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Strides Made in Reconstructing Past Weather and Climate

Historical climatology is situated at the interface of climatology and environmental history. As such, its goal is to reconstruct weather and climate, as well as natural disasters, for the last millennium prior to the creation of national meteorological networks. Historical climatology is also concerned with investigating the vulnerability of past economies and societies to climate variations, climatic extremes, and natural disasters, and with exploring past discourses and social representations related to climate.

Historical climatology investigates a variety of sources from anthropogenic archives, ranging from early instrumental data to documentary evidence contained in ship log books, farmers' diaries, reports about costs of maintaining dikes, and the like. Sometimes this evidence is supplemented and cross-checked with high-resolution evidence from natural archives. Though this type of evidence is usually well dated, it may suffer from temporal and spatial inhomogeneity related to changes in the position of the instruments or modifications of observational, reporting, and institutional conditions.

By cross-checking proxy data from natural archives with documentary evidence and relating these to instrumental measurements, such inhomogeneities may often be detected and removed. In doing so, documentary evidence helps to clarify the dating, the severity, and the meteorological properties of climate variations such as the Medieval Warm Period or the Little Ice Age.

Perhaps most important, documentary data are the only evidence available for assessing the frequency and clustering of rare but socioeconomically significant disasters such as intense storms, severe floods, and long-lasting droughts. Thus, results of historical climatology are at the center of the controversial debate about detecting anthropogenic climate change, where it is often claimed that the frequency of extreme events already lies outside the boundaries of natural climate variability.

An international conference in Kraków, Poland, recently brought together specialists in historical instrumental data and historical climatology who investigate climate variations of the past 200–1000 years in relation to the vulnerability of past societies. "Images and Reconstructions of Weather and Climate over the Last Millennium" was sponsored by the Institute of Meteorology and Water Management and the Polish National Committee of the International Geosphere-Biosphere Program.

The new material derived, for example, from Norwegian farmers' diaries and from weekly workers' wages paid in Bohemia, Czech Republic, was presented and found to provide solid and robust evidence, consistent with other reports such as the extent of the Baltic Sea ice cover.

The participants emphasized the detrimental effects of disregarding documentary observations; no other historical evidence offers equal potential to detect and describe natural disasters and extreme anomalies that occurred before the 20th century. Also, as historical climatology provides well-dated evidence, it may be used to calibrate and validate proxy data from natural archives such as ice cores, laminated lake varves, or impacts of extreme events registered in fluvial and slope sediments.

Using upscaling methods, monthly mean surface air pressure fields and monthly temperature and precipitation over Europe are reconstructed from time-series of indices based on documentary evidence back to 1659. The gridded data derived from these data are analyzed to assess past variations of the North Atlantic Oscillation (NAO) and other related indicators such as the Arctic Oscillation (AO).

The Kraków conference clearly demonstrated that remarkable progress has been made over the past 10 years. At first, there were a few isolated attempts to reconstruct local climate histories, but eventually regional evidence was successfully boiled down into quasi-homogeneous, highly correlated monthly time series of temperature and precipitation indices on the supra-regional scale. The greatest progress was made in central Europe; in particular, in Switzerland, Germany, and the Czech Republic, but also in Iceland, the Iberian Peninsula, Hungary, and Norway. Encouraging results are emerging from China, and a new project from the highlands in Bolivia was reported. The old Islamic annals are thought to include a wealth of evidence, but these have yet to be investigated.

The participants were optimistic that a spatial reconstructing of extreme anomalies seems to be possible back to the high Middle Ages. Historical climatology has already attained a high standard in Japan and China. Recent initiatives have been undertaken in Africa and Latin America. In these regions, it might be rewarding to cooperate with the Archival Climate History Survey (ARCHISS) project, which involves the World Meteorological Organization, UNESCO, and the International Council on Archives, to search for climate data in national archives (http://www.wmo.ch/index.html).

For the overall debate on global climate change, historical climatology may serve an important role. Comparative analyses of the present situation with historical situations help to differentiate between rare but not uncommon anomalies and novel situations related to climate change. In this way, historical climatology helps to design more rational response strategies to the threat of global warming while avoiding the confusion of "normal" rare events and real changes. In combination with dynamical knowledge encoded in dynamical GCM-type climate models, various geophysical proxy data and documentary data will serve as important forcing data in "data-assimilation" efforts to reconstruct the three-dimensional, time-dependent state of the global atmosphere and ocean.

"Images and Reconstructions of Weather and Climate over the Last Millennium" was held September 20–22, 2000.

Authors

Christian Pfister, Institute of History, University of Bern, Switzerland; *Rudolf Brázdil*, Department of Geography, Masaryk University, Brno, Czech Republic; *Barbara Obrebska-Starkel*, Department of Climatology, Institute of Geography and Space Economy, Jagiellonian University, Kraków, Poland; *Leszek Starkel*, Department of Geomorphology and Hydrology Polish Academy of Sciences, Kraków, Poland; *Raino Heino*, Finnish Meteorological Institute, Helsinki, Finland; and *Hans von Storch*, Institute of Hydrophysics GKSS, Geesthacht, Germany