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Introduction

Reconstructing past environments from remnants of human occupation and sedimentary archives in western Eurasia

Anson W. Mackay [a,*], Hedi Oberhänsli [b]

[a] Environmental Change Research Centre, Department of Geography, UCL, Gower Street, London. WC1E 6BT, UK
[b] Climate Dynamics and Sediments Section, GeoForschungsZentrum Potsdam, Telegraphenberg, D-14473 Potsdam, Germany

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Impacts of climate change and human occupation on the landscapes in western Eurasia are complex in terms of both their spatial distribution and temporal resolution. Reconstructing impacts is not straightforward, however; often, semi-arid conditions prevail, which reduce the extent of suitable archives for reconstructing past change. Other sites are very remote, so that few studies exist from which to make these reconstructions. In order to tackle some of these issues, we convened a session at the EGU (Vienna) April 2005 to compile recent research on Holocene environments in western Eurasia. In all, 22 presentations were given, with special emphasis on paleoenvironmental reconstructions from regions with rich archaeological histories. Several papers presented significant methodological advances with regard to reconstructing the past from lake sediments, while others brought the growing field of Russian archaeological pedology to the attention of other scientists. Studies from remote sites were also highlighted, because they served as useful comparisons from which to reconstruct past climatic impacts with minimal human disturbance in the western Eurasian region.

Many of the papers in this special issue of Quaternary Research demonstrate the importance of precipitation and humidity in the western Eurasian region. These factors have been reconstructed from sub-decadal to centennial-scale resolution, from the mid-Holocene up to recent decades. However, their impacts are complex, none the more so than evidence for recent climate variability over the last 1000 yr, spanning periods commonly referred to as the "Medieval Warm Period" (MWP) and "Little Ice Age" (LIA).

These nine papers have been arranged into three sections. The first section contains four studies undertaken at sites with very different archaeological histories. In semi-arid regions such as the Near East, paleoenvironmental interpretations are often hindered due to the lack of proxy data that can be obtained from continuous archives such as lake sediments. However, Pustovoytov et al. have attempted to provide for the first time a continuous Holocene proxy record from Upper Mesopotamia in the northern part of the Fertile Crescent in southeastern Turkey. Their approach has been to undertake radiocarbon and stable isotope ($\delta^{13}C$, $\delta^{18}O$) analyses on secondary pedogenic carbonate laminations on stones from precisely dated, intact architectural structures. Isotopic results indicate that after gradual warming during the early Holocene (10,000–6000 cal yr BP), prevailing climate in this region became warmer and more humid between ca. 6000 and 4000 cal yr BP, before becoming increasingly arid over the last 4 kyr. Khomutova et al. also make use of human structures to infer past climate, in this study from kurgans (burial mounds) in the steppic zone of the Russian plains. Like the Fertile Crescent, this is an archaeologically important region although the pedological work presented here is less well known outside of Russia. This study exploits the development of successive paleosoils in the kurgans, which form a soil chronosequence with differential impact on microbial communities over specific time periods. Their data suggest that approximately 4000 cal yr BP, more arid climates prevailed, similar to findings by Pustovoytov et al. However, humidity increased ca. 2000 cal yr BP in this region of the lower Volga, culminating in wet conditions ca. 750 cal yr BP, coincident with the MWP.

The next two papers take a different approach—rather than investigating human artefacts directly, fluvial and colluvial deposits are examined to provide much needed environmental context within which past settlements would have developed. Deckers and Riehl examined well-dated fluvial sequences and the proxy remains that they contained (mollucs, ostracods and pollen) to infer past environmental conditions (for example, whether rivers were fast flowing or not, or prone to flash

* Corresponding author.
E-mail address: amackay@geog.ucl.ac.uk (A.W. Mackay).

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floods) in northeastern Syria. Their findings highlight that the landscape and environment of the Upper Khabur Basin was very different in the past than it is today, especially in terms of the extent of woodland that persisted until the 3rd century. Over the last 5 kyr, river flow has varied in intensity, and while climate played an important role, human impact and the construction of irrigation systems cannot be ruled out in regulating this flow. In another study, Fuchs investigated the links between climate and settlement history on soil erosion and sedimentation rates from well-dated colluvial deposits in NE Peloponnese in Greece. He provides evidence that increased sedimentation rates occurred during periods of increased anthropogenic activity, for example the Neolithic period, Middle to Late Bronze Age, the Roman period and during the last 500 yr, and concludes that human impact has been the major driver in affecting soil erosion in southern Greece since at least the mid-Holocene. Yet, the role of climate and enhanced precipitation enhancing soil erosion is likely to explain the particularly high sedimentation rates experienced during the early Neolithic.

The next set of three papers marks the culmination of a joint Russian–German–Anglo programme called CLIMAN—Holocene climatic variability and evolution of human settlement in the Aral Sea Basin (http://climan.gfz-potsdam.de). One of the main objectives of this programme was to link new findings of settlement history from archaeological evidence with paleoenvironmental reconstructions from a continuous 11-m lake sediment core, spanning approximately the last 2000 yr. The records highlight that allochthonous proxies contained in sediments from the Aral Sea can be used to reconstruct regional-scale changes in climate. However, reconstructions based on diatom-inferred paleoconductivity records are also sensitive to changes in lake levels, which are impacted by both climatic and anthropogenic factors.

Sorrel et al. infer past mean temperatures and mean annual precipitation using the technique of probability mutual climatic spheres (PCS) from the pollen record of the Aral Sea sediments. The resolution achieved was ca. 50 yr, and the pollen data highlight that over at least the last 2000 years, centennial-scale climate events are recorded in the Aral Sea sediments. Three marked cold, arid periods are identified: before AD 400, between AD 900–1150 and AD 1500–1650, and it is suggested that these are associated with a negative phase of the North Atlantic Oscillation impacting large-scale atmospheric climate patterns over the eastern Mediterranean. In a second paper, Sorrel et al. have undertaken a novel study to try and reconstruct wind dynamics in the Aral Sea basin, based on the premise that variations in Al and Ti in core sediments, and thickness of core laminations, are a reflection of intensity of prevailing winds. Their data have been obtained at very high resolution using XRF-scanning of laminated portions of the sedimentary record. They identify several periods over the last ca. 2 kyr, which experienced enhanced atmospheric circulation and an increase in intensity of the Siberian High (SH), that are consistent GISP2 ice core dust records of changes in the intensity of the SH. Austin et al. provide the first quantitative reconstruction of past conductivity levels in the lake, which is related to fluctuating lake levels. Three periods of severe lake level regression are identified as (i) starting between AD 200–400, (ii) ca. AD 1195–1355 and (iii) ca. AD 1780–present day. The earlier two regressions are associated with a decline in penetration by Mediterranean cyclones to more inland regions, resulting in the natural diversion of the Amu Darya. However, archaeological evidence highlights that during each of these episodes, irrigation facilities around the lake were destroyed, and that this destruction was likely to enhanced the severity of the regressions observed. The most recent increase in diatom-inferred paleoconductivity seems to reflect recent observations that Aral Sea lake-level changes have responded to changes in solar insolation since at least the end of the 18th century, although these fluctuations were relatively minor compared to the regression caused by irrigation practices since the 1960s.

The final two papers investigate climate change reconstructions over the last 800 yr from a southern Siberian lake (Lake Teletskoye) with minimal human impact, and accordingly they describe an interesting site with which to compare results. Andreev et al. provide the first detailed pollen record for northern Altai mountains and were able to infer that at ca. AD 1200, the climate in this region was warm and humid, but by ca. AD 1560–1820, conditions became cooler and drier, concomitant with the LIA. Kalugin et al. developed quantitative transfer functions for average annual temperature and average annual precipitation records from Br and Sr/Rb ratio proxies in Lake Teletskoye sediments using XRF scanning and artificial neural networks (ANN). Their record spanned the period from AD 1210–1991, and during this time they were able to identify cooling that they associate with the Maunder Minimum within the LIA, and subsequent regional warming over the last 150 yr. This study is one of the few paleolimnological studies to use ANN; their results correlate the presence of decadal and sub-decadal solar forcing of climate interacting with North Atlantic thermohaline circulation.

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