Assessing the Medieval Climate Anomaly in the Middle East: The potential of Arabic documentary sources

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New evidence from documentary sources provides detailed climatic information to fill the Middle East gap in Medieval Climate Anomaly reconstructions.

The Middle East region harbors a wealth of documentary and natural archives that contain detailed information on climate conditions and events. To date, however, only a few proxy-based climate reconstructions are available from the area for the assessment of thermal and hydroclimatic characteristics of the Medieval Climate Anomaly (MCA). Existing chronologies and reconstructions mostly provide information for specific seasons and hydroclimatic parameters (commonly precipitation and droughts). The reconstructions are based on natural proxies such as tree rings (e.g., Touchan et al., 2007), pollen records (Kaniewski et al., 2010), speleothems (e.g., Bar Matthews et al., 1997; Frumkin et al., 1991; Fleitmann et al., 2004), lake sedimentary records (e.g., Kuzucuoğlu et al., 2011), Dead Sea sedimentary records (e.g., Enzel et al., 2003; Migowski et al., 2006) or Red Sea corals (e.g., Felis and Nimbur, 2010). For compilations of available data from natural and documentary archives the reader is referred to Luterbacher et al. (2006, 2011) and references therein. Most of this data is hampered by a high degree of spatial and temporal variability and/or insufficient spatio-temporal resolution to assess in detail the MCA climate. Therefore its spatial and temporal extent in the Middle East requires further investigations.

Historical climatology studies have shown that documentary archives are a valuable source for climate reconstructions during the last centuries (Brázdil et al., 2005, 2010; Glaser and Riemann, 2009; Glaser, 2008; Pfister et al., 1998, 1999). The large body of written historical sources from Islamic Medieval times shows great potential and perspective for climate reconstructions in the Middle East during the MCA. Apart from a few preliminary studies, e.g., by Grotzfeld (1991, 1995) and Oliver (1991), these sources have not yet been adequately explored from a climatological perspective (Jones et al., 2009). The recently funded German Science Foundation project "Historical Climatology of the Middle East based on Arabic sources since AD 800" aims at using Arabic sources to reconstruct past climate, including hydrological variations and extremes in the Middle East and northeastern Africa back to 800 AD.

Figure 1: A facsimile of a page from the diary of Ibn Tawq, a Damascene notary. The entry dated Shawwāl 9, 885 AH (12.12.1480 AD) describes among other things the end of autumn and the beginning of the winter season (see Ibn-Tawq, 2000).

Arabic historical documents as sources for climate reconstruction

In contrast to Europe, archives with regular and continuous records from Arabic medieval administrations have almost all either been completely destroyed or are barely accessible. Consequently, the source types for climate information for the period from 800 to 1500 AD are mainly restricted to the akhbār genre (historiographical literature) including universal and town chronicles, accounts of journeys, and occasional diaries. A basic principle in the analysis of these sources is the focus on reported events by contemporary authors.

Here we present preliminary results based on a survey of around 50 medieval Arabic historiographical literature sources. We include well known, edited works that have in some cases also been translated into English, German and French, such as al-Tabarī's "History of Prophets and Kings" (al-Tabarī, 1960-1969 AD, 1985-2002 AD) but also less known chronicles and diaries from manuscripts (for an example see Figure 1). From some diaries, weather tables can be derived, e.g., for the period from 1480-1500 AD from the diary of the Damascene notary Ibn Tawq. In total, more than 3000 excerpts amounting to 5000 references on climate related information, have been extracted from these sources.

The peak in the amount of available data for MCA occurred in the 13th century in the Arabic regions; this is much earlier than in Europe where such sources were mainly produced after ca. 1500 AD (Glaser and Riemann, 2009; Brázdil et al., 2010; Pfister et

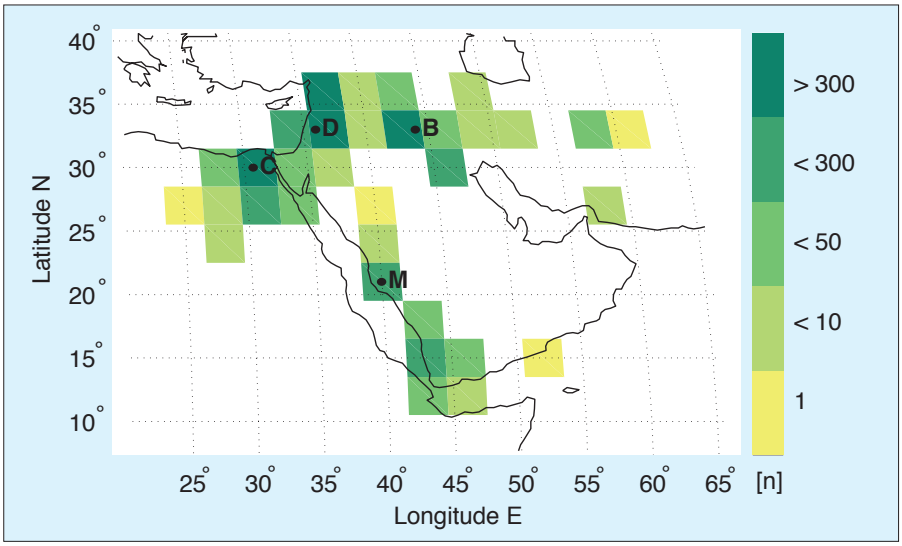

Figure 2: Spatial distribution of available information for the time period from 800 to 1500 AD. Squares show the location of reported events, the color indicates absolute number of reports. Note the concentration to the main cultural centers Baghdad (B) for the Abbassid period, Palestine and Syria with Damascus (D) for the Ayyubid period, Cairo (C) for the Fatimid and Mamluk period, and Hejaz with Mecca (M) and Medina.

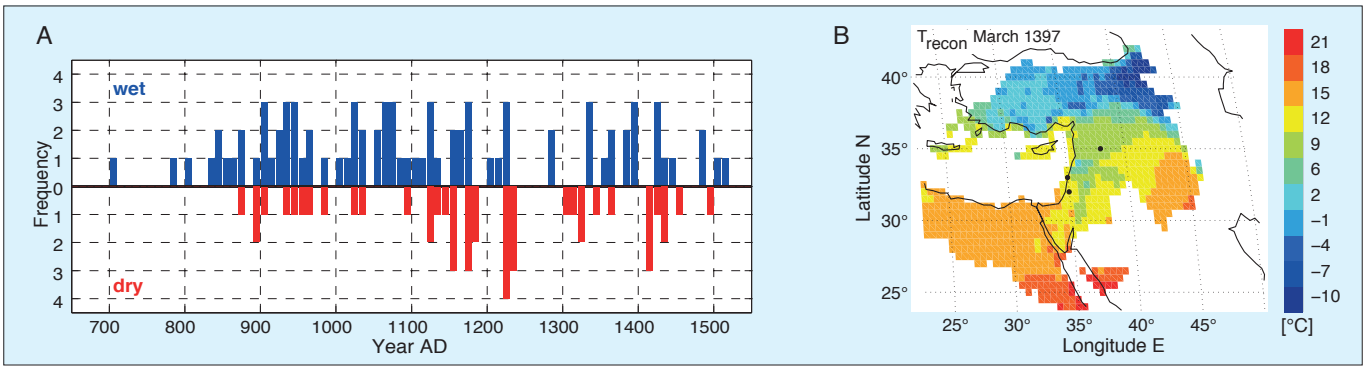

*Figure 3: **A**) Example of a time series for hydroclimatic conditions for Iraq showing the number of wet (blue bars) and dry (red bars) winters per decade (modified after Grotzfeld, 1991). **B**) Example of large scale absolute temperature field reconstruction based on historical sources for March AD 1397. Black dots indicate locations of historical information used for this reconstruction. Temperatures are calculated for areas with correlation values >0.8 with location of historical information. For details on reconstruction methodology see Riemann (2011).*

al., 1998). The decrease in available records after the 13th century could be related to a shift in the writing style and focus of the Arabic chronicles from accounts of events to biographical data and anecdotes at the turn of the 16th century (Grotzfeld, 1995).

Figure 2 shows the spatial distribution of information held in our database to date for the time period from 800 to 1500 AD. The geographical coverage includes Iraq, Egypt, Syria and Palestine as well as the Hejaz and Yemen. In the course of time from the 9th to 15th century the spatial focus of the reports is moving from the Abbasid centers of power and science in Iraq to the Ayyubid centers in Syria and Palestine and finally to Fatimid and Mamluk Egypt reflecting the political and cultural changes in the area.

Winter rain and almond blossom instead of summer drought and tasty wine

In terms of climate-related information, the Arabic and European sources are in many respects similar. The authors usually report on events in their hometown and vicinity. Sometimes comparisons with remote or historical events are also made. The climatic information within a source is more or less sporadic, describing single events, especially natural hazards such as floods, droughts, and exceptionally cold or dry winters. In addition, the impacts of such events, their effects on harvest yields, food supply, economic and social crises are described. Reported events focus mainly on hydroclimatic and less on thermal conditions. The onset of the winter rainy season is one of the most frequently reported features due to its crucial role for agricultural production. Also, closely related to food supply are reports on droughts. For some cities like Baghdad, there exists the potential to establish continuous flood chronologies (Weintritt, 2009). An often-reported specific type of extreme event in the Middle East is sand storms, which are often connected to a specific circulation pattern (lower level Red-Sea Troughs, Saaroni et al., 1998). Cloud coverage is typically reported in connection with observations of the lunar crescent. Phenological information is linked to regional agricultural products such as dates or almonds. However, this kind of information is too sparse for the reconstruction of continuous time series.

Comprehensive data set to reconstruct climate for medieval times

Preliminary results show that the methodology of historical climatology, which has been mainly developed on the basis of European documentary sources, can be applied to this body of data as well. The hermeneutic approach, including critical source analysis and interpretation using information beyond the source texts, as well as classification and derivation of (semi-quantitative) indices can be adopted, but specific adaptations are required. These include methodological aspects of the analysis of Arabic sources, for instance the evaluation of isnad (chain of narrators) when assessing the reliability of relevant accounts in secondary sources. The dating is given in the Hijra calendar system based on lunar months. Its conversion into the Gregorian calendar is typically possible with a precision of one day. Arabic documentary data can be used to establish time series of hydroclimatic information with at least decadal resolution for most of the time span from 800 to 1500 AD. However, for some sub-periods much higher resolution can be achieved, e.g., daily resolution for periods in the 13th and 15th century where we can rely on information from diaries. The spatial distribution of the data for some periods further allows the reconstruction of large-scale temperature and precipitation fields (Fig. 3b, for details on methodology see Riemann, 2011). Future work also includes the reconstruction of more or less continuous temperature and precipitation series at a seasonal time scale. Figure 3a presents a preliminary time series of hydroclimatic winter conditions for Iraq. This time series is not fully homogenous yet, with major data gaps between 1200 and 1400 AD and therefore it does not allow an interpretation of the climate in the area for the whole period. However, in the currently available data, for instance for the periods 900-950 and 1020-1070 AD, a higher frequency of particularly wet winters can be observed.

The results will be further refined and compared with independent climate evidence from natural archives. Furthermore, links with North Atlantic/European and subtropical/tropical climate will be analyzed. Paleo-model output will be used to understand climate variations from the MCA over the Little Ice Age onwards to current conditions in the Middle East.

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