Çatalhöyük and Its Landscapes

Gianna Ayala and John Wainwright

Panorama of the modern landscape looking west from the north part of the East Mound, showing the structure of large, irrigated fields. The course of the channelized modern Çarşamba River is picked out by the line of trees in the middle distance.

The landscape surrounding the site of Çatalhöyük has been transformed by centuries of land use and agricultural improvements (fig. 1). The most recent transformations started in the early twentieth century aiming to improve agricultural productivity by carrying out extensive irrigation and land-reclamation programs (Roberts 1990). Irrigation water was brought via the Beyşehir-Sugla canal system which was completed around 1911 (Money 1919), bringing irrigation water from Lake Beyşehir to the south. Further regulation of water supplies in the 1950s and 1960s included the construction of the Apa Dam on the Çarşamba River (completed in 1962) and World Bank support for extending irrigation schemes (fig. 2). Unsurprisingly, archaeological and palaeoenvironmental evidence from Çatalhöyük suggests significantly different environments at the time of occupation from that of the modern landscape. Therefore, it is essential for archaeological interpretations to be underpinned by robust palaeoenvironmental reconstructions.

Çatalhöyük is fortunate to have been the center of cutting-edge geoarchaeological and palaeoenvironmental research over several decades. This pioneering work has had a lasting impact not only on how the palaeoenvironment has been interpreted but also on the subsequent land-use models that have been put forward (Roberts and Rosen 2009). Early work by the pedologist de Meester (1970: 86), suggested that the Neolithic soils were formed under "semi-lacustrine marsh" conditions that had been formed in a deltaic environment. In the 1990s the KOPAL (KOnya basin PALaeoenvironmental research) project investigated the landscape in the immediate vicinity of the site. KOPAL's results concurred with de Meester's assessment of soil formation in marshy conditions. Roberts et al. (1999) defined three broad sets of deposit: (1) a dark, organic clay deposit interpreted as a marsh or backswamp deposit (p. 624), interpreted as being formed immediately before the Neolithic settlement of the East Mound (ca. 7400 cal BCE: Bayliss et al. 2015); (2) the "Lower Alluvium" representing a seasonally flooding environment, contemporary with occupation (from ca. 7000 cal BCE) (Roberts et al. 1999: 625); and (3) the "Upper Alluvium," which was slightly coarser, indicating a more dynamic flow during the mid-Holocene (p. 627).

The alluvial landscape was thus interpreted as a branch of the Çarşamba River, which underwent heavy seasonal flooding during the Neolithic occupation (Roberts and Rosen 2009: 396). Roberts and Rosen argued that the topography and hydrology had highly significant consequences for human ecology. They noted that seasonal wetlands around the site would have offered rich and varied natural resources, but that domesticated animals and crops would have been less well suited to year-round activity in the immediate vicinity of Çatalhöyük and would have been herded or cultivated at slightly higher elevations away from the flood-prone areas of the plain (Roberts and Rosen 2009: 396–97).

Roberts and Rosen argued for a mosaic of environments surrounding the site, but what exactly did this mosaic look like? This article builds upon these previous studies with data from

new fieldwork, which contributes a significantly higher spatial resolution dataset that improves not only the chronological accuracy of the sedimentary sequence but also provides greater clarity of the fluvial system surrounding the site, which has implications for our understanding of the land use at Çatalhöyük, not only the temporality but spatiality of Neolithic life. In this way, we are better able to understand what the Neolithic landscape looked like, but also to suggest how it was used by the inhabitants of the site. In what follows we discuss the current state of understanding of the ancient topography and environmental niches available to the Neolithic occupants of Çatalhöyük through a critical review of the palaeoenvironmental evidence currently available.

Figure 1. The East Mound from the east, showing concrete irrigation channels and sprinkler irrigation from the latest phase of landscape modification.

Approaches to Landscape Reconstruction

The current landscape project ran from 2007–2017. Within this period, fieldwork and laboratory analyses were undertaken in different periods. Fieldwork was organized in two phases of intensive coring. The first phase was undertaken in 2007–2008 followed by another phase of annual fieldwork in 2013, 2015, and 2017. Coring was initially undertaken by colleagues from Selçuk University with a percussion corer that allowed us to penetrate up to 8 m underground through dry and compacted ground and to recover preserved subsurface sedimentary sequences. Later coring included mechanical coring using a truck-mounted rig (fig. 3), necessary because of the hard, compact, and locally stony sediments that had to be penetrated and sampled. A total of twenty-nine sediment cores have been recovered from targeted coring locations (figs. 4 and 5).

In 2007–2008, sampling took place within the immediate area of the settlement mounds within 1 km^2. In 2013–2017 we expanded the sampling area to 2 km^2 from the site. The coring locations followed transects where possible, or targeted locations in the landscape to ensure representation of potentially varied microenvironments. This intensive coring program ensured that a clear and accurate picture of the buried landscape could be recovered

Figure 2. Channelized water system in the modern landscape: (a) the modern Çarşamba River is confined to a concrete channel immediately adjacent to the site; and (b) a deep irrigation ditch to the south of the site used to provide water to surrounding fields (via pumps and the concrete channels seen in fig. 1).

from the subsurface. It recognizes that dryland environments are inherently highly variable spatially. Once the cores were extruded, they were described in the field and packed for transportation to the laboratory for detailed scientific investigations.

Once in the controlled environments of the laboratory, the lithology of the cores was studied and subsampled for further analysis with a suite of methods. We made a preliminary description of the cores, including their color, sediment type, and grain size. More detailed laboratory analyses of the sediments then included magnetic susceptibility, loss on ignition (carbon content), and particle size at the Universities of Sheffield and Durham, and isotope analysis at the British Geological Survey (Ayala et al. 2017: 33). The results of these analyses were used to characterize the sedimentary sequence in order to interpret depositional environments and their change through time. Three main complexes were identified (basal, lower, and upper; Ayala et al. 2017: 34–35) that in turn were made up of a combination of defined strata. With the sheer number of cores investigated we were able to refine the chronostratigraphy through a dating program focussing on the Dark Clay layer that had previously been key to interpreting the initial phases of the occupation of Çatalhöyük (relative to deposits [i] of Roberts et al. 1999).

Radiocarbon (AMS) dating was undertaken on key strata on organic material and shells. Focussing on the Dark Clay layers visible in several of the cores in different locations across the study area, we have been able to identify a sequence of sedimentary complexes made up of series of individual strata that document the dynamic development of the alluvial landscape across the 2 km^2 area in the immediate vicinity of the site through time (Ayala et al. 2017: 34–35). The final step was to map the subsurface sedimentary units across the area by plotting them in RockWorks™ v16 software, which has enabled us to reconstruct the character and extent of the past hydrology and characterize the extent of the channel belt in the past (figs. 6 and 7).

Reinterpreting the Neolithic Landscape

Our interpretation of the Neolithic landscape is based on the series of depositional complexes as they map across the landscape. In Ayala et al. (2017: 41) we presented four chronological phases that documented changes in the depositional environment, and underlined what the immediate surroundings would have looked like at different temporal phases before, during, and after the Neolithic occupation of Çatalhöyük (fig. 8). At the time of the occupation of the East Mound, the environment directly surrounding the mound would have been dominated by the Çarşamba River. The type of channel and the frequency and nature of its flooding would have had direct impact upon the inhabitants living in the nearby settlement. Previous interpretations based on a limited number of cores detected a meandering channel that was subject to extensive seasonal flooding, which caused backswamp conditions in the vicinity of the East Mound prior to occupation, with extensive flooding conditions continuing during the Neolithic (Boyer, Roberts, and Baird 2006; Roberts and Rosen 2009; Roberts et al. 1999). The following interpretative model (Ayala et al. 2017) is based on much higher spatial resolution evidence and presents a more varied landscape.

The first two phases of the depositional sequence chart the period of retreat of Palaeolake Konya from the site in the late Pleistocene. The Palaeo-Çarşamba River would most likely have consisted of a single and possibly ephemeral channel that made its way through a landscape that was sculpted by local wind and water erosion. The topography at this point in time would have resembled badlands cut into the marl of the lake. With time the underlying marl deposits of the lake would have been eroded away into a rolling topography. The river in the second phase would have had a wide belt of multiple channels (several hundred meters in width) that is consistent with a humid multiple-channel system (fig. 9a; Ayala et al. 2017: 39). These channel-belt environments would have contained areas of wetter conditions, where lower parts of the landscape would have trapped water, or where channel cutoffs occurred. The final two phases reveal the hydrology and topography during the period of the Neolithic occupation of the East Mound and then from the Chacolithic period onwards. These final phases saw a steady increase in drier conditions as time progressed.

The Çarşamba River during the Neolithic was made up of multiple, small, silty channels, with intervening higher, drier ground. This style of channel is known as an anastomosing or anabranching river, which is composed of two or more channels that repeatedly connect and separate to carry flow across a floodplain (Nanson and Knighton 1996). The wide zone of channels occupied the broad areas available for the flow within a rolling topography left by the eroded marl substrate. Crucially, in this period the sediments

Figure 3. Sediment coring during the 2015 field campaign: (a) a core starting to be drilled. The screw core is taken down to the level of interest, and then a core tube (seen lying on the frame in the foreground) is pushed into the sediment to obtain a core sample; and (b) sediments recovered from core 2015/B (see fig. 6 for location).

transported and deposited by the belt of shallow channels suggest a transformation of the channel system from one characterized by more humid conditions into one with more dryland characteristics (fig. 9b).

This change from a humid-style channel system to an arid one is important for the reconstruction of the landscape because it highlights how the floods and layout of the channels themselves would respond to fluctuations in seasonal precipitation. Therefore, with this change, the Çarşamba would have maintained a similar morphology made up of multiple channels, but the flooding regime would no longer have been tied to such high levels of seasonal precipitation. Therefore the extensive flooding and raised water table, which would have seen less stable alluvial islands and extensive wetland areas, would have been replaced. In the subsequent, more dryland system, the channel belt still responds to seasonal flow variations, but maintains more stable dry islands between the multiple channels.

In Ayala et al. (2017), we challenged the interpretation of Roberts and Rosen (2009: 397) that the Neolithic environment was composed of "backswamp basins gradually infilled" by spring floodwaters. The interpretation of "backswamp" conditions is not consistent with the structure of a multichannel (anastomosing) channel system (see further discussions by Charles et al. 2014 and Doherty 2017). Analyses carried out on the early sediments (dark clay *sensu* Roberts et al. 1999) using carbon isotopes and ratios of carbon to nitrogen contents of the sediments does support the idea that the Dark Clay was deposited in wet conditions (fig. 10). Geochemical signatures of the sediments suggest that they had relatively high organic matter but were periodically dry (Ayala et al. in press; see also the discussion in Doherty 2017). However, our dating of the more waterlogged conditions suggested by the Dark Clay layers precedes occupation (except for a localized outlier that dates to the Chalcolithic; Ayala et al. 2017: 39). The geochemistry of the sediments that overlie the Dark Clay (those roughly similar to the Lower Alluvium of Roberts et al. 1999) is consistent with drier conditions. We have not found that a more generally marshy environment continues into the Neolithic, although other palaeoenvironmental data support the idea that it was locally present (Wolfhagen et al. in press).

Further issues with the spring floodwater model of Roberts and Rosen (2009), are discussed in Ayala et al. (in press) highlighting the data used to build their model and the subsequent modelling method that was used to estimate flooding regime at the time. The data upon which they build their hydrological interpretation come from Bozkir as it has remained a tract of river that has not undergone extensive modification in the recent past. The extensive channelization

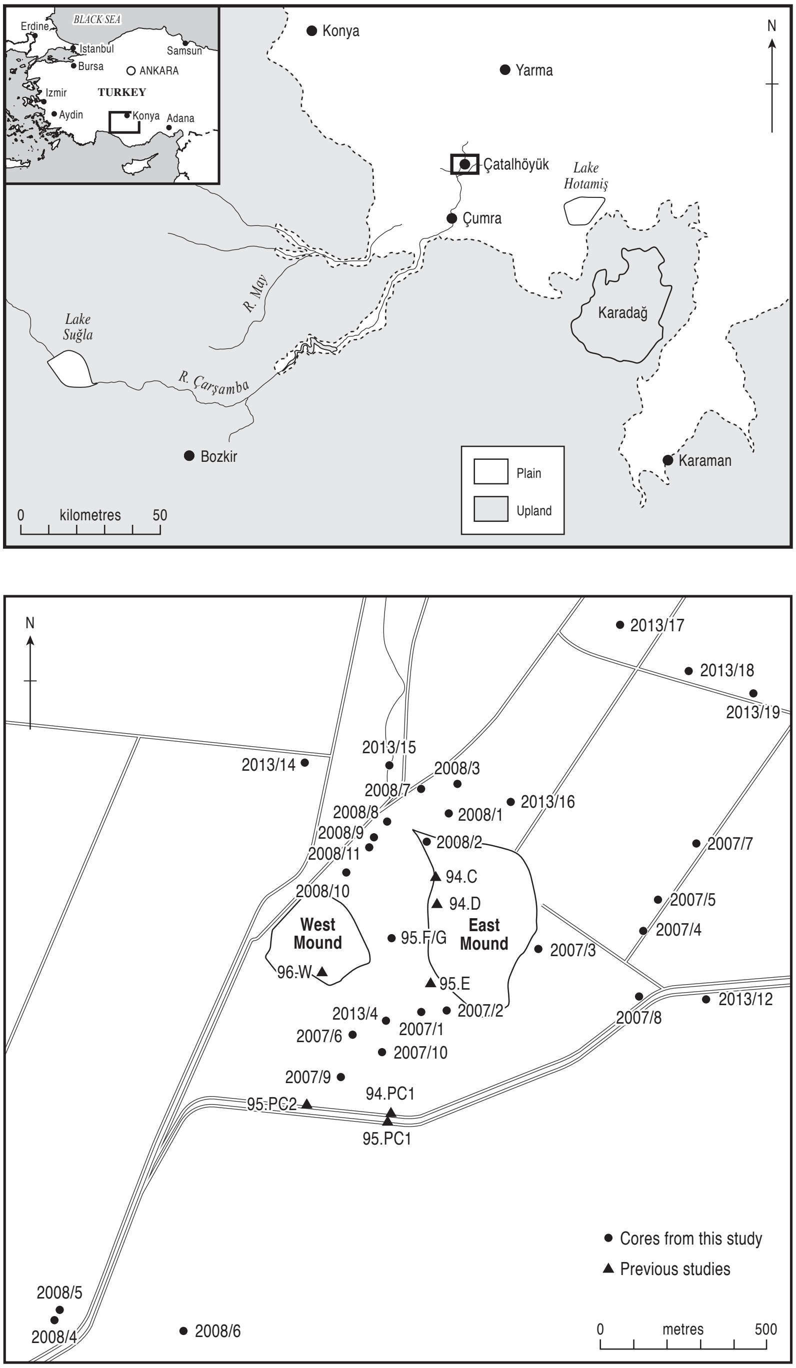

Figure 4. Location of Çatalhöyük and its broader context in the Konya plain and surrounding uplands.

schemes in the late nineteenth and early twentieth centuries (especially the Beyşehir-Çarşamba Canal) and the dam at Apa have significantly altered the flows in the lower part of the Çarşamba so that modern instrumental records are not useful for interpretation of past flow. Unfortunately, Bozkir is a long way upstream (32° 12′ 34″ N, 37° 10′ 24″ E), at an elevation of 1,156 m with a catchment area of only 206 km^2, compared to an estimated 2079 km^2 for the estimated Neolithic Çarşamba just downstream of Çumra. Thus, the catchment area feeding the channel system at Çatalhöyük is an order of magnitude larger than that producing the flow at Bozkir, rendering the potential model coming from this dataset inappropriate to be applied to

Figure 5. Map of coring locations in relation to the two tells at the site. The red line shows the location of the section A-A′ used in the interpretation of the lithology and stratigraphy of the northern transect sampled in 2015 (see fig. 9).

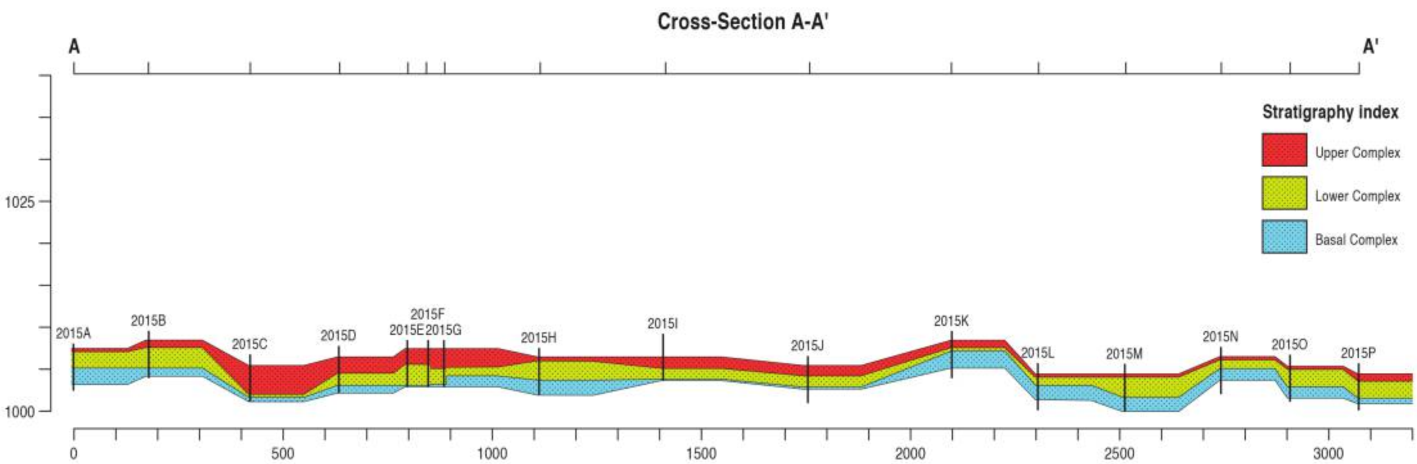

Figure 6. Sedimentological correlation of the cores CH2015A-CH2015P along section A-A′ (see fig. 6). Elevations of the tops of the cores are estimated from the SRTM DTM.

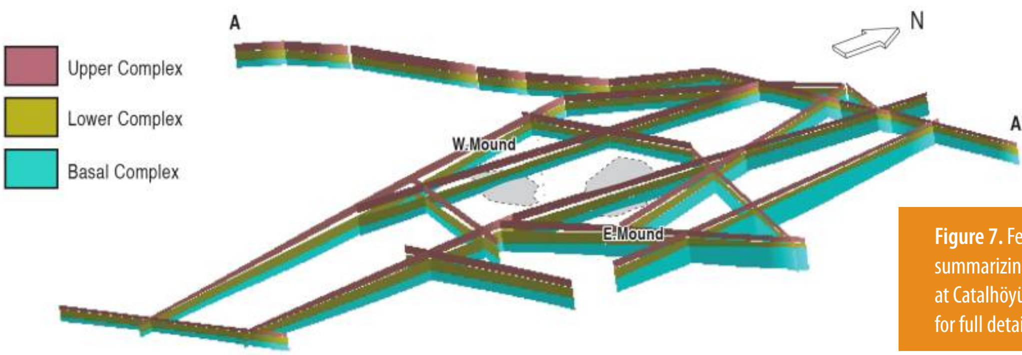

Figure 7. Fence diagram of the 2007–2015 cores summarizing the palaeoenvironmental sequence at Catalhöyük. See Ayala et al. 2017 and in press for full details.

the reconstruction of the nature and flow of the Neolithic Çarşamba.

This discrepancy would have a great impact on the magnitude of flow and response to seasonal precipitation. As noted by Roberts and Rosen (2009: 396) "the Taurus Mountain region above Bozkir receives high precipitation, much of it as snowfall, whose melting gives rise to the main annual river flood peak in March and April." However, much of the rest of the catchment is at lower elevation and receives less precipitation as snowfall. Precipitation is also more evenly spread through winter to the spring period. Although some of this precipitation is in the form of snowfall, more of it is as rain, so that runoff and river flow may well have been more evenly spread through the year in the lower Çarşamba. Thus, not only would spring flooding have been relatively smaller in magnitude than has been previously suggested, it would have also been more evenly dispersed across the landscape because of the multiple-branched nature of the channel system.

Reinterpreting Land Use

Previous reconstructions of the channel system suggest it would have reacted to seasonal flooding by creating extensive wetlands that would have rendered the area immediately adjacent to the site impractical for most forms of agriculture for many months out of the year—either directly by flooding, or indirectly because of the unavailability of spring-sown crops (Roberts and Rosen 2009; Roberts et al. 1999). We argue instead that the multiple-thread, dryland channel system would have created a very different environment. The multiple river channels would have been divided by higher ground that remained drier throughout the year. Consequently, the immediate environment around the site would have been a mosaic of landscape types that could have hosted a variety of microenvironments and subsistence practices. This interpretation is consistent with many other environmental proxies from Çatalhöyük (Lewis et al. 2017; Bogaard 2017; Charles et al. 2014; Wolfhagen et al. in press).

Modern rivers with these types of channel belts in Australia and Africa

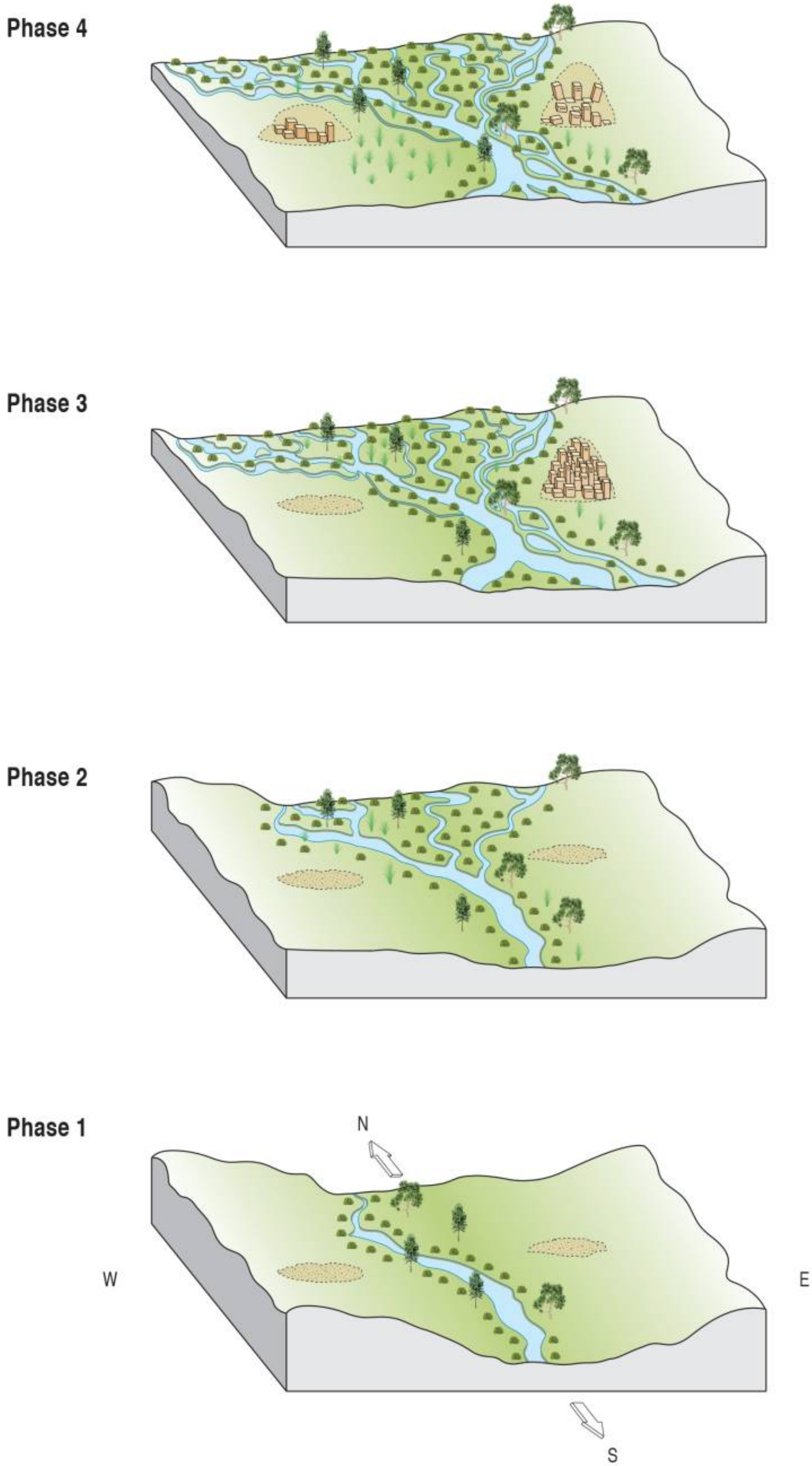

Figure 8. Palaeohydrological reconstruction of the site through time from Ayala et al. 2017; fig. 9 with superimposed interpretation of vegetation patterns based on the discussion in Ayala et al. in press.

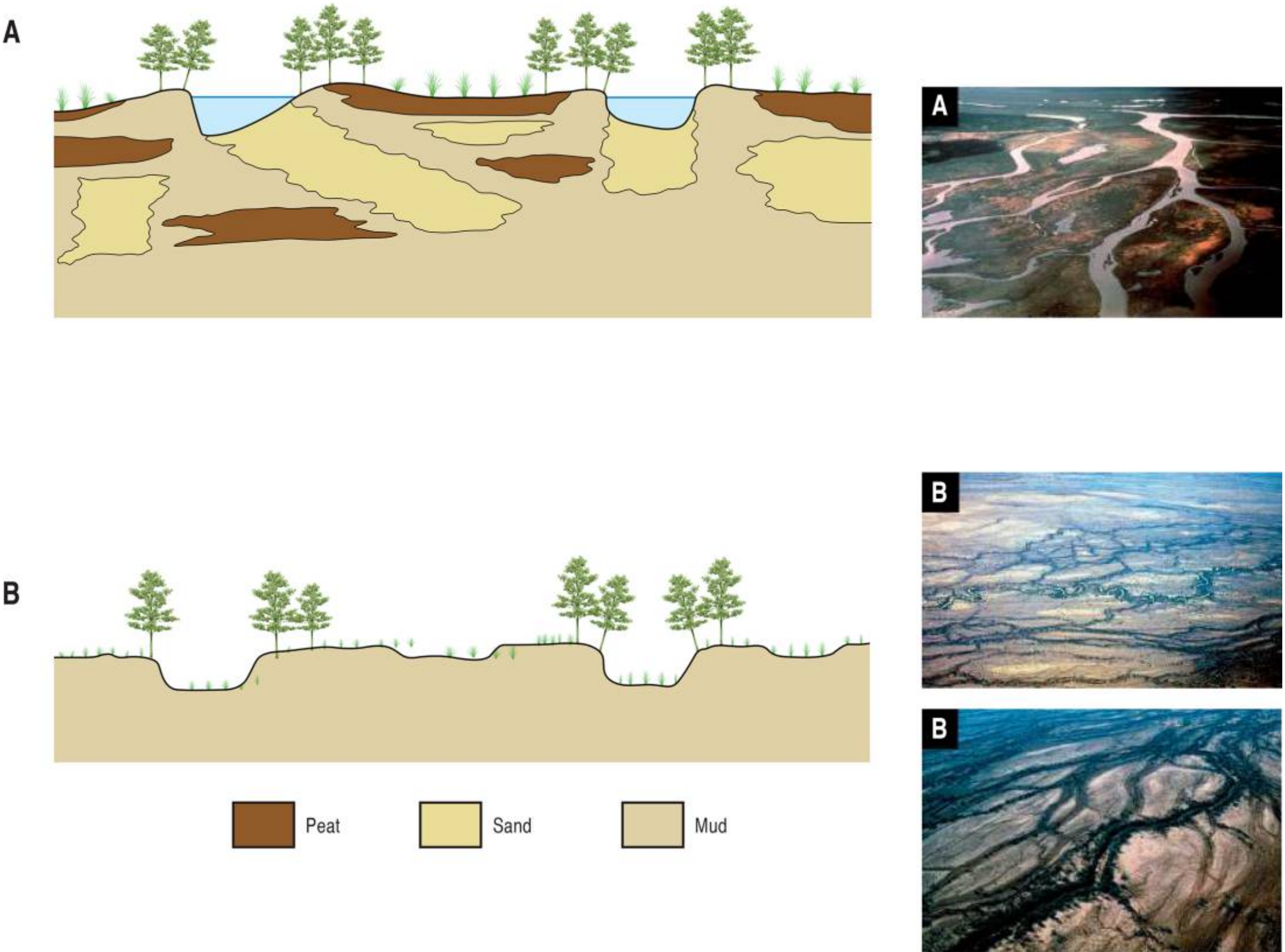

Figure 9. Examples of anabranching systems: (a) humid and (b) dryland. Redrawn from Nanson and Knighton 1996 and from North, Nanson, and Fagan 2007.

(Nanson and Knighton 1996; North, Nanson, and Fagan 2007; Tooth and Nanson 1999; Tooth et al. 2000), have raised "islands" where trees and shrubs can grow and enhance the cohesion of the banks. The nature of the sediments that are transported by the channels are fine silts and clays that also act to reinforce the banks of these raised areas, further stabilizing them during periods of flooding. The sediment record would suggest that in drier periods of the year, local seasonal ponding also took place, leaving pockets of wetter conditions even into the Chalcolithic (Ayala et al. 2017: 39).

With this more nuanced understanding of the topography of the landscape in the immediate vicinity of the site, with dry stable islands standing proud of the river channels within the broad channel belt, the possibilities available to the Neolithic inhabitants for subsistence practices are more extensive than previously thought. Currently there is no direct evidence indicating water management, either irrigation or drainage in the immediate landscape. Environmental evidence from the excavated cultural sequences onsite suggest exploitation of the wild resources (Wolfhagen et al. in press) as well as domesticates (both plant and animals; Bogaard et al. 2014, 2017; Charles et al. 2014) that fit well with this new reconstruction. Not only are the microenvironments of this mosaicked landscape being exploited for wild resources, but the availability of relatively stable and dry higher ground would have provided arable potential closer to the site than previously believed. However, the distribution and nature of agricultural practice is dependent upon further refinement of this new model of landscape reconstruction beginning from a robust understanding from the ground up.

Conclusions

Because of the high level of spatial and temporal variability of dryland environments, our work in reconstructing the past landscapes of Çatalhöyük continues in order to allow us to fill the gaps that still exist in our knowledge. As well as using traditional sedimentological techniques, we are starting to employ novel isotopic and geochemical signatures of the sediments to extract as much detail as possible from the dirt beneath the modern plain.

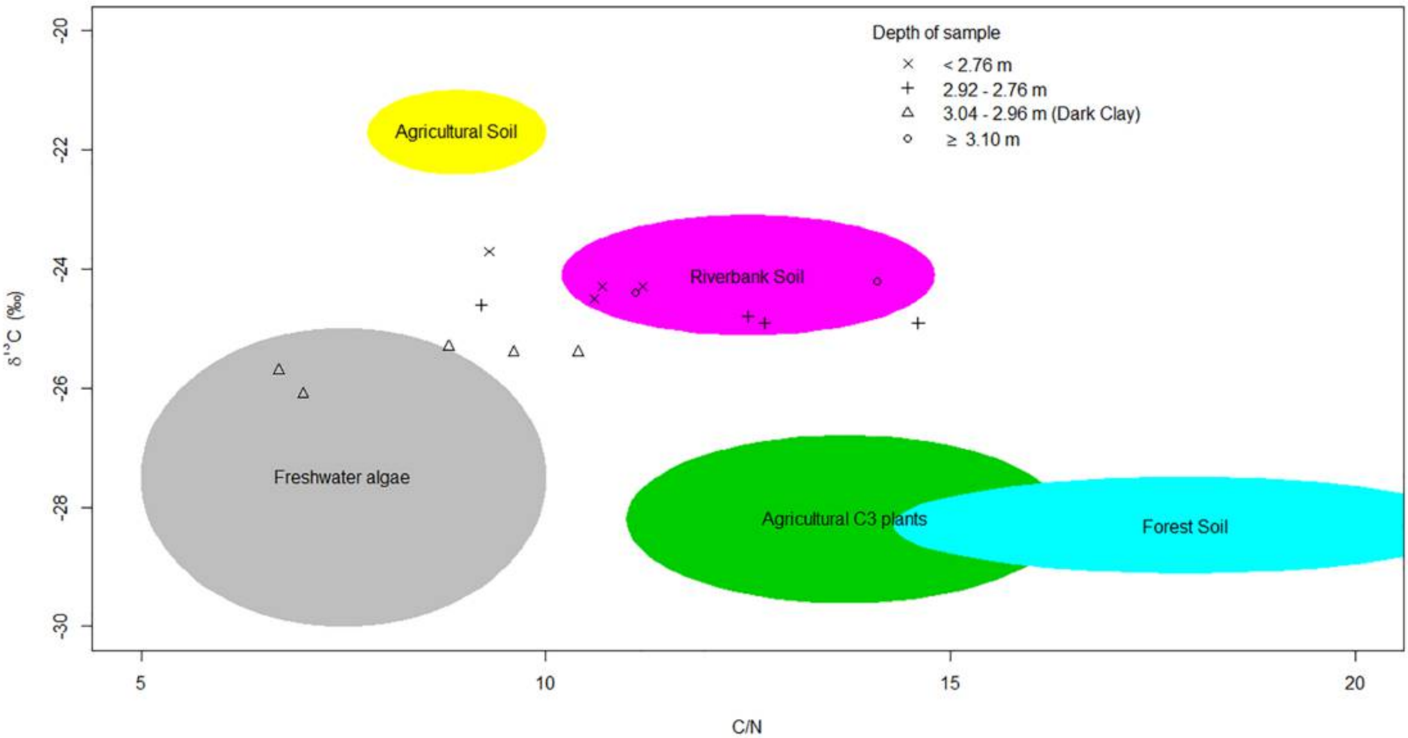

Figure 10. Graph showing the relationship of the C/N and $\delta^{13}C$ values in core 2013/14 in relation to known environments, suggesting that the Dark Clay relates to wetter and riverbank conditions. See Ayala et al. 2017 for further details.

Neolithic Çatalhöyük most likely sat within a broad channel belt of multiple anastomosing channels with a series of drier islands and localized wetter areas. There would have been a mosaic of conditions, with river banks supporting tree and shrub vegetation, and the islands providing areas for cultivation. The wetter areas were used for a further, diverse set of activities. As sedimentation around these channels built the land surface progressively higher above the marl from the palaeolake, the surface would have become increasingly dry. Seasonal floods would have occurred, as in any dryland, but were less pronounced than has previously been suggested for the site. The anastomosing nature of the river with a wide band of multiple channels would have made floods shallower and less erosive, thus providing some resilience for the local landscape and subsistence practices of its inhabitants.

References

Ayala, Gianna, John Wainwright, Joanna Walker, Rachel Hodara, Jerry M. Lloyd, Melanie Leng, Chris Doherty. 2017. Palaeoenvironmental Reconstruction of the Alluvial Landscape of Neolithic Çatalhöyük, Central Southern Turkey: The Implications for Early Agriculture and Responses to Environmental Change. *Journal of Archaeological Science* 87:30–43. DOI: https://doi.org/10.1016/j.jas.2017.09.002

Ayala, Gianna, John Wainwright, Jerry M. Lloyd, Joanna Walker, Rachel Hodara Nelson, Melanie Leng, Chris Doherty, and Michael Charles, In press. Disentangling the Palaeoenvironmental Reconstructions of Çatalhöyük. In *Humans and Environments of Çatalhöyük: Reports from the 2009–2017 Seasons*, ed. Ian Hodder. Los Angeles: Cotsen Institute of Archaeology.

Bayliss, Alex, Fiona Brock, Shahina Farid, Ian Hodder, John Southon, and R. E. Taylor. 2015. Getting to the Bottom of It All: A Bayesian Approach to Dating the Start of Çatalhöyük. *Journal of World Prehistory* 28:1–26.

Bogaard, A., E. Henton, J. A. Evans, K. C. Twiss, M. P. Charles, P. Vaiglova, and N. Russell. 2014. Locating Land Use at Neolithic Çatalhöyük, Turkey: The Implications of $^{87}Sr/^{86}Sr$ Signatures in Plants and Sheep Tooth Sequences. *Archaeometry* 56.5: 860–77. DOI: https://doi.org/10.1111/arcm.12049

Bogaard, Amy, Dragana Filipović, Andrew Fairbairn, Laura Green, Elizabeth Stroud, Dorian Fuller, and Michael Charles. 2017. Agricultural Innovation and Resilience in a Long-Lived Early Farming Community: The 1,500-Year Sequence at Neolithic to Early Chalcolithic Çatalhöyük, Central Anatolia. *Anatolian Studies* 67:1–28. DOI: https://doi.org/10.1017/S0066154617000072

Boyer, Peter, Neil Roberts, Douglas Baird. 2006. Holocene Environment and Settlement on the Çarşamba Alluvial Fan, South-Central Turkey: Integrating Geoarchaeology and Archaeological Field Survey. *Geoarchaeology* 21.7:675–98. DOI: https://doi.org/10.1002/gea.20133

Charles, Michael, Chris Doherty, Eleni Asouti, Amy Bogaard, E. Henton, Clark S. Larsen, Christopher Ruff, Philippa Ryan, J. W. Sadvari, Katheryn Twiss. 2014. Landscape and Taskscape at Çatalhöyük: An Integrated Perspective. Pages 71–90 in

Integrating Çatalhöyük: Themes from the 2000–2008 Seasons, ed. Ian Hodder. Cotsen Institute of Archaeology, Los Angeles.

de Meester, T. 1970. *Soils of the Great Konya Basin, Turkey.* Wageningen, Netherlands: Centre for Agricultural Publishing and Documentation.

Lewis, Jonathan P., Melanie J. Leng, Jonathan R. Dean, Arkadiusz Marciniak, Daniella E. Bar-Yosef Mayer, and Xiaohong Wu. 2017. Early Holocene Palaeoseasonality Inferred from the Stable Isotope Composition of Unio Shells from Çatalhöyük, Turkey. *Environmental Archaeology* 22.1:79–95.

Money, R. I. 1919. The Irrigation of the Konia Plain. *Geographical Journal* 54:298–303.

Nanson, Gerald C., A. David Knighton. 1996. Anabranching Rivers: Their Cause, Character and Classification. *Earth Surface Processes and Landforms* 21.3:217–39. DOI: https://doi.org/10.1002/(SICI)1096-9837(199603)21:3<217::AID-ESP611>3.0.CO;2-U

North, Colin P., Gerald C. Nanson, Simon D. Fagan. 2007. Recognition of the Sedimentary Architecture of Dryland Anabranching (Anastomosing) Rivers. *Journal of Sedimentary Research* 77.11:925–38. DOI: https://doi.org/10.2110/jsr.2007.089

Roberts, Neil. 1990. Human-Induced Landscape Change in South and Southwest Turkey during the Later Holocene. Pp. 53–67 in *Man's Role in the Shaping of the East Mediterranean Environment*, ed. S. Bottema, G. Entjes-Nieborg, and Willem van Zeist. Rotterdam: Balkema.

Roberts, Neil, and Arlene Rosen. 2009. Diversity and Complexity in Early Farming Communities of Southwest Asia: New Insights into the Economic and Environmental Basis of Neolithic Çatalhöyük. *Current Anthropology* 50.3:93–402. DOI: https://doi.org/10.1086/598606

Roberts, Neil, S. Black, P. Boyer, W. J. Eastwood, H. I. Griffiths, H. F. Lamb, M. J. Leng, R. Parish, J. M. Reed, D. Twigg, and H. Yiğitbaşioğlu. 1999. Chronology and Stratigraphy of Late Quaternary Sediments in the Konya Basin, Turkey: Results From The Kopal Project. *Quaternary Science Reviews* 18:611–30.

Tooth, Stephen, and Gerald C. Nanson. 1999. Anabranching Rivers on the Northern Plains of Arid Central Australia. *Geomorphology* 29:211–33.

Tooth, Stephen, Gerald C. Nanson, A. M. Gurnell, C. R. Hupp, and S. V. Gregory. 2000. The Role of Vegetation in the Formation of Anabranching Channels in an Ephemeral River, Northern Plains, Arid Central Australia. *Hydrological Processes* 14(16–17), 3099–117. DOI: 10.1002/1099-1085(200011/12)14:16/17<3099::AID-HYP136>3.0.CO;2-4

Wolfhagen, Jesse, R. Veropoulidou, Gianna Ayala, D. Filipović, C. Lancelotti, M. Madella, C. Kabukcu, K. Pawłowska, C. S. Santiago-Marrero, and John Wainwright. In press. The Seasonality of Using Wetland and Riparian Environments at Çatalhöyük, In *Humans and Environments of Çatalhöyük: Reports from the 2009–2017 Seasons*, ed. Ian Hodder. Los Angeles: Cotsen Institute of Archaeology.

Gianna Ayala is a lecturer of geoarchaeology in the Department of Archaeology at the University of Sheffield, UK. Much of her work has focused on landscape archaeology and geoarchaeological analysis in order to answer important questions about human history. She has extensive landscape and excavation experience across the Mediterranean spanning a wide chronological range from the Upper Palaeolithic to the classical period.

John Wainwright is professor of physical geography in the Department of Geography, Durham University, UK. He has worked extensively on human–environment interactions across multiple scales, from the formation of archaeological sites to the evolution of whole landscapes. His work particularly emphasizes landscape transformations from the later prehistoric to modern periods in the drylands of the world, with other recent projects working on the US Southwest, East Africa as well as the Mediterranean.