Overview of the Special Issue “Meteorological Disasters and Climate Variations in Historical Times”

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In early July of this year (2018), disasters occurred in Western Japan related to unprecedented mudslides and flooding rivers, which were caused by record-breaking heavy rainfalls that accompanied activated Baiu (early summer rain) fronts. The total number of fatalities exceeded 200. In July 2017 and in August 2014, similar torrential rainfall-related disasters also occurred in the same area, with 40 fatalities in Northern Kyushu and more than 70 in Hiroshima Prefecture.

Every time such severe meteorological disasters occur, expressions such as “unpredictable heavy rain”, “unprecedented catastrophe”, and “record-breaking heavy rain” are used. However, in Japan, official meteorological observational data were not available before 1872 in Hakodate and 1875 in Tokyo. Usually, early observational data before the 1870s are not certified as official records by the Japan Meteorological Agency (JMA). Therefore, even if a disaster is described as occurring “for the first time in the history of observations” or as “record-breaking”, it is based on data covering only a period of 140 years at most.

In Japan, studies for reconstructing climate variations since the 17th century, which include the Little Ice Age, have been undertaken by a few historical climate researchers, mainly based on historical diary weather records kept in local libraries (e.g., Mikami, 2008; Hirano

and Mikami, 2008; Hirano *et al.*, 2012, 2013; Mikami *et al.*, 2015). This journal (*Journal of Geography*), also featured the special issue “Little Ice Age in Japan” (Vol. 102, No. 2, 1993), which documented attempts to reconstruct climate variations during the Little Ice Age from old weather diaries, tree ring data, and cherry blossom records. In recent years, in addition to qualitative data such as diaries, several examples of meteorological observational data before JMA official observations started have been found in Japan. Correction, homogenization, and digitization of these data are proceeding, and longer-term meteorological time-series combined with JMA’s official data will become available. Such longer observational time-series in comparison with reconstructed climate time-series will make it possible to quantitatively analyze climate variations, and objectively evaluate the intensities and tracks of tropical typhoons, which have caused heavy rainfall and strong winds since historical times.

The longest period covered by this special issue “Meteorological Disasters and Climate Variations in Historical Times” dates back nearly 300 years, and includes nearly 200 years since the 18th century when official meteorological observational data were not available in Japan. The target period includes the Little Ice Age during the Edo period of Japan, and it is possible to discuss meteorological disasters in

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relation to long-term climate change. One problem is to obtain a method for objectively and quantitatively evaluating actual climate variations and meteorological disasters in historical times without meteorological observational data.

In this special issue, the following research themes are discussed: (1) research on unofficial meteorological observation records before JMA observations started, (2) study on climate reconstruction based on diary weather records, (3) research on 19th century meteorological observations made by foreign missionaries, (4) research on typhoon track reconstructions using meteorological observation data from the 19th century, and (5) research on historical meteorological disasters based on documentary materials in Japan and China.

Therefore, the purpose of this special issue is to understand long-term climate variations spanning hundreds of years by clarifying the actual state of fluctuations in the intensity of various weather disasters, occurrence frequencies, typhoon tracks, and so on. This special issue is outlined below in order.

Zaiki *et al.* (2018) collected meteorological data from various parts of Japan, which were observed in the 19th century before the Japan Meteorological Agency was established. After correction and homogenization of these data, it is clear that the temperature variations in the South-eastern Kanto region from 1840 to 1850 are characterized by a climate with warm winters and summers. In addition, detailed meteorological data observed in the latter half of the nineteenth century (after 1877), which were obtained from coastal lighthouses in Japan, are also being digitized and are expected to be used effectively in climate change research.

Grossman *et al.* (2018) used the following materials for their analysis: (1) English-language newspaper published in Japan, (2) Historical Weather Database of Japan, (3) lighthouse meteorological observation records from various parts of Japan, (4) logbooks of UK/US ships, and (5) Imperial Meteorological Observation Data of Tokyo. As a result, in

1877, four typhoons were detected to have approached and landed on the Japanese coastal area, and attempts were made to reconstruct the central positions, moving tracks, lowest pressures, and damage. In this paper, the importance of clarifying the tracks and intensities of historical typhoons is pointed out.

Kubota (2018) compared two typhoons which landed on the Kii Peninsula of Japan and the Visayas area of the Philippines in 2011 and 2013, respectively, with typhoons occurring at the end of the 19th century, in terms of moving tracks/speed and disaster situations. During the 19th century, although digitized official meteorological observation data cannot be obtained, a large number of paper-based meteorological records are available in Japan and Southeast Asia, which would be very valuable for reconstructing past typhoons. “Data rescue” activities aimed at imaging and digitizing them should be encouraged.

Beillevaire (2018) analyzed and examined, from a meteorological historical point of view, the life and local meteorological observations of the French missionary Father Louis Furet, who was sent to the Ryukyu Kingdom (present Okinawa) in the latter half of the 1850s. The observational record of Furet is included in an official document of the “French National Weather Service”, which contains detailed meteorological observational data obtained during his stay in Ryukyu. These data give important clues for understanding the climate of Southwest Japan in the mid-19th century.

Demarée *et al.* (2018) focused on the barometric observations conducted five times a day during the period 1856–1858 by Father Furet mentioned above. Barometric air pressure data were corrected for sea level and temperature, and monthly mean values were calculated and graphed in comparison with present average values. Besides, daily variations in the atmospheric pressure data indicate that a remarkable pressure drop on May 18, 1857 might have been caused by an approaching typhoon witnessed by Father Furet.

Tagami *et al.* (2018) clarify strong wind-

related disasters in East Asia and their variations during the Little Ice Age since 1700 by analyzing historical weather documents in Japan and China. The results indicate that strong wind-related disasters in Japan and China were mainly due to tropical cyclones and typhoons; therefore, they discuss the relationships between long-term fluctuations in the areas/times of occurrence and the east-west displacement of Pacific high pressure. Long-term historical documents, which include meteorological disasters occurring over hundreds of years, will play important roles in climate change research.

Hirano *et al.* (2018) analyzed the characteristics of rainfall fluctuations in Yokohama from 1863 to 1869, for which JMA observational data are not available, using meteorological records from observations carried out by J.C. Hepburn, an American missionary. As a result, it is revealed that the summer in 1868 was extremely rainy, whereas rainfall in 1867 was extremely small with a tendency for dry weather. Comparisons with the meteorological disaster record are in good agreement for both years.

Ichino *et al.* (2018) focused on the close relationship between daily weather conditions and global solar radiation, and attempted to estimate monthly mean solar radiation based on weather records described in diaries kept in various parts of Japan during the first half of the 19th century. Severe famines occurred during the target period in the 1830s. In 1836, serious crop damage was caused by cold weather, and solar radiation estimated from diary weather records decreased from May to September in many places.

Tanioka (2018) analyzes the chronology Inpu-Nenpyo (1697–1870), which includes meteorological disaster records for events such as “heavy rain”, “flood”, “heavy snow”, and “drought” in Tottori Prefecture, western Japan, and clarifies long-term changes in the frequency of related disasters.

Fukuma (2018) collected daily weather and related phenomena from an Edo period (1661–1868) diary kept in the Hirosaki City Library,

and digitized all the data to create Excel files. By analyzing the digitized diary weather descriptions, long-term fluctuations in the frequency of meteorological disasters can be clarified by searching for specific terms such as floods and mudslides.

Finally, we hope this special issue will contribute to the progress of climate change studies and will be used for predicting future meteorological disasters.

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