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Abstract booklet

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Droughts in (late) medieval Hungary: the role of direct and indirect evidence

Andrea Kiss

Andrea Kiss¹ kiss@hydro.tuwien.ac.at

¹ Institute of Hydraulic Engineering and Water Resources Management, Vienna University of Technology, Austria

In the presentation an overview of documented medieval droughts, with a special emphasis on the late medieval period, are provided concerning medieval Hungary. The high medieval period is rather underrepresented in this respect and thus, most of the drought evidence refers to the late Middle Ages. Whereas in the medieval period only a few direct information is available regarding droughts or dry spells, primarily related to major (hydrological, agricultural) droughts, a rather interesting and much more information can be gathered and utilised from the indirect evidence.

In the presentation three major topics are addressed:

- 1) A first overview of documented medieval droughts and reported low water level cases are provided, mainly based on contemporary, direct source evidence.
- 2) The types and utilisation possibilities of indirect evidence are discussed in more detail, placing the possibly drought-related references into a(n East-)Central European (neighbouring countries) and a multi-disciplinary (comparison with tree-ring information) context. Apart from fires, mass casualties of domestic animals, heat and bad grain (hay) harvest reports, rather interesting indirect drought indicators can be identified especially in legal evidence, including such everyday socio-economic conflicts as, for example, land ownership disputes, contradiction over the access rights to water bodies, or criminal cases related to water accessibility and unauthorized land use (and its change).
- 3) In the form of mini case studies, some best-represented great drought events, and their main characteristics are presented, based on direct and indirect evidence.

Learning from documentary-based climate reconstructions: Czech experience

Rudolf Brázdil

Rudolf Brázdil^{1,2} brazdil@geogr.muni.cz

Petr Dobrovolný^{1,2} dobro@sci.muni.cz

1 Institute of Geography, Masaryk University, Brno, Czech Republic

2 Global Change Research Institute, Czech Academy of Sciences, Brno, Czech Republic

Documentary data of weather and related phenomena can be used for highly resolved climate reconstructions. Generally two types of series can be used: a) series of temperature/precipitation indices, b) (bio)physical series. Applying standard approach of paleoclimatological reconstruction with the existing overlap between documentary and instrumental data (to have calibration and verification periods), long-term quantitative temperature (°C) and precipitation (mm) series can be obtained. This approach has been used for several climate reconstructions based on the use of the Czech documentary data: (i) monthly, seasonal and annual Central European temperature series reconstructed from temperature indices (Dobrovolný et al., 2010), (ii) seasonal and annual precipitation series for the Czech Lands reconstructed from precipitation indices (Dobrovolný et al., 2015), (iii) Czech March–June temperature series reconstructed from winter wheat harvest dates (Možný et al., 2012), (iv) April–August temperature series for Bohemia reconstructed from grape harvest dates (Možný et al., 2016a), (v) April–August SPEI series for Bohemia reconstructed from grape harvest dates (Možný et al., 2016b). Central European temperature series and Czech precipitation series were then used to reconstruct seasonal, half-year and annual series of drought indices: SPI, SPEI, Z-index and PDSI (Brázdil et al., 2016). Compared to proxies from natural archives (e.g. tree-rings) shorter period of overlap, but generally stronger correlation to target, are typical for documentary data. While they demonstrate good ability to capture high frequency signal and individual extremes, amount of low frequency (especially in index series) is questionable. Documentary-based reconstructions data are fully comparable to other paleoclimatological reconstructions in terms data pf quality, methods and reconstruction skill statistics. They add complementary information and assist in their interpretation.

From words to grades: Methodology for quantifying climate and social-economic changes on the base of semantic differential

Fang Xiuqi

Fang Xiuqi¹ xfang@bnu.edu.cn

1 Faculty of Geographical Science, Beijing Normal University, Key Laboratory of Environmental Change and Natural Disaster of Ministry of Education, Beijing 100875, China

Historical documents are unique among the proxy data used for reconstructions of climate and social-economic change over past thousands of years. Among the abundant Chinese documents, description in words is the most common one that recorded or described the climate extremes or social-economic conditions qualitatively in China over the past 2000 years. The semantics of these words is definite and less changed during the history. Therefore, according to the difference in meaning of the words, the historical description in words could be used to reconstruct graded climatic series and socio-economic series quantitatively based on Semantic Differential method.

Semantic Differential method originated from Psychology. It usually adopts a bipolar (opposite) adjectives to describe or distinguish the properties of the objects, and adds the adverbs expressing a difference in degree, such as extreme, very, somewhat, normal, etc., to quantitatively distinguish the different levels. The core of the Semantic Differential method is to transfer the qualitative description of the climate extremes or the social-economic conditions in words into quantitative grades of climate or social-economy, according to the meaning of the words. The key of the method is to establish the standards of gradation by given a group of standard vocabularies to each grade. It is important to pay attention to whether the meanings of the standard vocabularies are easily distinguished, and to consider the physical meanings of the standard vocabularies corresponding to each level as much as possible. All items of description in words could be given their grades by referencing to the standard vocabularies.

The most success use of the Semantic Differential method is the reconstruction of dry/wet index in China. It was first used to reconstruct wet/dry grade over past 500 years for 120 stations in China in 1970s, then to past 1000 years and 2000 years in eastern China after 1990s. The gradation of wetness and dryness is based on fact that there is some linkage between the real rainfall and the description on drought and flood in words. 5 dry/wet grades ranking from 1 to 5 indicate differences of precipitation from more to less. Each grade corresponds to a given probability or range of standard deviation of precipitation. In addition to the dry/wet index, the Semantic Differential method has been used to reconstruct climate change such as cloud index. Almost all historical records related to climate could be used to reconstruct climate change by the method of gradation. But it is a semi-quantitative reconstruction instead of a quantitative one.

To study the process and mechanism of the influence of historical climate change on social economy, continuous and high resolution social-economic series need to be reconstructed. Using the gradation methodology of semantic differential, 4 historical social-economic graded series of China in 10 years resolution over the past 2000 years, including harvest economy, finance and social vicissitudes, have been quantitatively reconstructed. The two key technologies of quantifying social and economic series based on semantic differential are gradation of literal description and uniformity of time resolution. Time resolution normalization

is mainly used to solve the problems that time resolutions of original grade sequences are not equal or the periods are not continuous, regarding 10 years as the basic time unite, up scaling and down scaling method are used in annual data and decadal data respectively.

Key words: Proxy data, Chinese documents, Gradation, Semantic Differential method, Climate change

Water level observations of Lake Nansi (China) during 1758-1902 AD

Jie Fei

Jie Fei¹ jiefei@fudan.edu.cn

¹ Institute of Historical Geography, Fudan University, Shanghai 200433, China

In order to understand high resolution environmental changes, historical water level changes on decadal and centennial scales have been conventionally analyzed employing documentary records and lake sediments. However, annual records are still limited. Here we report the discovery of water level observations (up to monthly) in the historical literatures of the Qing Dynasty (1644-1912 AD). We reconstruct the chronologies of annual water level changes over 1758-1902 AD of Lake Nansi, i.e. Lakes Weishan, Zhaoyang, Nanyang and Dushan. We identify a high water level interval during 1851-1855 AD, corresponding to the southward migration of the Huaihe River in 1851 AD, and the northward migration of the Yellow River in 1855 AD. In particular, the flooding of the Yellow River significantly affected Lake Nansi. It always resulted in extremely high water levels in Lake Nansi. The flooding in 1871 and 1873 AD even destroyed the bank between Lake Weishan-Zhaoyang-Nanyang and Lake Dushan, thus formed a united Lake Nansi.

Key words: Lake Nansi, Historical water level change, 1758-1902 AD, the Yellow River, the Huaihe River

Climate and society in Rouen, 1315 to 1715. An overview

Chantal Camenisch

Chantal Camenisch^{1,2} chantal.camenisch@hist.unibe.ch

1 Institute of History/Oeschger Centre for Climate Change Research, University of Bern, Switzerland

2 Humanities Research Centre, University of York, UK

During Medieval and Early Modern Period, the city of Rouen played an important political and economic role in the duchy of Normandy and as actual sea harbour of Paris also in France. With about 75'000 inhabitants around the year 1500, it was also one of the largest cities in France. Until the 20th century the bridge in Rouen was the last over the Seine before the river flows in the English Channel. In this paper the impact of climate variability and extreme weather on the society of Rouen from 1315 to 1715 will be discussed. The information used in this paper derive from narrative as well as from administrative sources. Each source type has its own focus on weather events as well as on societal impacts of weather and a combination of them improves the analysis of the data.

During the examined period, Rouen had to cope with devastating storms, floods of the Seine that caused damage to houses in the city or drifting ice which destroyed the bridge. Moreover, extreme weather conditions could damage or destroy grain, fruit and grape harvest what might lead to increasing prices and dearth. In order to support the people in need during crisis times, the city council of Rouen realised large infrastructure projects and payed the poor men, women and children with money and food for their work. In addition, the poor relief was several times reorganised after periods of scarcity. Recurrent epidemics – some of them are linked to certain weather conditions – forced the city council to repeated reorganisations of the hospitals.

Introduction to the Climate Records of Imperial China

Qing Pei

Qing Pei ¹ qingpei@eduhk.hk

¹ Education University of Hong Kong, Hong Kong, China

The rich documentation on the history of climate in China has remained largely unfamiliar to non-Chinese scholars. To bridge this gap, features of documents from imperial China — including physical support, sources of information, language, methods, and scholarly conventions will be surveyed. Data on key topics has been paid with great attention such as natural disasters, precipitation, and ecological conditions, and comment on the methods and techniques that earlier Chinese scholars used to extract information that would be relevant to fellow scholars or court officials. The understanding of climate change and its socio-economic consequences also takes into account the cultural framework within which data was collected, processed, and preserved. This is why the Confucian dimension has been included that climate history was given through the “Mandate of Heaven” concept. It believes that a wider understanding of China’s documentation about its past climate may open new perspectives on global climate research, and result in a better appreciation of primary sources on East and Central Asia.

Climate variability during the Late Maunder Minimum and its impact on society in northeast Switzerland - An analysis of the weather observations in the Einsiedeln monastery's diary between 1670 and 1704.

Lukas Heinzmann

Lukas Heinzmann^{1,2} lukas.heinzmann@hist.unibe.ch

1 Oeschger Centre for Climate Change Research, University of Bern, Switzerland

2 Institute of History, University of Bern, Switzerland

At the end of the 17th century, the monastery of Einsiedeln (CH) was not only a popular destination for pilgrims, but also maintained contacts with the political, religious and social elites. The ownership of extensive agricultural areas on today's territory of northeast Switzerland partly contained the dominion about individuals and required a diligent administration, since it ensured the monastery's self-support. Father Joseph Dietrich (1645-1704), a monastery's property custodian, was the main author of the Einsiedeln monastery's diary. It was written between 1670 and 1704 and includes 18 books with a total number of 12'000 pages. The almost daily written notes contain a wide range of subjects and provide an insight into every day's life in 17th century. Due to the detailed and frequent descriptions of weather phenomena and its impacts on society, the diary is an important source for the research of the Late Maunder Minimum (1685-1715) and especially the cold phase in the last decade of the 17th century, which led to a supply crisis in northeast Switzerland.

Based on the diary, the aim of the PhD thesis is first to complement the existing climate reconstruction of Switzerland by expanding the amount of data for the treated period and second to analyse the impacts of extreme climatic conditions on a pre-industrial society. To this end, a set of elaborated methodological approaches is used and adapted to the specific demands. The available information in the diary (weather observations, wine phenology, grain phenology etc.) is collected, classified along the Pfister temperature and precipitation Indices and compared to already existing data in the database Euroclimhist (www.euroclimhist.unibe.ch). Based on these results, the coping strategies of different actors in times of political instability (conflicts between Catholics and Protestants), climatic deterioration and supply crises are studied.

Reconstructing historical floods and flood protection measures on small rivers and mountain torrents: sources and methods

Melanie Salvisberg

Melanie Salvisberg^{1,2} melanie.salvisberg@hist.unibe.ch

1 Oeschger Centre for Climate Change Research, University of Bern, Switzerland

2 Institute of History, University of Bern, Switzerland

The historical floods and flood protection measures on small rivers and mountain torrents have so far been mostly neglected by research, since the focus has been mostly on large – and more damaging – rivers. However, the historical flood situation of small watercourses is worthy of investigation. Firstly, the floods caused damage that was often hard for the people affected to cope with. Secondly, large-scale events are the result of the flooding of multiple tributaries, and thus knowledge about small rivers is essential not only for environmental history, but also for hydrology and risk prevention.

A small river which is suitable for historical studies is the Gürbe river, located south of Bern, Switzerland. This pre-alpine river is very prone to floods due to its hydrological and geological circumstances, and often causes inundations. Such events have heavily affected the lives of the local residents, and they have therefore left various traces in the well preserved historical documents.

The presentation aims to analyse the sources and methods for reconstructing historical floods of small rivers and mountain torrents. Using the example of the Gürbe river, it answers the following questions: What kind of sources can be used for detecting historical floods of small watercourses? Which reconstruction approaches come into question and what are the respective problems? What can we learn from historical sources about flood protection measures?

Reducing complexity for periods with limited documentary data: The index method revisited

Martin Bauch

Martin Bauch¹ martin.bauch@uni-leipzig.de
Thomas Labbé^{1,2} thomas.labbe@u-bourgogne.fr
Annabell Engel¹ annabell.engel@leibniz-gwzo.de

1 Leibniz Institute for the History and Culture of Easter Europe (GWZO), Leipzig, Germany

2 Maison des Sciences de l'Homme de Dijon (USR CNRS - uB 3516), France

The method of seasonal climate indices is a long established and repeatedly refined methodology to quantify information from documentary data. It was fully developed for Early Modern periods with relatively dense information (mainly by Chr. Pfister), and it has been successfully expanded for the 15th century (independently by C. Camenisch/L. Litzenburger). But applying it for earlier periods has been a challenge for a relative scarcity of sources.

After presenting once more major difficulties of applying the index method as such (e.g. scale problems, contradictory data, the 'zero' problem), we want to discuss a new proposal to reduce complexities (and problems) by using a semi-annual form of indices, focusing not on seasons, but on the growing/non-growing period of plants. By using data from our Dantean Anomaly project, we want

- a) to discuss advantages and disadvantages of this new semi-annual indexing and
- b) explore the chronological limits of this approach in different European regions
- c) reflect on the applicability of semi-annual indices to Non-European documentary data

The Harvest length – an indicator of late summer precipitation

Kathleen Pribyl

Kathleen Pribyl¹ k.pribyl@uea.ac.uk

¹ Climatic Research Unit, University of East Anglia, UK

Many reconstructions employ phenological dates such as the start of the grain or wine harvest as a proxy. However, there is also another proxy that can be derived from the length of the grain harvest, which reflects the amount and frequency of rainfall during the harvest. The aim is always to harvest as speedily as possible for reducing the risk of the standing corn to the vagaries of the weather. But the duration of the harvest is also linked to the availability of labour, the bulk of the harvest and the harvesting method. The presentation will highlight the advantages and disadvantages of the use of the length of the grain harvest as an indicator of the precipitation shortly before and during the grain harvest, i.e. the months July, August and September. A high summer to early autumn precipitation index for East Anglia from the late thirteenth to the early fifteenth century based on the harvest length is compared to other precipitation-responding proxy data. The index is valuable for identifying interannual fluctuations in rainfall, phases of higher and lower rainfall and extremes. For harvesting, and also agriculture in general under England's maritime climate, high and highly variable precipitation levels were linked to lowered harvest success.

The longest homogeneous series of Grape Harvest Dates, Beaune 1354-2018, and its significance for the understanding of past and present climate

Thomas Labbé and Christian Pfister

Thomas Labbé^{1,2} thomas.labbe@u-bourgogne.fr

Christian Pfister^{3,4} christian.pfister@hist.unibe.ch

Chantal Camenisch^{3,4} chantal.camenisch@hist.unibe.ch

Stefan Brönnimann^{3,5} stefan.broennimann@giub.unibe.ch

1 Leibniz Institute for the History and Culture of Easter Europe (GWZO), Leipzig, Germany

2 Maison des Sciences de l'Homme de Dijon (USR CNRS - uB 3516), France

3 Oeschger Centre for Climate Change Research, University of Bern, Switzerland

4 Institute of History, University of Bern, Switzerland

5 Institute of Geography, University of Bern, Switzerland

Records of grape harvest dates (GHD) are the oldest and the longest continuous series of phenological data in Europe. However, most scholars uncritically drew such evidence from nineteenth century publications instead of going back to the archives. The GHD from the famous vine region of Beaune (Burgundy) were entirely drawn from the archives, cross checked with narrative evidence and calibrated with the new Paris temperature series 1658-2018. The Beaune series is well correlated with the Central European Temperature series (from 1500) and long tree-ring evidence. It shows impressively, that outstanding extreme events in the past, such as the heat and drought years 1473 and 1540, were outliers within the climatic context of the Boreal Little Ice Age, while very early vintages became almost the norm since the transition to rapid Global Warming in 1988. Last but not least it is concluded, that extremely early vintages often followed a specific seasonal pattern that might be useful for the early detection of extreme heat and drought seasons.

A Climate History of the Monsoon in Southern India 1730-1920

Gemma Ives

Gemma Ives¹ glives1@sheffield.ac.uk
Julie Jones¹ julie.jones@sheffield.ac.uk
Grant Bigg¹ grant.bigg@sheffield.ac.uk
George Adamson² george.adamson@kcl.ac.uk
David Nash³ D.J.Nash@brighton.ac.uk

1 The University of Sheffield

2 Kings College London

3 The University of Brighton

Changes in the timing and the intensity of monsoon rainfall have a significant impact on the livelihoods of the people of India, particularly those who are dependent on India's largest economy; agriculture. Despite its importance, this complex climate phenomenon is not fully understood, this can be partly attributed to the restrictive length of regional instrumental data, which is sparse before 1871. However, India's colonial past has left in its wake a wealth of historical, English language documents. Using those sources which have repeatedly demonstrated their ability to capture meteorological information, this project is able to build upon the very small number of existing historical climatology studies which aim to reconstruct monsoon intensity in Indian states.

Firstly, using archives of social and governmental documents - including newspapers - this research has achieved a seasonal reconstruction of northeast monsoon intensity, as manifest over modern-day Tamil Nadu, from 1730-1920; classified on a five-point scale. When combined with early instrumental data, this reconstruction is refined to a monthly resolution from 1791 – 1920. Both reconstructions are calibrated and verified in a 50-year overlap period with modern instrumental data. Secondly, two further reconstructions have been created using the zonal wind component, derived from the semi-instrumental data contained within ships' logbooks, as a proxy for rainfall. Monsoon intensity is reconstructed for both the southwest and the northeast monsoons, as manifest over modern day Kerala and Tamil Nadu respectively. Again, each reconstruction is verified during a 50-year overlap period between logbook and modern instrumental data.

The Little Ice Age at Sea: Wind, Sea Ice, and Currents in Mariners' Accounts

Dagomar Degroot

Dagomar Degroot¹ Dagomar.Degroot@georgetown.edu

¹ Georgetown University, USA

Multi-proxy studies by historical climatologists and paleoclimatologists usually reconstruct regional trends in the mean and variability of temperature or precipitation. Climate historians have indeed shown that these trends had particular significance for the agroeconomic foundations of most pre-modern societies. Yet for economic and military activities at sea, shifts in atmospheric and to a lesser extent oceanic currents – which only partly reflect or provoke trends in temperature or precipitation – were often much more important.

This paper explains how early modern sources written at sea – including ship logbooks, correspondence, and diary entries – can be used alongside scientific evidence to reconstruct trends in local or regional wind velocity, wind intensity, and sea ice distribution. It then introduces online repositories of textual sources, written at sea, that record weather at high temporal and geographic resolutions. Finally, it details both the challenges and opportunities of using such sources to gain insights into how early modern mariners experienced and recorded the climatic fluctuations of the Little Ice Age.

Sea-ice cover reconstructions of Nunatsiavut (Labrador), 1750-1950

Marie-Michèle Ouellet-Bernier

Marie-Michèle Ouellet-Bernier¹ ouellet.bernier.mm@gmail.com

Anne de Vernal¹ devernal.anne@uqam.ca

Daniel Chartier² chartier.daniel@uqam.ca

1 Geotop, Université du Québec à Montréal

2 International Laboratory for the Comparative Multidisciplinary Study of Representations of the North, Université du Québec à Montréal

Sea-ice cover plays an important role for Arctic and Subarctic communities. Transport, fishing and hunting depend on the extent, stability and seasonal duration of sea-ice. Its seasonal formation, drift and melt are driven by hydrographic conditions (salinity, temperature, currents), air temperature and atmospheric circulation. To document changes in sea-ice cover along the coast of Labrador over the last centuries, a reconstruction based on historical archives is proposed here. Such archives are useful in this area because paleoclimatic data are rare. Moreover, the historical archives contain information about exceptional events that may have played an important role on the human environment.

A large part of the documentary material was obtained from the archives of the Moravian missionaries. Freeze-up and break-up dates were extracted from Moravian journals to provide an average number of months with sea-ice cover. The report of the first kayak and first dog-sled (*komatik*) trips and first hunt on sea-ice were also used as indicators of sea-ice cover extent. The preliminary results from the Nain area indicate that the median dates of sea ice formation and break-up were December 11th and June 19th, respectively, during the interval spanning from 1771 to 1808. Other written archives, referred to as discursive sources, were also used to provide additional information of sea-ice and winter conditions. Discursive sources include personal journals, Inuit life-stories and novels. As an example, an anonymous journal dated of 1832 describes the day-to-day break up of sea ice in Battle Harbour and mentions that the ice stayed in the bay with a Northeastern wind and floes out of the bay with South and Western winds.