Effects of Medieval Warm Period and Little Ice Age on the hydrology of Mediterranean region

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abstract

Medieval Warm Period (950 – 1250) and Little Ice Age (1450 – 1850) are the most recent periods that reflect the magnitude of natural climate variability. As their names suggest, the first one was characterized by higher temperatures and a generally moister climate, while the opposite happened during the second period. Although their existence is well documented for Northern Europe and North America, recent findings suggest strong evidence in lower latitudes as well. Here we analyze qualitatively the influence of these climatic fluctuations on the hydrological cycle all over the Mediterranean basin, highlighting the spatial characteristics of precipitation and runoff. We use both qualitative estimates from literature review in the field of paleoclimatology and statistical analysis of proxy data series.

proxy data

The literature reviewed included many different methods for the reconstruction of the past hydro-climatic conditions. These reconstructions were based on:

- Historical documents
- Marine / Lake sediments
- Speleotherms (caves)
- Glaciers
- Tree-Rings
- Lake levels
- River alluvation
- Pollen data

general findings

During the **Medieval Warm Period** (MWP, 950 – 1250 AD) the temperature was generally higher than today at the western Mediterranean basin especially in the summer. However, there was a certain interval (1080 – 1140 AD), when temperature had fallen sharply causing a temporary glacier expansion. Interestingly, according to the (scarce) available historical information, during MWP the eastern Mediterranean experienced rather cold conditions with severe, extended winters.

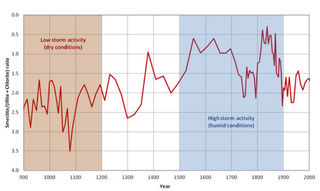
The hydro-meteorological conditions that prevailed during this period show distinct regional variability. Arid conditions dominated in Spain and S. France, and gradually became more humid towards eastern longitudes. Between these two opposing regimes (western dry/eastern wet) climate exhibited enhanced variability and instability in the northern central part of Mediterranean, where years of droughts and extreme floods succeeded each other; also, there were consecutive years with out-of-season rain or even snow.

The low temperatures that characterized the **Little Ice Age** (1450 – 1850) all over the northern latitudes were evident in the Mediterranean basin as well. The decline in temperature was homogenous, although locally some periods with exceptionally hot summers can be observed for few decades .

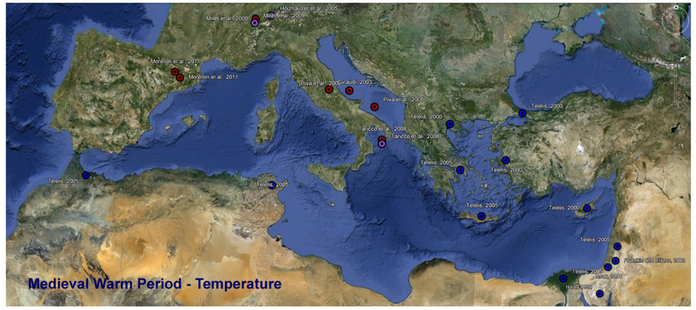
At the western Mediterranean this was a period of consecutive heavy rainfall, severe floods and high humidity. This has been confirmed by a new proxy series of paleo-storm events along the French Mediterranean coast (Sabbatier et al., 2012 – see graph below).

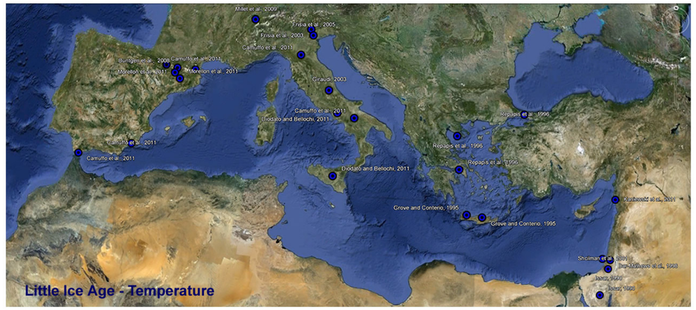
At the same time, in the eastern part the opposite conditions prevailed: droughts were more frequent, river flow was generally low, as well as lake levels. Similarly to Medieval Warm Period, the region of northern central Mediterranean exhibited enhanced climatic variability.

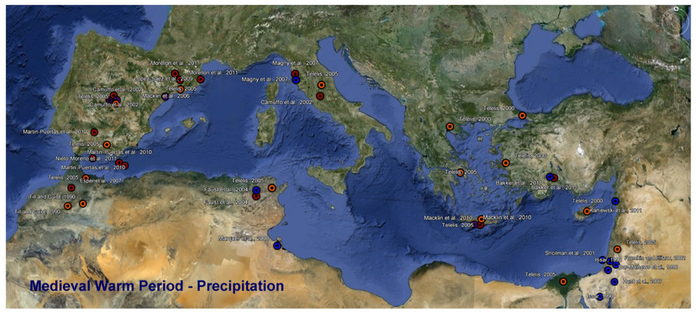
The overall precipitation regime of inverse correlation between western and eastern Mediterranean, is in agreement with the 'See-saw' pattern hypothesis, also known as Mediterranean Oscillation (Conte et al., 1989; Martin-Puertas et al., 2010; Roberts et al., 2011), both in Medieval Warm Period and Little Ice Age.

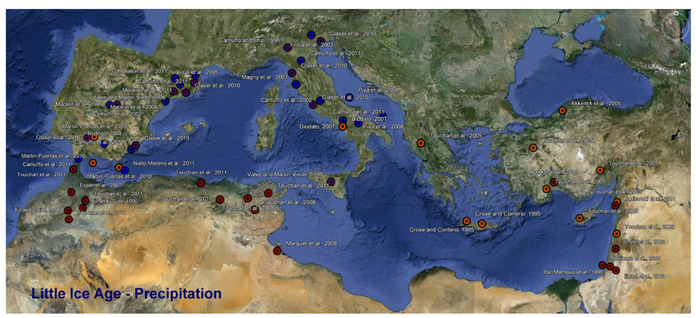


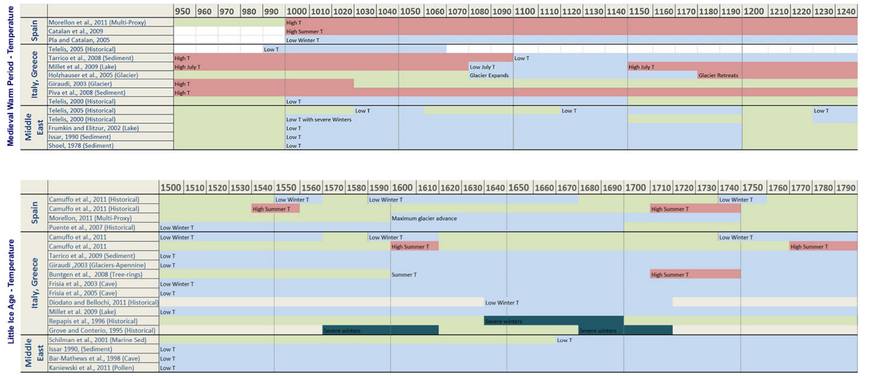
Frequency of Paleo-storm events in Gulf of Lions in S. France.
The y-axis is reversed as low values of smectite/(illite+chlorite) correspond to periods of high storm activity (Sabbatier et al., 2012).

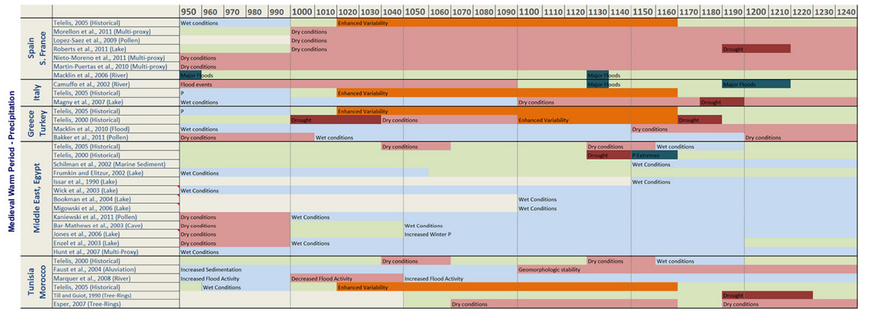


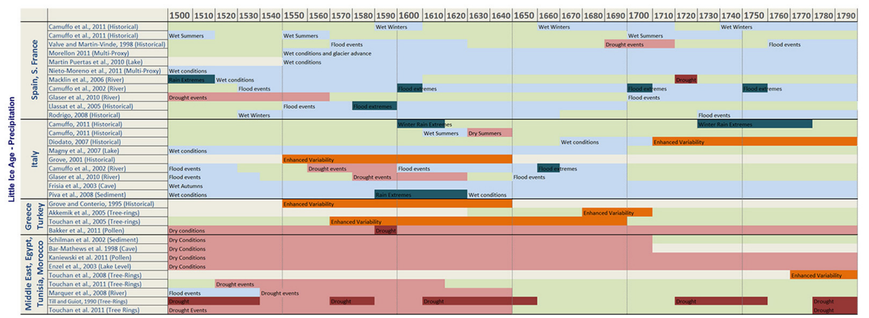












map legend

Temperature
- High Temperatures / Extremely Hot Summers
- Low Temperatures / Severe Winters
- Drop in Temperature during 1080 – 1140 AD

Precipitation
- Dry conditions / Low Precipitation
- Humid conditions / High Precipitation
- Humid conditions / High Precipitation
- Enhanced variability (out of season rain/snow, etc.)

timeline legend

Temperature
- Normal conditions
- High Temperatures
- Low Temperatures
- Severe Winters

Precipitation
- Normal conditions
- Dry conditions
- Humid conditions
- Enhanced variability
- Frequent floods
- Drought

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