, or *mura* in Japanese, are quite valuable historical material. The local governors of Takahama wrote diaries every year, which were carefully preserved in the depository of the Ueda House, the family of the village head (*shoya*), until the present time, more than 200 years ago. These diaries detail the disasters and important events that occurred in the area and how the people of Takahama understood and managed them.

A *shoya* was the term for a peasant in the early modern villages of Japan. However, the term also refers to the administrative representative of the village. In Japan, the village head and administrator, i.e. the *shoya*, was free to keep an administrative diary to ensure the continuity and se-

Table 1 Disasters in Takahama, 1793–1818

Year	Bad Harvest	Flooding (times)	Drought**	Water Shortage**	Severe Wind	Earth-quake	Fire	Small-pox****
1793	0	0	0	8	0	0	0	2
1794	uk*	uk	uk	uk	uk	uk	uk	uk
1795	0	0	0	0	0	0	0	1
1796	uk	uk	uk	uk	uk	uk	uk	uk
1797	0	0	2	4	0	0	0	0
1798	0	0	0	9	0	1	0	2
1799	1	0	3	11	0	0	1	0
1800	uk	uk	uk	uk	uk	uk	uk	uk
1801	1	1	0	1	0	0	1	3
1802	0	0	0	5	0	0	0	0
1803	1	2	0	0	0	0	0	3
1804	0	4	0	2	0	0	0	1
1805	0	0	0	3	0	2	0	1
1806	1	1	0	6	0	1	0	0
1807	0	1	0	0	0	0	1	83
1808	0	0	1	2	1	1	2	126
1809	1	0	1	7	0	0	1	8
1810	0	1	0	0	2	0	0	11
1811	uk	uk	uk	uk	uk	uk	uk	uk
1812	0	0	0	2	0	0	1	1
1813	uk	uk	uk	uk	uk	uk	uk	uk
1814	0	0	0	6	2	0	1	100
1815	0	0	0	3	1	2	2	1
1816	1	0	0	0	1	1	0	2
1817	0	2	1	0	1	1	0	2
1818	1	0	4	9	0	2	0	4
Total	7	12	12	78	8	11	10	351

Notes *uk= unknown; **= Number of days when drought was at issue ; ***= Number of days delegated for rain making rituals; ****= Number of smallpox patients
Source Original digitised database from Amakusa-cho Kyoiku-iinkai (1985–1998); UkM, *Ueda Yoshiuzu Diaries*.

curity of local administration. However, it is rare to find such diaries. In addition to diaries, all local historical documents such as population registers, correspondence, official letters, and village budgets from the eighteenth and nineteenth centuries are safely preserved and available today. The position of *shoya* was usually hereditary, and thus the village's historical materials were long kept in the home of the village head's family.

The village head (*shoya*) of Takahama and Imatomi kept diaries describing the administration of the village community. The archives of the

Ueda House contain 89 diaries.[5] From these diaries, we were able to examine the comments of the village head, Yoshiuzu Ueda, between 1789 and 1818. Yoshiuzu served as *shoya* of Takahama for 30 years. As part of our research project, these diaries, which total 1,849 pages and over one million characters, were digitized into book form. Thanks to this digitization, we were able to more easily evaluate Yoshiuzu's diaries, which cover 26years. These diaries are not just memories, but serve as documentation, a manual for the administration, and evidence of how the government maintained the safety and peace of the village community.

By counting the records of disasters in the diaries of the village head using 21 diaries covering 26 years between the years 1793 and 1818, we learned that during this period there were five cases of crop failure, eleven earthquakes, ten fires, including three major fires, seven floods, and eight severe wind events that were probably storms (table 1). Two special smallpox outbreaks were recorded, as mentioned earlier, from 1807 (Bunka 4) to 1808 (Bunka 5) and in 1814 (Bunka 11).

Flooding in a Small River

Until the middle of the Meiji era (1868–1912), floods occurred almost every year in Japan's alluvial plains. In the delta regions, everyday drainage perplexed the inhabitants (Okuma 2007, 12). Since the introduction of modern civil engineering technology in the last quarter of the nineteenth century, water management in Japan has changed dramatically, with disaster prevention no longer the responsibility of individuals and communities but of the state. Water management has been greatly improved by large-scale construction projects with government capital investment and by the establishment of higher research and educational institutions for hydrological civil engineering (Doboku Tosyo-kan and Doboku-shi Kenkyu 2004).

In the hundred years that have passed since Western technology was introduced for river improvement processes, habitual flooding has been almost completely prevented under state management. Riverbanks have been made higher and much more stable against flooding. Flood gates, sluices, dams in upper streams, and drain pumps have been used

5 Higashi (2016, 27, 31): Buhitsu (who was a *shoya* from 1755 to 1789) left one diary; Yoshiuzu (= Gichin) (1789–1818), left 28 diaries; Nobuchika (1819–1822), left four diaries; Sadayuki (1823–1861), left 34 diaries; Sadauzu (1861–1872), left nine diaries; and a son of Yoshiuze, a *shoya* of Imatomi (a neighbouring village of Takahama) named Teion (1804–1818), left 13 diaries.

to control the flows of rivers. This was only the beginning of the history of the 'conquest' of nature in Japan. It seems to have been a victory of modern river improvement. Flooding in Japan has become surely less frequent. However, especially sediment-related disasters are caused, recently because of climate crisis, almost every year by extreme rainfall in Japan.

Traditional technical means of controlling rivers were pursued not only through labour-intensive efforts of the inhabitants, but also through various and systematic works on the banks based on communication and cooperation between villages. However, under the Tokugawa shogunate, no regional or national control system was possible, especially for long rivers flowing from the highest mountains to the seashore, because such rivers were divided into many regional and local dominions, and a unified river improvement control system based on national capital did not yet exist (Okuma 2007, 20).

In contrast, pre-modern waterproofing technologies did exist and should be considered the result of cumulative learning from ancient times. The seventeenth-century *Hyakusho Denki*[6] (*Chronology of Farming*) shows a series of 27 instructions on river improvement and water regulation, detailing dam construction, river drainage, and flow control methods. The collections of knowledge and technology were available to all Japanese villages. Two of the most important recommendations from the *Hyakusho Denki* were that (1) the residents themselves should check the water levels in their rivers and the weather conditions on a daily basis, and (2) that they should repair water facilities and dam reinforcement instruments every year and review river control construction projects as necessary (Furushima 1997, I, 187–8). In particular, the control of small rivers seemed to be well served by these instructions.

Today, the Japanese Ministry of Land, Infrastructure, Transport and Tourism defines the types of rivers in Japan (Ministry of Land, Infrastructure, Transport and Tourism Japan, n.d.-a). First-grade rivers are regulated by the River Law and administered by this Ministry. In 2010, there were 109 first-grade river basins and 13,935 rivers belonging to such a basin. The shortest stretch of the main first-grade river is 28 km long and the longest stretch, the Shinano River, is 367 km long. The larger

6 Furushima (1997, I, 186–232). The part of the book that was written from 1680 to 1682 shows technological attainment of perfection. Explanations of the book by Furushima (1997, II, 203–07).

river extensions between 50 and 100 km include 42 river basins. There are 2,714 second-grade river basins, which include 7,081 rivers.[7]

According to the River Law, the second-grade basin system includes rivers that are of public interest like the first-grade rivers, but these rivers are administered by individual prefectures rather than by the Ministry. The Takahama River, located in Takahama, Shimo-jima, one of the Amakusa Islands in Kumamoto Prefecture, is a second-grade river located only 3.5 km from its mountainous source. The Takahama is one of 81 basin systems, including 148 rivers managed and controlled by Kumamoto Prefecture. The average length of the main rivers is 8.2 km; the longest river is about 23 km long and the shortest is 1.6 km (Kumamoto Yearbook 2011). These small but diverse river systems, which exist in areas with warmer climates in southwestern Japan, can help grow a variety of crops and diverse vegetable cultivation cycles on a small scale throughout the year (Tanaka 2010, 73).

Small-scale river management has never been thoroughly studied due to the lack of historical material. However, our examination of the village head's records for the Takahama River uncovered rich material, such as administrative diaries, pictorial maps depicting disaster damage, and other original materials.

Regarding the 1803 flood (Kyowa 3), the village head's historical sources provide detailed information on heavy rains, the onset of heavy and persistent rains that caused flooding, damage assessments, detailed pictorial maps, and records of the reconstruction processes, including the number of workers and their schedules in the two-year post-flood reconstruction projects.

Flood, Drought, and Lack of Sunshine

Figure 5 shows the number of days on which rain-making rituals occurred between 1793 and 1818 and the number of flooding events. Since there are no records for five years (marked with an asterisk), we observed 21 years of events. In only three of these 21 years were there neither rain-making rituals nor flooding events. In 15 of the 21 years studied (71.4 percent), prayer rituals for rain were performed almost every year. Water scarcity appears to have been a major concern for Takahama residents. However, water scarcity was often associated with flooding in 1801, 1804, and 1806

7 Ministry of Land, Infrastructure, Transport and Tourism Japan (n.d.-b). These data were obtained on 30 April 2012.

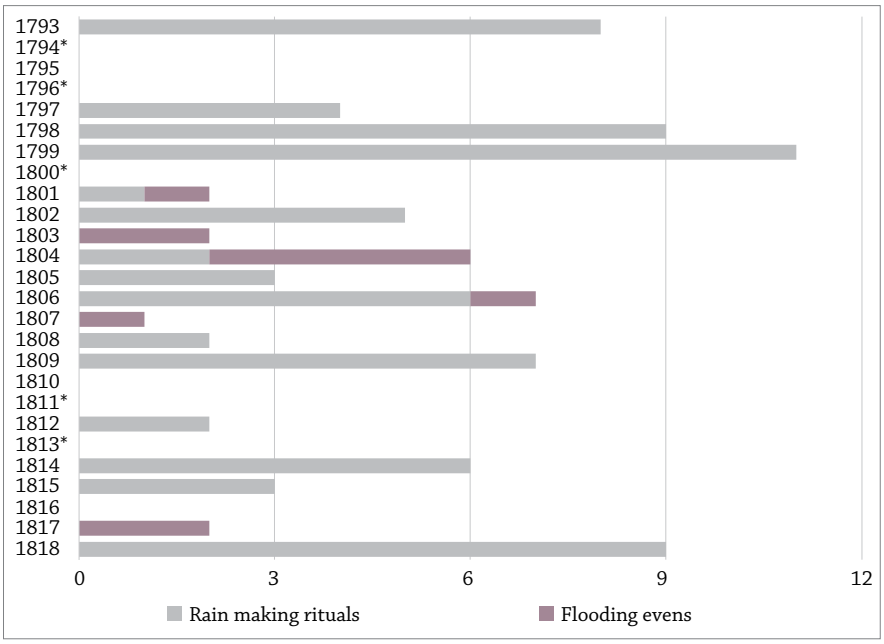

Figure 5 Annual Number of Rainmaking Ritual Days and Flooding Events, 1793–1818

Source Original digitised database from Amakusa-cho Kyoiku-iinkai (1985–1998); UkM, *Ueda Yoshiuzu Diaries*.

when these events were observed annually. Flooding also occurred when villagers and village officials were very concerned about water shortages.

The diaries also tell us about bad harvests because the villages had to pay taxes, especially on the amount of rice harvest. The first column of table 1 shows us the years in which bad harvests occurred. Within the observed 21 years, there were seven bad harvest years: 1799, 1801, 1803, 1806, 1809, 1816, and 1818. The reasons for the bad harvests were complicated. In 1799, there was a combination of drought and water shortage; in 1801, there was flooding and water shortage; in 1803, there was flooding; in 1806, there was flooding and water shortage; in 1809, there was drought and water shortage; in 1816, no explanations were given; and in 1818, there was drought and water shortage.

What we need to pay attention to here are the records from 1817. Since we have counted the number of drought days that appear in the diary, an entry stating that the 'drought could be avoided' was counted as well. This was the case in 1817. There was no bad harvest. The reason was that

even for a single village, there were drought-affected districts and other areas where irrigation could be used as usual; therefore, farmers were able to successfully adjust to the administrative policy of the village and minimize the damage. This shows that the rainfall and irrigation system affected the micro level, as they could manage the agricultural bases of the whole village in one unit, which enabled successful drought prevention. Floods also occurred in 1817.

On the other hand, drought damage also occurred in the year when prayer rituals for rain were frequent, often resulting in a bad harvest. Typical examples of this were the years 1799 and 1818. On the other hand, the year 1798 had the second highest number of days with rain rituals among the records from the observed 21 years. Despite this fear of water scarcity, there appears to have been no drought damage. This is considered a matter related to the amount of rainfall or its timing. Unfortunately, since there were no measurements of rainfall in Japan in the early modern period, we consider here the timing and frequency of rainy/cloudy or sunny, i.e. wet or dry, days.

Natural disasters such as earthquakes and storms were also noted in the diaries at the top of each day, as the village head briefly noted the day's weather after the date description, using terms such as 'fine', 'cloudy', 'rainy', 'storm', 'north wind', 'south wind', 'severe wind', and 'earthquake in the afternoon'. On 15 May 1797 (Kansei 9), for example, we find in the lunar calendar the description 'cloudy weather, southwest wind, calm wave'. Similarly, on June 19, the description was 'clear weather, northwest wind' In addition, on July 23, the description was 'sunny, easterly wind, daytime evening rain'. The description of 2 July 1803 (Kyowa 3), as mentioned above, was high waves and 'rainy, south-southward from the southeast and big wave'.

To quantify these weather statements, we assigned 2 points for rain, 1 point for clouds, 0 points for sunny days, 2.5 points for heavy rain, and 1.5 points for weak rain. Figure 5 shows a drought year in 1799, a flood year in 1803, a bad harvest year in 1816, and a normal harvest year in 1804. The difference in rainfall from May to August was determined using the monthly average points. Adequate rainfall and sunshine during these months were critical factors for rice cultivation and production. All lunar calendar data were converted to solar history data.

Figure 6 shows that the quantified, descriptive weather information from the diaries corresponds excellently with the years of the 1803 flood and the 1799 drought. It can also be seen that a normal rice harvest was

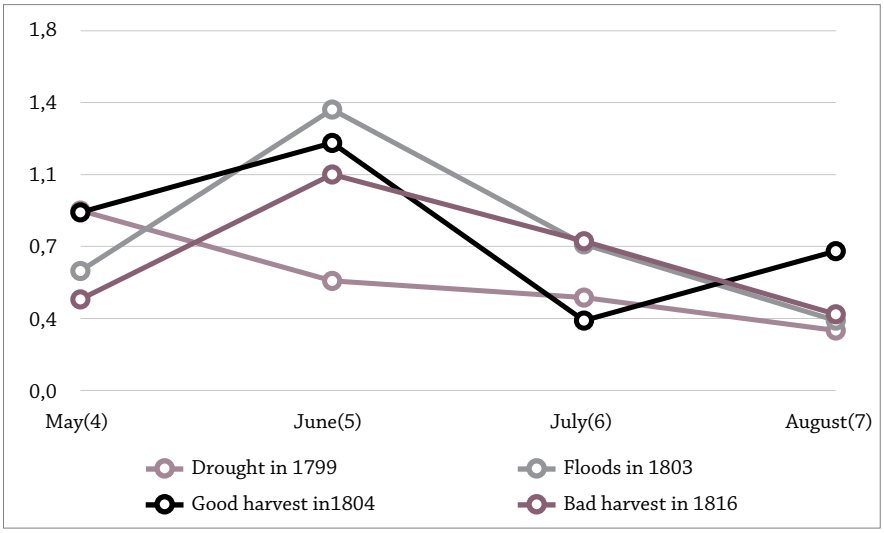

Figure 6 A Comparison of a Drought Year in 1799, a Flooding Year in 1803, a Good Harvest Year in 1804, and a Bad Harvest Year in 1816

Notes Monthly averages of weather points were drawn from the diaries' descriptive records on rainy, cloudy, and sunny days from May to August. A traditional lunar calendar was adjusted to a solar calendar. A higher index indicates a rainier month: extreme/heavy rain = 2.5, rain = 2, light rain = 1.5, cloudy = 1, and clear = 0.
Source Original digitised database from Amakusa-cho Kyoiku-iinkai (1985–1998); UkM, Ueda Yoshiuzu Diaries.

achieved in 1798. The crucial point was the timing of the rain. Regarding the rainy days in 1803, the number of days that rain fell was exceptional. The case of 1816 may indicate that there was not enough sunshine in July and not enough rain in August, so there was not enough mature rice for the harvest.

In summary, there was no rainy season in the drought year 1799. Second, the line plots for June (5) comparing the daily rainfall of 1799, 1803, 1804, and 1816, the 1803 curve of the flood year shows in the 1803 curve that the intense rains seems to be lasted longer than usual during the rainy season. According to the diary, the heavy rain surely continued from May 9 to 10, the fifth month of the lunar calendar (June 27–28 in the solar calendar). Then there were floods. Third, comparing the case of 1816 with that of 1804, when there was a normal harvest, figure 5 shows that the main rainy season in 1816 was not very strong. There were only a few days of fine weather in July; it is assumed that there was a lack of a sufficient amount of sunshine.

Figure 7 Monthly Averages of the Weather Index of Good Harvest Years: 1798 and 1804

Source Original digitised database from Amakusa-cho Kyoiku-iinkai (1985–1998); UkM, *Ueda Yoshiuzu Diaries*.

Comparing the average rainfall index (= average monthly rainfall points) in 1798 and 1804, when relatively good rice harvests occurred, figure 7 shows that the two curves are shaped similarly to oblique N curves. Thus, the optimal seasonal weather conditions for rice cultivation are (1) sufficient but not excessive rain in June, (2) sunny weather in July, and (3) moderate rainfall and fair weather in early August and late August and September until the harvest.

Peasants and village leaders wished for rain to improve the situation of rice cultivation. In this sense, it was possible to determine the relationship between rainy days and prayers for rain. We compared 1798, a relatively good harvest year, with 1799, a year of drought. Figure 8 shows the changes in monthly averages for both years. As shown in table 2, the number of dry days in June 1799 was much higher than in June 1798. In July, the inhabitants performed rain rituals four times. However, drought damage was recorded in the diary on July 23 (June 19 of the lunar calendar). This indicates that the possibility of buying grain for tax

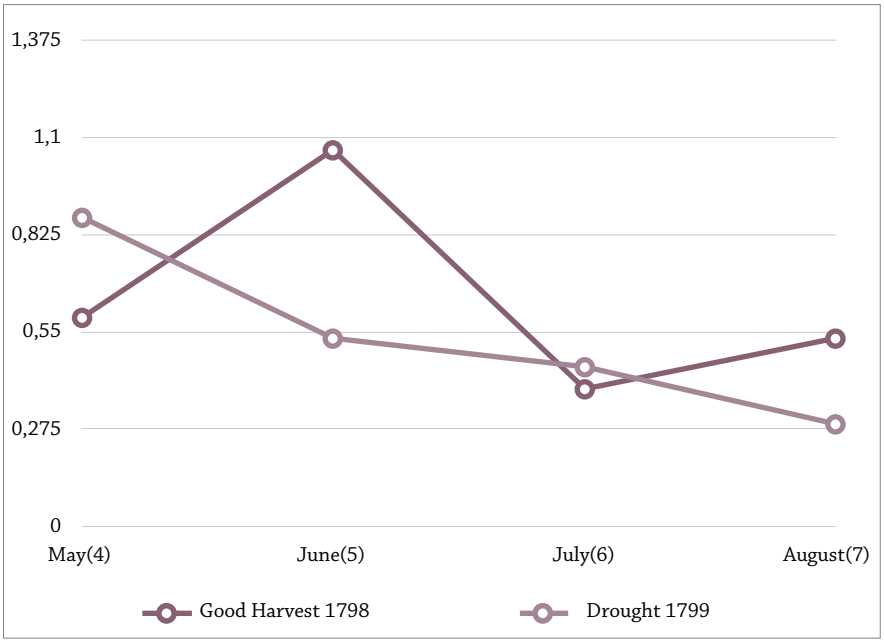

Figure 8 Average Monthly Weather Index Values of a Good Harvest Year in 1798 and a Drought Year in 1799

Source Original digitised database from Amakusa-cho Kyoiku-iinkai (1985–1998); UkM, *Ueda Yoshiuzu Diaries*.

was explored. The rainy days then continued for some time. In August, there were two weeks of sunny days. Although the rainy days began after August 23, drought damage was noted in the diary on August 23 (July 23 of the lunar calendar). This happened too late for the rice plants, which had already died.

It is clear that the timing of rainy and fair weather was crucial in avoiding agricultural crises. Drought can be avoided by having the desired amount of rainfall each year; thus, people developed various rituals to produce rain. A good harvest could be the result of a lucky combination and good timing between rain and sunshine. Even in 1798, a relatively good harvest year, two rainmaking rituals took place in August, because the rice harvest is always uncertain as it depends on weather conditions.

Flooded Paddy Fields in 1803 and a Recovery in 1804

According to the descriptions in the diaries, several episodes of heavy rains within ten days caused flooding in 1803. After heavy rains on April

Table 2 Occurrence of Dry Days and Rainmaking Rituals from June to August (Solar Calendar) for a Good Harvest Year, 1798, and a Drought Year, 1799

Solar C.	1798		1799	
	Dry days	RMR events	Dry days	RMR events
June	13		21	
July	25		21	1.Jul
				4.Jul
				8-12-Jul
		30.Jul		21-?-Jul
August	22	2-6-Aug	26	
		10-12-Aug		17.Aug

Source Original digitised database from Amakusa-cho Kyoiku-iinkai (1985–1998); UkM, *Ueda Yoshiuzu Diaries*.

29 (June 18 in the solar calendar), the diaries reported that on May 1 the river swelled and seemed to overflow its banks, damaging several parts of the banks as well. In the early morning of May 10 of the lunar calendar, a flood occurred. The water percolated from 2:00 pm to 3:00 pm. The flood damage was immediately investigated and a summary of the damage was listed in a special document dated May 11. The damage is summarized in table 3 and compared to other flood events. Residents of the cooperative village quickly and expeditiously surveyed the damaged sites and buildings. Unlike the flood of 1801, it took only a week for people to report the damage. A new image map was created in the following months to visualize the disaster.

Before mapping the damaged sites after the 1803 flood, an emergency construction project began on May 13 to stop the flow of water and prevent the spread of damage. A village official inspected each damaged site or structure, and by the end of May, broken walkways had been restored. Local government officials came to survey the damage and estimated that the damage in *kokudaka* was 130 *koku*, meaning that more than one-fifth of the village *kokudaka*, about 615 *koku*, was destroyed. On July 2, Takahama suffered further heavy damage from a large wave.

The *shoya* of Takahama submitted a request to the local government on July 5 for an estimate of the number of workers needed to repair the flood-damaged irrigation systems, including shore protection at the mouth of the river.[8] Figure 9 is a pictorial map of Takahama submitted

8 According to a description dated on July 5 in Original digitised database from Amakusa-cho Kyoiku-iinkai (1985–1998); UkM, *Ueda Yoshiuzu Diaries*.

Table 3 Damage Due to Floods in 1801 (Kansei 13), 1803 (Kyowa 3), and 1817 (Bunka 14)

Floods in Jun 13, 1801			Floods in May 11, 1803			Floods in Jun 6, 1817		
Type	Number	Scale	Type	Number	Scale and Remarks	Type	Number	Scale and Remarks
River Banks	8	234 m	River Banks	38	1411.2 m	River and Tide Banks	41	1148.4 m
			Tide Banks	2	63 m			
						River Shelves	14	8,424 m
						Mizu-Hane	4	81 m
						River Weirs	14	1,568 m
Shirasu Banks		360 m	Shirasu Banks	2	270 m			
Rice Fields		99 a*	Rice Fields	1,118.0 a	became river	Rice Fields	346.5 a	became river
			Rice Fields	1,287.0 a	flooded with water	Rice Fields	693,0 a	flooded with water
			Other Fields		sweet potatoes	Other Fields	198.0 a	land slide
			Houses	2	collapsed	Houses	4	collapsed
			Huts	1	collapsed	Huts	3	washed away
			Houses	8	walls collapsed			
						Fishing Boats	16	washed away

Note *a=100 square meter
Source Original digitised database from Amakusa-cho Kyoiku-iinkai (1985–1998); UkM, *Ueda Yoshiuzu Diaries*.

with the request. Shortly before this submission, on July 2, an additional 297.5 *a* (= 100 square meter) of rice paddies were flooded.

A new draft of an illustrated map of the village was started by Denkuro and Godayu on August 20 and completed on August 23. The composition and content differed fundamentally between this illustrated map (figure 9) and the illustrated map drawn several months later (map 3). The local government and the village official checked the site again, and Takeshiro, who was invited as a new painter, drew the details of the damaged areas from September 10 to October 9 with Sahichi's help.[9]

9 According to a description dated on October 9 in Original digitised database from Amakusa-cho Kyoiku-iinkai (1985–1998); UkM, *Ueda Yoshiuzu Diaries*.

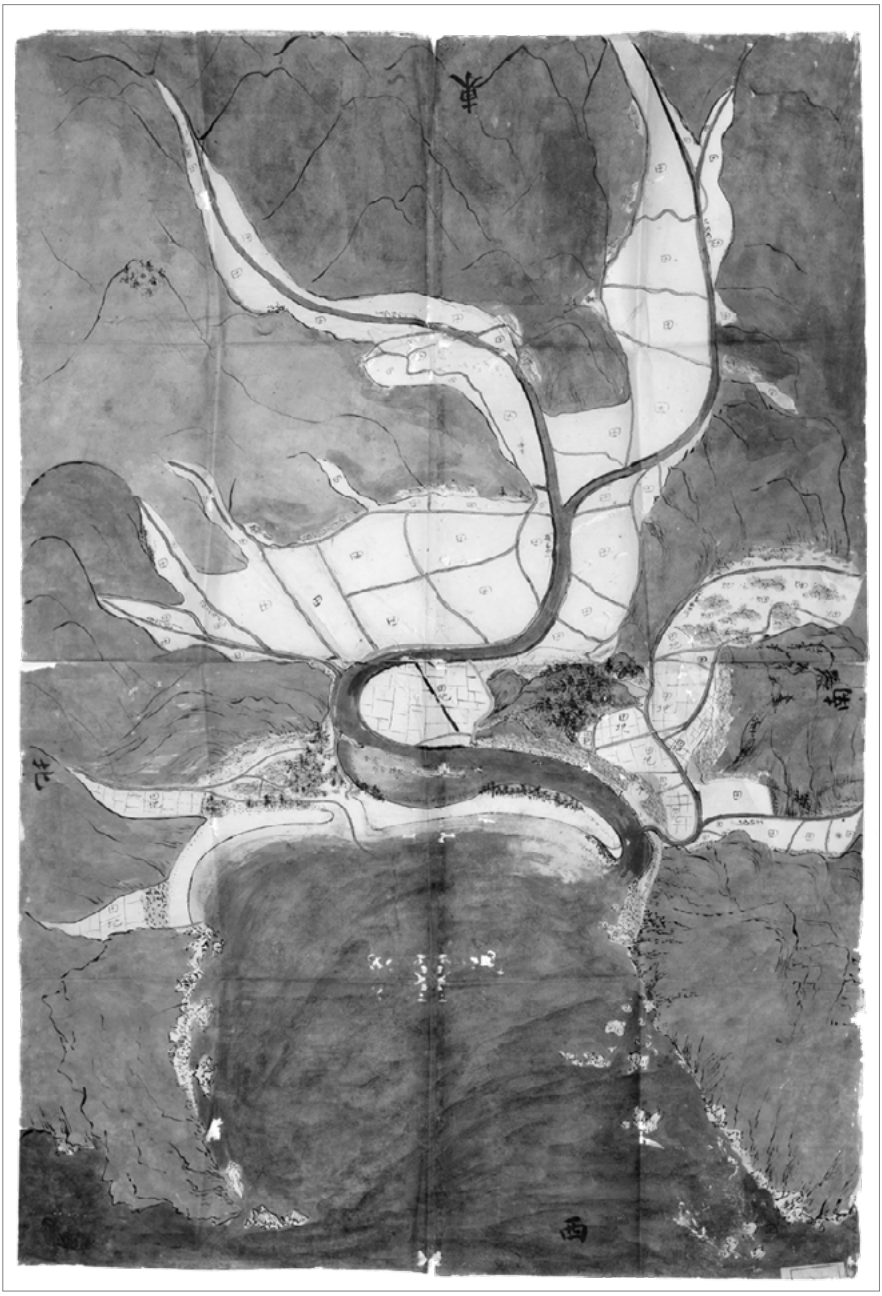

Figure 9 Map of Takahama, Drawn and Painted Before the Beginning of July 1803

Source UkM, Village Takahama Pictorial Map, 18, 2.

Figure 10 Flooded Areas that Were Caused by Floods on 9–10 May and by High Tide on 2 July 1803; These Maps Were Drawn and Painted Before 9 October 1803

Source UkM, Village Takahama Pictorial Map, 18, 3.

Collapsed banks and flooded areas were described in an accurate survey (i.e. figure 10). All communal water management sites were shown and the measured lengths of the structures were also drawn on the map in their correct locations. The shapes and locations of rivers, trails, and roads approximated their actual sizes and locations. After an accurate and rapid survey and its mapping, the village was able to secure the support of the local government. The support funds arrived on July 1 of the following year, 1804.

In June 1803, an emergency plan was put into effect to prevent the spread of damage after floods. From February of the following year, namely 1804 (Kyowa 4), the restoration of particularly damaged paddy fields and the improvement of riverbanks and river gates began. During the 27 months from June 25, 1803 (Kyowa 3) to September 10, 1805 (Bunka 2), about 11,317 person-days (figure 8) were mobilized. However, there were other challenges during and after the reconstruction process. On September 18 and October 2, 1805, Takahama was again hit by a high wave and a tidal wave, respectively. Although the mouth of the Takahama River was a port for merchant ships and thus a fairly important part of the village's infrastructure, shore protections suffered repeated damage and had to be repaired again and again. The village head's diary contains records of the reconstructions and repairs of the river mouth that took place in 1807 (Bunka 4) and 1814 (Bunka 11).

The villagers who were engaged in restoration work, especially in March 1804, were paid by the local government. This was a successful proposal of the village head, who, together with his colleagues, had calculated and mapped the flood damage in 1803. Although the villagers harvested almost nothing from the rice fields in this area in the year of the flood, they managed to successfully repair the fields the next year before sowing the rice crops. The crucial point was that after the extreme destruction caused by the freshwater and saltwater floods in 1803, they were able to harvest a normal crop in 1804.

Discussion and Concluding Remarks

Japan is located in the East Asian monsoon region (figure 3). The Amakusa Islands of Kyushu are located in southwestern Japan and belong to a relatively warmer region of Japan. They are frequently hit by typhoons and heavy rainfall. However, in terms of agricultural damage, we were able to confirm that there was no flooding during the peak typhoon season, but that heavy rain, especially during the rainy season, caused tremendous

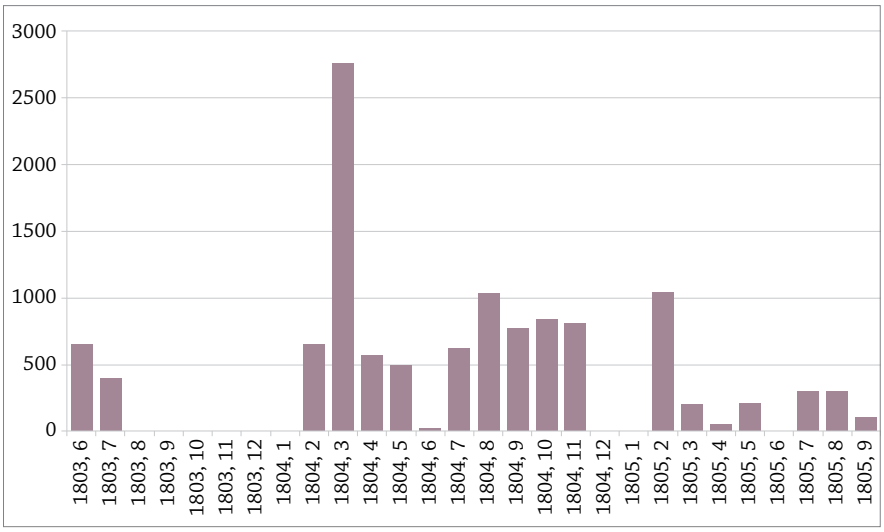

Figure 11 Number of Restoration Labourers from June 1803 to September 1805
Source Original digitised database from Amakusa-cho Kyoiku-iinkai (1985–1998); UkM, *Ueda Yoshiuzu Diaries*.

flooding damage. In addition, of course, there was constant concern that there would be insufficient rain, as suggested by the rain-seeking rituals, since such rituals were performed in more than 70 percent of the years observed. In addition, it was confirmed that sunshine was expected in July and, at the same time, prompt rains that ensured sunshine and fair weather in August. It was confirmed that the rhythm and balance of rainfall and solar radiation are important for rice growth.

Relationships with other agricultural products, such as wheat and sweet potatoes, were important in sustaining the lives of the villagers. In this chapter, we have focused only on rice, an important annual crop. However, in addition to agriculture, the livelihood of the entire village was maintained as the pottery stone industry also played an important role in the economy, although further comprehensive study of the economic situation is needed. In many ways, however, this society was heavily dependent on the organic economy, and the influences of meteorological phenomena were great. In addition, fluctuating weather conditions and even extreme weather phenomena were unavoidable conditions that led local people to produce sweet potatoes for stockpiling, take action in various village units, and develop local management strategies to discuss with regional governments.

The payment of the annual contribution was the most important task in villages like Takahama, which had a relatively large population. The *kokudaka* of Takahama village, which served as a standard for assessing tax payment, was not particularly high. However, purpose-built rice fields were set aside for the collection of annual contributions. Thus, after the flood of 1803, when the rice fields that had been specially planted for tax payment were severely damaged, the local self-government of the village immediately requested assistance from the regional government. The villagers received funds to restore the flooded fields and damaged river irrigation systems. This enabled them to restore the rice fields as early as possible the following year through their own paid labour.

On the other hand, it should be noted that all other types of damage, such as the destruction of the harbour by high waves and tides, were repaired on the village's own responsibility, and this also happened in the case of floods when the damage to the rice fields was minor. In other words, the facilities associated with the annual contribution were supported by the government in return for collecting the annual contribution, but almost everything else was left to the villagers alone. This meant that in the second layer of Braudel's composition discussed at the beginning of this chapter, the market was largely divided into two parts, one of which was the rice market, which was directly under the control of the government because of the collection of the annual tax. However, rice cultivation is also highly constrained by climatic and weather conditions such as water shortage and frequency, rainfall volume, and solar radiation. Ecological constraints should also be included in the bottom layer of Braudel's composition, along with sub-economies. In addition, other market transactions, such as participation in the Kitakyushu porcelain market by mining and transporting pottery stones, were very important in Takahama. They are the second type of market economy that involved self-responsibility, and are believed to have been dismissed to some degree.

It is true that despite being a society driven by an organic economy based on sunlight, discretionary freedom was never small. In the event of a bad harvest, a request was made to the government for a tax reduction. In some cases, they purchased items with other funds, such as those from the pottery business, and also rebuilt themselves. Villagers' self-discretion could further their future or destroy their subsistence. For example, in 1817, some plots had sufficient water while others suffered from water shortages. The only way to avoid a drought crisis was to adapt within the village.

The village, in this sense, was a form of enterprise on a small economic scale, albeit with more than 3,000 inhabitants, whose individual and economic performances were conditioned by the possibility of a communal tax payment, obtained through the harvest of rice fields, which were prone to flooding, drought and lack of sunshine. All villagers worked against natural disasters almost every year. Amakusa, an East Asian monsoon region, developed a kind of social capital that was able to mobilize 11,317 person-days from among the residents, including men and women, in the following years, so that the village's rice production soon recovered after the disastrous flood of 1803.

Acknowledgement

This study is based on reports at several international conferences. We have received much feedback and advice from the following conference participants. We would like to take this opportunity to express our appreciation: 1. Local diversity and changing organic economies during the Industrial Revolution: Otagi, Kyoto, Japan, 1880-1908. Satoshi Murayama and Hiroko Nakamura. WEHC 2018, Subsistence, sustenance, and changing living spaces: Comparative studies of Eurasian economies from the 16th to the 20th centuries. Boston Marriott Cambridge & MIT Campus, Boston, MA, USA, August 2 (July 29-August 3), 2018; 2. Flood, drought, and lack of sunshine in the East Asian monsoon region: An environmental history of Takahama in the Amakusa Islands, Kyushu, Japan, 1793-1818. Satoshi Murayama, Hiroko Nakamura, Noboru Higashi, and Toru Terao, presented at EAEH 2019 (October 24-27), National Cheng Kung University, Tainan, Taiwan, October 26, 2019; 3. Flood, Drought, and Lack of Sunshine in the East Asian Monsoon Region: Quantified Analysis of Weather Statements in Administrative Diaries of a Village, Takahama in the Amakusa Islands, Kyushu, Japan, 1793-1818. Satoshi Murayama and Toru Terao, presented at AOGS 2021 (Aug. 1-6), Aug. 6, Singapore, 2021. (Online).

This study is the first result of an ongoing project, which is funded by Grants-in-Aid for Scientific Research (B) (20H01523), supported by the Japan Society for the Promotion of Science from April 2020 and by a JSPS/MESS bilateral project from April 2019. I am also grateful to the Eurasian Project, which was conducted from April 1995 to March 2000, funded by the Japanese Ministry of Education, Culture, Sports, Science, and Technology, which provided us with the opportunity to select Takahama in the Amakusa Islands as our research field, and other projects supported by the Japan Society for the Promotion of Science. In this study, we used the digitalized database sets of the village head's dia-

ries, which were produced by the Grants-in-Aid for Scientific Research (A) (19203018) funded from April 2007 to March 2011.

Archival sources

UkM: *Ueda-ke Monjyo*
Population Register of Amakusa Islands in 1692: Amakusa Shima-ju Hitodaka-cho, Genroku 4, 7, 2965.
Ueda Yoshiuzu Diaries: Ueda Yoshiuzu Nikki, 6, 2787-2808.
Village Records: Meisai-cho, 4, 999-1014, 1016-1018.
Village Takahama Pictorial Map: Takahama Mura Ezu, 18, 2/3.

References

Alfani, G., and M. T. Tullio. 2019. *The Lion's Share: Inequality and the Rise of the Fiscal State in Preindustrial Europe.* Cambridge: Cambridge University Press.

Amakusa Komonjyo-kai, ed. 1988–1993. *Amakusa-gun Mura-mura Meisai-cho*, I/II/III (Jo/Chu/Ge), II/III, 239–405: II (*Chu*), Nr. 1002, 1005, 1009; III (*Ge*), Nr. 1001, 1004, 1007, 1011, 1016, 3716, 4886. Hondo: Amakusa Komonjyo-kai

Amakusa-cho, Kyoiku-iinkai, ed. 1985–1998. *Ueda Yoshiuzu Nikki.* 20 vols. Amakusa: Amakusa-cho Kyoiku Iinkai / Ueda Touseki Goshi Kaisya

Braudel, F. 1986. *Une leçon d'histoire de Fernand Braudel.* Paris: Arthaud-Flammarion.

Chu, J.-H., C. R. Sampson, A. S. Levine, and E. Fukuda. 2002. 'The Joint Typhoon Warning Center Tropical Cyclone Best-Tracks, 1945–2000.' Naval Research Laboratory NRL/MR/7540-02-16, Joint Typhoon Warning Center.

Dennison, T. K., and S. Ogilvie. 2007. 'Serfdom and Social Capital in Bohemia and Russia.' *Economic History Review* 60 (3): 513–44.

Doboku Tosyo-kan Iinkai & Doboku-shi Kenkyu Iinkai. 2004. *Furuichi Koi to sono Jidai.* Tokyo: Nihon Doboku Gakkai.

Furushima, T., ed. 1997. *Hyakusyo Denki.* Vol. 1/2. Tokyo: Iwanami Bunko.

Hayami, A. 2003. 'Kinsei Nihon no Keizai Hatten to Industrious Revolution.' In *Kinsei Nihon no Keizai Shakai,* edited by A. Hayami, 287–306. Kashiwa: Reitaku University Press.

Higashi, N. 2016. *Kinsei no Mura to Chiiki-Joho.* Tokyo: Yoshikawa Kobun-Kan.

Imhof, A. E. 1988. *Die Lebenszeit: vom aufgeschobenen Tod und von der Kunst des Lebens.* München: Beck.

———. 1990. *Lebenserwartungen in Deutschland vom 17. bis 19. Jahrhundert.* Weinheim: VCH, Acta humaniora.

Kumamoto Yearbook. 2011. 'Heisei 24-nen Tokei Nenkan.' http://www.pref.kumamoto.jp/site/statistics/h24nenkan.html#1.

Ministry of Land, Infrastructure, Transport and Tourism Japan. N.d.-a. 'Mizu-kanri & Kokudo-hozen.' http://www.mlit.go.jp/river/toukei_chousa/.

Ministry of Land, Infrastructure, Transport and Tourism Japan. N.d.-b. 'Nikyu-kasen no Encho tou Shirabe.' http://www.mlit.go.jp/river/toukei_chousa/kasen/jiten/toukei/birn105p1.pdf?0517.

Morinaga, T., ed. 1968. *Nagasaki Daikan Kiroku-shu, II (Chu).* Nagasaki: Hanka-cho Kanko-kai

Muldrew, C. 2011. *Food, Energy and the Creation of Industriousness: Work and Material Culture in Agrarian England, 1550–1780.* Cambridge: Cambridge University Press.

Murayama, S., and H. Nakamura. 2021. '"Industrious Revolution" Revisited: A Variety of Diligence Derived from a Long-Term Local History of Kuta in Kyô-Otagi, a Former County in Japan.' *Histories* 1 (3): 108–21.

Murayama, S., and N. Higashi. 2012. 'Seashore Villages in Amakusa: Takahama and Sakitsu: A Comparative Study of Population Registers and Disaster Management in the 19th Century, Kyushu, Japan.' *Populazione e Storia* 13 (1): 9–28.

Murayama, S., H. Nakamura, N. Higashi, and T. Aoki. 2017. 'Disaster Management and Integrated Economy in Early Modern Japan: Amakusa in the 19th Century.' In *Integrated Peasant Economy in a Comparative Perspective: Alps, Scandinavia, and Beyond,* edited by A. Panjek, J. Larsson, and L. Mocarelli, 241–66. Koper: University of Primorska Press.

Nakamura, S. 1968. *Meiji Ishin no Kiso Kozo.* Tokyo: Mirai-Sha.

Ogilvie, S. 2007. '"Whatever Is, Is Right?" Economic Institutions in Pre-Industrial Europe.' *Economic History Review* 60 (4): 649–84.

Ogilvie, S. 2010. 'Consumption, Social Capital, and the "Industrious Revolution" in Early Modern Germany.' *Journal of Economic History* 70 (2): 287–325.

Okuma, T. 2007. *Kozui to Chisui no Kasen-shi.* Tokyo: Heibon-Sha.

Saito, O. 2005. *Pre-modern Economic Growth Revisited: Japan and the West.* London: London School of Economics.

———. 2015a. 'Zen-Kindai Keizai Seicho no Futatsu no Pattern: Tokugawa Nihon no Hikaku-Shi-Teki Ichi.' In *Shin-Pan Hikaku-Shi no Enkin-Ho,* edited by O. Saito, 151–229. Tokyo: Shoseki Kobou Hayayama.

———. 2015b. 'Growth and Inequality in the Great and Little Divergence Debate: A Japanese Perspective.' *Economic History Review* 68 (2): 399–419.

Smith, T. C. 1988. 'The Land Tax in the Tokugawa Period.' In *Native Sources of Japanese Industrialization, 1750–1920,* edited by T. C. Smith, 50–70. Berkeley: University of California Press.

Tanaka, K. 2010. 'Higashi Asia Monsoon Chiiki no Seizon Kiban to shite no Jizoku-teki Nogyo.' In *Chikyu-ken, Seimei-ken, ningen-ken: jizoku-teki na seizon-kiban wo motomete,* edited by K. Sugihara, S. Kawai, Y. Kono, and A. Tanabe, 61–88. Kyoto: Kyoto University Press.

Vries, J. de. 2008. *The Industrious Revolution: Consumer Behavior and the Household Economy, 1650 to the Present.* Cambridge: Cambridge University Press.

———. 2013. 'The Industrious Revolutions in East and West.' In *Labour-Intensive Industrialization in Global History,* edited by G. Austin and K. Sugihara, 65–84. London: Routledge.

Wrigley, E. A. 2016. *The Path to Sustained Growth: England's Transition from an Organic Economy to an Industrial Revolution.* Cambridge: Cambridge University Press.

Xie, P., and P. A. Arkin. 1997. 'Global Precipitation: A 17-Year Monthly Analysis Based on Gauge Observations, Satellite Estimates, and Numerical Model Outputs.' *Bulletin of the American Meteorological Society* 78 (11): 2539–58.

Appendix

Quantification method used to determine monthly averages of weather points and two sets of sample data for four months from May to August in 1788 and 1789

Monthly weather index averages were calculated from the diaries' descriptive records on rainy, cloudy, and sunny days from May to August. Figure 7 shows a comparison between a good harvest year in 1798 and a drought year in 1799. A traditional lunar calendar was adjusted to a solar calendar. A larger index indicated a rainier month, because the descriptive records counted extreme/heavy rain as 2.5 points, rain as 2 points, light rain as 1.5 points, cloud as 1 point, and clear weather as 0 points. This calculation, including original Japanese descriptions and English translations, is demonstrated in the following two tables.
Source: ASU *Ueda-Yoshiuzu-Nikki.*

Table A1 Weather index from May to August in 1798

Date, 1798	Lunar calendar		Weather	Wind and others	Weather point	Monthly average of weather points
5.1	3.16	三月十六日　晴天（風向きなし）	fine weather		0	0,5893
5.2	3.17	三月十七日　晴天　北風	fine weather	north wind	0	

Date, 1798	Lunar calendar		Weather	Wind and others	Weather point	Monthly average of weather points
5.3	3.18	■ 十八日　晴天　北風	fine weather	north wind	0	
5.4	3.19	三月十九日　晴天　北風	fine weather	north wind	0	
5.5	3.20	■ 廿日　晴天　北風	fine weather	north wind	0	
5.6	3.21	三月廿一日　（晴雨風向共なし）				
5.7	3.22	三月廿二日　（晴雨風向共なし）				
5.8	3.23	三月廿三日　（　〃　）				
5.9	3.24	■月廿四日　晴天　（風向きなし）	fine weather		0	
5.10	3.25	三月廿五日　晴天　（　〃　）	fine weather		0	
5.11	3.26	三月廿六日　晴天　（　〃　）	fine weather		0	
5.12	3.27	三月廿七日　晴天　北風　曇	fine weather/ cloudy	north wind	1	
5.13	3.28	三月廿八日　晴天　南風	fine weather	south wind	0	
5.14	3.29	三月廿九日　雨天　南風	rainy weather	south wind	2	
5.15	4.1	■月晦日　晴　北風	sunny	north wind	0	
5.16	4.2	四月朔日　晴天　北風	fine weather	north wind	0	
5.17	4.3	四月二日　晴天　北風	fine weather	north wind	0	
5.18	4.4	四月三日　晴天　南風	fine weather	south wind	0	
5.19	4.5	■■ 日　雨天　南風	rainy weather	south wind	2	
5.20	4.6	四月五日　曇天　北東風	cloudy weather	north-east wind	1	
5.21	4.7	四月六日　雨　西北風	rain	west-north wind	2	
5.22	4.8	■ 八日　晴　北風	sunny	north wind	0	
5.23	4.9	四月七日　雨天　北東風	rainy weather	north-east wind	2	
5.24	4.10	四月九日　晴天　北風	fine weather	north wind	0	
5.25	4.11	四月十日　雨天　西南風	rainy weather	west-south wind	2	
5.26	4.12	四月十一日　晴　南風	sunny	south wind	0	
5.27	4.13	四月十二日　雨天　北風	rainy weather	north wind	2	
5.28	4.14	四月十三日　晴　南風	sunny	south wind	0	
5.29	4.15	■■■■　晴天　南風	fine weather	south wind	0	
5.30	4.16	四月十五日　晴天　西南風	fine weather	west-south wind	0	
5.31	4.17	四月十六日　曇昼ヨリ雨夜ニ入大雨　南風	cloudy/rain from noon/ heavy rain at night	south wind	2,5	
6.1	4.18	四月十七日　晴　西北風	sunny	west-north wind	0	1,0667
6.2	4.19	■■■■　晴天　西北風	fine weather	west-north wind	0	
6.3	4.20	四月十九日　晴　南風	sunny	south wind	0	
6.4	4.21	四月廿日　晴天　南風	fine weather	south wind	0	
6.5	4.22	四月廿一日　晴　南風　平波	sunny	south wind and calm wave	0	

Date, 1798	Lunar calendar		Weather	Wind and others	Weather point	Monthly average of weather points
6.6	4.23	四月廿二日　雨天　南風	rainy weather	south wind	2	
6.7	4.24	四月廿三日　雨　東風	rain	east wind	2	
6.8	4.25	■■ 四日　晴　南風	sunny	south wind	0	
6.9	4.26	四月廿五日　雨　北東風	rain	north-east wind	2	
6.10	4.27	四月廿六日　雨　北東風	rain	north-east wind	2	
6.11	4.28	四月廿七日　晴天　北風	fine weather	north wind	0	
6.12	4.29	四月廿八日　晴　北風	sunny	north wind	0	
6.13	4.30	四月廿九日　曇天　北風	cloudy weather	north wind	1	
6.14	5.1	■ 朔日　晴天　北風	fine weather	north wind	0	
6.15	5.2	五月二日　晴天　北風	fine weather	north wind	0	
6.16	5.3	五月三日　晴天　北風	fine weather	north wind	0	
6.17	5.4	五月四日　曇　北東風　昼刂雨	cloudy/rain from noon	north-east wind	2	
6.18	5.5	五月五日　雨天　北東風	rainy weather	north-east wind	2	
6.19	5.6	五月六日　雨天　北東風	rainy weather	north-east wind	2	
6.20	5.7	五月七日　雨天　北東風	rainy weather	north-east wind	2	
6.21	5.8	五月八日　雨天　北東風	rainy weather	north-east wind	2	
6.22	5.9	五月九日　雨天　北東風	rainy weather	north-east wind	2	
6.23	5.10	五月十日　雨天　北東風	rainy weather	north-east wind	2	
6.24	5.11	五月十一日　雨　西南風　昼晴	rain/sunny from noon	north-east wind	2	
6.25	5.12	■ 十二日　晴天　西風	fine weather	west wind	0	
6.26	5.13	■ 十三日　晴天　西北風	fine weather	west-north wind	0	
6.27	5.14	五月十四日　曇天　北東風	cloudy weather	north-east wind	1	
6.28	5.15	五月十五日　雨天　東南風	rainy weather	east-south wind	2	
6.29	5.16	■ 十六日　雨天川水出　東南風昼刂西北風	rainy weather/flooding from river	east-south wind/west-north wind from noon	2	
6.30	5.17	五月十七日　雨　東南風	rain	east-south wind	2	
7.1	5.18	五月十八日　晴　西南風	sunny	west-south wind	0	0,3871
7.2	5.19	五月十九日　雨　東南風　半夏也	rain	east-south wind/*hange*: 11 days from summer solstice	2	
7.3	5.20	五月廿日　晴　西北風	sunny	west-north wind	0	
7.4	5.21	五月廿一日　晴天　西北風	fine weather	west-north wind	0	

Date, 1798	Lunar calendar		Weather	Wind and others	Weather point	Monthly average of weather points
7.5	5.22	■■■■ 曇天 東南風 昼過ヨリ雨	cloudy weather/rain from noon	east-south wind	2	
7.6	5.23	五月廿三日 曇 南風 暁頃大雨朝飯過ヨリ晴ル	cloudy/heavy rain from later night/sunny from the time of breakfast	south wind	2,5	
7.7	5.24	五月廿四日 晴天 南風	fine weather	south wind	0	
7.8	5.25	五月廿五日 晴天 南風	fine weather	south wind	0	
7.9	5.26	五月廿六日 晴天 西北風	fine weather	west-north wind	0	
7.10	5.27	■■ 七日 晴天 西北風	fine weather	west-north wind	0	
7.11	5.28	五月廿八日 晴天 北風	fine weather	north wind	0	
7.12	5.29	五月廿九日 晴天 西北風	fine weather	west-north wind	0	
7.13	5.30	五月晦日 晴天 西北風	fine weather	west-north wind	0	
7.14	6.1	■ 朔日 晴天 西北風	fine weather	west-north wind	0	
7.15	6.2	六月二日 晴天 南風	fine weather	south wind	0	
7.16	6.3	六月三日 晴天 南風 夕方雨夜半大雨	fine weather/rain from evening/heavy rain from midnight	south wind	2,5	
7.17	6.4	六月四日 曇 南風 夜雨少シ	cloudy/light rain at night	south wind	1,5	
7.18	6.5	六月五日 晴天 南風 夜雨少降	fine weather/light rain at night	south wind	1,5	
7.19	6.6	六月六日 晴天 南風	fine weather	south wind	0	
7.20	6.7	六月七日 晴天 南風	fine weather	south wind	0	
7.21	6.8	六月八日 晴天 南風	fine weather	south wind	0	
7.22	6.9	六月九日 晴天 西南風	fine weather	west-south wind	0	
7.23	6.10	六月十日 晴天 西北風	fine weather	fine weather	0	
7.24	6.11	六月十一日 晴天 西北風	fine weather	fine weather	0	
7.25	6.12	六月十二日 晴天 西北風	fine weather	fine weather	0	
7.26	6.13	■■■■ 晴天 西南風	fine weather	west-south wind	0	
7.27	6.14	六月十四日 晴天 西南風	fine weather	west-south wind	0	
7.28	6.15	六月十五日 晴 西南風	sunny	west-south wind	0	
7.29	6.16	六月十六日 晴天 西風	fine weather	west wind	0	
7.30	6.17	六月十七日 晴天 西南風	fine weather	west-south wind	0	
7.31	6.18	六月十八日 晴天 西南風	fine weather	west-south wind	0	
8.1	6.19	六月十九日 晴天 西風	fine weather	west wind	0	0,5323

Date, 1798	Lunar calendar		Weather	Wind and others	Weather point	Monthly average of weather points
8.2	6.20	六月廿日　晴天　朝東風昼西風	fine weather	east wind in the morning/ west wind from noon	0	
8.3	6.21	■■ 一日　晴天　西風	fine weather	west wind	0	
8.4	6.22	六月廿二日　晴天　西風	fine weather	fine weather	0	
8.5	6.23	六月廿三日　晴天　西風	fine weather	fine weather	0	
8.6	6.24	六月廿四日　晴天　西風	fine weather	fine weather	0	
8.7	6.25	■■ 五日　晴天　西風	fine weather	fine weather	0	
8.8	6.26	六月廿六日　晴天　西風	fine weather	fine weather	0	
8.9	6.27	六月廿七日　晴天　西北風	fine weather	west-north wind	0	
8.10	6.28	六月廿八日　晴天　西南風	fine weather	west-south wind	0	
8.11	6.29	六月廿九日　晴天　西北風夕方少雨降	fine weather/ light rain in the evening	west-north wind	1,5	
8.12	7.1	七月朔日　晴天　西南風　昼頃大雨	fine weather/ heavy rain around noon	west-south wind	2,5	
8.13	7.2	七月二日　雨　南風	rain	south wind	2	
8.14	7.3	七月三日　晴天　北風	fine weather	north wind	0	
8.15	7.4	七月四日　晴天　北東風	fine weather	north-east wind	0	
8.16	7.5	七月五日　晴天　西北風	fine weather	west-north wind	0	
8.17	7.6	七月六日　晴天　北風	fine weather	north wind	0	
8.18	7.7	七月七日　晴天　北風	fine weather	north wind	0	
8.19	7.8	七月八日　曇　西北風夕方ヨリ大雨	cloudy/heavy rain from the evening	west-north wind	2,5	
8.20	7.9	七月九日　曇　西南風　夜雨	cloudy/rain at night	west-south wind	2	
8.21	7.10	七月十日　雨天　西南風　河水出、	rainy weather/ flooding from river	west-south wind	2	
8.22	7.11	七月十一日　晴天　北風	fine weather	north wind	0	
8.23	7.12	七月十二日　晴天　西北風	fine weather	west-north wind	0	
8.24	7.13	七月十三日　晴天　西北風	fine weather	west-north wind	0	
8.25	7.14	七月十四日　雨　西南風	rain	west-south wind	2	
8.26	7.15	七月十五日　晴　南風	sunny	south wind	0	
8.27	7.16	七月十六日　晴　西南風	sunny	west-south wind	0	
8.28	7.17	七月十七日　晴曇　西南風　平波	sunny&cloudy	west-south wind and calm wave	1	
8.29	7.18	七月十八日　曇　西南風	cloudy	west-south wind	1	

Date, 1798	Lunar calendar		Weather	Wind and others	Weather point	Monthly average of weather points
8.30	7.19	七月十九日　晴天　北風	fine weather	north wind	0	
8.31	7.20	七月廿日　晴天　北東風	fine weather	north-east wind	0	

Table A2 Weather index from May to August in 1799

Date, 1799	Lunar calendar		Weather	Wind	Weather point	Monthly average of weather points
5.1	3.27	三月廿七日　雨天　南風	rainy weather	south wind	2	0,8750
5.2	3.28	三月廿八日　晴天　北風	fine weather	north wind	0	
5.3	3.29	三月廿九日　雨天　南風	rainy weather	south wind	2	
5.4	3.30	三月晦日　晴天　北風	fine weather	north wind	0	
5.5	4.1	四月朔日　晴天　南風	fine weather	north wind	0	
5.6	4.2	四月二日　雨天　南風	rainy weather	south wind	2	
5.7	4.3	四月三日　同断	rainy weather		2	
5.8	4.4	四月四日　同断　昼ヨリ晴	rainy weather/ sunny from noon		2	
5.9	4.5	四月五日　同断　南風	rainy weather/ sunny from noon	south wind	2	
5.10	4.6	四月六日　同断	rainy weather/ sunny from noon		2	
5.11	4.7	四月七日　晴　南風	sunny	south wind	0	
5.12	4.8	四月八日　晴天　北風	fine weather	north wind	0	
5.13	4.9	四月九日　晴天　北風	fine weather	north wind	0	
5.14	4.10	四月十日　晴天　北風	fine weather	north wind	0	
5.15	4.11	四月十一日　晴天　北風	fine weather	north wind	0	
5.16	4.12	四月十二日　晴　北風	sunny	north wind	0	
5.17	4.13	四月十三日　晴　北風　昼曇南風　雨	sunny/cloudy at noon/rain	north wind/ south wind from noon	2	
5.18	4.14	四月十四日　（晴雨風向共になし）				
5.19	4.15	四月十五日　（　〃　）				
5.20	4.16	四月十六日　（　〃　）				
5.21	4.17	四月十七日　（　〃　）				
5.22	4.18	四月十八日　（　〃　）				
5.23	4.19	四月十九日　（　〃　）				
5.24	4.20	四月廿日　雨天	rainy weather		2	
5.25	4.21	四月廿一日　雨天	rainy weather		2	
5.26	4.22	（四月廿二日は無し）				
5.27	4.23	四月廿三日　晴天　北風	fine weather	north wind	0	
5.28	4.24	四月廿四日　晴天　北風			0	
5.29	4.25	四月廿五日　晴天　北風			0	
5.30	4.26	四月廿六日　曇天　南風	cloudy weather	south wind	1	
5.31	4.27	四月廿七日　晴天　北風	fine weather	north wind	0	

Date, 1799	Lunar calendar		Weather	Wind	Weather point	Monthly average of weather points
6.1	4.28	四月廿八日　晴天　北風	fine weather	north wind	0	0,5333
6.2	4.29	四月廿九日　晴天　北風	fine weather	north wind	0	
6.3	4.30	四月卅日　晴天　北風	fine weather	north wind	0	
6.4	5.1	五月朔日　晴天　北風	fine weather	north wind	0	
6.5	5.2	五月二日　晴天（風向なし）	fine weather		0	
6.6	5.3	五月三日　晴天　北風	fine weather	north wind	0	
6.7	5.4	五月四日　南風　雨天	rainy weather	south wind	2	
6.8	5.5	五ノ五日　雨天　南風　昼ヨリ晴レ	rainy weather/ sunny from noon	south wind	2	
6.9	5.6	五ノ六日　晴天　北風	fine weather	north wind	0	
6.10	5.7	五ノ七日　晴天　北風	fine weather	north wind	0	
6.11	5.8	五月八日　晴天　北風	fine weather	north wind	0	
6.12	5.9	五月九日　晴天　北風	fine weather	north wind	0	
6.13	5.10	五月十日　晴天　南風	fine weather	south wind	0	
6.14	5.11	五月十一日　雨天　西南風	rainy weather	west-south wind	2	
6.15	5.12	五月十二日　晴　北風	sunny	north wind	0	
6.16	5.13	五月十三日　晴　北風	sunny	north wind	0	
6.17	5.14	五月十四日　雨　北東風	rain	north-east wind	2	
6.18	5.15	五月十五日　晴　北風	sunny	north wind	0	
6.19	5.16	五月十六日　雨天　北東風	rainy weather	north-east wind	2	
6.20	5.17	五月十七日　曇天　北風	cloudy weather	north wind	1	
6.21	5.18	五月十八日　晴　北風	sunny	north wind	0	
6.22	5.19	五月十九日　晴天　北風	fine weather	north wind	0	
6.23	5.20	五月廿日　晴天　南風	fine weather	south wind	0	
6.24	5.21	五月廿一日　雨天　南風	rainy weather	south wind	2	
6.25	5.22	五月廿二日　雨天　南風	rainy weather	south wind	2	
6.26	5.23	五月廿三日　曇天　南風	cloudy weather	south wind	1	
6.27	5.24	五月廿四日　晴天　南風	fine weather	south wind	0	
6.28	5.25	五月廿五日　晴天（風向なし）	fine weather		0	
6.29	5.26	五月廿六日　晴天（　〃　）	fine weather		0	
6.30	5.27	五月廿七日　晴天（　〃　）	fine weather		0	
7.1	5.28	五月廿八日　晴天（　〃　）	fine weather		0	0,467741935
7.2	5.29	五月廿九日　晴天（　〃　）	fine weather		0	
7.3	6.1	六月朔日　晴天　北風	fine weather	north wind	0	
7.4	6.2	六月二日　晴天　北風	fine weather	north wind	0	
7.5	6.3	六月三日　晴天　北風	fine weather	north wind	0	
7.6	6.4	六月四日　晴天　北風	fine weather	north wind	0	
7.7	6.5	六月五日　晴天　北風	fine weather	north wind	0	
7.8	6.6	六月六日　曇天　南風	cloudy	south wind	1	
7.9	6.7	六月七日　晴天　南風	fine weather	south wind	0	
7.10	6.8	六月八日　晴天　南風	fine weather	south wind	0	
7.11	6.9	六月九日　晴天　南風	fine weather	south wind	0	
7.12	6.10	六月十日　曇天　東南風	cloudy weather	east-south wind	1	

Date, 1799	Lunar calendar		Weather	Wind	Weather point	Monthly average of weather points
7.13	6.11	六月十一日　昼ヨリ大雨　東南風	heavy rain from noon	east-south wind	2,5	
7.14	6.12	六月十二日　曇天　雨止ミ南風	cloudy/rain is stop	south wind	1	
7.15	6.13	六月十三日　晴天　西南風	fine weather	west-south wind	0	
7.16	6.14	六月十四日　晴　西北風	sunny	west-north wind	0	
7.17	6.15	六月十五日　晴天　西風	fine weather	west wind	0	
7.18	6.16	六月十六日　晴天　西北風	fine weather	west-north wind	0	
7.19	6.17	六月十七日　晴天　西北風	fine weather	fine weather	0	
7.20	6.18	六月十八日　晴天　西北風	fine weather	fine weather	0	
7.21	6.19	六月十九日　晴天　西北風	fine weather	fine weather	0	
7.22	6.20	六月廿日　晴天　西北風	fine weather	fine weather	0	
7.23	6.21	六月廿一日　晴天　西北風	fine weather	fine weather	0	
7.24	6.22	六月廿二日　晴天　西北風	fine weather	fine weather	0	
7.25	6.23	六月廿三日　晴天　西北風　昼ヨリ南風夜半雨	fine weather/rain from midnight	fine weather	2	
7.26	6.24	六月廿四日　曇天少雨降　西南風	cloudy weather with light rain	west-south wind	1,5	
7.27	6.25	六月廿五日　曇天　西南風　夕方雨夜半頃大雨	cloudy weather/ rain in the evening/heavy rain at mid-night	west-south wind	2,5	
7.28	6.26	六月廿六日　曇天　西南風	cloudy weather	west-south wind	1	
7.29	6.27	六月廿七日　曇晴　西南風	cloudy&sunny	west-south wind	1	
7.30	6.28	六月廿八日　曇天　南風	cloudy weather	south wind	1	
7.31	6.29	六月廿九日　晴天　西南風	fine weather	west-south wind	0	
8.1	7.1	七月朔日　晴天　北風	fine weather	north wind	0	0,2903
8.2	7.2	七月二日　晴天　北風	fine weather	north wind	0	
8.3	7.3	七月三日　晴天　南風	fine weather	south wind	0	
8.4	7.4	七月四日　晴天　南風	fine weather	south wind	0	
8.5	7.5	七月五日　晴天　南風	fine weather	south wind	0	
8.6	7.6	七月六日　晴天　西南風	fine weather	west-south wind	0	
8.7	7.7	七月七日　晴天　北風	fine weather	north wind	0	
8.8	7.8	七月八日　晴天（風向なし）	fine weather		0	
8.9	7.9	七月九日　晴天　北風	fine weather	north wind	0	
8.10	7.10	七月十日　晴天　北風	fine weather	north wind	0	
8.11	7.11	七月十一日　晴天　朝北風昼ヨリ南風	fine weather	north wing in the morning/ south wind from noon	0	
8.12	7.12	七月十二日　晴天　右同断	fine weather	north wing in the morning/ south wind from noon	0	

Date, 1799	Lunar calendar		Weather	Wind	Weather point	Monthly average of weather points
8.13	7.13	七月十三日　晴天　西南風	fine weather	west-south wind	0	
8.14	7.14	七月十四日　晴天　南風	fine weather	south wind	0	
8.15	7.15	七月十五日　晴天　南風	fine weather	south wind	0	
8.16	7.16	七月十六日　晴曇　西南風	sunny&cloudy	west-south wind	1	
8.17	7.17	七月十七日　晴天　南風	fine weather	south wind	0	
8.18	7.18	七月十八日　晴天　南風	fine weather	south wind	0	
8.19	7.19	七月十九日　晴天　西南風	fine weather	west-south wind	0	
8.20	7.20	七月廿日　晴天　西南風	fine weather	west-south wind	0	
8.21	7.21	七月廿一日　晴天　東風	fine weather	east wind	0	
8.22	7.22	七月廿二日　晴天　東風	fine weather	east wind	0	
8.23	7.23	七月廿三日　晴天　東風　昼頃夕雨	fine weather/ shower around noon	east wind	2	
8.24	7.24	七月廿四日　晴天　東風	fine weather	east wind	0	
8.25	7.25	七月廿五日　晴天　東南風　昼過夕雨	fine weather/ shower after noon	east-south wind	2	
8.26	7.26	七月廿六日　晴天　東南風	fine weather	east-south wind	0	
8.27	7.27	七月廿七日　晴天　南風	fine weather	south wind	0	
8.28	7.28	七月廿八日　曇天　西南風　夜半過刁雨	cloudy weather/ rain after mid-night	west-south wind	2	
8.29	7.29	七月廿九日　雨　西南風	rain	west-south wind	2	
8.30	8.1	八月朔日　晴天　南風	fine weather	south wind	0	
8.31	8.1	八月二日　晴天　西北風	fine weather	west-north wind	0	