CLIMATE AND WORLD ENVIRONMANTAL HISTORY

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Contents

Summary

The chapter summarizes the last thousand years of climate history. Starting with a definition of climate history an introduction discusses usable data for climate reconstructions and the effects of the NAO-Index. It presents the main characteristics of climatic events and their impacts on the respective societies from the 8th century until present. It concludes with a section about climate change, ozone depletion and global warming.

1. Introduction

In Climate History, scientists consider the last 10000 years of civilization. For that reason climate historians are researching the relations connecting humans and climate events in the past. The aim of climate history is to differentiate climatic events, which may have had impacts or even altered the activities, the existence and subsistence of human beings.

Since the end of the last Ice Age, ca. 15000 BP, the earth has lived trough global warming at a high level. This era - the so called Holocene - started with a fast warming, then a comparable, 1000 year cold break, 12000 years before present followed. After this interruption, ca. 6000 BP, a milder climate arose ending in a phase to some extent of conditions even warmer than today. On this planet the last six millennia were almost similar to our modern climatic situation.

The Holocene was a never-ending fluctuation of temporary climate variations caused by not well conceived connections between the seas and the atmosphere. The past six millennia showed these characteristics as well. In the era of The Roman Empire, the climate of Europe showed a little bit lower temperatures than in the 20th century. But the climax of the following Medieval Warm Period was characterized by long series of temperate summers. Beginning approximately around 1310 AD and enduring for ca. 550 years, these climatic conditions turned out to be more variable, occasionally stormy, and chilly, and were related to irregular climatic extremes. This era is described as the Little Ice Age (LIA).

The Climate of the last 1000 years, not only concerning the European continent but also further parts of the world should be separated into these three most important periods. The first period, namely the “Medieval Warm Period” (MWP) continued from approximately 950 AD to 1200 AD. An era of climatic worsening then came along, explicitly the Little Ice Age, from about 1550 AD to 1850 AD. In the 150 years from 1550 AD to 1700 AD climatic factors were accentuated. The last but recent climatic phase, starting around 1900 AD can be typified as a global warming period. These three main periods will be applied for describing climate history of the second millennium AD.

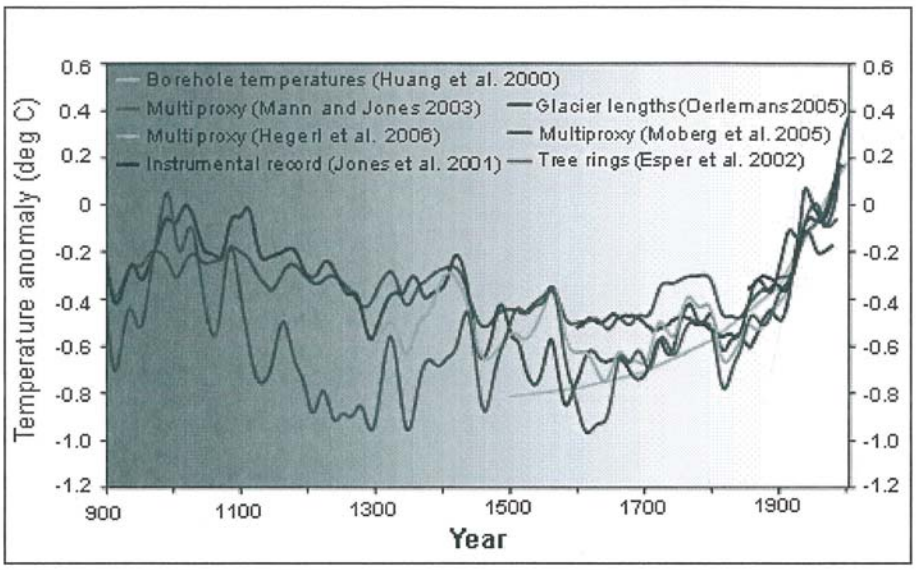

Figure 1. Surface temperatures over the last 1100 years. Reference: NRC, 2006. (Figure reprinted with permission from Surface Temperature Reconstructions© (2006) by the National Academy of Sciences, Courtesy of the National Academies Press, Washington, D.C.). http : / / www . epa . gov / climatechange / science / images / surface _ temps . gif (accessed 22.11.2008)

In the preceding 1000 years of human interactions with the natural world, impermanent climate changes have for these times been in a complex condition of fluctuation. To overlook these temporary changes is to disregard one of the liveliest backgrounds of the human exposure.

Striking examples would be the food disasters that overwhelmed Europe while the Little Ice Age: For instance the great famine from 1315 to 1319, the food crisis of 1741 or the "Tambora year" 1816, remembered as the "the year without a summer". Such predicaments in themselves did not endanger the sustained subsistence of western culture, but they certainly played significant role in the developments of European history.

Climate change is a disregarded actor in the historical theater. Such a disregard lasts moderately because of a long-established mistaken supposition that there would exist a small number of important climatic reallocations over the last thousand years, which might probably have exaggerated human culture.

This disrespect also exists for the reason that just a small number of historians have pursued the remarkable developments in historical climatology since the 1990s. Today scientists know that throughout the LIA temporary climatic anomalies harassed especially the societies in the north of Europe.

They further started to associate explicit climatic modifications with political, social, economic and even cultural transformations, attempting to review what climate's real influence possibly was, is and will be.

Historical scientists refused to consider climate as a possible driving parameter. This denial also concerns subjects of possible susceptibility such as agrarian history and demography.

A scientific discussion regarding the potential influence of climate on history and societies persists to endure from bequest of climatic determinism. In consequence of this kind of thinking the characteristic peculiarities of people, their abilities, the altering patterns of political dominance, economic differences and several other social characteristics and developments are the result of climatic settings and climatic variability.

In combination with other kinds of environmental determinism, this hypothesis was firmly disapproved especially in the second half of the 20th century. Today this kind of thinking still exists in everyday life.

2. Data-Bases and Types of Data to Reconstruct Past Climate

The data-base for historical climatology should be generally classified as direct and/or-indirect data. The direct data should be seen as descriptive documentary data, for instance narrative descriptions of weather prototypes or early instrumental measurements—documents or indirect proxy data showing the impact of weather on the elements in the biosphere, the hydrosphere or the cryosphere. That would be the covering of waterways with ice, floods, or the starting and ending point of harvests. In agreement to their source, indirect data can also be man-made or founded on natural proxy data (see Table 1).

<table>
<tr><th>Archives
Information</th><th colspan="2">Natural</th><th colspan="3">Man-made</th></tr>
<tr><td>Direct observation of weather and climate or instrumental measurement of meteorological parameters</td><td colspan="2"></td><td rowspan="4">Documentary</td><td>Observed
• Anomalies
• Natural hazards
• Weather situations
• Daily weather</td><td>Measured
• Barometric pressure
• Temperature
• Precipitation
• Water-gauge, etc.</td></tr>
<tr><td rowspan="4">Indirect references: (Proxy data) indication of controlled or affected processes through meteorological parameters</td><td rowspan="4">Organic
• Tree rings
• Fossil pollen
• Animal and plant remains
• Fossil wood (trees) etc.</td><td rowspan="4">Nonorgani
• Ice cores
• Varves
• Terrestrial sediments
• Temperature of boreholes
• Moraines, etc</td><td>Organic
• Plant phenology
• Yield of vine
• Time of grain and vine harvest
• Sugar content of wine, etc</td><td>Non-organic
• Water levels
• Snow fall
• Freezing of water bodies
• Snow cover, etc</td></tr>
<tr><td colspan="2">• Cultural: rogations</td></tr>
<tr><td>• Pictorial</td><td>• Epigraphical</td></tr>
<tr><td colspan="2">Material:</td><td>• Archeological remains</td></tr>
</table>

Table 1. Natural and man-made data for reconstructing past weather and climate. Reference: (Pfister, C. copyright Paul Haupt Verlag 1999) In: Brazdil et. al. (2005) p. 371

Documentary data are a specific type of historical climatic information that is founded on direct observance of various meteorological factors like temperature, rainfall, wind, cloudiness, snow-cover, sea-ice distribution and so on. For this purpose, it is possible to use them on the one hand to confirm extreme values concerning natural proxies and on the other for comprehensive images of “historical” weather. Most significantly, they are the only facts of verification that is in a straight line connected to the socio-economic effects of exceptional natural disasters; for example enormous floods, extreme storms, and durable dry phases in times previous to the association of instrumental network observations. That is why climate reconstructions founded on documentary data play a significant role in the improved greenhouse discussion.

The largest part of the natural proxies, which scientists make use of, are connected to the historical variations of tree rings, glacier tongues, variations in the structure of ice cores, pollen-profiles, sliced sediments extracted from lake or sea floors, spelaeothem records, corals, geothermic data and other natural proxies. Collections of tree ring records increased not only all through the Northern Hemisphere, but they also grew with a rising wealth of temperature information from ice cores received especially in Antarctica and Greenland. All reconstructions made from natural archives cannot be adapted to cyclic or monthly analysis. These reconstructions do not always contain a characteristic partition of the impacts of rainfall and temperature. However, a thorough analysis is required for researching climatic influences on societies.

It is quite complicated to restructure past climate changes for the reason that trustworthy instrumental reports are accessible only for Europe and North America. Early scientists mainly wrote these reports since the end of the 18th century. In India methodical studies of the weather started in the 19th century. Precise weather-related reports for the tropical regions in Africa exist since ca. 80 but not more than 90 years. Concerning earlier epochs, scientists are researching what they identify as proxy records derived not only from imperfect written records, but also from ice cores and tree rings. Priests, monks and early scientists occasionally set-aside weather accounts over extended times. These narrative documentary data contain, on the one hand, direct data on the subject of weather and concerning occurrences and events, which were subject to weather on the other. Narrative documentary data are remarkably informative, containing written reports from annals, chronicles, daily weather reports, memoirs, private and authorized messages, economic records, early newspaper writings, ship logbooks, different diaries, pictures, and so on. Chronicles for example are very useful for their comments on abnormal weather, but their usefulness in realizing assessment is often limited.

Homogeneous sequences of documentary proxy data can generally be extracted from governmental records. Normally these series are extensive, incessant and quasi-uniform; that is why it is possible to calibrate them with instrumental measurements. According to the western and the central parts of Europe, the chronological variety is limited to the last 1000 years. Since the preceding millennium the concentration and value of climatic information grew immensely as Brazdil et. al (2005, 376-377) have listed:

"(i) Prior to AD 1300: Reports of socio-economically significant anomalies and (natural) disasters.
(ii) 1300-1500: More or less continuous reports on characteristics of summers and winters (to some extent also of spring and autumn) including reference to "normal" conditions.
(iii) 1500-1800: Almost complete description of monthly weather, also of daily weather to some extent. Growing number and diversity of continuous series of documentary proxy data produced by the early modern local, regional and state bureaucracies.
(iv) 1680-1860: Instrumental measurements made by isolated individuals. First short-lived international network observations (e.g. Breslau-Network and Palatine-Network).
(v) From 1860: Instrumental observations in the framework of national and international meteorological networks."

This catalog should be recognized in a growing sense. The methods of climate interpretations, which became more and more obsolete, were not displaced but positioned over a number of new ones. The excellence of the data advances, solidity and time resolution of the data is growing as also their distribution in space expands over time.

Outlying the Byzantine territory the circumstances considered above coincided initially to those in the 9th century, which was the era of Charlemagne. That covers mainly not only the states of modern France, Germany, Belgium, the Netherlands, Switzerland and the north of Italy, but also Ireland and to some extent the British Isles. From ca. 1050 the tradition of observing chronicles reached the countries of modern Denmark, Catalonia, Iceland, the Czech Republic, Slovakia, Hungary, Poland and afterwards also states in the Baltic region, Finland and Russia. Climatic reports from the Southeast of Europe seem to be insufficient up to the 18th century.

Historians researching climate issues are close to an understanding and reconstruction of yearly summer and winter temperature variations over a large part of the Northern Hemisphere. Such temperature reconstructions are going back to about 1400. They are able to describe the LIA as a complex picture of temporary climatic swings that swept through the societies of Europe in times of extraordinary transformation. This age continued for 700 years and can be described as Europe's progress from medieval feudalism and its developments, while the following centuries saw the rise of modern Europe.

3. The NAO-Index as Leading Factor for the Climate of Europe

Multifaceted relations connecting the ocean and the atmosphere govern the climate of Europe. A continually changing pressure gradient determines, over the North Atlantic and to a great extent Europe's climate, its power as persistent in the north as the eminent Southern oscillation (ENSO) of the southwestern Pacific, which reigns El Niño events and most of tropical weather. The North Atlantic Oscillation (NAO) is a swinging of atmospheric pressure between a constant high near the Azores and regularly a common low over Iceland. The "NAO index" states the permanent changes in the fluctuation of an annual and decadal rhythm. A high NAO index shows low pressure in the region of Iceland and high pressure off Portugal and the Azores, a state that gives drives westerly airstreams. These westerly winds transport warmth from the Atlantic's surface to the centre of Europe, combined with great gales. The same winds retain gentle temperatures in winter, and cause arid weather conditions in the south of Europe. A low NAO index carries shallow pressure gradients, feeble westerly winds, and causes much lower temperatures over Europe. NAO's winter fluctuations are responsible for nearly half of the inconsistency in winter temperatures in the North of Europe and also exert a significant influence on precipitation during the summer months. A high NAO index implies more precipitation in the summer, as for is evident, for example in the year 1314.

The intense oscillation of the NAO is due to the energy inputs from the various parts of the atmosphere and the northern Atlantic, which result from sea-surface temperature abnormalities, the power of the Gulf Stream, the structure of atmospheric waves, and the distribution of ice on the oceans. Although these relations are not understood fully and clearly, it appears likely that a lot of the fluctuations in the NAO are consequences of variations in surface temperatures in the northern Atlantic.

The NAO has influenced the climate of Europe for several thousands of years. By compiling data from ice cores, documentary data, tree rings, and contemporary meteorological data it establishes evidence of the influence of NAO as far back as the year 1675. Low NAO indices appear to match with identified cold breaks at the end of the 17th century. In the previous two hundred years, NAO extreme values have matched with unusual climatic conditions. Examples are the extremely bitter winters in England in the 1880s. A further low index sequence in the 1940s reflects the sinking of Europe into severely low temperatures- the time when Hitler's troops tried to conquer Russia. The 1950s appeared rather milder, but the 1960s showed the hardest winter conditions since the 1880s. Over the last quarter-century, high NAO indices have indicated nearly all accentuated inconsistencies ever evidenced and moderated the conditions in the Northern Hemisphere considerably, possibly as a consequence of anthropogenic climatic change.

For several centuries, Europe's climate has been victim to impulsive fluctuations of the NAO Index and the Arctic conditions. It is neither known what is causing high or low indices, nor is it yet feasible to forecast the abrupt turnarounds that trigger climatic disasters.

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Biographical Sketch

Guido Nicolaus Poliwoda is an environmental historian of Germany and Switzerland. Furthermore, climatic history, economic and social history are main topics of his scientific research. He completed his PhD-thesis in 2004. The title "Learning from disasters. Saxony fights the floods of the river Elbe from 1784 to 1845" which was published by Böhlau. It is the first empirical study showing how a society reacts and learns under permanent climatic stress. After 2005, Poliwoda was (assistant) lecturer at the historical and economic institute at the University of Berne and Co-Personal-Instructor in the project CAPRICORN of the NCCR-Climate (National Competence Center Research). Moreover, he is finishing his second book. The subject is "Financial Mitigation and Economic Impacts of Floods and Winter Storms in Switzerland and Germany in the 20th and 21st Century".