Journal of Archaeological Science 87 (2017) 30–43

Contents lists available at ScienceDirect

Journal of Archaeological Science

journal homepage: http://www.elsevier.com/locate/jas

Palaeoenvironmental reconstruction of the alluvial landscape of Neolithic Çatalhöyük, central southern Turkey: The implications for early agriculture and responses to environmental change

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ARTICLE INFO

Article history:
Received 21 November 2016
Received in revised form
31 July 2017
Accepted 2 September 2017

Keywords:
Neolithic
Turkey
Geoarchaeology
Isotope analysis
Modelling
Agriculture

ABSTRACT

Archaeological discussions of early agriculture have often used the Neolithic village of Çatalhöyük in central southern Turkey as a key example of the restricting effect of environment on agricultural production and organization. Central to these discussions is the palaeoenvironmental reconstruction of the landscape surrounding the site. This paper presents an important new dataset from an intensive coring programme undertaken between 2007 and 2013 in the immediate environs of the site, designed to improve significantly the spatial resolution of palaeoenvironmental data. Using sediment analyses including organic content, magnetic susceptibility, particle size, total carbon and nitrogen contents and carbon isotope analysis, coupled with 3D modelling, we are able to present a new reconstruction of the palaeotopography and sedimentary environments of the site. Our findings have major implications for our understanding of Neolithic agricultural production and social practice.

We present four phases of environmental development. Phase 1 consists of the final phases of regression of Palaeolake Konya in the later parts of the Pleistocene, dominated by erosion due to wind and water that created an undulating surface of the marl deposited in the palaeolake. Phase 2 occurs in the latest Pleistocene and early Holocene, and indicates increased wetness, probably characteristic of a humid anabranching channel system, in which there are localized pockets of wetter conditions. In Phase 3a, this infilling continues, producing a flatter surface, and there are fewer pockets being occupied by wetter conditions. The fluvial régime shifts from humid to dryland anabranching conditions. The earliest period of occupation of the Neolithic East Mound coincides with this phase. Phase 3b coincides with the shift of occupation to the West Mound in the Chalcolithic, when there is evidence for a very localized wetter area to the southeast of the West Mound, but otherwise a continuation of the dryland anabranching system. Finally, Phase 4 shows a shift to the pre-modern style of fluvial environment, modified by channelization. This reanalysis demonstrates the importance of extensive spatial sampling as part of geoarchaeological investigations.

With this new evidence we demonstrate that the landscape was highly variable in time and space with increasingly dry conditions developing from the early Holocene onwards. In contrast to earlier landscape reconstructions that have presented marshy conditions during the early Holocene that impacted agriculture, we argue that localized areas of the floodplain would have afforded significant opportunities for agriculture closer to the site. In this way, the results have important implications for how we understand agricultural practices in the early Neolithic.

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https://doi.org/10.1016/j.jas.2017.09.002
0305-4403/

1. Introduction

The site of Çatalhöyük (*c.*7400–6000 cal BCE: Bayliss et al., 2015; Cessford, 2001) in central southern Turkey has played a pivotal rôle in ongoing discussions regarding Neolithic settlement and the onset of agriculture. The environmental reconstruction of the surrounding landscape of Çatalhöyük has been at the centre of evolving archaeological debates about early agricultural communities and their adaptation to environmental change (Sherratt, 1980; Roberts, 1991; Bogaard et al., 2014; Charles et al., 2014). Central to the palaeoenvironmental reconstruction of the past landscape is the characterisation of the alluvial landscape in the vicinity of the site. The modern Çarşamba River flows close to the edge of the site and extends southwards until the termination of the Konya Plain at limestone hills that border the Taurus Mountains (Fig. 1). Previous geoarchaeological research has characterized the alluvial plain as a very marshy environment subject to significant seasonal flooding (Roberts et al., 1999; Boyer et al., 2006; Roberts and Rosen, 2009) which has driven models of land use (Fairbairn, 2005; Roberts and Rosen, 2009). In particular, Roberts and Rosen (2009) have suggested that agriculture during the Neolithic phases of the site would have been constrained by the marshy conditions and could only have been undertaken upon the well-drained foothills up to 12 km from site, which has significant implications for social and economic nature of settled life (see also Rosen and Roberts, 2005). These palaeoenvironmental models have been based on sedimentological data derived from nine coring locations and trench sections near the tells as well as the investigation of 16 archaeological sites (four of which date from the Palaeolithic to Bronze Age) further away in the area of Palaeolake Konya (Boyer, 1999: 63; Boyer et al., 2006, 2007: 684). Recent interpretations of land use and *taskscapes* have attempted to integrate the sedimentological data with on-site evidence, including but not limited to archaeobotanical and faunal remains, as well as clay sourcing (Charles et al., 2014). At times this on-site environmental evidence fits well within the model that suggests a dominantly wet landscape contemporary with the Neolithic settlement, but there is increasing on-site palaeobotanical evidence that is beginning to challenge the pervasiveness of the marsh environment (Bogaard et al., 2014; Charles et al., 2014).

As a consequence of these apparently conflicting interpretations of the Neolithic landscape, a further campaign of geoarchaeological research was undertaken between 2007 and 2013, with the specific aim of resolving these conflicts, using both more intensive and extensive sampling protocols. This research provides an important body of data that raises significant questions about the validity of these earlier palaeoenvironmental models and established ideas about early agriculture derived from them, which would have required extensive time away from site for large numbers of the population to tend fields. In this paper we provide data from a coring programme undertaken that targeted a further 29 coring locations within a radius of up to 1.6 km of Çatalhöyük to provide a more nuanced approach to landscape reconstruction. The combination of sediment with isotope analysis and 3D modelling of the stratigraphic sequence enables us to construct a more refined understanding of the hydrology and resulting dynamic topography of the low-lying alluvial plain around this crucial time of early agricultural society in the near East. This high-resolution environmental reconstruction provides direct evidence of the Neolithic alluvial landscape from which we can advance archaeological discussions of cultural response to environment and environmental change.

1.1. Regional setting

Çatalhöyük is located in the Çumra District on the Konya Plain (Fig. 1). The current climate is defined by the Köppen-Geiger classification as BSk (de Meester, 1970, 5; Kuzucuoğlu et al., 1999), or cold semi-arid/steppe climate, having hot, dry summers and cold, wet winters. The majority of rainfall at Çumra occurs between December and May, with an average annual precipitation of 350 mm, and there is a considerable seasonal temperature range of over 20 °C between the warmest and coolest months. The climate regime can also be seen to include a three-month period of drought between July and September, and throughout the year the winds in the basin come mainly from the north (Fontugne et al., 1999).

The surface of the plain is fairly flat, with shoreline terraces and beaches rising up to 30 m above the margins of the plain, suggesting that a fairly shallow, albeit expansive lake (>400 km^2) occupied this basin at its maximum extent. The basin has not been tectonically active in radiocarbon history, and so recent stratigraphic sequences remain *in situ* (Roberts, 1995).

Soil surveys by de Ridder (1965) and de Meester (1970), revealed that the basin is in places infilled with in excess of 400 m of Quaternary marl sediments, testifying to the lengthy presence of a lake in this location. More recently with greater water management the plain has dried, and three marshy depressions within the basin, the Yarma marshes, the Konya marshes and the Hotamiş Lake, have become desiccated leaving only the seasonal Sultaniye Lake and permanent Akgöl Lake as water-holding depressions in the basin (Fontugne et al., 1999).

The plain today is dominated by irrigation agriculture, yet studies have shown that in recent history *Artemisia* steppe and Chenopodiaceae were the chief plants present, with the volcanic soils having open forests of *Quercus,* and limestone soils containing forests of *Pinus* and *Juniperus* (Kuzucuoğlu et al., 1999; Fontugne et al., 1999). Further analysis of the palaeovegetation sequence is hindered by limited palynological investigations in the Konya basin, which have been confined to deposits collected from the Yarma and Akgöl basins, allowing few long vegetation sequences to be created, and none locally to the Çarşamba fan (Bottema and Woldring, 1984; Kuzucuoğlu et al., 1999; Woldring and Bottema, 2003; Roberts et al., 2016). Traditionally, pastoral grazing of sheep on the plain has been crucial to the livelihoods of local populations which has undoubtedly controlled the development of vegetation. Today though, grazing has moved onto the higher slopes surrounding the plain (Russell and Martin, 2005).

1.2. Previous palaeoenvironmental research in the Konya Basin

The Konya Basin is a closed pluvial basin that has actively responded to changes in climate and precipitation. Projects such as the KOPAL (*KO*nya basin *PAL*aeoenvironmental research) programme utilized a variety of radiometric dating techniques to try to constrain the ages of different deposits and in doing so create a chronostratigraphic sequence for the basin (Boyer, 1999; Boyer et al., 2006, 2007; Roberts et al., 1999).

Çatalhöyük is located to the east of the present course of the Çarşamba River, but the river has been heavily channelized for the last fifty years and so can no longer adjust to changing conditions. It previously debouched from a relatively confined section to the south of Çumra to form an extensive, low-angled fan and in the last century consisted of a single-branched channel which previously passed between the East and West Mounds. The Çarşamba fan has been subject to a variety of interpretations, in part because of its low angle sloped deposits, with its form being described as “more akin to an alluvial floodplain than an alluvial fan environment” (Roberts, 1995: 209). Initially, de Meester (1970: 86) described the entry of the river to the basin as deltaic, and it was suggested that the Neolithic soils found upon it were formed under “semi-lacustrine marsh” conditions. The KOPAL project concurred with de