

DEVELOPMENTS OF THE PERCEPTION OF CLIMATE CHANGE AND ABNORMAL WEATHER IN POSTWAR JAPAN

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ABSTRACT: Climate research has been presented as a largely Anglophone and European affair, while other regional contributions and concerns have been left largely unexamined. An investigation of the Japan Meteorological Agency's 'Abnormal Weather Reports' and related literature instead reveals the concerns of an island nation anxious about immediate weather abnormalities, causes of climate variability, and predicting the consequences of global warming within a geographically vulnerable Japan. Researchers initially focused on the topic of global cooling in the 1970s, sparking fears about Japan's self-sustainability in the event of a long-term decline in temperatures. By the 1980s, though cooling fears persisted, focus also turned to how El Niño cycles provoked climatic variability, even as initial concern with global warming resulting from human activities, carbon dioxide (CO₂) emissions, and ozone depletion grew. Following the Kyoto Protocol's recognition of anthropogenic climate change and creation of a global cooperative framework, research has begun to focus on the consequences of global warming in exacerbating Japan's meteorological risks and on mitigating further anthropogenic temperature increases.

KEYWORDS: Climate change research, global cooling, abnormal weather, global warming, Japan Meteorological Agency

Introduction

In recent years, Japan has been subject to fierce heat waves during the summers, as well as disastrous flooding and landslides. Abnormal weather and climate change are seen as pressing problems contributing to these events. In actuality, the Kishocho, the Japan Meteorological Agency (JMA) began publishing initial reports on abnormal weather in the 1970s. For the last 50 years, what kind of discussions and claims have been made about abnormal weather in Japan, and how have they been communicated to society? Drawing on the JMA's official reports on abnormal weather and other publications, as well as the three national newspapers with the largest publication base, *Asahi Shimbun* (*Asahi*),

Mainichi Shimbun (*Mainichi*), and *Yomiuri Shimbun* (*Yomiuri*),¹ this article is one of the first attempts in English to overview how such issues have been conceived and treated in Japan. Moreover, it sheds light onto the history of climate change research and related concerns from a rarely discussed Japanese perspective.² It will argue that due to concerns about recent abnormal weather and the perceived geographical vulnerabilities, those researching and writing about abnormal weather and climate change in the 1970s-80s initially emphasised cooling trends that would harm Japan's ability to be self-sufficient. Driven by media and political actors, domestic concern about cooling and its effects on agriculture would persist through the 1980s, even as researchers moved toward more international perspectives in accounting for weather data variability with the study of El Niño events and anthropogenic-driven global climate change in the mid-1980s. As the human contributions accelerating climatic warming were recognised, researchers began to investigate and attempt to caution about the disastrous consequences of long-term warming, even as Japan haltingly moved forward with policies aimed at mitigating the worst of these.

Situated along the eastern edge of the Pacific Ring of Fire, the main four islands of the Japanese archipelago stretch more than 2,000km and the nation extends over about 3,000km from north to south when including the Ryukyu Islands. Climatic zones range from the subarctic in Hokkaido to the subtropical in Okinawa, while the archipelago is subject to frequent geological and meteorological disasters. The lands are heavily forested and 70-80% mountainous. Due to such geography and labour migration, postwar Japan cities have rapidly grown even as the countryside depopulated, resulting in a high urbanisation rate, increasing from 63% in 1960, to 77% in 1990, before topping 90% by 2010.³ Much of this population is concentrated within lowland coastal cities, with some 80% living on land at 0-100 meters within sea level (Kokudogijutsukenkyusenta, nd). Furthermore, approximately 4 million Japanese live at or below sea level within 580 square kilometres of sunken land.⁴ In the postwar period, Japan has never been fully self-sufficient in terms of foodstuffs, not having been higher than 80% self-sufficient since the 1960s, and presently relies on foreign trade for more than 60% of its food goods (Hirasawa, 2017). Japan is similarly mostly resource poor in terms of energy and must turn to imports for fuels used in electrical generation and transport. The percentage of imported coal reached 80% in 1980, 90% in 1988, and has exceeded the 99% mark since 2002. As for crude oil, the import percentage has consistently been over the 99% mark since 1964. Liquefied Natural Gas imports, which have recently risen to almost a quarter of Japanese energy production since 2014, similarly stand at 98% (Keizaisangyosho Shigenenerugicho, 2020).

¹ Most of these articles' authors are not attributed and are referenced in the text with the italicised abbreviated title of the newspaper and date of publication.

² For examples of previous major works on climate change research history from US or European perspectives, see Howe (2014), Oreskes & Conway (2012), and Coen (2014); Japanese researchers working abroad did significantly contribute to global warming research from the 1970s on, see Weart (2008).

³ By 2007 the majority of the world's population lived in urban areas (see Our World in Data, 2019 and World Bank, 2020).

⁴ This 'sunken' land is mostly due to postwar pumping of groundwater for industrial purposes, causing widespread subsidence in the metropolitan areas of Tokyo, Osaka, Nagoya and other cities (Kokudokotsusho, 2006b).

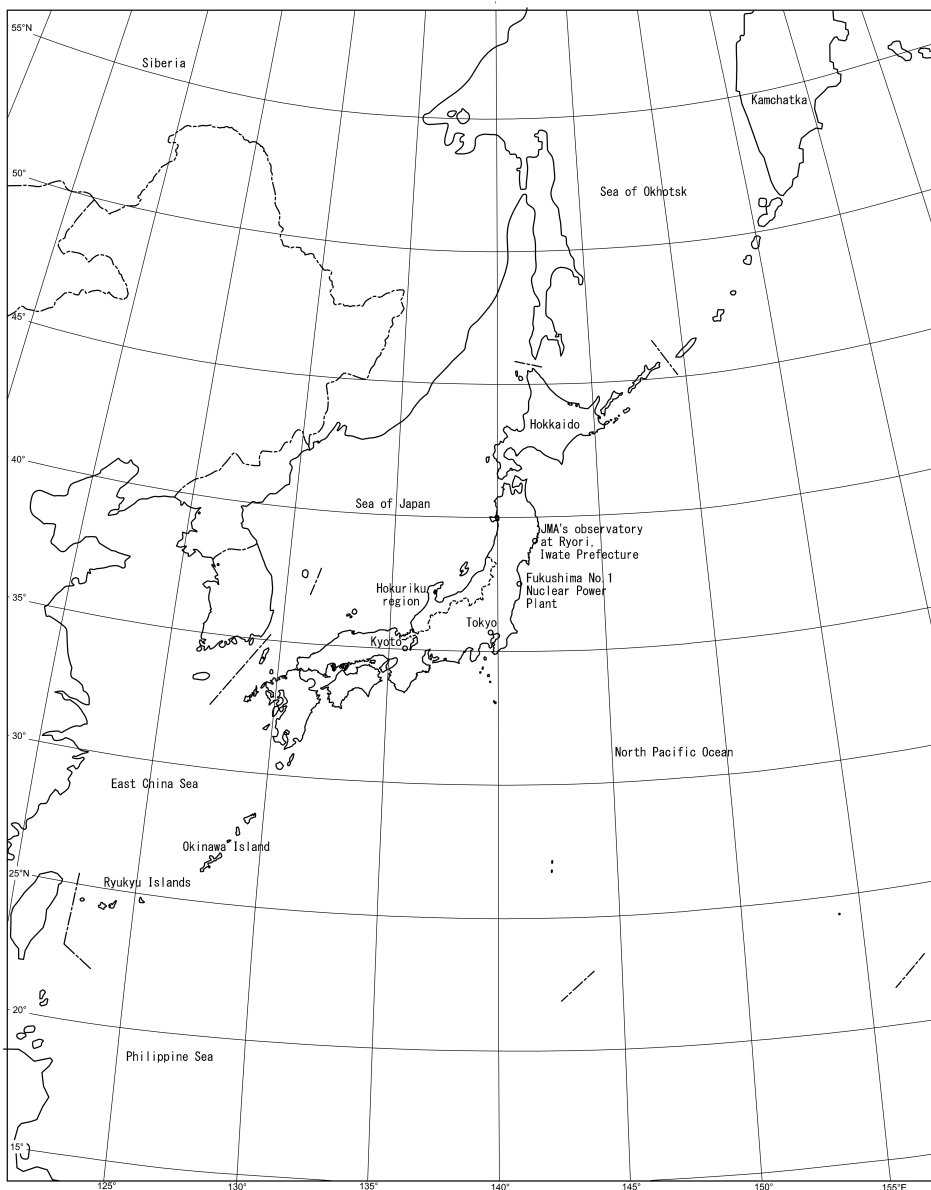


Figure 1 - The Geography of Japan and its Surroundings

Perceptions of abnormal weather and climate change in the 1960s

Meteorological observatories have been established throughout Japan since the 1870s, monitoring temperature, wind, rainfall, and gathering atmospheric and oceanic data. Early research into weather patterns included decades of establishing sets of data from which observers could over time deduce long-term seasonal patterns for the archipelago's

regions.⁵ World War Two curtailed meteorologically-related research and its publication and circulation, with Japanese scientists only taking up the subject of weather and long-term climate again in earnest from the 1950s. Freely circulating their work in academic journals, researchers focused on examining extended time-period data sets and with a particular concern for aiding the rebuilding of a country struggling to feed itself (Okamoto, 1951; Maejima, 1957). As postwar national planning initiatives began to take hold and regional development was emphasised, there was a need to enhance agricultural techniques through regional observation and experimentation and aim for optimal growing conditions (time periods, precipitation, temperature) (Ozawa and Fujita, 1952). Crop failures, particularly in the colder north, began to raise questions about whether there was a trend toward cooling (Ogasawara, 1950; Fukui, 1958). Scientists also investigated the formation of glaciers and glacial periods, as well as sunspots and the waxing and waning cycles of solar energy during the 1950s, though largely directed their concerns toward Japan and local Japanese agriculture (Kawabata, 1953; Takahashi, 1958; Yamamoto, 1958; Tsukada, 1958; Abe, 1959; Kobayashi, 1962). Newspapers published before the early 1960s show a parallel concern to highlight the effects of hail, hoarfrost, spells of rain, cool summers, etc. on agricultural production.⁶ However, detailed popular media discussions from a long-term or global viewpoint were much fewer and were only partially emergent in the 1950s.⁷

Broad scientific and general public interest in *Ijokisho* or ‘abnormal weather’⁸ within Japan was spurred by cold waves in the early 1960s and particularly 1963 with heavy snowfall in the north-central Hokuriku region, about which, as one article among a series of twelve on abnormal weather in the *Asahi* newspaper in 1976 noted, “meteorologists uniformly felt” was abnormal (Mikado, 1976e, p.4). In 1963 concern was expressed in newspapers about

⁵ For information on Japanese observations and meteorological science, see for example Tamura (1905) & Sanders (1921).

⁶ For instance, *Asahi* (1879, p. 1; 1910 p. 2; 1945, p. 2) and *Yomiuri* (1877, p. 1; 1879, p. 2; 1880, p. 3; 1885a, p. 2; 1885b, p. 3; 1892, p. 2; 1895, p. 5; 1898a, p. 3; 1898b, p. 3; 1901, p. 3; 1902a, p. 3; 1902b, p. 2; 1934a, p. 3; 1934b, p. 2; 1934c, p. 2; 1947, p. 2; 1949a, p. 2; 1949b, p. 2; 1953, p. 2; 1954a, p. 1; 1954b, p. 2; 1954c, p. 2; 1957a, p. 5; 1957b, p. 3).

⁷ For instance, *Yomiuri* (1904, p. 5; 1934d, p. 7; 1937, p. 7; 1940, p. 7; 1945, p. 2).

⁸ The term *Ijokisho* (‘abnormal weather’) carried a variety of meanings. In general media it has been used to describe a variety of phenomena, including temperature, rainfall and snowfall that deviate significantly from the average figures (although this ‘average’ is not consistently expressed in mathematical terms and can refer to what some feel is normal or not). For example, the term has often been used to refer to various instances of weather that (generally negatively) affects human life in some way, such as heat or cold that is felt to be severe or is actually harmful to the human body; temperatures, precipitation, and weather phenomena such as hail and frost that damage crops; and wind and rain that cause disasters. The term as used by the JMA has had similar nuances, though the major difference is that scientifically for JMA researchers to consider weather events or short-term patterns to be abnormal these must markedly deviate from the data sets of the 30 previous years. Specifically, deviations that have not been observed in the previous 30 year period, or else variances from the average that are at least double in nature, are considered to be ‘abnormal’ lows or highs. The JMA’s reports, from its 1974 report onward, both record and analyse phenomena that have occurred in the five years since the previous report, although they always include long-term analysis of climate changes in a greater than 30-year context, with attention to data as far back as it can be gathered. This is similar to the WMO’s standard, and this definition is cited by the JMA in ‘Regarding Global Weather in Recent Years’ (Kishoko, 1973) and is standard in the introduction to ‘Abnormal Weather Reports’ from the 1980s onward. Media reporting references these differences when writing of ‘abnormal weather’ and climate change research with varying degrees of accuracy, though naturally there is some slippage in the usage. Every effort has been made in this article to reflect source material use of references to ‘abnormal weather,’ which so often appear in discussion of both short-term weather events and long-term climate.

global cooling continuing for at least a decade or longer due to low sunspot activity and the meandering of the jet stream (westerlies) (*Asahi* 1963a, p. 14; 1963b, p. 14; 1964a, p. 2; 1964b, p. 7). The issues were discussed in relation to fears of food scarcity, particularly due to the cold-weather damage in Japan. In 1965, in the wake of yet another spell of cold weather, this time in spring for the first time in forty years, the NHK (Japan Broadcasting Corporation) featured an abnormal weather campaign. It was feared that the cold-weather damage could be as severe as during in Tenmei era in the 1780s when some 900,000 people died due to starvation or plague. Newspapers introduced a one-hour long evening program to be broadcast on television for two consecutive nights during which meteorologists and agronomists discussed the abnormal weather and agricultural technologies to overcome it.⁹ Adding to these concerns, Japan's population was expected to increase by some 18 million, from 98 to 116 million, between the mid-1960s and 1985, accompanied by an urbanisation rate of 80%.¹⁰

Following these initial concerns in the 1960s, there was some debate as to whether Japan's future was warming or cooling. Hitoshi Takeuchi, a famous geophysical scientist, argued that energy consumption intensity in Japan was 70 times as large as the world average, which would precipitate global warming. Takeuchi argued that machines burning large amounts of coal and oil (such as postwar Japanese heavy industry) released large amounts of carbon and sulphur into the atmosphere. He projected that if other countries began burning fossil fuels at the same rate as Japan, this would disrupt the carbon cycle, interfere with plant respiration, and disturb the natural state of wind and waves, causing abnormal weather and also warming the Earth. However, Junkichi Nemoto, a well-known meteorologist at the JMA disparaged this argument, stating that intensive energy consumption in Japan would not directly lead to abnormal weather, but Takeuchi's argument could be considered as a warning (*Asahi*, 1972a, p. 3). Though Takeuchi endeavored to spread his argument (eg *Asahi*, 1973a, p. 9; Takeuchi & Hasegawa, 1974), he also noticed that it prompted little reaction, presumably because his warning was taken as something for a distant future (*Asahi*, 1972b, p. 5). Rather, it was Nemoto's views that were widely proliferated. Nemoto was a representative forecaster and a staunch advocate of global cooling, as shown in the (translated) titles of his books, such as *The Earth Heading for a Glacial Period* (1973), *The Earth is Cooling Down* (1974), *A Glacial Period is Coming* (1976) and *The Earth Shivers with Cold* (1980). *Mainichi* reported on one of his books, *A Glacial Period is Coming*, emphasising his argument about the possible advent of a food crisis due to cooling. The book sold 80,000 copies in one month and rose to a high rank on the monthly best-sellers list (*Mainichi*, 1976c, p. 7).

The JMA's early reports on abnormal weather in the 1970s

Given the context of the previous decade, the official initial investigations into climate change research in the 1970s were rooted in concerns about global cooling, rather than global warming. The first attention-gathering official publication was the JMA's 'Regarding Global Weather in Recent Years' (Kishocho, 1973).¹¹ This short document opens by citing

⁹ *Asahi* (1965a, p. 9; 1965b, p. 8); *Mainichi* (1965a, p. 8); *Yomiuri* (1965a, p. 11; 1965b, p. 11). Also see the coverage of a similar program on NHK radio: *Asahi* (1965c, p. 9); *Mainichi* (1965b, p. 8); *Yomiuri* (1965c, p. 10).

¹⁰ Kensetsusho (1966, pp. 2-5). In actuality, the population topped 121 million by 1985, having already increased from 72 million after the end of the war. See Statistical Bureau of Japan (2020b).

¹¹ Translated title, in Japanese as *Kinnen no sekai no tenko nitsuite* (1973).

increasingly frequent incidents of flooding, drought, and cold and heat waves in the late 1960s and early 1970s, following a comparatively warmer period from 1930-1960. Though the report emphasises the need to be careful about the difference between short-term weather and long-term climate, it makes clear that such abnormal weather could potentially be a portent of longer-term climate change, perhaps in the form of a 'Little Ice Age.' Due to Japan's geographical circumstances, subject to north-south winds from Siberia and Kamchatka, there is a marked possibility for colder temperatures in the north, shorter summers in eastern and central Japan, and widespread drought in the western portions of the islands. These were noted as having significant social and economic consequences, especially in light of Japan's swelling population (until 2010) and expanding urbanisation, as well as existing domestic environmental issues, all of which had the power to affect people of every social strata. An afterword briefly posits several potential causes, carbon dioxide (CO₂) and fine dust from human activities are among them, but only as part of a much larger list that includes hypotheses about geological factors (volcanic eruptions, earth movements) and cosmic ones (orbital and pole shifts, the decline of the sun's energy).

Against this backdrop, it was of little surprise that newspapers noted that the Meteorological Agency's white paper elucidated the tendency of cooling, which might last for the remaining years of the 20th Century and adversely affect agricultural production (*Asahi*, 1973b, p. 3; *Mainichi*, 1973, p. 1; *Yomiuri*, 1973, p. 22). In January 1974, a few months before the publication of the Meteorological Agency's first full report on abnormal climate issues, *Asahi* also referred to an article from the US-published *Fortune* magazine (Alexander, 1974). It noted both the Agency's forecast about the cooling of the country and also featured similar predictions about global cooling by specialists like Reid Bryson, chairman of the University of Wisconsin-Madison's Center for Climate Research (*Asahi*, 1974a, p. 10). Two years later, *Asahi* also carried an article based on a CIA report on abnormal weather.¹² Based on the research by Bryson, it predicted long-term cooling in the northern hemisphere and warned about the prospect of world-wide famine (*Asahi*, 1976a, p. 2).

Domestic and international research inspired the compilation and publication of the first 'Abnormal Weather Report,' (Kishochō, 1974),¹³ issued every five years from 1974, as Japanese researchers began to grapple with irregular weather patterns and the need to issue long-term predictions about them. The JMA's full report expanded on its 1973 predecessor, largely reflecting researchers' concerns about a downward trend in temperature that could last many years into the future. It is worth noting that global cooling advocate Nemoto is listed among the authors of the report. Here, Japanese researchers were not completely on their own, but working among a minority of Amero-European scientists more concerned with the prospect of cooling in the northern hemisphere and a potential new Ice Age.¹⁴ The JMA predicted average lower temperatures for a period of 10 years or longer in the northern

¹² Unspecified but probably Central Intelligence Agency (1974).

¹³ Depending on the year of publication, the official reports published by the JMA every 5 years since 1974 has been varyingly named *Kinnen niokeru sekai no ijokisho no jittaichosa to sono chokimitoshi nitsuite*; *Kinnen niokeru sekai no ijokisho to kikohendo sono jittai to mitoshi*; or *Ijokisho repoto kinnen niokeru sekai no ijokisho to kikohendo sono Jittai to mitoshi*. The reports are numbered and we have subsumed the series under the translated title of 'Abnormal Weather Report.' 'Report', unless otherwise stated, will refer to these publications.

¹⁴ For further discussions of the minority research focus on global cooling, see Peterson, Connolley & Fleck (2008, p. 1325-1338).

hemisphere, with either abnormal heavy rain or drought becoming a more prominent issue in the world's southern half. These initial investigations sought to anticipate abnormalities that would affect the immediate and near future, rather than focus consideration on any particular underlying cause for the cooling that Japanese scientists expected to come.

Given a focus on immediate consequences, newspaper readers could notice the preponderant influence of cooling theory and agricultural concern. Research for the first report on abnormal weather in 1974 was conducted not by the Meteorological Agency alone, but in cooperation with the Ministry of Agriculture and Fisheries (*Yomiuri*, 1974, p. 18). Moreover, in contrast to the responses of foreign meteorological agencies who indicated that a long-term forecast of abnormal weather was still technically impossible, the 1974 report ventured to predict the aforementioned long-term cooling in the northern hemisphere (*Mainichi*, 1974, p. 18). *Asahi* described the forecast as “considerably bold.” The newspaper cited, as a reason for the prediction, one of the JMA’s forecasters’ remarks that it was necessary to provide a definite forecast about abnormal weather in order to make predictions about the supply and demand of food (*Asahi*, 1974b, p. 3). The following day, the *Asahi* reported that the Ministry of Agriculture’s own agriculturally-oriented white paper, which underscored “the need to strengthen the food self-supporting system,” was published “as if to respond” to the promulgation of the JMA’s report on abnormal weather (*Asahi*, 1974c, p. 4).

Concerns about Japanese self-sufficiency are even more understandable in the context of not only cooling concerns, but also the reverberations occurring as a result of global trade disruptions in 1973-74. First, increasing crude oil prices from the 1973 global oil crisis (see Venn, 2016) sent import costs skyrocketing, impacted energy consumption, and temporarily forced the Japanese economy into negative growth in 1974.¹⁵ Second, a chain of events beginning with the USSR’s return to the grain market and worldwide crop failures led to the US clamping down on food exports beginning in 1973. This included the embargoing of soybean shipments to Japan. Whereas the US had previously been a reliable trading partner in terms of foodstuffs, the soybean crisis prompted a rethinking of not only US-Japan trade relations, but Japanese self-sustainability, as fears grew about whether or not the island nation of Japan would be able to reliably feed itself in the future (Hirasawa, 2017, p. 2-24).

Recognition of global warming

Despite the overwhelming concern about cooling, there was some recognition of opposing trends. In 1976, Japanese newspapers reported warnings by the World Meteorological Organization (WMO) regarding ozone layer depletion (*Mainichi*, 1976a, p. 18; *Yomiuri*, 1976, p. 4) and warming through anthropogenic factors (*Asahi*, 1976b, p. 3; *Mainichi*, 1976b, p. 1). The *Asahi* introduced the arguments of climatologists such as Mikhail Budyko and Hubert Lamb who claimed that warming in the northern hemisphere was already under way. The JMA would accordingly reconsider the arguments in its previous reports and “course correction” was thought to be “inevitable” (*Asahi*, 1976c, p. 1). Among a series of twelve articles on abnormal weather in the *Asahi* newspaper, two were concerned with warming in the southern hemisphere and the other two explained human-induced factors of warming such as the greenhouse effect due to CO₂ emissions increase and the ‘heat

¹⁵ See Statistical Bureau of Japan (2020a). For general economic trends, see Macrotrends (2020).

island' phenomenon in major cities (Mikado, 1976a, p. 4; 1976b, p. 4; 1976c, p. 4; 1976d, p. 4).

The findings of the 1979 official report (Kishocho, 1979) reflected growing international concerns that global warming, not cooling, might be the long-term trend of the future, and perhaps that this warming was not entirely natural. The JMA nevertheless steadfastly estimated that any new warming would take a decade—the entirety of the 1980s—to overcome the cooling trend of the 1970s. The report did, however, make note of growing concerns with human activity and the distribution of CO₂ into the atmosphere as having potential long-term impacts on the global climate. Newspapers also again underlined that the JMA's 1979 report articulated that the cooling would persist until the end of the 20th Century (*Asahi*, 1979a, p. 23; *Mainichi*, 1979, p. 22; *Yomiuri*, 1979, p. 22).

That underlying assumption would begin to be steadily challenged by growing foreign research on global warming, however. In February 1979, a month before the publication of the JMA's second report, the first international conference on climate change, the World Climate Conference, was held in Geneva under the auspices of the WMO.¹⁶ This conference paid attention to such matters as the increase of CO₂ emissions as a factor that might prompt global warming. Along with this were early discussions of the effect of Chlorofluorocarbon/Chlorofluoromethane (most commonly referred to as CFCs) emissions such as freon gas, widely used as a coolant and an aerosol propellant, as leading to the depletion of the stratospheric ozone layer. The thinning of the ozone layer that protected the Earth by reducing incoming ultraviolet rays was hypothesised as leading to increased risk of skin cancer in humans.¹⁷ In the wake of this conference, the Meteorological Agency decided to set up a specialist panel on climate problems with a view to exchanging information with other countries (*Asahi*, 1979b, p. 3). In July 1980, the Meteorological Agency announced the creation of an investigation section to study abnormal weather, following the WMO's recognition of particles in the atmosphere and CO₂ emissions as factors of abnormal weather, the former for cooling, and the latter for warming (*Mainichi*, 1980a, p. 3; *Yomiuri*, 1980a, p. 3). The Agency also reported to the Transport Ministry that emissions, particularly those from the consumption of fossil fuels, might be influencing the recent abnormal weather in the form of warming at higher latitudes and cooling in lower latitudes, with the flow of the jetstream becoming unpredictable (*Asahi*, 1980a, p. 23; *Mainichi*, 1980b, p. 1; *Yomiuri*, 1980b, p. 3). Newspapers argued that a greater range of preparations should be made for abnormal weather becoming common and that the issue should be discussed much more widely and earnestly (*Asahi*, 1980c, p. 1; Takagi, 1980, p. 5; *Yomiuri*, 1980c, p. 4).

Further research into natural and anthropogenic factors

¹⁶ For the original papers and declaration from the 1979 World Climate Conference, see WMO (1979a) and WMO (1979b).

¹⁷ The idea that CFCs/freon gas thins the ozone and leads to increased risk of skin cancer originates from the claims of Frank Sherwood Rowland, University of California chemistry professor, as indicated in a 1980 *Asahi* newspaper article, but in 1980 the paper still considered it "beyond the realm of hypothesis." At the same time, the paper highlighted the Meteorological Agency's announcement that its actual survey from 1977-1980 confirmed that freon gas, on which the USA had demanded a strict regulation, had been increasing in the atmosphere over the Greater Tokyo Area of Japan. The paper was alarmed that the Agency's findings were in line with those made by the other institutions in the world, demonstrating the increase of CFCs/freon gasses in the atmosphere over such places as the Atlantic, Alaska, Canada, and the UK. See *Asahi* (1980b, p. 1).

The data identified above pushed JMA researchers more heavily into considering the factors underlying weather abnormalities and the change from cooling to warming trends in their third report in 1984 (Kishocho, 1984). Along with their colleagues in the West, this included inquiries into the mechanisms of El Niño climatic cycles, wherein a combination of winds and sea surface temperatures over the Pacific variably produces cycles of warming and cooling, most significantly in regions within Africa, the Asian Pacific, and Latin America. The focus on this additional variable that could produce abnormal phenomenon which diverged from recorded data was seen as especially urgent when the 1982-83 El Niño event produced an increase of average monthly temperatures as high as 3.3°C over a six season period, which was then noted as the highest in a century.¹⁸ Anthropogenic factors such as CO₂ also begin to be featured more prominently, while discussions of global cooling or ice ages are notably absent from the third report. Methods of gathering climate data such as examining solar radiation or ice levels in regions to the north of Japan also became more prominent.

Against this backdrop, in the JMA's 1984 report on abnormal weather, "greenhouse effect" was identified as an "unignorable" matter (*Yomiuri*, 1984b, p. 9). Newspapers underscored the report's findings that the warming in the northern hemisphere had started and would continue, and that human-caused factors such as CO₂ emissions were pertinent to abnormal weather (although the warming in Japan was expected to commence a dozen or so years later) (*Asahi*, 1984a, p. 3; *Mainichi*, 1984, p. 1; *Yomiuri*, 1984a, p. 1). Here the newspapers deviated somewhat from the official reports, which expected a slow but steady rise in temperatures, except in northern Japan (Kishocho, 1984, p. 279-281). Overall, however, *Asahi* described the report as, "so to speak, a warning that 'civilization is destroying the globe as such.'" The report sold well and in less than two months after first printing of 6,000 copies, another 5,000 copies were reissued (*Asahi*, 1984b, p. 1).

The final report of the 1980s followed in 1989 (Kishocho, 1989) and reflects a maturation of analyses of the El Niño cycle (now also referred to in its present form, as ENSO, or El Niño-Southern Oscillation, accounting for warm and cold phases) as well as the new urgency surrounding concerns about role of CO₂ in accelerating global warming and CFCs in depleting the ozone layer. Causal factors of abnormal weather and climate change are directly attributed to not only natural factors (including atmospheric, solar, volcanic, and ENSO cycles) but also to anthropogenic causes, "such as increased concentrations of greenhouse gases and land surface alterations including deforestation and desertification." The report concludes, however, with the observation that "[a]mong these factors, the increase in the concentration of greenhouse gases will be the most important factor when considering climate change in the next few decades" (Kishocho, 1989, p. 406). Furthermore, the report followed the widespread publication of a 1985 article on an expedition to the Antarctic that discovered that the ozone layer was notably thinning over the region (commonly reported as a 'hole' in the ozone) (Farman, Gardiner, and Shanklin, 1985). Though research on the ozone layer has been conducted since the 1970s and the 1979 WMO conference highlighted the risks of CFCs, the aforementioned article in particular is credited as having mobilised the passage of the 1987 Montreal Protocol on Substances that Deplete the Ozone Layer that froze the global production and use of the CFCs (including freon gas), which were eventually fully recognised as being responsible for ozone loss.¹⁹ It is

¹⁸ At least until five seasons in 1997-1998 produced increases of 3.6°C. For records of +/- .5°C variations (longer than six months) of El Niño/La Niña cycles, see Kishocho (2020a).

¹⁹ For an explanation of the impact of the 1985 expedition and publication see Soloman (2019).

no surprise then that CFCs and ozone issues are prominently discussed in the Japanese report as well.

Governmental agencies stepped up their monitoring mechanisms to track greenhouse gasses and in 1987, the JMA began monitoring CO₂ emissions from an observatory at Ryori in Iwate Prefecture and also tracked methane emissions from 1991 (Kishocho, 2020b). Additionally, in 1987, the Environmental Agency's specialist panel on the protection of the stratosphere's ozone layer published its interim report urging for measures to restrict the emission of CFCs, including freon gas (*Mainichi*, 1987, p. 3). It was urged that the Japanese government should follow the American example to set about tackling the issue in earnest (*Asahi*, 1988, p. 4).

In January 1989, the greenhouse effect section of the JMA's specialist panel on climate problems indicated in its report that if the greenhouse effect gasses continued to increase at the present ratio, the average temperature of the Earth would rise by 1.5 to 3.5 °C by the 2030s (*Mainichi*, 1989a, p. 3). Newspaper coverage on April 6th underscored this point and focused on the increasing severity of global warming when reporting the JMA's 1989 report (*Asahi*, 1989a, p. 3; *Mainichi*, 1989b, p. 30; *Yomiuri*, 1989a, p. 1). The following day, newspapers reported the Transport Minister's statement in a press conference after the cabinet meeting that he was positively considering the offer by the WMO to establish an international database centre for abnormal weather in Japan (*Asahi*, 1989b, p. 1; *Yomiuri*, 1989b, p. 1). In August 1989, the Ministry of Construction announced its interim report on problems in river administration related to global warming, which was compiled from the JMA's previous research. It was estimated that if the sea level rose 1.5 meters, the area of land at sea level or below would be enlarged by 3.5 times from the present 1200km² to 4200km², with a rise in the population affected from 3.2 million to 9.8 million, necessitating the raising of sea embankments by 4.1 to 5 meters (*Yomiuri*, 1989c, p. 2). While the ex-official Junkichi Nemoto and the current Director General of the Meteorological Agency Ryozo Tatehira were wary of the preponderance of anthropogenic factors with regard to warming (Nemoto, 1990, p. 5; Tatehira, 1990, p. 1), it was also recognised that it was necessary that every citizen endeavoured to restrain global warming (Yokoyama, 1992, p. 5).

The 1989 report also begins a clear trend of examining meteorological disasters through the lens of climate change. Though disasters were among reasons for the initial interest in climate change research in the 1970s, their reintroduction here is notable. From the 1990s onwards, the various versions of the JMA's report on abnormal weather and climate change underscored the concern about warming due to anthropogenic factors (*Asahi*, 1994, p. 3; *Mainichi*, 1994, p. 10; *Yomiuri*, 1994a, p. 30; *Mainichi*, 1995, p. 8; *Asahi*, 1999, p. 14; Hiranuma, 1999, p. 18; *Yomiuri*, 1999, p. 38; *Asahi*, 2005, p. 23; *Mainichi*, 2005, p. 28; Okubo, 2005, p. 15; *Yomiuri*, 2005, p. 22; *Mainichi*, 2014, p. 15; *Asahi*, 2015, p. 10), while the JMA would begin to publish a set of 'Climate Change Monitoring' reports from 1991 (Kishocho, 1991-1995).²⁰ Newspapers called for effective measures against human-caused factors of global warming (*Yomiuri*, 1994b, p. 3; *Asahi*, 2001, p. 2).

For the already geographically vulnerable island nation of Japan, research from the 1990s onward would more closely examine the potential consequences of global warming in the form of the relationship between long-term anthropogenic climate change and natural disasters. Following past reactions, dramatic variations in seasonal temperature, including

²⁰ Translated title, the original is *Chikyu ondanka kanshi repoto*.

that of the 1997-98 El Niño phase (which saw a 3.6°C increase in temperature over five seasons) spurred concern about drought and further worry about food supplies. Eventually, the Ministry of Agriculture began publishing reports on global warming's impact from 2007.²¹ Additionally, the threat of rising sea levels is explicitly spelled out by the 1999 Abnormal Weather Report, noting that, “[a]s many of the world’s major cities are located on coastlines, there are concerns about storm surge intensification due to future water level rises and the degradation of various city and port functions” (Kishocho, 1999, p. 258). The report further bluntly states that, particularly “in the Pacific islands and countries with extensive coastal lowlands, rising water levels are a problem of life and death” (ibid). Finally, for the both heavily mountainous and urbanised island nation of Japan, seasonal monsoon rains were predicted to become deadlier. This was particularly emphasised with regard to the increasing frequency of localised torrential rain well beyond the sewer capacity in large cities. The rains themselves were thought to be connected to urbanisation and the heat island phenomena, in which heat arising from urban concentrations hastens the accumulation of thunderclouds, in turn potentially causing serious flooding damage (*Mainichi*, 2000 - Local page for Tokyo; Kato and Sakata, 2005, p. 132). This led to a recognition in the Cabinet Office’s white paper on disaster management and climate of the need for a new kind of disaster risk management, one which better accounted for the possibility of sudden “guerrilla rains,” the consequences of urbanisation, and for improved measures in allocating resources to aid aging populations distributed in depopulated areas, as well as calling for enhanced inter-departmental cooperation (*Yomiuri*, 2009, p. 3).

The direct attribution of climate change to individual disasters is still an emerging science. Nevertheless, it has become possible to say with some measure of confidence that long-term anthropogenic climate change has an impact on the risks involved within the nexus of natural and human forces in terms of the magnitude and probability of individual disasters.²² Japanese researchers have similarly expressed worry over the confluence of global warming and Japan’s island nature, concluding in 2006 that “in the long term, there is a concern that rising sea levels due to global warming will reduce the safety of coastal areas against floods and storm surges, and that typhoons will become more powerful” (Kokudokotsusho, 2006a, p. 1). Along those same lines in 2018, that along with “impacts of climate change on natural disasters and the condition of coastal areas, the flooding of rivers due to increased intensity and frequency of sudden downpours, damage due to slope failures, high tides due to more intense typhoons, and other damages have become a concern” (Ministry of the Environment, et al, 2018, p. 5). These factors were demonstrated during the summer flooding of 2018 that occurred along with unprecedented high temperatures peaking at 41°C, events from which the JMA concluded would not have occurred in the manner that they did without influence from factors of global warming.²³

²¹ These reports can be found in the Ministry of Agriculture’s website: Norinsuisansho (2020).

²² For instance, see the National Academies of Sciences, Engineering and Medicine’s 2016 review of disaster attribution research, where the findings were summarised as: “In the past, a typical climate scientist’s response to questions about climate change’s role in any given extreme weather event was, ‘We cannot attribute any single event to climate change.’ The science has advanced to the point that this is no longer true as an unqualified blanket statement. In many cases, it is now often possible to make and defend quantitative statements about the extent to which human-induced climate change (or another causal factor, such as a specific mode of natural variability) has influenced either the magnitude or the probability of occurrence of specific types of events or event classes.” National Academies of Sciences, Engineering and Medicine (2016, p. 16).

²³ The JMA’s report concluded that: “The long-term trend of increased intensity in observed extreme precipitation events in Japan and the clear upward trend in amounts of airborne water vapour also suggest that the Heavy Rain Event may be linked to global warming. Global warming and ongoing

Developments of legislation following the Kyoto Protocol

Meanwhile, Japan held the COP3 session in Kyoto in 1997, setting standards for the Kyoto Protocol, and the following year the Law Concerning the Promotion of Global Warming Countermeasures was enacted to establish a framework for promoting domestic countermeasures to combat global warming. However, major newspapers pointed out various problems in the process, and the Japanese government's efforts were criticised acutely. As for the COP3, compromise reduction targets for the countries were set due to the intervention of the Ministry of International Trade and Industry (MITI) and the Ministry of Foreign Affairs (MOFA), based on considerations of US and domestic industrial intentions, in the formulation of the greenhouse gas reduction plan (*Mainichi*, 1997, p. 5). As for the Law concerning the Promotion of Global Warming Countermeasures, the original draft bill prepared by the Environment Agency made preparations for a plan to control greenhouse emissions mandatory for the national government, local governments, and businesses. However, due to resistance from industry and the MITI, the final draft of the bill that was submitted to the National Diet was changed from a mandatory to suggested provision as far as the businesses were concerned, merely encouraging them to prepare and publish their plans (*Asahi*, 1998, p. 5; *Mainichi*, 1998a, p. 5; *Yomiuri*, 1998a, p. 3). When the law was unanimously passed at a 1998 plenary session of the House of Councillors, it was reported that “the world's first comprehensive law for the prevention of global warming” had been enacted. At the same time, the exemption of business interests from the law's mandatory provisions due to the opposition of the MITI and industry left “doubts about the effectiveness of the law” (*Mainichi*, 1998b, p. 3).²⁴

In March 2010, the Cabinet approved the Basic Bill on Global Warming Countermeasures, which included a numerical target of reducing greenhouse gas emissions by 25% by 2020 (compared to 1990 levels) and measures to achieve this goal. However, newspapers questioned whether the bill could even be enacted into law due to conflicts between the Ministry of the Environment (upgraded from an agency in 2001), which wanted to ensure a reduction, and the Ministry of Economy, Trade and Industry (the successor to MITI), which was concerned about the impact on economic activity, as well as criticism from the business community (Hoshino & Takenaka, 2010, p. 7). Furthermore, there were doubts about the bill's policy of promoting nuclear power generation as a means of reducing greenhouse gas emissions (*Asahi*, 2010, p. 3). A year after this cabinet decision was made, the Fukushima nuclear disaster resulting from the Great East Japan Earthquake forced a fundamental rethinking of the policy of emphasising nuclear power, and the bill was eventually scrapped in November 2012 (*Asahi*, 2012, p. 5; *Mainichi*, 2012, p. 5). Subsequently, both the central and local governments began to focus on infrastructure maintenance and (re)development, the development of agricultural and fishery products capable of weathering warmer temperatures, the creation of hazard maps, and other measures to mitigate the damage to crops and the influence of weather-related disasters caused by the ongoing global warming. In 2018, the Climate Change Adaptation Law was enacted, which requires local governments to endeavour to make an adaptation plan for a range of measures to reduce damage due to climate change and establish a regional centre for

higher-than-normal zonally averaged tropospheric air temperatures associated with the northward shift of the subtropical jet stream are also considered responsible for the extreme heatwave.” JMA, Tokyo Climate Center (2018, p. 1).

²⁴ Also see *Yomiuri* (1998b, p. 17).

climate change adaptation (Igarashi, 2018, p. 2). However, the creation of these centres at the local level has been retarded due to the difficulties in securing human and financial resources (Oba, 2019, p. 1; Watanabe, Oba & Saito, 2019, p. 3).

Conclusion

For Japan, interest in climate research grew out of concerns for food self-sufficiency in the 1960s and 1970s in response to perceived cooling trends and international economic and trade crises. Some focus on global cooling lingered into the 1980s, even as domestic and international researchers began to focus on long-term warming trends, investigating what the causes were, and if those causes and the resulting climatic variation were part of natural cycles (ENSO) or human-driven (CO₂ emissions and other gasses). Concerns about Japan's vulnerability would persist, centring not just around food production, but also on the probability and magnitude of disasters. The 'Abnormal Weather Reports' evidence attempts to establish a set of climatic standards, efforts to understand what is driving variations from the norm and to give guiding predictions for a future where previous baselines are being dramatically shifted.

Japan is an island nation with a heavily urbanised population, small amount of arable farmland and low food production. It is mountainous and subject to seasonal downpours, with a large percentage of its population concentrated in low-lying coastal lands, including some portions below sea level. This is of course not just a Japanese problem. Citing the third Intergovernmental Panel on Climate Change (IPCC), the 2005 Abnormal Weather Report argues that anthropogenic climate change is:

likely to be accompanied by a growing number of 'extreme phenomenon,' such as heavy precipitation and droughts, and that today's global warming and other aspects of climate change are one of the most significant and serious challenges to humanity, one that threatens the very foundation of our existence (Kishocho, 2005, n.p)

On the other hand, however, Japan is also a heavily industrialised country boasting the third largest economy in the world and is, per capita, also the third largest emitter of greenhouse gasses (UN Environment Programme, 2019). After the Great East Japan Earthquake and the subsequent halting of most nuclear power generation, Japan has been slow to transition away from the cheaper coal power that presently makes up more than 30% of its electrical generation (Mainichi, 2019, p. 5). Nevertheless, as of 2020 Japan has made some moves to reduce inefficient coal power plants (Nikkei, 2020), limit the sale of gasoline engine vehicles (Takeuchi & Saikawa, 2020, p. 1), and Prime Minister Yoshihide Suga has pledged to begin to steer Japan towards carbon neutrality by 2050 (Kikuchi, 2020). It remains to be seen to what extent Japan's promises, and those of the rest of the world, will live up to the reality.²⁵

²⁵ In its last rating (September 2020), Climate Action Tracker rated Japanese efforts to be 'Highly Insufficient,' along with most of the world's largest economies and biggest greenhouse gas emitters. See Climate Action Tracker (2020).

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