

CRIAS 3rd workshop:

State of the Art of Historical Climatology in International Perspective

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Contents

Scope of the workshop3

Workshop Programme

 Section 1: Scholars from China.....4

 Section 2: Scholar from Asia (excluding China)10

 Section 3: Scholars from Europe.....16

 Section 4: Scholars from Europe and Argentina20





Scope of the workshop

The workshop “State of the Art of Historical Climatology in International Perspective” is organized by The Past Global Changes (PAGES) Climate Reconstruction and Impacts from Archives of Societies (CRIAS) working group.

The 3rd PAGES-CRIAS workshop will focus on advancing methods and international cooperation in the reconstruction of past climates using written sources, focusing on global comparisons of methods and results in historical climatology. Participants from different regions in the world will share their latest findings and achievements by using social archives to reconstruct past climate change.



Section 1: **Scholars from China**

Temperature and Dry-Wet index series reconstructed from historical documents in monsoon China for the past 2000 years

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Abstract

China is distinguished by a prominent monsoonal climate with large variability. Because of the long history of Chinese civilization, there are abundant and well-dated documentary records for climate reconstruction. Here we present the documentary-based reconstructions on the series of temperature and dry-wet index in monsoon China for the past 2000 years. We focus on the data sources, the derivation of proxies and the methodologies for quantifying the descriptive records, especially on the principal approach based on various information recorded in different documentary sources, and the synthesis approaches for assembling several separate data derived from different documentary sources and different periods respectively. This will be helpful for using the reconstructed data in study of climate change and comparison to instrumental data.

Severe Droughts of 1876-1878 in North China and Possible Causes

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Abstract

Based on the reconstructed precipitation series in North China from historical documents, the 1876–1878 drought was identified as the most severe and extreme one in North China over the past 300 years. This long-lasting drought started by the spring of 1876 and did not stop until the spring of 1878. Within the three years, the harvest failures brought the rice price increased to 5–10 times than that in the normal year, and the total population in the five provinces over North China decreased by more than 20 million due to a large number of dead people and migrations. Concurrently, most regions of Northern Hemisphere occurred extreme drought. Here, we used the reconstructed high-resolution hydroclimatic (PDSI/precipitation) datasets, investigated the seasonal-annual hydroclimatic spatial patterns and drought intensity with time evolution from 1876 to 1878 in North China. Furthermore, we selected combined Sea Surface Temperature (SST) modes with positive IOD/PDO and El Niño from the 1200-year control run simulations of HadCM3 to diagnose the causes of this severe drought. The results showed that the large-scale drought of 1876-1878 was mainly driven by El Niño and positive PDO, while the effect of IOD was not significant. El Niño may trigger Circumglobal Teleconnection of Northern Hemisphere, and meridional disturbance of mid-latitude Rossby wave train changed the intensity of trough and ridge, and further blocked water vapor transportation.

From Climate Anomaly to Adaptation: Historical Sources of Climate Change in the Integrated Natural Disaster Information System of the Qing Dynasty

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Abstract

The records of natural disasters, such as drought, flood, frost, and severe cold, in the abundant Chinese historical documents, are one of the important sources for reconstructions of climate change and its impacts on social-economic change over past thousands of years. The historical natural disaster database named Integrated Natural Disaster Information System of the Qing Dynasty, has collected the records on multiple disasters (meteorological, geological, environmental, etc.) from 9 kinds of historical documents (archives, chorography, newspapers, etc.) in the Qing Dynasty. The records in the database covers the whole process of natural disasters from the climate anomaly to the adaptation which is divided to climate anomaly, hazard, prevention, impact, response, and cognition.

The records in this database could be used to reconstruct: (1) historical climate anomaly, such as quantitative or semi-quantitative reconstruction of long-term climate change, the process and spatial distribution of extreme climate events; (2) transition of the impacts of climate anomaly in the human system, which is transmitted within and among the subsystems from production to economic, population, and society; and (3) the adaptation of climate anomaly in different subsystems, such as irrigation in production subsystem; personal donation and government relief in economic subsystem; migration in population subsystem; robbery in society subsystem.

A case study is made using the records of drought and poor harvest during 1870-1879 in Integrated Natural Disaster Information System of the Qing Dynasty, to examine the capability of the information for reconstruction of historical climate change and its impacts.

Keywords

Proxy data, Chinese documents, Historical Climate change, Integrated Natural Disaster Information System of the Qing Dynasty.

Water level change of Lake Machang in Eastern China during the past 200 years.

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Abstract

Lake Machang, occupying an area of about 30 km² in Jining City of Shandong Province, was a historical reservoir on the Grand Canal existing from early 15th century to early 20th century. The monthly water level observation of Lake Machang commenced in 1814, and was terminated in 1902. The gaps of extant observation data total 24.4% over the period 1814-1902.

Although the water level was seemingly artificially controlled by the local authority, seasonal water level fluctuation and annual water level variability still correlated well with precipitation. That is, climate is still the dominant factor of water level changes on seasonal and annual scales.

In 1900, the central government approved the application by the local authority regarding the reclamation of Lake Machang. Two years later, the administration of the Grand Canal was dissolved, and the function of the Lake Machang as a reservoir of the Grand Canal was finished. Hereby local residents poured in and reclaimed the reservoir. As a result, Lake Machang soon dried up in the following years. The annual precipitation did not significantly decrease in the early 20th century. It was not climate change, but reclamation, that caused the drying up of Lake Machang.

**The potential and challenges of phenological records from Chinese poems for
climate reconstruction**
— — Take poems of the Tang and Song Dynasties (618-1279 AD) as an example

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Abstract

As one of the most unique historical archives in China, poetry contains abundant evidence of past climate changes, especially phenological records. However, there are controversies on whether poetry can be used as one of the evidence sources for past climate changes. By taking the poems of the Tang and Song Dynasties (618-1279 AD) as an example, the following issues concerning phenological records from poems as proxy for climate reconstruction were discussed: (1) the introduction of Chinese poems as proxy; (2) the certainties of phenological records from Chinese poems; (3) the characteristics of phenological records from poems compared with other common sources of phenological records; (4) the key problems to be solved in climate reconstruction by phenological records from poems. The overall objective is to demonstrate the potential and challenges of phenological records from Chinese poems for climate reconstruction.



Section 2: Scholar from Asia (excluding China)

Recent progress in the Historical Climatology of Japan

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Abstract:

In Japan, two types of historical data have been available and utilized for the study of Historical Climatology: a) Documentary sources (qualitative data), such as lake-freezing records and daily diary records; b) Meteorological data (quantitative data), which include non-JMA old meteorological data in 19th century. Cross-Dating with calibration and verification would be required to combine above-mentioned two types of historical data. When we discuss global climatic variations, the time-series reconstruction and the time-slice reconstruction would be useful for analyzing the changes in atmospheric circulation patterns. Progress in historical climatology will encourage further collaborations among climatologists and historians.

Key Words:

Lake-freezing data, diary records, atmospheric circulation patterns

Comparison of winter daily weather patterns in Japan reconstructed from old diaries and 20th century reanalysis data during the 19th century

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Abstract

Historical daily weather records in old diaries are useful proxy data for reconstructing daily synoptic weather patterns for the pre-instrumental period (before 1872) in Japan. On the other hand, development of global atmospheric reanalysis data back to the early 19th century has been progressed in recent years. We compared winter daily weather patterns reconstructed from Historical Weather Data Base (Yoshimura,2013) in Japan and circulation field represented in 20th century reanalysis data ver.3(Slivinski et al.,2019). On the basis of Historical Weather Data Base, we defined “winter monsoon type weather day (WM-day)” by focusing on weather contrasts between Sea of Japan and Pacific Ocean side of Japanese Islands for the period from 1836 to 1863. Then, we made composite analysis of daily mean sea level pressure (SLP) field and 500hPa level field using 20th century reanalysis data ver3. As a result, we confirmed strengthening of winter monsoon circulation and development of mid-tropospheric trough over East Asia for WM-day. Although, few surface pressure data in East Asia were assimilated in the 19th century, our results suggested that wintertime circulation fields around Japan were reasonably represented by reanalysis data except for some years.

Keywords

Japan, historical weather documents, winter, reanalysis data

References

Yoshimura M., (2013) Making the database of weather record in old diaries and its significance. *The Historical Geography (Rekishi-Chirigaku)*, 55-5: 39-47.

Slivinski L.C. et al., (2019) Towards a more reliable historical reanalysis: Improvements for version 3 of the Twentieth Century Reanalysis system. *Q J RMeteorol Soc.*145:2876–2908. <https://doi.org/10.1002/qj.3598>

Re-examination of Original Documents of Freezing and Omiwatari Dates for Lake Suwa

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Abstract

The dates of freezing and Omiwatari (the physical phenomena of thermal ice ridges) at Lake Suwa were published by Arakawa (1954) as climatic reconstruction data. This database is well-known worldwide and has been widely used to reconstruct winter severity in Japan.

The Arakawa (1954) database was collated from several original documents. We examined these original documents and found that the Arakawa database contains some different dates compared with the original documents. Additionally, we observed differences in data quality throughout the documents.

The oldest existing original document, called Toushasinkouki, is an integration of the copies of reports concerning Omiwatari (which was believed to be the trace of God) that the head priest of Suwa-taisha (the main Shinto shrine of this region) had written to the magistrate's office. The existing documents cover the period of 1444–1682 and contain freezing, Omiwatari, and the report dates; the report date is probably the date when the document was written.

In this document, the Omiwatari date is also accompanied by a time. In those days, the observatory would have determined the dates and times of Omiwatari occurrences, and these times were mainly in the early morning. However, today, the observatory watches the lake from the shore during the daytime, to determine the occurrence of Omiwatari by the height of the ridge. Using this method, we cannot determine the exact time of each Omiwatari occurrence. Therefore, the observation method seems to be completely different in these two periods.

Even in the Toushashinkouki document, the quality seems to have changed over 200 years. For example, in the 1400s, the Omiwatari date and the report date are the same, whereas in the 1600s, these dates have a delay of three to five days.

Keywords

Climate change, Lake Suwa, lake ice, winter

Reference

Arakawa, H. (1954). Fujiwhara on five centuries of freezing dates of Lake Suwa in the Central Japan. *Archiv für Meteorologie, Geophysik und Bioklimatologie, Serie B*, 6(1), 152-166.

Exploring ENSO from archives of societies: looking at the strong El Niño of 1877-8 in Singapore and Malaysia

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Abstract:

The El Niño of 1877-8 was one of the strongest ENSO events of the nineteenth century. Its devastating impacts on parts of Asia, especially India, China and Australia have been documented, even if the climate record itself is still being recovered. This event occurred at a time where meteorological science was developing rapidly and the number of registering stations around the globe was steadily increasing, albeit still with gaps and problems. However, this event was critical in early understandings of global climatic teleconnections, recognised by scientists across the globe due to the extent and extreme nature of the event.

This paper has two aims. First, it proposes to explore the types of archives of societies available to study the 1877-8 event for Singapore and Malaysia, a relatively understudied region for this type of investigation. In so doing it will also look at gaps and problems inherent in using these archives. Second, it also seeks to uncover the social impacts of this event on what was then the Straits Settlements under British imperial authority. It looks at intersections between climate and health; governance and mitigation of weather, and its influence on contemporary understanding of climatic and environmental change.

Keywords:

El Niño, Singapore, Malaysia, instrumental records, social impacts

Speaker Biography:

A social and environmental historian working on intersections between climate & urban society in Singapore, Malaysia and Hong Kong, especially how climate shaped cities, societies, and cultures. Williamson also works on the history of weather science in the China Seas region and have undertaken studies on the burgeoning meteorological services of British Malaya and Hong Kong during the nineteenth and early twentieth centuries. She is currently engaged in a variety of multi-disciplinary projects, including the history of urban heat and the Urban Heat Island effect (UHI); nature-induced disasters and extreme weather, and climate change with scientists and geographers including the international ACRE initiative.



Section 3: Scholars from Europe

Towards a unified description of paleoclimate data and historical Documents

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Abstract

In the field of Historical Climatology, several related methodological approaches based on comparable parameters have been established worldwide. While impressive collections exist in databases or web portals, there is no standard storage format enabling easy intersection and cross-validation between other historical and/or non-historical paleo climatological data sets. Here we propose a variant of the LiPD standard that encompasses historical documents, based on discussion from the Linked Earth Working group (http://wiki.linked.earth/Category:Historical_Documents_Working_Group).

The scheme we propose lists the necessary elements and their possible integration into the LiPD infrastructure using the sensor-archive-observation framework (Evans et al., 2013). Sensors correspond to authors, while archives match their written sources. Observations map to phenomena described in the text and include location and time. Phenomena are grouped thematically, as clusters like temperature, precipitation, hydrology, clouds and visibility, wind and air pressure, natural hazards and phenomena, society, plant phenology, animal phenology and economy. Each cluster contains several, combinable parameters, determined by enumerators, indices or measured values. The proposed elements can be adapted or enhanced and voting ensures the usability for the community.

The LiPD infrastructure offers standardized tools for analyzing large paleoclimate datasets. In addition to the import and export to python or R, methods specific to Historical Climatology could be developed: Dictionaries collecting phrases for the different grades of phenomena; index values transformed to unit values by calibration; evaluation of chains of effects; fixed, periodic time series or rasterized fields could be derived and displayed.

All in all, this would offer manifold opportunities towards verification and cross-validation or the calibration of different methodological approaches: a huge step forward by using FAIR principles inside the Historical Climatology Community and a strengthened visibility within the scientific community and the public.

Counting famines and droughts: a proxy for climate change or political unrest?

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Abstract

In the absence of any meaningful direct historical data on the weather (at daily or seasonal scale) for the Roman or Byzantine Empire, modern historians often rely on such indications as mentions of drought or floods, or such weather-related phenomena as harvest failures and famines. Counting the number of famines in a certain period and region of the Mediterranean world is used as a proxy for climate, arguing that more famines indicate increased precipitation in those regions that are vulnerable to excess rainfall, or increased drought in regions that are vulnerable to drought. Recent publications use the frequency with which famines are mentioned in ancient sources pertaining to the Later Roman Empire and early Byzantine Empire as an indication of climate change in Late Antiquity. A supposed increase in the number and severity of famines mentioned in literary sources is argued to reflect an adverse climate change, which is often related to the so-called Late Antique Little Ice Age. The methodological problems with such arguments is that (1.) the mention of famines (like other catastrophes such as earthquakes, pestilence or locusts) is determined by the availability and perspective of literary sources for particular regions and periods; (2.) reflects the authors' political-religious perspective on society, in which such natural phenomena are used to express animosity towards rulers. Hence, in times of political unrest, natural catastrophes are more frequently mentioned, giving rise to a false causation that sees climate change as the cause of both political unrest and famines.

Potential of documentary data to study past fires related to weather effects: a first overview

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Abstract

Sedimentary charcoal and black carbon records can provide information about past changes in paleo-fire regimes, such as biomass burned and fire frequency, on multidecadal to millennial scales. Their careful interpretation also provides indications of the long-term factors controlling paleo-fire activity at these time scales during the Holocene. However, this kind of “environmental” fire proxy is different from fire history data from historical records. Longer historical reconstructions inferred from documents, photographs, ethnographic records, or other archives tend to focus on the most destructive fires and rarely provide evidence of broad changes in fire regimes. Each type of fire-history data has unique strengths and weaknesses in terms of spatial and temporal coverage. Historical records provide an opportunity to study fire-human-climate interactions and to disentangle climate and human influences on changing fire regimes by examining regions with e.g., similar climatic histories and contrasting demographic, cultural or agricultural changes.

In this overview we demonstrate the potential of historical documents as an important source of data to study past forest and settlement fires related to specific weather effects, especially severe drought events, at regional scales in Europe. But also, for developing reconstructions of climatic variations during past centuries. Indeed, forest fires often start and grow at the time of maximum heat and drought stress.

We examine the spatial and temporal distributions of historical records about narratives of fire in both Western and Eastern Europe. We also discuss the type of available information to identify specific extreme climate events, and the differences in the quality of records depending on the type and origins of archives. Finally, we briefly discuss the limitations in the use of fire-history data mainly due to the nature and extent of human activities (human-caused fires often boosted by timber framing in preindustrial settlements), and the need to compare with dendrochronological and charcoal records when examined from similar temporal and spatial perspectives.



Section 4: Scholars from Europe and Argentina

The auxiliary science of historical chronology and its role for climatologists

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Abstract

For a long time, auxiliary sciences in history such as palaeography and diplomatics have constituted an essential part in the education of history students to be prepared for source criticism. For historical climatologists, knowledge of historical chronology is probably the most important auxiliary science of historians. However, non-historians are in many cases not aware of the problems caused by different dating systems in the sources. This concerns on the one hand different starting dates of the New Year causing sometimes “doubled events” in two subsequent years. On the other hand, the Gregorian calendar reform of 1582 correcting the gap between the date in the Julian calendar system used so far and the actual date of the solar year has to be considered for long-time climate reconstruction based on proxy data such as grain and vine harvests or snow/ice cover. The problem even becomes more complicated as the majority of catholic territories adopted Pope Gregory XIII’s reform immediately, whereas the territories with Lutheran or Calvinist churches dominating refused this reform until around 1700 or even longer (parts of the Swiss canton of Grisons remained with the old calendar until the early 19th century!). In particular, sources from countries such as Switzerland and Germany with a mix of confessions have to be evaluated even more accurately before they can be used for climate reconstruction. The same is true for documentary evidence from orthodox countries such as pre-revolution Russia, i.e. before 1917, where the Gregorian calendar system has been introduced even two centuries later. Contact zones of western European and orthodox culture such as the Baltic States or territories on the Balkans therefore require specific attention when dealing with climatologically relevant data. This paper will give an overview of the different systems (based on the handbook by German historian Hermann Grotefend) and will provide examples how climatologists can avoid fake dating of their sources.

Evaluating the utility of qualitative personal diaries in precipitation reconstruction in the eighteenth and nineteenth centuries

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Abstract

To date few studies have reconstructed weather from personal diaries (also known as private diaries). In this presentation, I will consider different methods of indexing daily weather information, specifically precipitation, from eighteenth and nineteenth-century personal diaries. I will explore the correlation between indexed weather information and local instrumental records for the period, thereby assessing the potential of discursive materials in reconstructing precipitation series. I will demonstrate the potential for the use of diaries that record weather incidentally rather than as the primary purpose, and the value and utility of diaries covering short periods when used alongside nearby contemporary diaries. Using multiple overlapping personal diaries can help to produce a more objective record of the weather, overcoming some of the challenges of working with qualitative data. Indices derived from such qualitative sources can create valuable records of precipitation. There is the potential to repeat the methodology described here using earlier material or material from further away from extant instrumental records, thereby addressing spatial and temporal gaps in current knowledge globally.

Climate variability and interpersonal violence in Iceland and Scotland: a deep time, diachronic analysis

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Abstract

In this paper we will outline a roadmap for our comparative analysis of climate variability and violence in Iceland and Scotland between the 13th and 18th centuries.

Climate change is understood increasingly as a security challenge – a hazard that could exacerbate interpersonal violence. Many governments now cite climate change as a national security risk, threatening critical infrastructure, public health and civil and political conflict (Barnett and Adger, 2007). A handful of studies have observed the linkage between climate and violence, but few have focused on why different forms of interpersonal violence—from state-level to domestic violence—increase when precipitation and temperature regimes change (Hsaing et al., 2013). Hsaing et al. (2013) reviewed 60 historical case studies and datasets for linkages between climate and violence, noting a number of examples that range from interpersonal violence and crime to political instability and societal collapse. Although their research showed statistical evidence for increased climate-linked violence from 1950, the nature of this linkage remains poorly understood (see Hsaing and Burke, 2014).

Our paper expands the chronological scope and provides a comparative analysis of climate change and interpersonal violence in Iceland and Scotland, with the aim of understanding the relationship between climate variability and the manifestation of violence in its varied forms. The time spanning the 13th to 18th centuries includes multiple forms of violent conflict that ebb and flow in intensity. In this period, Iceland transitioned from independence to becoming subsumed within a larger, complex polity, while Scotland transitioned from internal plurality to a unified complex polity. Over the course of this period, both also exhibit marginality in different ways and were influenced by a range of climate stressors and social exposures. Both in Iceland and Scotland, marked changes in socio-political and economic organisation, population, and resource access have coincided with periods of climate variability (Nelson et al. 2016; Oram, 2011). Analysis of the commonalities and differences over the longue durée of Iceland and Scotland can contribute to further understanding of the link between climate variability, different manifestations of violence, and causes of human insecurity. Thus, a human security perspective (O'Brien and Barnett, 2013) is used to examine the association between socio-political context and environmental change—driven by climate variability.

Keywords

Climate variability; human security; emergent violence

Reference

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Recent advances of historical climatology in the Paraná River basin, South America

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Abstract

The Paraná River of southeastern South America is one of the ten largest rivers in the world. It constitutes an important waterway, a major source of hydropower, and a vital water resource. Besides, extreme Paraná floods have devastating socioeconomic consequences. Therefore, in the context of the actual climate change, it is important to improve the understanding of long-term variations of climate and floods in the Paraná basin. Although this goal could be achieved by analyzing many “archives of societies” that are available for this basin, these sources of information still remain largely unused. To improve this situation, we are conducting the following activities in the Paraná basin: (i) rescue of 19th century instrumental observations of river level; and (ii) analyses of climate information contained in 16–19th century documents such as personal diaries, governmental and religious reports, newspapers, narratives of travelers, and old maps depicting the areas affected by extreme floods. Preliminary results show that historical climatology has a large potential in the Paraná basin for studying long-term climate fluctuations, and for improving disaster risk management.

Keywords

South America; Paraná river; last five centuries; climate data rescue; documentary climate reconstructions