Climate Change in Japanese History and Prehistory: A Comparative Overview

Bruce L. Batten, Ph.D.

Professor of Japanese History, J. F. Oberlin University
3758 Tokiwa-machi, Machida-shi, Tokyo 194-0294, Japan
bruce@obirin.ac.jp

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I. Introduction

It is difficult to think of a contemporary issue as important or widely discussed as global warming. Scarcely a day goes by without another story about melting glaciers, shrinking icecaps, torrential storms, or devastating droughts. Debate has shifted from whether or not global warming is real, or whether or not we are to blame; most observers now agree that it is, and we are. The question is no longer what is happening or why; it is what we can expect if present trends continue and what, if anything, we can do to slow or halt them.

Although popular accounts sometimes give the impression that climate was relatively stable before people began burning fossil fuels, that is far from the case: it changed frequently, and for largely natural reasons. Global temperatures fluctuate on scales of 20,000-100,000 years as the result of changes in the earth’s orbit (the so-called Milankovich cycles). Climate is also affected by natural changes in the atmospheric concentration of greenhouse gases and aerosols, in solar radiation, in volcanic activity, and
in oceanic and atmospheric circulation. Some of these variations, such as those in atmospheric composition, operate at truly geological scales; others, such as those caused by volcanic eruptions, are measured at most in years.

During the lifetime of our species, perhaps the most striking example of climate change was the long, bumpy transition from the Last Glacial Maximum or LGM (23,000-18,000 BP) to the warm, stable conditions of the Holocene or recent period (roughly the last 10,000 years). This early instance of global warming was what made agriculture – and civilization as we know it – possible. As this example suggests, in

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3 Before Present; “present” customarily refers to 1950 CE.


5 According to William James Burroughs, *Climate Change in Prehistory: The End of the Reign of Chaos* (Cambridge: Cambridge University Press, 2005), reduced climatic variability, rather than increased temperature per se, was the key factor.
premodern times climatic change could have an important, if not determining, influence on society – unlike today, when the influence tends to run the other way. (Another conclusion to be drawn is that climatic change, even global warming, is not necessarily a bad thing: it all depends.)

During the past few decades, historians and archaeologists in Europe and North America have paid increasing attention to the role of climate change in human history. Ultimately, this trend reflects scholars’ concern about contemporary environmental and climatic issues, but it has also been facilitated by spectacular new scientific data from ocean sediments, ice cores, and other sources. (Needless to say, most of the research responsible for the new data has also been spurred by current concerns over climate change.)

Detailed climatic reconstructions for Japan are also available, but so far have failed to attract widespread attention from historians. True, Japanese archaeologists are quick to...

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acknowledge the importance of climate for prehistoric cultures in the archipelago. And for
the historic period, the crop failures and famines of the seventeenth through nineteenth
centuries are routinely blamed on Little Ice Age conditions. But there have been few
systematic attempts to examine the larger patterns in Japanese history from a climatic
perspective. This is unfortunate, not just because of the contemporary relevance of the
topic, but because (as we shall see) the Japanese case offers some interesting comparisons
and contrasts with what is known from other regions of the world.

The purpose of the present study is to summarize what is known about Japan’s
climatic history during the period of human occupation, and to offer some tentative
speculations about the role of climate in Japanese history and prehistory from an explicitly
comparative perspective. I begin with an overview of the various methodologies that have

7 Important exceptions include Yutaka Sakaguchi, “Warm and Cold Stages in the Past 7600
Years in Japan and Their Global Correlation — Especially on Climatic Impacts to the
Global Sea Level Changes and the Ancient Japanese History —,” Bulletin of the
Department of Geography, University of Tokyo 15 (1983): 1-31; Sakaguchi, “Kako 8000
nen no kikō henka to ningen no rekishi” (Climate Change and Human History during the
Past 8000 Years), Senshū jinbun ronshū (Senshū University Essays in the Humanities) 51
(1993): 79-113; William S. Atwell, “Volcanism and Short-Term Climatic Change in East
29-98; and William Wayne Farris, “Famine, Climate, and Farming in Japan, 670-1100,” in
Heian Japan, Centers and Peripheries, ed. Mikael S. Adolphson, Edward Kamens, and
Stacie Matsumoto (Honolulu: University of Hawai‘i Press, 2007), 275-304.
been used to reconstruct past climates in Japan. This is followed by a new, eight-stage periodization of the Japanese past based on climatic criteria. For each era, I provide a brief description of major climatic trends and discuss some of the important historical questions they suggest when viewed from a comparative, global perspective.

II. Methodologies

How can we reconstruct past climates? The most reliable information, of course, comes from instrumental data, but this is generally unavailable for premodern times. In the absence of instrumental data, past temperatures or climatic trends can be reconstructed using proxies. These fall into two major types: information gleaned from historical sources (historical proxies), and that based on measurements of various physical quantities (natural proxies).
1. Instrumental Data

Until recently, it was believed that instrument-based meteorological observations in Japan began as part of the Meiji government’s modernization program, specifically with the establishment of a meteorological station in Hakodate, Hokkaido, in 1872. (Observations in Tokyo began three years later, in 1875.) However as Demarée and others have recently shown, Dutch observers in Nagasaki were making instrument-based observations as early as 1819, over half a century before the Hakodate station was established.  

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remains true that prior to the nineteenth century we are entirely without instrumental data

on Japanese weather and must rely on proxies such as those discussed below.

2. Historical Proxies

Japan has a voluminous historical record going back to about 700 CE (and containing

references, not always reliable, to still earlier times). Descriptions of weather conditions are

found in sources ranging from poetry collections (e.g., Man’yōshū; Collection of Ten

Thousand Leaves) to official chronicles (e.g., Nihon Shoki; Chronicles of Japan). However,

by far the best information comes from diaries. For the old capital of Kyoto, we have

aristocratic diaries going back to the ninth century. For the rest of the country, diary

coverage is relatively limited until the Edo period (1600-1867), when literacy became

widespread and warriors, clerics, and even commoners throughout the country began to

take note of their daily activities.9 Japanese diary entries, whether written by Heian

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9 For a more or less comprehensive index of fifteenth-century and later diaries and travel
accounts useful for purposes of climatic reconstruction, see Yamamoto Takeo, Fukaishi
Kazuo, Maejima Ikuo, Mizukoshi Mitsuharu, Yoshimura Minoru, Shitara Hiroshi,
Urushibara Kazuko, Hayashi Yōsei, and Kurosaka Hiroyuki, “Kokikō fukugen ni riyō
aristocrats or nineteenth-century schoolchildren, routinely begin with a laconic comment about the weather, so taken in sum, these sources constitute a very precious resource for the climate historian.

Since about 1970, Japanese researchers have used a variety of techniques to reconstruct past climate from historical proxies, particularly for the well-documented Edo period. The following discussion, which is by no means exhaustive, introduces some of the principal methodologies employed.

**a. Phenological data from dates of cherry-viewing**

Anyone who has lived in Japan will be familiar with the custom of “cherry-blossom viewing.” This custom is an ancient one and many old diaries, particularly from Kyoto, note the dates of the flower viewing parties held each spring on the day or days when the

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cherries were in full bloom. As we all know from experience, warm weather in early spring causes flowers to bloom early, while cool weather tends to delay their appearance. Annual variations in the date of blossom viewing parties at a given location, then, presumably reflect differences in mean spring temperatures. Arakawa, Yamamoto, and most recently Aono and Omoto have used this approach to reconstruct climatic trends in Kyoto. Aono’s work, in particular, is noteworthy for its use of comparative modern data to calculate mean

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March temperatures for Kyoto going back more than 1200 years to 801 CE. Climatic reconstruction based on the dates of cherry blooms has also been attempted for Kanazawa (by Kawamura) and Tokyo (by Aono) but only since the early nineteenth century, presumably for lack of suitable earlier data.  

b. Snow ratio and snow cover

Diaries also contain useful information on precipitation, including snowfall. Yamamoto, Maejima, and others have computed the “snow days ratio” (the ratio of snowy days to total days with precipitation during the winter months) for various sequences of years (again, mainly for Kyoto). The basic idea is that higher snow ratios reflect colder winter

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temperatures. Another rough guide to mean winter temperatures is the date of first or last appearance of snow cover on selected hills or mountains. This approach was used by Yamamoto for Mt. Kurakake in Yamanashi, northern Honshu, and by Yaji and Misawa for Mt. Iwaki in Aomori, also northern Honshu.\(^\text{13}\)

c. Freezing of lakes and rivers

Also indicative of winter temperatures are the dates of freezing or thawing of rivers or lakes.

Yamamoto used records of freezing of the Yodo and Saho Rivers in the Kansai area to argue for the existence of cold winters in the early eighth century.\(^\text{14}\) However, by far the best source of information on winter freezes comes from Lake Suwa in Nagano, for which a


near-continuous historical record (kept by officials at the lakeside Suwa Shrine) exists from
the fifteenth century. Dates of freezing and “omiwatari” (literally, “divine crossing”), an
unusual buckling of surface ice caused by geothermal circulation in the lake, have been
used by Yamamoto and others to estimate mean winter temperatures for the region. Most
recently, Mikami and coworkers used statistical comparisons with modern data to produce
an absolute curve of mean winter temperatures going back to 1444 (Figure 1).

15 Arakawa Hidetoshi, “5 seiki ni wataru Suwako omiwatari no kenkyū / On Five
Centuries of Freezing Dates of Lake Suwa (36° N, 138° E) in the Central Japan,” Chigaku
ikō ‘Suwako keppyō kijitsu narabi ni omiwatari kijitsu nippyō’ ni tsuite / Fujiwhara on Five
Centuries of Freezing Dates of Lake Suwa (36° N, 138° E) in the Central Japan,” Chūō
kishōdai kenkyū jihō / Journal of Meteorological Research 6, no. 5 (1954): 138-46;
Yamamoto, “On the Climate Change” and “A.D. 1-1600 nen no Nihon”; Minoru Tanaka
and Masatoshi M. Yoshino, “Re-Examination of the Climatic Change in Central Japan

16 T. Mikami and Y. Tsukamura, “The Climate of Japan in 1816 as Compared with an
Extremely Cool Summer Climate in 1783,” in The Year without a Summer? World Climate
in 1816, ed. C.R. Harrington (Ottawa: Canadian Museum of Nature, 1992), 462-75;
Mikami Takehiko and Ishiguro Naoko, “Suwako ketsuei kiroku kara mita kako 550 nenkan
no kikō hendō” (Climate Change during the Past 550 Years as Seen from Records of
Freezing of Lake Suwa), Kishō kenkyū nōto (Meteorological Research Notes) 191 (1998):
73-83; Mikami, “Quantitative Climatic Reconstruction in Japan Based on Historical
Documents,” Kokuritsu rekishi minzoku hakubutsukan kenkyū hōkoku / Bulletin of the
Temperature Reconstructions in Japan,” PAGES News 10, no. 3 (2002): 17-18; Mikami,
“Kako 1000 nenkan no kikō hendō to 21 seiki no kikō yosoku / Global Climatic Variations
for the Last 1000 Years and Their Prospects in Future,” Chiri zasshi / Journal of
d. Precipitation frequency

Summer temperatures have also been estimated on the basis of comparisons with modern data. The earliest work in this area was, again, by Yamamoto\(^\text{17}\), but the best recent research

Figure 2. July Temperatures in Tokyo, 1721-1995


is by Mikami. Modern instrumental data show a negative correlation between frequency of summer precipitation and mean summer temperature in Tokyo; Mikami combined this data with information on rainfall from Edo-period sources to produce an absolute curve of summer temperatures going back to 1721 (Figure 2).\(^{18}\)

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\(^{18}\) Mikami, “Climate Variations in Japan During the Little Ice Age – Summer Temperature Reconstructions since 1771 –,” In Proceedings of the International Symposium on the Little Ice Age Climate, ed. Mikami, 176-81; Mikami, “Nikki tenkō kiroku kara suitei shita
3. Natural Proxies

As interesting as these techniques may be, they retain the limitations of the sources on which they are based. Historical data are subjective and increasingly fragmentary the farther we go back in time, disappearing for all practical purposes around 700 CE. For more objective, complete data on historical periods, and for any data at all on earlier periods, we must turn to physical evidence, that is, to natural proxies. Some of the more important natural proxies that have been used by to reconstruct Japanese climate are described below.

a. Pollen

As in many other countries, the first scientific studies of past climates in Japan made use of fossil pollen. Although various researchers have contributed, by far the most important body of work is by Sakaguchi, who (like Mikami) worked at Tokyo Metropolitan shōhyōki kōhan no kaki onhendō / Summer Temperature Variabilities in Japan Reconstructed from Diary Weather Records During the Little Ice Age,” Chiri zasshi / Journal of Geography 102, no. 2 (1993): 144-51; Mikami, “Long Term Variations of Summer Temperatures in Tokyo since 1721,” Geographical Reports of Tokyo Metropolitan University 31 (1996): 157-65; Mikami, “Quantitative Climatic Reconstruction”; Mikami, “Summer and Winter”; and Mikami, “Kako 1000 nenkan.”
Figure 3. Temperature Reconstruction

Based on Pine Pollen from Ozegahara (Full Sequence)

Source: Redrawn from Sakaguchi Yutaka, “Kako 8000 nen no kikō henka to ningen no rekishi” (Climate Change and Human History during the Past 8000 Years), Senshū jinbun ronshū (Senshū University Essays in the Humanities) 51 (1993): 86.

University for most of his career. In an important series of papers, Sakaguchi analyzed pollen from a 450 cm peat column collected from a pit dug at Ozegahara Moor in 1973.19

19 Except as otherwise noted, information in this and the following paragraph come from Yutaka Sakaguchi, “Warm and Cold Stages in the Past 7600 Years in Japan and Their Global Correlation — Especially on Climatic Impacts to the Global Sea Level Changes and the Ancient Japanese History —,” Bulletin of the Department of Geography, University of Tokyo 15 (1983): 1-31. Other important works by the same author are: “Climatic Variability During the Holocene Epoch in Japan and Its Causes,” Bulletin of the Department of Geography, University of Tokyo 14 (1982): 1-27; “Nihon no senshi, rekishi jidai no kikō: Ozegahara ni kako 7600 nen no kikō henka no rekishi o saguru” (Climate in Japanese Prehistory and History: Searching at Ozegahara for the History of Climate Change during the Past 7,600 Years), Shizen (Nature) 39, no. 5 (1984): 18-36; Ōzegahara no shizenshi (Natural History of Ozegahara), Chūkō shinsho (New Books from Chūō Kōron), No. 928 (Tokyo: Chūō kōronsha, 1989); and “Kako 8000 nen no kikō henka to ningen no rekishi” (Climate Change and Human History during the Past 8000 Years), Senshū jinbun
(Ozegahara, the largest raised bog in Japan, is located approximately 150 km north of Tokyo in the mountains of Gunma.)

For his analysis, Sakaguchi sliced the column in sections of 2 cm in thickness before extracting and identifying the enclosed pollen grains. He obtained $^{14}$C dates at intervals of 50 cm and calibrated them using the known dates of four intercalated layers of tephra (volcanic ash). The total record extended back about 8000 years. Sakaguchi based his analysis on pine pollen, which fell into two types, spherical (Diploxylon) and hemispherical (Haploxylon). The Haploxylon pollen were ascribed to Pinus pumila and P. parviflora, two cold-adapted species currently found on the slopes of nearby Mt. Shibutsu.

The average proportion of Haploxylon pollen among total pine pollen across the entire interval was 8%. Samples containing more than 8% were interpreted by Sakaguchi as representing cooler intervals, and those with less as representing warmer ones (Figures 3, 4). The general validity of this approach was confirmed by the tendency of Haploxylon pollen frequencies to fluctuate in parallel with those of pollen from cold-loving conifer genera.

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such as *Abies* (fir), *Picea* (spruce), and *Tsuga* (hemlock). According to Sakaguchi, average annual temperatures at Ozegahara varied on the order of ±3 °C over the period in question. To this day, Sakaguchi’s work on the Ozegahara peat column remains unique in Japan for its chronological depth and completeness.

Figure 4. Temperature Reconstruction
Based on Pine Pollen from Ozegahara (Last Two Millennia)

Source: Redrawn from Sakaguchi Yutaka, “Kako 8000 nen no kikō henka to ningen no rekishi” (Climate Change and Human History during the Past 8000 Years), *Senshū jinbun ronshū* (Senshū University Essays in the Humanities) 51 (1993): 86.

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b. Tree rings

Important information about past climates can also be obtained from tree rings.

Dendroclimatological studies in Japan have been based on physical characteristics such as width and density of tree rings, as well as chemical characteristics such as the ratio of stable carbon isotopes. All of these are affected in complex ways by climate and other variables.

Let us begin with isotope ratios.

![Figure 5. Temperature Reconstruction Based on $\delta^{13}$C from Yaku Island Cedar](source-image)

Source: Redrawn from Kitagawa Hiroyuki, “Yakusugi ni kizamareta rekishi jidai no kikō hendō” (Climate Change during the Historical Period as Inscribed in Yaku Cedars), in Rekishi to kikō (History and Climate), ed. Yoshino Masatoshi and Yasuda Yoshinori, vol. 6 of Kōza: Bunmei to kankyō (Lectures on Civilization and Environment) (Tokyo: Asakura shoten, 1995), 50.
Probably the best-known dendroclimatological study in Japan is that by Kitagawa and Matsumoto, who examined carbon isotopes in giant Japanese cedars (*sugi; Cryptomeria japonica*) on Yaku Island to the south of Kyushu. These authors measured \( \delta^{13}C \), that is, the ratio of \(^{13}C\) to \(^{14}C\) expressed in parts per thousand (‰), from tree cellulose in modern cedars on the island. They found that \( \delta^{13}C \) was highly dependent on elevation, and hence average annual temperature. (Specifically, \( \delta^{13}C \) increased as temperatures went down and decreased as they went up.) Although other factors, including precipitation, physiology, and light intensity, also affect \( \delta^{13}C \) values, these were fairly uniform across the area of study and could safely be ignored. Kitagawa and Matsumoto then applied the observed relationship between \( \delta^{13}C \) and temperature to a core taken from a giant ancient cedar growing on the same island, measuring \( \delta^{13}C \) for every tenth successive tree-ring to create a reconstruction of temperatures fluctuations in Yaku over the past two millennia (Figure 5).\(^{21}\) Although the time depth in this study is significantly less than in Sakaguchi’s

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\(^{21}\) Kitagawa Hiroyuki, “Yakusugi ni kizamareta rekishi jidai no kikō hendō” (Climate Change during the Historical Period as Inscribed in Yaku Cedars), in *Rekishi to kikō*, ed. Yoshino and Yasuda, vol. 6 of *Kōza: Bunmei to kankyō* (Lectures on Civilization and Environment) (Tokyo: Asakura shoten, 1995), 47-55; H. Kitagawa and E. Matsumoto,
palynological work, the resolution is much better because tree rings are annual and can be counted with minimal risk of error.

Figure 6. Temperature Reconstruction Based on Kiso Cypress Tree-Ring Widths


There is also some Japanese research based on physical characteristics of tree rings such as width and density. Of particular note are several papers by Sweda, who studied Japanese cypress (*hinoki; Chamaechyparis obtusa*) trees from Kiso in the mountains of central Honshu. Sweda first established an empirical correlation between winter temperature and width of tree-rings in modern cypress. Then he went on to apply these results to disks and cores from about 200 medieval and early modern logs lying in the same forest. The result was a detailed temperature curve going back to 1177 CE (Figure 6).

Similar studies, with somewhat less impressive results, have been published by Kobayashi and coworkers for fir (*Abies*) and by D’Arrigo and coworkers for oak (*Quercus*). Another

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approach is represented by the research of Yasue and coworkers, who found that the
density of spruce (*Picea*) tree-rings correlated positively with summer temperatures and
used this result to calculate temperatures in northern Japan going back to 1750.²⁴

c. Borehole temperatures

To the layman, possibly the most bizarre scientific approach to climatic reconstruction
involves the measurement of actual temperatures at different depths in boreholes.²⁵ The
basic idea is that temperature at a given depth is a function of surface temperature, thermal
conductivity distribution, and heat flow from below. If measured temperatures differ from
what would be predicted based on these factors, it is argued, the deviation reflects
variations in past surface temperatures, whose effects have propagated downward in
proportion to elapsed time. As even its practitioners admit, borehole temperature analysis

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²⁴ Koh Yasue, Ryo Funada, and Yoshihiro Nobori, “Tree-Ring Data Obtained by
Densitrometric Analysis as Indicators for Past Climate Reconstruction in Northern Japan,”
in *Proceedings of the International Conference on Climate Change and Variability*, ed.
mikami, 121-26.
²⁵ Note that this technique differs from the others discussed here in that “temperature itself
is being measured, not a proxy for temperature”: Committee on Surface Temperature
Reconstructions for the Last 2,000 Years, *Surface Temperature Reconstructions for the
Last 2,000 Years*, 78.
has rather poor resolution – centuries, as opposed to decades or years. Nonetheless, it can be useful in confirming long-scale climatic trends.

In Japan, borehole temperatures have been the subject of several studies. Perhaps the most ambitious was by Gotō and coworkers, who recorded temperatures within a 920 m borehole at Karasuma on the southeastern coast of Lake Biwa, central Honshu, and then used the data to reconstruct surface temperature trends for the past 3000 years (Figure 7). Although the analysis produced credible results (showing, among other things, effects due to the Medieval Warm Period and the Little Ice Age), the researchers found somewhat greater temperature disparities than they expected. They attributed this to tectonic movement, specifically earthquakes that had alternately drowned and exposed the location of the borehole relative to the surface of the lake.26 In addition to the work by Gotō and coworkers, a number of rather crude reconstructions going back to 1500 have been

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published online by Taniguchi.footnote[27]

Figure 7. Temperature Reconstruction Based on Borehole Temperatures at Lake Biwa (Last Two Millennia)


d. Lake sediments

Other data related to paleoclimates comes from sediment cores from lakes, which can be dated by counting annual varves or, more typically, by AMS (accelerator mass

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footnote[27]{Available in the Borehole Temperatures and Climate Reconstruction Database maintained by Shaopeng Huang at the University of Michigan: http://www.geo.lsa.umich.edu/climate/ASI.html}
spectrometry) radiocarbon. Researchers record geochemical or sedimentological features of the sample at various depths, and then attempt to relate observed variations to climatic fluctuations, such as temperature, in the past. In Japan, some of the more illuminating studies using lake cores were by Fukusawa for Lake Suigetsu (Fukui) and Lake Mikurigaike (Toyama), both on the Sea of Japan coast of Honshu, and by Adhikari and Kumon for Lake Nakatsuna (Nagano) in the mountains of central Honshu.

**e. Other**

Other proxies abound, for example variations in annual bands in coral, which were used by

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Morimoto and coworkers to calculate ancient sea surface temperatures for the waters around Kikai Island, south of Kyushu. But enough on methodology; it is now time to turn to the results of the various studies described above and what they imply for human history in Japan.

### III. Climate in Japanese History and Prehistory

After such a lengthy buildup, it is perhaps anticlimactic to report that most studies conducted in Japan, whether using historical or natural proxies, simply confirm what is already known about global climatic trends. Of course, there are many short-term

discrepancies. But what concern us here are the long-term trends, and for these, the
Japanese results are similar to those from other temperate regions of the northern
hemisphere. This is reassuring, because otherwise one would either have to doubt the
validity of the Japanese studies, or look for an explanation of why Japan should be
climatically unique.

What, then, are these broad, long-term features? At the crudest level, the northern
hemisphere experienced rapid warming after about 14,500 BP, followed by a brief return to
near-glacial conditions between roughly 12,900 and 11,600 BP (the so-called Younger
Dryas), followed in turn by a long period of relative climatic stability (the Holocene)
lasting until the present. The term “relative” is important, because the Holocene has also
been punctuated by several climatic fluctuations, minor in absolute terms, but important to
the people living through them. Among the more recent events were periods of marked
cooling during the first millennium BCE and the first millennium CE; the so-called Medieval
Warm Period; the Little Ice Age; and the recent period of anthropogenic warming.

Sakaguchi, based on his observations of these and other trends in the pollen samples
from Ozegahara, proposed a climatic periodization of Japanese prehistory and history.\textsuperscript{31}

Although his scheme has much to recommend it, some modifications are called for in order to highlight the complex interaction between climate and human society.

For purposes of the following discussion, I have divided the period of human habitation in Japan into eight stages. These stages are based primarily on climatological trends, which are not unique to Japan. However since the purpose of the discussion is to highlight the interplay between climate and society in the Japanese islands, I have taken Japanese archeological and historical developments into account when that seemed appropriate. For each stage, I give a brief description of climatic conditions and then offer some speculations on how these may or may not relate to important social or historical trends. In the end, as shall be seen, we are left with many questions and few definite answers.

\textsuperscript{31} See works cited in note 19, above.
1. 35,000–14,500 BCE

The first human occupation of the Japanese islands took place during the last Ice Age.

Local temperatures were considerably lower than today, as attested by pollen and other fossil evidence. (Another potential, although largely unexploited, source of information is the 40,000-year sequence of varves from Lake Suigetsu on the Sea of Japan coast.\textsuperscript{32})

Although popular works often convey the impression that the Japanese islands were connected to the Asian continent by “land bridges” during the Ice Age, this idea appears to be false except for the case of Hokkaido.\textsuperscript{33} An important corollary is that the first people to arrive in the other Japanese islands must have done so by boat, as was the case in Australia, which was settled as early as 60,000 BP.

The date of initial human occupation of Japan has been the object of much scholarly


confusion, thanks to a series of spectacular frauds perpetrated in the late twentieth century by Fujimura Shin’ichi, a rogue amateur archaeologist. At present, the oldest actual human remains are the femur and humerus of a child of 6 or 7 that were discovered at Yamashita-chō Cave in Okinawa in 1986. These have been radiometrically dated to 32,000 BP, which in terms of actual calendar years probably works out to a few thousand years earlier. (Currently, calibration for $^{14}$C dates extends back only to 26,000 BP.) A date in this general range makes very good sense in the context of what is known about the spread of anatomically modern humans in other parts of Asia and Oceania. Note that this was considerably before the LGM, meaning that humans first came to the islands before sea levels reached their minimum.

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35 Research on this topic continues to expand exponentially; for a good recent overview (based largely on genetic research) see Oppenheimer, The Real Eve.
As noted above, the LGM came to an end around 18,000 BP. Temperatures oscillated and then warmed very dramatically around 14,500 BP (the “Bølling warming”). Then, between 12,900 and 11,600 BP, there was a return to near-glacial conditions (the “Younger Dryas”) when a massive burst of freshwater from Lake Agassiz temporarily shut down the Gulf Stream. (Lake Agassiz, in what is now eastern Canada, had formed from the melting of the Laurentide Ice Sheet.) Following the resumption of thermohaline circulation in the Atlantic, temperatures rose again until around a second pulse of meltwater from Lake Agassiz caused them to plummet between 8200 and 8000 BP. This so-called “8.2 ka event” was followed by the Holocene “climatic optimum” or “hypsithermal” of around 6000 BP, when average temperatures in the Northern hemisphere were several degrees above contemporary levels.\(^{36}\) In Japan, according to Sakaguchi’s pollen data, the hottest period was between

\(^{36}\) On these changes, see Fagan, *The Long Summer*; and Burroughs, *Climate Change in Prehistory*. Quite recently, a team of scientists has argued that the onset of the Younger Dryas resulted from extraterrestrial impacts in North America. This does not necessarily negate the “meltwater” hypothesis, as the impacts are said to have destabilized the Laurentide Glacier. See R.D. Firestone, A. West, J.P. Kennett, L. Becker, T.E. Bunch, Z. S. Revay, P. H. Schultz, T. Belgya, D.J. Kennett, J.M. Erlandson, O.J. Dickenson, A.C. Goodyear, R.S. Harris, G.A. Howard, J.B. Kloosterman, P. Lechler, P.A. Mayewski, J.
5871 and 4360 BCE.\(^37\) (Sea levels also rose as the result of global warming and isostatic effects, culminating in the so-called “Jōmon Transgression” of c. 6500-5000 BCE.\(^38\)) In general, the climate remained warm until about 1000 BCE, although the pollen data for Japan show another brief cold spell between 2587 and 2409 BCE.\(^39\)

This period under discussion corresponds archaeologically to the Jōmon culture, distinguished from the Paleolithic culture that preceded it by the appearance of fixed settlements and what is apparently the world’s oldest pottery. The origins of the pottery are a mystery, but that aside, most studies of the Jōmon culture link its emergence to climatic changes, specifically to early Holocene warming. Many older works give the impression that the Jōmon culture appeared around 10,000 BCE, but that is not correct; the first pottery

\(^{37}\) Sakaguchi, “Warm and Cold Stages,” 11-16; Sakaguchi, “Kako 8000 nen,” 87-89. Note that these dates give an impression of greater accuracy than exists: Sakaguchi’s data by no means have an annual resolution.


\(^{39}\) Sakaguchi, “Warm and Cold Stages,” 11-16; Sakaguchi, “Kako 8000 nen,” 87-89.
actually dates from around 14,500 BCE. Habu, in her discussion of this problem, notes that this date places the emergence of the Jōmon culture before the end of the last Ice Age, nullifying any explanation based on climatic warming per se. Habu herself thinks that climatic oscillation was the deciding factor.\(^{40}\) Presumably, rapid oscillations in climate would have placed unusual demands on human society.

For comparative purposes, it is perhaps worthwhile to note that the transition from the Ice Age to the Holocene is associated with the “Neolithic Revolution” in the core areas of Eurasia. In the Near East, which is best known, the initial warming after the LGM was followed by the emergence of fixed settlements and early experiments with the domestication of animals and plants. Then, during the Younger Dryas, arid conditions forced a subsistence crisis that could only be solved by a full-scale conversion to agriculture.\(^{41}\)

The Jōmon people in Japan must also have faced difficult times during the Younger

\(^{40}\) Habu, *Ancient Jomon*, 26-42.

Dryas, but they did not turn to agriculture, possibly because the natural environment was so rich, or possibly for lack of suitable cultigens. Rice and other cereals (with the possible exception of barnyard millet) are not native to Japan, and while remains of these and other cultigens have been found at various Jōmon sites\textsuperscript{42}, it is not clear (at least to me) whether any of these finds go back as far as the Younger Dryas. Their presence later in the period shows that the Jōmon people had at least some contacts with the Asian mainland and were familiar with the idea of agriculture. That they never went further than limited horticulture is perhaps further evidence for the basic richness of their environment, making the Jōmon the ultimate “affluent foragers.”\textsuperscript{43}

3. 1000 BCE-250 CE

though, it represents a transition between the warm conditions of the post-glacial Jōmon era and the extremely cold conditions of the succeeding stage. According to Fagan, a reduction in solar activity led to widespread cooling in the first millennium BCE.\textsuperscript{44} For Japan, the story is best told by the pollen record at Ozegahara.\textsuperscript{45} First, there was a sudden, dramatic cooling around 1000 BCE, described by Sakaguchi as “the most important climatic turning point of the past 8000 years.”\textsuperscript{46} Next, there was a return to warm, wet conditions from around 580 to 100 BCE. Finally, between 100 BCE and 250 CE there was a gradual deterioration of climate forming a prelude to the very cold conditions that prevailed after 250 CE.

In terms of human society, this stage corresponds to the Yayoi period, which was initiated by the arrival of agricultural colonists from the Asian continent.\textsuperscript{47} Food production fueled rapid population growth among the immigrants, who replaced or

\begin{flushright}
\footnotesize
\textsuperscript{44} Fagan, \textit{The Long Summer}, 197-98.
\textsuperscript{45} Sakaguchi, “Warm and Cold Stages,” 16-17; Sakaguchi, “Kako 8000 nen,” 87-89.
\textsuperscript{46} Sakaguchi, “Kako 8000 nen,” 88.
\textsuperscript{47} The literature on this topic is, of course, immense, but one essential reading in English is Mark J. Hudson, \textit{Ruins of Identity: Ethnogenesis in the Japanese Islands} (Honolulu: University of Hawai‘i Press, 1999).
\end{flushright}
absorbed the indigenous Jōmon foragers throughout much of the archipelago. Agriculture also facilitated surplus accumulation, social stratification, and the concentration of political power in regional chiefdoms.

The beginning of the Yayoi period is traditionally dated to 300 or 400 BCE, which appears to make sense climatologically – after all, would not the warm, wet conditions prevailing at that time be conducive to the adoption of agriculture? However, AMS dating now shows that the Yayoi period began much earlier than previously believed, specifically, around 900 or 1000 BCE. This is just after the beginning of a very cold phase, suggesting a possible causal relationship between climatic deterioration and the appearance of the new culture. Were the Yayoi immigrants fleeing from harsher conditions in the continent? We may never know. In any case, it seems likely that colder conditions in Japan were inimical to the Jōmon way of life, making food production an attractive and indeed necessary alternative for immigrants and perhaps indigenes alike. Although the situation in Japan is

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complicated by the factor of immigration, the notion of human populations being forced into agriculture by climatic deterioration is congruent with what is known about conditions in the Middle East during the Younger Dryas. Once agricultural society was firmly established, the later temporary warming of the climate may have had little effect, except to facilitate the spread of wet-rice farming into the colder regions of northern Honshu.

4. 250-700 CE

The next stage, referred to by Sakaguchi as the “Kofun Cold Stage,” was one of profound and sustained cooling.\textsuperscript{49} According to the same author, this was the longest cold stage of the past 7600 years, and its intensity exceeded that of the more famous Little Ice Age.\textsuperscript{50} The period was not only cold but also wet, at least judging from the flood deposits seen at various archaeological sites.\textsuperscript{51}

Like the other stages discussed in this paper, the “Kofun Cold Stage” was not

\textsuperscript{49} Sakaguchi, “Warm and Cold Stages,” 17-22; Sakaguchi, “Kako 8000 nen,” 89-91.
\textsuperscript{50} Sakaguchi, “Warm and Cold Stages,” 19.
\textsuperscript{51} Sakaguchi, “Kako 8000 nen,” 90-91.
localized to Japan; temperate zones everywhere experienced dramatic cooling. The initial cooling may have resulted from volcanism, which was rampant during the third century.\(^{52}\)

Another factor seems to have been lower concentrations of atmospheric CO\(_2\), which are reported from ice cores between around 200 and 600. Ruddiman, an eminent climatologist, ascribes the reduction in atmospheric CO\(_2\) to heavy mortality in Eurasia from plague and other epidemic diseases. Specifically, he claims that large-scale population loss was accompanied by the reversion of cropland to forests, resulting in lower atmospheric concentrations of CO\(_2\) and CH\(_4\) (methane).\(^{53}\) It remains to be seen whether this argument will stand the scrutiny of other climatologists and historians.

Whatever the initial cause of cooling, conditions were considerably worsened in 536 CE by a mysterious “dry fog” recorded in historical sources from the Mediterranean to China. Tree ring studies confirm that solar irradiation was reduced for an incredible fifteen years.

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\(^{52}\) Joel D. Gunn, “A.D. 536 and Its 300-Year Aftermath,” in The Years without Summer: Tracing A.D. 536 and Its Aftermath, ed. Joel D. Gunn (Oxford: Archaeopress, 2000), 11-12. Note, however, that Committee on Surface Temperature Reconstructions for the Last 2,000 Years, Surface Temperature Reconstructions for the Last 2,000 Years, 104, Figure 10-3, does not seem to support this claim.

\(^{53}\) Ruddiman, Plows, Plagues & Petroleum.
years. There is no scientific consensus on the nature of the 536 event, although the leading contenders are comet debris and the eruption of a supervolcano. In any case, the disaster led to widespread crop failures and social disruption in Eurasia, Africa, and the Americas.\textsuperscript{54}

Although clearly important, the 536 event has been the subject of exaggerated claims by some authors. A book-length study by Keys, for example, argues that “in a matter of decades, the old order died and a new world – essentially the modern world as we know it today – began to emerge.”\textsuperscript{55} Regarding Japan, Keys states that the event of 536 caused famines that paved the way for the introduction of Buddhism, the Sinicization of Japan, and “ultimately the emergence of the Japanese nation.”\textsuperscript{56} Needless to say, this claim is so broad as to be virtually devoid of meaning. That said, there is some indirect evidence of famine, specifically a reference in \textit{Nihon shoki} to the establishment of public granaries in 536 as


\textsuperscript{56} Keys, \textit{Catastrophe}, 172-180; quotation from flow chart, 178.
(among other uses) a “preparation for evil years.”

Although it is difficult to make a case for the long-term effects of the 536 event per se on Japanese society, the “Kofun Cold Stage” as a whole is another matter. In terms of social development, the single most important feature of the four and a half centuries beginning in 250 CE was state formation, manifested archaeologically by the appearance of the huge tumuli or kofun for which the period is named. I suggest, following earlier speculation by Sakaguchi, that state formation in the Japanese islands was at least in part a response to the cold, wet conditions prevailing at the time. The emergence of the Yamato polity is generally understood as the natural result of the growth in population and social complexity that accompanied the spread of agriculture in the preceding Yayoi period. There may be an element of truth to that, but just as the adoption of agriculture was probably “forced” by cold climate after 1000 BCE, so the emergence of a new level of social

57 W.G. Aston, tr., Nihongi: Chronicles of Japan from the Earliest Times to A.D. 697, two volumes in one (Rutland, Vermont: Tuttle, 1972), vol. II, 34.
organization – the state – may have occurred as a response to the challenges posed by increasingly cold, wet conditions. Among other things, I would argue, crop failures and floods required countermeasures such as public granaries and hydraulic works, which in turn required better organization and central direction. Japan’s first state may have been the result.\(^\text{60}\)

5. 700-1300 CE

The notion of a Medieval Warm Period originates with Hubert Lamb, the pioneer of historical climatology. Working from such evidence as was available in the 1950s and 1960s, Lamb argued that there had been four centuries of relatively warm weather beginning around 800. As he also showed, the onset and end of warming varied

\(^{60}\) This hypothesis differs somewhat from the one offered by Sakaguchi, who places emphasis on competition between regional powers over increasingly scarce agricultural resources and on the role of rulers in introducing and improving agricultural techniques. On state formation in general, see the parsimonious discussion in David Christian, Maps of Time: An Introduction to Big History, The California World History Library, No. 2 (Berkeley and Los Angeles: University of California Press, 2004), 245-52. Christian distinguishes between “top-down” and “bottom-up” theories of state formation, concluding reasonably that most states probably resulted from a combination of top-down direction and bottom-up needs.
significantly by region. Today’s scholars have access to much better data than did Lamb.

Some have used the accumulating evidence of regional variation to discredit the idea of a Medieval Warm Period, but as a general rule Lamb’s notion has held up surprisingly well. 61

The causes of the Medieval Warm Period are not entirely clear, although one factor may have been reduced levels of volcanic activity. 62 Also at work, according to Ruddiman, were increased levels of atmospheric CO₂ and methane, which he ascribes to population recovery (and thus renewed conversion of forests into agricultural land) after the “Dark Ages.” 63

The Medieval Warm Period is generally defined as beginning around 800 or 900, but here I am using a chronology that seems to better fit the Japanese case. Although for earlier periods proxy evidence is mostly limited to pollen, tree rings, and borehole

61 See Fagan, The Great Warming, 12-18, for background. For a contrary view see Tim F. Flannery, The Weather Makers: How Man Is Changing the Climate and What It Means for Life on Earth (New York: Atlantic Monthly Press, 2005), 44, which states that “the idea of a global Medieval Warm Period is bunk.” Flannery’s point is that the period was not universally warmer than the present day, which may be true, but he ignores the important fact that in most regions it was considerably warmer than the immediately preceding or succeeding periods. (This lapse aside, Flannery’s book has much to recommend it.)
62 Committee on Surface Temperature Reconstructions for the Last 2,000 Years, Surface Temperature Reconstructions for the Last 2,000 Years, 21.
63 Ruddiman, Plows, Plagues & Petroleum.
temperatures, after 700 we also have historical records, making it possible to paint a rather
detailed portrait of climate in Japan. Sakaguchi, based on his study of pollen at Ozegahara,
argued that temperatures became warm after 732 and stayed that way through the thirteenth
century.  
Maejima, Tagami, and others have refined this picture using historical records.

To summarize, summers between 700 and 1300 were generally hot, with frequent droughts,
except for a temporary cool spell in the ninth century. Winter temperatures, however, did
not warm up until about 900. Winters from 900 to 1300 were generally mild, with the
exception of a cold spell in the late twelfth century. (Note that here we are speaking here
of average conditions; there was considerable variation from year to year.)

From a world historical standpoint, not just the timing, but also the effects of the
Medieval Warm Period varied considerably by region. Some areas, for example Europe and
China, experienced significant agricultural and demographic growth, although drought was

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Also see Adhikari and Kumon, “Climatic Changes During the Past 1300 Years”; Aono and
Omoto, “Sakura no kaika shiryō”; Aono, “Sakura no kaika no kisetsu suii”; and Aono,
“Kyōto no kokiroku.” On droughts in particular, see Farris, “Famine, Climate, and
Farming”; and Farris, Japan’s Medieval Population: Famine, Fertility, and Warfare in a
Transformative Age (Honolulu: University of Hawai’i Press, 2006).
sometimes a problem. Good weather is said to have allowed the Norse to colonize Iceland and Greenland, while conversely a drying out of the steppes is often cited as a factor in the eruption of the Mongols from their traditional homeland. In the Americas, recurrent, severe droughts associated with the Medieval Warm Period have been implicated in the collapse of the Classic Maya in Mesoamerica and of the Chaco Canyon culture and other societies in the American Southwest.\textsuperscript{66}

What about Japan? In terms of traditional historiography, the period from 700 to 1300 encompasses the Nara and Heian eras, as well as most of the Kamakura epoch. This half millennium witnessed the consolidation of imperial authority and the flourishing of aristocratic culture in the capital, followed by a slow drift toward decentralization and the militarization of local society. It is difficult to see what, if any, relationship such trends

\textsuperscript{66} On the effects of the Medieval Warm Period, the best overview is Fagan, \textit{The Great Warming}. On the Maya, see Richardson B. Gill, \textit{The Great Maya Droughts: Water, Life, and Death} (Albuquerque: University of New Mexico Press, 2000); and Jared Diamond, \textit{Collapse: How Societies Choose to Fail or Succeed} (New York: Viking, 2005), 157-77. On Chaco Canyon, see Diamond, \textit{Collapse}, 136-56. Diamond presents a well-organized argument to the effect that social collapse typically results from some combination of five contributing factors: (1) damage that people inadvertently inflict on their environment; (2) climate change; (3) hostile neighbors; (4) decreased support by friendly neighbors; and (5) society’s responses to its problems: Diamond, \textit{Collapse}, 10-15.
might bear to climate. More relevant for our purposes is the fact, recently established by Farris, that Japanese society experienced little or no demographic or economic growth during these five centuries. At first glance this seems odd, especially given the apparently robust nature of the Nara and early Heian states. Farris places the blame on recurrent epidemics of smallpox, measles, and influenza, coupled with recurrent drought. Although the epidemics had nothing to do with climate, the droughts most certainly did. So it seems fair to say that the Medieval Warm Period was not particularly kind to Japan, although the consequences were far less severe than in the case of, say, the Classic Maya.

6. 1300-1600 CE

This brings us to the next period, here defined as lasting from about 1300 to 1600. Some researchers consider these centuries to be part of the Little Ice Age, while others prefer to reserve that term for the period after the late sixteenth or even late seventeenth century.

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67 Although it has been argued that rise of warrior society in eastern Honshu was made possible by warmer temperatures, which made the Kanto Plain more attractive for agriculture than in earlier centuries: Toyama Shūichi, Shizen to ningen no kankeishi (History of the Nature-Human Relationship) (Tokyo: Kokon shoin, 2008), 140.
68 Farris, Japan’s Medieval Population, and “Famine, Climate, and Farming.”
This is mainly a matter of definition or taste, since all authors seem to agree that the climate began to deteriorate around 1300 but that the most severe conditions came later.

Accordingly, I have chosen to split the period in two, which makes sense not only climatologically but also in terms of historical developments in Japan. For reasons of convenience, the causes of the Little Ice Age will be discussed in the following section. In the present section we will stick to the climatic facts and their effects on human society in Japan.

First, regarding Japanese climate, we are on increasingly solid ground thanks to the many available natural and historical proxies. To make a long story short, summer in Japan remained generally warm throughout this period. The real difference from the preceding Medieval Warm Period came in winter, which was generally cold. The very coldest periods were in the 1340s through 1360s; around the beginning of the fifteenth century; around 1490; and then from the 1500s through the 1540s. Mild winters, by contrast, were the norm for a time after 1470 and during the second half of the sixteenth century.69

69 This is based mainly on Maejima and Tagami, “Climatic Change During Historical Time,” 164-67, with additional information from Adhikari and Kumon, “Climatic Changes
Next, regarding the historical implications of these trends, the record defies easy interpretation. Outside of Japan, famines in early fourteenth century Europe can be confidently ascribed to the deteriorating climate (specifically to cold and rain). But from a world historical viewpoint, the most important events of the fourteenth through sixteenth centuries were the spread of the Black Death; the European “discovery” of the New World; and the resulting “Columbian Exchange,” in which (among other things) the native American population was decimated by exposure to Eurasian disease pools. It seems safe to say that none of these developments had much to do with climate.

What about Japan? As is well known, these centuries, roughly corresponding to the


70 Fagan, _The Little Ice Age_.


72 Unless for some reason cold weather brought humans into closer contact with rats, increasing the likelihood of plague transmission. For a fascinating ecological study of rats and plague in an earlier period, see Michael McCormick, “Rats, Communications, and Plague: Toward an Ecological History,” _Journal of Interdisciplinary History_ 34, no. 1 (2003): 1-25.
Muromachi and Sengoku (Warring States) periods, were characterized by political and social turmoil. Many specific uprisings can be traced to crop failures resulting from bad weather.\textsuperscript{73} One is therefore tempted to generalize and blame all of the sociopolitical problems of this period on the cooler climate. However that would be a mistake. Although temperatures were on average lower than during the Medieval Warm Period, overall that was probably a plus, as we shall see below. Further arguing against any simple link between climate and social conditions is the example of the subsequent stage, which saw a return to political stability despite profound climatic deterioration.

There is another aspect of this period that merits consideration, and that relates to agricultural production and demography. In stark contrast to the bleak political situation, Japan’s economy and population grew by leaps and bounds during these three centuries. (In traditional agrarian societies, of course, economic and demographic growth are often more or less the same thing.) According to Farris, Japan’s population “expanded on the order of 300 percent, from about 5.5-6.3 million in 1150 to 15-17 million in 1600, with almost all

\textsuperscript{73} See the many cases discussed by Atwell, “Volcanism and Short-Term Climate Change.”
the growth coming after 1280.”74 Absent immigration (not a significant factor in medieval Japan), population growth can only result from increased life expectancy, or increased fertility, or both. Although Farris couches his argument is slightly different terms, both factors seem to have been present in this case. Longevity was promoted by decreased mortality from epidemic disease and famine, both of which had been rampant in the previous period. Longer life also resulted from a general increase in physical well-being, which Farris ascribes to agricultural improvements and a host of other indirect factors. Better health also presumably led to increased fecundity, although as Farris readily admits, the direct evidence for this is weak.

Looking at all of this from a climatological perspective, I would point out that the decreased number of famines probably relates to the return of temperatures to a more “normal” range following the extremes of the Medieval Warm Period. The obverse of this point is that climatic conditions in the Muromachi period were probably better suited to rice

74 Farris, Japan’s Medieval Population, 5. Note that Kitō, the leading Japanese authority, finds only a doubling, from 6.8 million to 12.3 million, over the same period: Kitō Hiroshi, Jinkō kara yomu Nihon no rekishi (Japanese History as Read from Population), Kōdansha gakujutsu bunko (Kōdansha Academic Library), No. 1430 (Tokyo: Kōdansha, 2000), 16-17.
agriculture than those in the preceding stage. It is usually a mistake to discount human agency, and I have no doubt that the technological and social improvements cited by Farris were important. But it would equally be a mistake to ignore the probable positive effects of climate change on agricultural productivity – and thus, indirectly on human longevity and fecundity – during the Muromachi and Sengoku periods.75

7. 1600-1850 CE

This brings us to the (narrowly defined) Little Ice Age, which has been of particular interest to scholars because of its relatively dramatic consequences and its proximity to our own time.76 Japanese climatologists, like their colleagues elsewhere, have actively pursued

75 Farris, *Japan’s Medieval Population*, 94-127, seems to recognize the role of climate when he describes the period from 1370 to 1450 as the “Muromachi Optimum,” but unfortunately there are problems with this concept. First, among climatologists the term “optimum” is reserved for periods that are hotter than normal (otherwise known as “hypsithermals”). So while the Medieval Warm Period was a climatic optimum (and is often referred to as such in the literature), the Muromachi period was not. It is possible, of course, that the years from 1370 to 1450, while not an optimum in the technical sense, were somehow optimal for agriculture in Japan. Perhaps this is Farris’s point. But if that is the case, there seems little need to single out this particular 80-year interval. Except for a few, relatively brief, periods of intense winter cold, similar climatic conditions prevailed throughout the fourteenth through sixteenth centuries in Japan.

research on this period. Most significantly, in 1991 Tokyo Metropolitan University hosted an “International Symposium on the Little Ice Age Climate,” whose proceedings contain more than a dozen important papers on this topic as it relates to Japan. 

In contrast to the Medieval Warm Period, which varied in timing and intensity according to region, the Little Ice Age was relatively uniform in its effects, at least in

For a more popular account, see Fagan, The Little Ice Age.

temperate regions of the northern hemisphere. The causes of the Little Ice Age seem to have been multifarious. Many scholars have blamed decreased solar activity, particularly during the so-called “Maunder Minimum” of c. 1645-1710. Volcanic eruptions also certainly played a role, especially in the late eighteenth and early nineteenth centuries. For example, the so-called “Year Without a Summer” in 1816 was caused by volcanic dust in the atmosphere from the 1815 eruption of Tambora, in what is now Indonesia. The Tambora eruption is said to have been the most violent of the entire Holocene. Finally, as during the “Kofun Cold Stage,” ice cores show reduced levels of atmospheric CO$_2$, first between 1300 and 1400, and then again, more dramatically, from 1500 to 1750. By now, readers will be unsurprised to learn that Ruddiman ascribes these drops in CO$_2$ levels to population loss following pandemics. Specifically, he attributes the fourteenth century drop to the effects of the Black Death in Eurasia, and that between 1500 and 1750 to the loss of native


79 Ruddiman, Plows, Plagues & Petroleum, 119.
populations in the Americas following the “Columbian Exchange.”

Moving on to Japan, climatic conditions during this period have been reconstructed in great detail using data from diaries and other historical records, tree-rings, and other proxies. The conclusions of various previous studies are summarized in Table 1, below. As was the case in Europe and elsewhere, temperatures were generally, but not uniformly, cold. The coldest conditions occurred from approximately 1611 to 1650, 1691 to 1740, and 1781 to 1880. During these three phases, winters were severe with much snowfall, particularly on the Sea of Japan side of Honshu. Summers were cool, particularly in the northern part of the country, and frequently rainy. Interestingly, the “Year Without a Summer” was wholly unexceptional in Japan, although an earlier “Year Without a Summer” occurred in 1783 following the eruptions of Mt. Asama in Japan and the Laki fissure in Iceland.

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81 Maejima and Tagami, “Climatic Change During Historical Time.” Also see Maejima and Tagami, “Climate of Little Ice Age in Japan.”
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<td>Ishikawa family diary</td>
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Notes to Table 1


c Ikuo Maejima and Yoshio Tagami, “Climate of Little Ice Age in Japan,” *Geographical Reports of Tokyo Metropolitan University* 18 (1983): 91-111.


What effects did the Little Ice Age have on human society? Discussions of this topic by world historians typically center on crop failures and associated famines, particularly in Europe.\(^\text{84}\) As noted earlier, there is also a substantial literature on the Little Ice Age in Japan, and much of this also focuses on famines. Many authors, for example, have noted that the Genroku Famine of 1695-1696, the Tenmei Famine of 1782-1787, and the Tenpō Famine of 1833-1839 all occurred during particularly cold periods, and that all had their

\(^{84}\) See discussion in Fagan, *The Little Ice Age*.\(^{85}\)
most severe effects in northern latitudes, where temperatures were lowest. Since the

Tenpō Famine was part of the background to the domestic unrest that contributed to the fall

of the Tokugawa Shogunate, the enthusiastic climate historian might be forgiven for

claiming that the Little Ice Age put an end to Japan’s ancien régime, paving the way for

modernization.

While it is true that cool temperatures frequently led to famine, this is not all there

was to the Little Ice Age, either in Japan or elsewhere. Another frequently-cited negative

effect involves the failure of the Norse settlements in Greenland, which had been

established during the preceding Medieval Warm Period. But what climate historians

85 Maejima and Tagami, “Climatic Change During Historical Time,” 169. Also see Mikami,

“Kikin no kōzō: Tenmei no kikin o rei to shite” (The Structure of Famine: The Case of the

Tenmei Famine), Chiri (Geography) 27, no. 12 (1982): 51-57; Mikami and Tsukamura,

“The Climate of Japan in 1816”; Yaji and Misawa, “Tenpō kikin zengo”; and Yamakawa,

“Climate Variations and Natural Disasters.” Another major famine, the Kyōhō Famine of

1732, was caused by a plague of locusts and was most severe in western Japan. There is

some interesting evidence from upland regions in central Honshu that in times of poor

harvests peasants began to cultivate horse chestnuts as an alternate source of food: J.

Kitagawa, T. Nakagawa, T. Fujiki, K. Yamaguchi, and Y. Yasuda, “Human Activity and

Climate Change During the Historical Period in Central Upland Japan with Reference to

Forest Dynamics and the Cultivation of Japanese Horse Chestnut (Aesculus turbinata),”


86 Neil Roberts, The Holocene: An Environmental History (Oxford: Blackwell Publishers,

1998), 179-80; Diamond, Collapse, 248-76. Note that the Norse settlements met their end

around 1500 and thus somewhat before the Little Ice Age as defined here.
have inexplicably failed to note is that the Little Ice Age was not universally bad. Viewed as a whole, the period saw dramatic demographic and economic growth, as well as state- and empire-building, throughout the core regions of Eurasia.\(^{87}\) This suggests either that colder temperatures had some sort of positive influence on society (by stimulating people or states to greater efforts?), or alternatively, that the Little Ice Age was largely irrelevant to the important historical trends of the era. In either case, historians may need to take off their blinders and reexamine this topic from a broader perspective.

What can be said for world history can be said for Japanese history as well. Although I concede that famines were important, and that many of them can be directly blamed on the weather conditions of the Little Ice Age, I must also note that this period saw some very positive developments, especially in the seventeenth century. As just one example, Japan’s population continued to grow rapidly, doubling, according to Farris, from 15-17 million in 1600 to 31 million in 1721.\(^{88}\) Most of this increase took place during very

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\(^{88}\) Farris, *Japan’s Medieval Population*, 263. Kitō believes that Japan’s population in 1600
cold conditions. While it is true that population growth ceased after 1721, this has nothing to do with climate; it was simply that Japanese society had reached the demographic “limits to growth” imposed by available resources and technologies. (Economic growth, however, did continue, albeit at a slower pace, throughout the period.) How are we to explain these facts if the Little Ice Age was such a terrible thing? Again, the question is begging to be reopened.

8. 1850-2000 CE

The last phase in Japan’s climatic history is the contemporary period of anthropogenic warming since around 1850. The facts are clear and well-known, and I see no need to reiterate them here. Moreover, unlike for all the earlier periods described above, there is little point in trying to tie specific developments in human society to climate. Climate was, and is, not irrelevant; but it was no longer the primary engine of change – if, indeed, it ever

was only 12 million, but agrees with the figure of 31 million for 1721. Kitō, Jinkō, 16-17. If this is correct, population growth during the early Edo period was even more rapid than Farris’s figures suggest.
had been. Society in the nineteenth and twentieth centuries developed largely according to its own logic.

IV. Conclusion

This survey of the role of climate in Japanese history and prehistory has been, at best, sketchy and tentative. Much work remains to be done before we have a comprehensive picture of how the weather and climatic change affected people and society in the Japanese archipelago. The big picture seems relatively clear, but many of the details are missing. Worse (or perhaps better, for those who like puzzles), even when we know what happened, we do not usually know why.

Some of the results of this survey seem to fly in the face of common sense. For temperate regions like Japan, it would seem natural to expect that warm conditions were “good” for agriculture and society while cold conditions were “bad.” My working hypothesis when I began this study was that warm conditions would be associated with
periods of growth and consolidation, while cold conditions would be associated with periods of stagnation and disruption. That turns out not to be true; if anything, the reverse was the case.

Cold conditions often produced good results for society in Japan. For example, the origins of pottery (the Jōmon culture), of rice agriculture, and of the state all seem to be causally linked to unusually cold temperatures. The same is true of the explosive demographic and economic growth of the seventeenth and early eighteenth centuries. The full explanation for these apparent paradoxes must await the results of future research. Here let me simply repeat my “hunch” that adverse climatic conditions brought out the best in the residents of the Japanese islands, who collectively rose to the challenges presented them by nature.

Conversely, warm periods could produce bad results for society in Japan. True, the generally warm Jōmon period was one of exceptional prosperity for the hunter-gatherer residents of the archipelago. But following the advent of full-blown agriculture, warm conditions appear, if anything, to have been a liability. A case in point is the Medieval
Warm Period. Although the degree of political integration during the Nara and early Heian periods was generally high, from a demographic or economic perspective these centuries were characterized above all by stagnation. If this premodern example of global warming had such dire consequences for Japanese society, one can only wonder where current trends will lead. Yes, over time, the Japanese, like people elsewhere, have demonstrated increasing control over their environment. But will technology save the day this time around? Only time can tell.
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