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RESILIENCE IN THE NEOLITHIC: HOW PEOPLE MAY HAVE MITIGATED ENVIRONMENTAL CHANGE IN PREHISTORY

ABSTRACT: Neolithic populations in Central Europe lived in a world of dynamic climate change. This paper explores human-environmental interactions in light of local environmental changes linked to human activity and small-scale climate change, with a case study from the 2011–12 investigations at two small early Late Neolithic settlements (c. 5000 BC) set along palaeomeanders of the Körös River in Békés County, Hungary. During the course of the Neolithic, this region saw complex development in social and settlement organization, including the nucleation of populations in large settlements and the continued reoccupation of living space. Utilizing archaeological and environmental data, we tackle the question of why these communities adopted different settlement systems, whether they maintained other cultural traditions, and how these choices may reflect efforts to mitigate environmental change. Historical ecology and the related concept of resiliency provide a conceptual approach to understanding the ways that human societies and the environment affect each other. By cultural resiliency, we mean the ability of a society to maintain and develop identity, knowledge and ways of making a living, despite challenges and disturbances, by resisting damage and recovering quickly. In this case, we speculate about ways that Neolithic populations on the Great Hungarian Plain triggered some kinds of environmental change, and how they coped with the combination of these and naturally occurring changes in palaeohydrology.

KEY WORDS: Historical ecology – Palaeoenvironment – Geoarchaeology – Neolithic – Körös area

INTRODUCTION

Holocene Central Europe was a region of dynamic environmental change within a period of relative global climate stability. In this paper we explore human-environmental interactions in light of local environmental changes with a case study from the 2011–12 investigations at two small early Late Neolithic settlements (c. 5000 BC) set along palaeomeanders of the Körös River near Csárdaszállás in Békés County, Hungary. We will provide an overview of the questions we are trying to address – how Neolithic farmers in waterside settlements

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maintained cultural traditions in times of change and could mitigate environmental change – explain what we mean by resilience, and use early results from this ongoing case study to demonstrate how we think we can address these questions. In this discussion, we will draw inspiration from Historical Ecology, which provides us with a framework for understanding how people, as the dominant entity in most ecosystems, interact with, influence and respond to environmental processes. We believe that archaeology is uniquely suited not only to describe the past, but also to provide case study examples of how people may be affected in the present. Although our results are preliminary and therefore somewhat speculative, our example provides some insights into how small-scale farmers might be affected by climate change, and what methods people might be able to use to mitigate these changes.

People in Neolithic Central Europe were not subject to major climatic disruptions, like the onset of a new ice age. Instead, they confronted small-scale or relatively short-term climate change, shifting fluvial morphodynamics and gradual fluctuations in groundwater levels. When we discuss human-environmental interactions, we are not advocating environmental determinism: we do not think, for example, that people were forced to "adapt" to floods, as early models of cultural change in the Carpathian Basin proposed. Floods were a fact of life for people in Central Europe, with moderate yearly floods and catastrophic flooding each decade or so. Annual floods were incorporated into the seasonal round, and whilst catastrophic floods were less predictable and more difficult to manage, they do not appear to have driven prehistoric inhabitants to adopt alternative lifeways, although some modifications of existing lifeways are indicated (Gillings 1996, Gulyás, Sümegi 2011, Gyucha *et al.* 2011).

On the other hand, we are uncomfortable with the idea of humans as somehow separate from the environment, doing whatever they desire and enacting their agency, disconnected from the brute world. We believe that any narrative we build must include a role for the physical environment in which human agency occurs. To achieve this balance, we begin by accepting two premises: the main one being the interaction part of human-environmental interactions, and the other related one being affordances.

AFFORDANCES AND POSSIBILISM

Early discussions of resource exploitation within archaeology and related disciplines became dehumanizing, tied to ideas of unilinear evolution, environmental determinism and rational actor theory. Not only do we know that the environment does not shape every human action and motivation, not only do people not have to pursue every resource in their ecosystem, and not only are humans infrequent rational actors, the resource exploitation concept neglected both human perception and cultural knowledge. Gibson (1977) introduced the concept of "affordances" in ecological psychology to understand how organisms, including humans, interact with the available resources and limitations of the environment. Gibson argued that people directly perceive certain environmental possibilities, and act on these. Following Gibson (1977), Norman (1990) and Ingold (2000), what the world affords is restricted to what people *think* it affords, what options and opportunities people see as being possible, and this is partly constrained by cultural traditions. Cultural knowledge acts both to constrain what people perceive as being afforded within the environment, and to enable us to engage skilfully with these affordances. A classic example for affordances is a chair: we might see the chair as affording something to sit on, stand on or to block a door with, whilst a baby learning to walk sees it as affording something to hold on to, to keep from falling. People from other cultures may see a chair as something uncomfortable and unnecessary, and prefer to sit on cushions on the floor.

One difficulty with the affordance concept in prehistory is that whilst a focus on the resources available within catchment areas became environmentally deterministic, affordances often discount the role of the environment, giving all power of perception to the enculturated individual. Environmental possibilism is an alternative concept, one that accepts environmental factors as essential, but does not accept environmental determinism (Ellen 1982). The environment limits choices in many situations, but does not determine human action: environment and culture together establish what is possible. An example of this is the relationship between bison and Native American groups on the North American Great Plains. Bison, before they were nearly exterminated by Euro-Americans, typically aggregate into enormous herds, numbering in the tens of thousands, for part of the year and then split up into small herds of a few tens of animals at other times. Larger herds afford different hunting and social opportunities, including allowing large numbers of people to gather and hunt together, or smaller groups of people to follow the same herd without intermingling. Smaller herds afford different possibilities, but people ultimately decide the optimal size of the foraging group.

A second difficulty is the inherent subjectivity of affordances. We are not using subjective as a pejorative; what any given thing affords is dependent on the cultural and empirical experiences of each person. We simply cannot know what Neolithic farmers thought a chair or a rock outcrop would afford, and any speculation is primarily an interesting heuristic exercise. Further, people may have dealt with some aspects of environmental change through ideology rather than through technology, and therefore have left no material traces of their mitigation. This ideology, as a form of social knowledge, would constrain what people perceived as being afforded in the environment, but is not accessible to us today. Possibilism encourages us to focus on the archaeological or ecological data, and to ascertain the relationships between things and people. Temporality and feedback are introduced when we consider that the environment will always adapt to human activity, and will therefore present a different set of resources, constraints and possibilities.

HUMAN-ENVIRONMENTAL INTERACTIONS

This leads to the more important premise, which is that humans and environments interact, and they do so in a dynamic and reciprocal fashion. Everything people do affects the environment, whilst everything the environment "does" affects people, and this is a continuous process of co-adaptation, or mutual change and adjustment. In some cases, the effect is small. For example, butchering and cooking cause changes in the geochemistry of soil where these activities take place. This is a relatively small and certainly unplanned change in the environment, but that change is both visible to scientists today, and together with other changes caused by other activities around a settlement or camp, would have been experienced by inhabitants, even if only at some low level of consciousness. Moreover, this change would have affected how people perceived their place (e.g. Salisbury 2012a, 2012b).

Human-environmental interactions also take place at varying temporal scales. An earthquake would be rather abrupt, whilst deforestation, agriculture and erosion may take place over several decades. In each situation, people work within their total environment, both the "cultural" and "natural" parts, and any changes they make require altering their cultural traditions, or their physical environment, or both, thus altering what is possible. An advantage of the affordance concept is that it is relational. Rather than identifying artefacts and natural resources, a relational approach can help us to focus our thinking on the interactions between people, things and the ecosystem.

SOCIO-CULTURAL RESILIENCE

As we mentioned earlier in this paper, we believe that archaeology is in a position to provide case study examples of how people dealt with environmental change in the past and which methods people might be able to use to mitigate similar changes in the present. Theoretical concepts from Historical Ecology provide a conceptual approach that helps us to understand the ways that human societies and the environment affect each other. By using soil, and proxies contained within the soil, as our artefact, we can collect data to answer these questions.

Historical ecology (Balée 1998, 2006) is the interdisciplinary study of the interactions between humans and their natural, social and built environments, with a focus on the inter-relatedness of humans and environment in the changing relationships between human and non-human communities. Resiliency is the ability of an entity or system to respond to stress or disturbance by resisting damage and recovering or renewing itself quickly. By cultural resiliency, we mean the ability of a society to maintain and develop identity, knowledge and ways of making a living, despite challenges and disturbances, by resisting damage and recovering quickly. Resilience theory in archaeology strives to "understand the source and role of change – particularly the kinds of change that are transforming" (Redman 2008: 72). The focus is again on dynamic relations, in this case on how cultural transformations can be better understood by focusing on a dynamic society interacting with a dynamic environment (Weiberg 2012). This assumes that change is inevitable, but when coupled with environmental possibilism, particular human responses to environmental change are not inevitable – choices people make are historically and culturally contingent. In this case, we are looking for ways that Neolithic populations on the Great Hungarian Plain handled environmental change, and how transformational changes may reflect cultural resiliency.

THE NEOLITHIC CENTRAL KÖRÖS REGION

Our case study comes from our 2011–12 investigations at two small Late Neolithic settlements (c. 5000 BC) set along palaeomeanders of the Körös River in Békés County, Hungary, as part of the Neolithic Archaeology and Soilscapes Körös Area project. This larger project seeks to clarify how human responses to environmental change, and human causes for local environmental change, influenced Neolithic cultural transitions.

The study area falls within the Körös-Berettyó geomorphological micro-region of the Carpathian Basin in Hungary (*Figure 1*). The sites of Csárdaszállás 8 and Csárdaszállás 26 are located in central Békés County, in agricultural fields along old channels of the Hármas Körös River (*Figure 2*). The modern, artificially straightened course of the Hármas Körös lies approximately 4 km north of the sites. These settlements are part of an unconsolidated cluster of sites scattered along a series of relict fluvial channels, mostly to the south of the Hármas Körös River, a cluster that does not include a tell or "super-site" settlement (Salisbury 2010).

The Körös-Berettyó basin forms a shallow depression consisting of an extensive system of meandering channels and floodplains that lie a few meters below the alluvial fans of the Tisza and Maros Rivers. The Tisza and Körös are low-energy graded rivers, meaning that erosion and deposition are largely in balance. In addition, both rivers are meandering, and created numerous oxbows, meanders, backswamps and palaeochannels (Gyucha *et al.* 2011). Between the Hármas Körös and Berettyó rivers there once were extensive marshlands called the Great Sárrét (*Nagy Sárrét*) and Small Sárrét (*Kis Sárrét*). Prior to regulation, the Sebes Körös flowed through the *Kis Sárrét* and the Berettyó flowed through the *Nagy Sárrét*, maintaining both perennial wet areas and the water levels of the isolated ponds and marshes that had formed the oxbows and meanders and whose water levels relied on rain and groundwater levels. Fluctuations in river water volume and discharge caused variation in the size of the meanders

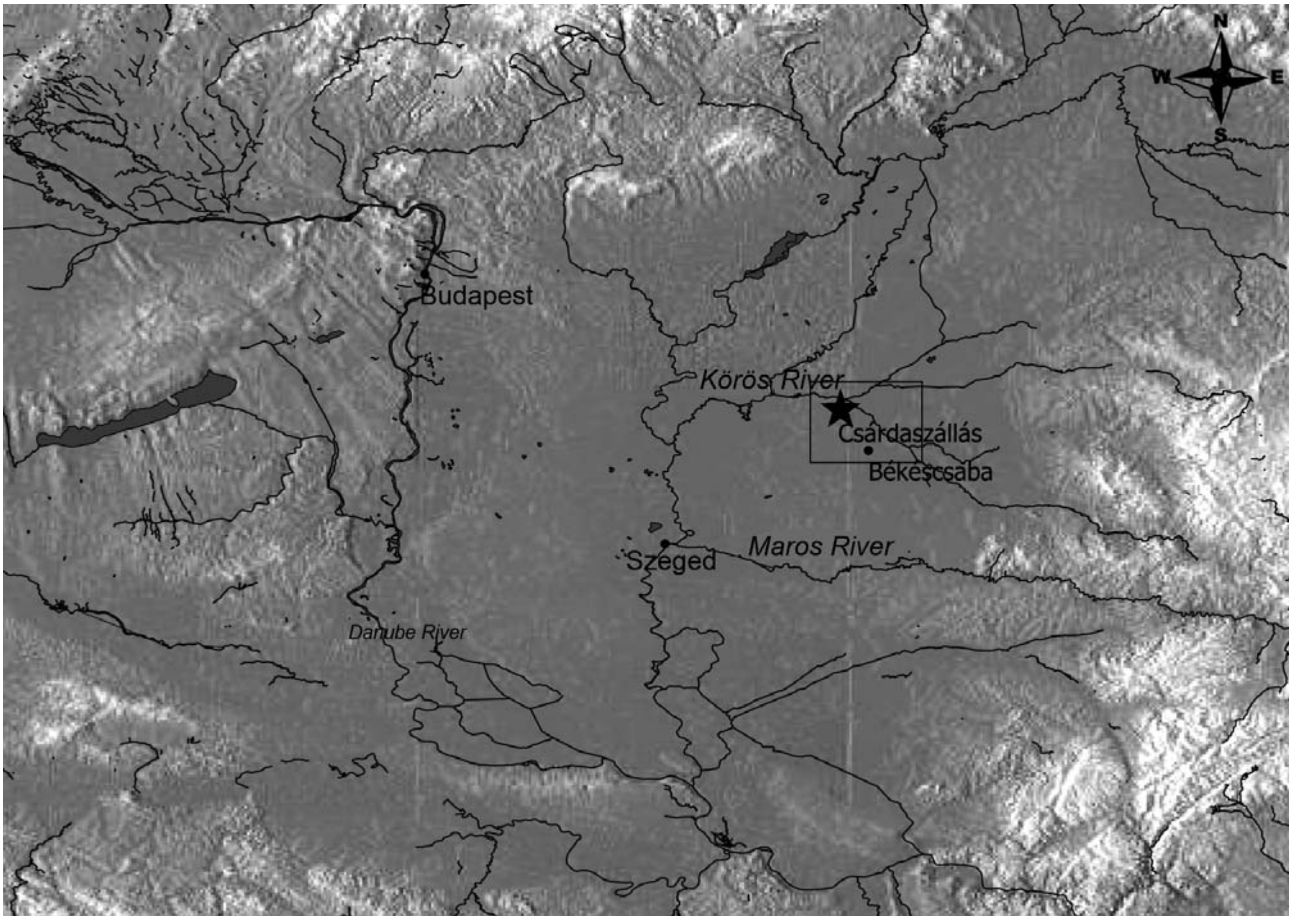

FIGURE 1. Location of the Körös Area study region (box) and the Csárdaszállás sites (star) in eastern Hungary.

and oxbows and their associated lag surfaces and alluvial fans (Gábris *et al.* 2000). All of the major rivers in the region have been straightened, with work beginning in the nineteenth century under the Hapsburgs, and most of the swamps were drained (Dóka 1997, Gyucha *et al.* 2011). Because the Körös basin is several meters lower than the surrounding areas, it has been especially prone to inundation during the two annual floods of the Tisza, Berettyó and Körös rivers. These floods not only deposit additional clay and silt-sized sediments, but also filled oxbow lakes, backswamps and meanders. High spots became relict surfaces, probably either completely free from floods or affected only by the most severe floods. The relict ridges on which the Csárdaszállás sites are immediately adjacent to the remnant palaeochannels, which are visible as grey lines weaving across *Figure 2*.

This regional landscape offered several different environmental zones during the Neolithic, well suited for small-scale agriculturalists, hunter-gatherers or any version of shifting subsistence, while also limiting settlement options to those areas less likely to be flooded. Sparse poplar forests, marsh grasses and willow groves grew along marshlands and oxbow lakes and gallery forests grew along the rivers, alternating with steppe woodlands on the Pleistocene lag surfaces (Gyulai 1993, Kosse 1979, Sümegi 2004a, 2004b, Willis 2007, Willis *et al.* 1995). Regional soils in this alluvial landscape also have a patchy distribution. Hydromorphic soils dominate in the Körös Basin, and annually inundated areas set back from the palaeochannels typically show alkali meadow clays covered with salt-meadow grasses (Gyucha *et al.* 2009, Salisbury 2010). These soils are rich

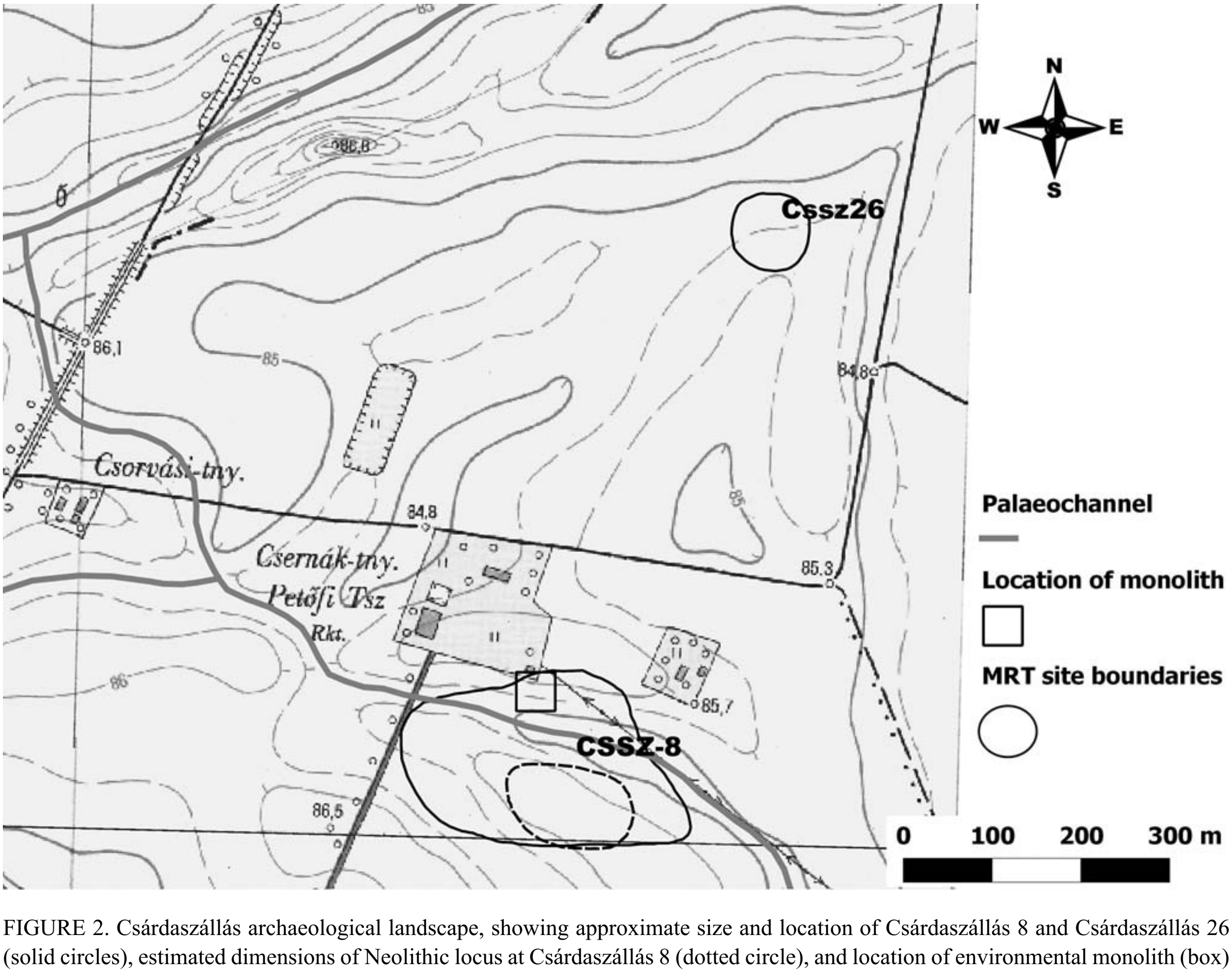

FIGURE 2. Csárdaszállás archaeological landscape, showing approximate size and location of Csárdaszállás 8 and Csárdaszállás 26 (solid circles), estimated dimensions of Neolithic locus at Csárdaszállás 8 (dotted circle), and location of environmental monolith (box) over contour map (original 1:10 000 scale).

in organic matter, but are also very compact and difficult to till. Soils on residual loess ridges and islands are generally less clayey fertile meadow soils. Climate in the Carpathian Basin is influenced by the cooling trend in Southern Europe and the stable continental climate from the east.

During the course of the Neolithic, the Körös region saw complex developments in social and settlement organization, including the nucleation of populations in large settlements, the continued reoccupation of living space and the eventual abandonment of these large settlements (Parkinson *et al.* 2004, Sherratt 1982, Sümegi 2003). In the periods before and after population aggregation on tells, most people lived in small farmsteads scattered along low ridges immediately adjacent to oxbow lakes or backswamps. They dug wells to access fresh water, had small garden plots near their houses (Bogaard 2004), and had several consistent activity zones within their household clusters (Salisbury 2010, 2012b). During the tell period itself, houses were packed closely together, and agriculture appears to have occurred outside of the settlement boundaries. By combining archaeological and environmental data, we tackle the question of why these communities chose different lifeways, and how these choices may reflect efforts to mitigate environmental change.

Our project develops a comparative methodology for examining the synergy between small communities, cultural traditions and environmental change. The Neolithic Archaeology and Soilscapes Körös Area project integrates geoarchaeology, archaeological prospection and palaeoenvironmental analyses. Prospection methods are not deployed to search for sites because we already knew where these two sites were: they were identified in the 1980s as part of the Hungarian Archaeological Topography (MRT) project (Jankovich *et al.* 1998). Our methods are geared towards intra-site prospection, and in this case to treating these two settlements and their local landscape as potentially one archaeological site. That is, the palaeochannels, the settlement space and the surrounding land can be treated as one archaeological site, one prehistoric landscape. For example, human induced vegetation changes from both settlements will be evident in the pollen record in the local palaeochannels. We have done soil phosphate survey, controlled surface collection using 10m squares, magnetic survey, multi-element geochemistry for the main occupation area of both settlements, magnetic susceptibility survey for Csárdaszállás 26 and environmental samples from a nearby palaeochannel. This multi-method integration gives us a good idea of what we have here before we do any excavations.

RESULTS

Results derived from an environmental monolith collected from the palaeochannel near Csárdaszállás 8 are summarised in *Table 1*. Although the top 70 cm of the column is badly damaged due to ploughing and vertical mixing, prehistoric pollen is preserved beneath this, and we have a record extending from the late Pleistocene into the Bronze Age, with approximately 40 cm thick deposits from the Neolithic. The pollen data

TABLE 1. Predicted environmental conditions at Csárdaszállás based on palynological and sedimentological pilot data. Adapted from Salisbury *et al*. (2013a) and Sümegi (2012).

Depth (cm)	Environmental conditions	Approximate date
210–192	Steppe with mixed leaf taiga	Late Pleistocene–beginning of Holocene
192–156	Forest steppe with forest dominant Oligotrophic oxbow lake	Early Holocene c. 9000–6800 BC
156–140	Humid floodplain forest expansion; peak pollen diversity	Late Mesolithic c. 6800–6000 BC
140–130	More organic matter, charcoal, and flue ash in the section, and first evidence for cereals	Neolithic c. 5800–5000 BC
130–120	Maximum anthropogenic impact, including less tree pollen and increasing grass pollen. Increasing sedimentation and eutrophication of oxbow lake	c. 5000–4000 BC
120–100	Fewer trees; more crops, sedges and ruderal weeds. Permanent human occupation	Copper Age c. 4000–3000 BC
100–70	Lowest percentage of the trees. Oxbow lake evolves to marshland	Late Copper Age–Early Bronze Age

itself (*Figures 3, 4*) suggests a naturally patchy wooded steppe environment, with a sharp increase in human effects (cultivation, clearance, cereals, weeds, long-term settlement) after c. 5733 cal BC, i.e. the Early Neolithic, based on an AMS radiocarbon date (D-AMS 1217-093), and increasing continuously through time (Salisbury *et al.* 2013a, Sümegi 2012).

A minerorganic layer found in the Csárdaszállás soil column corresponds with similar silt-rich, minerorganic lake sediments found at other locations on the Hungarian Great Plain (Sümegi 2005, Sümegi, Molnár 2007, Sümegi *et al.* 2011). These sediments formed in this region until about 12,000 years ago, and are used in conjunction with sedimentation rates averaging 1 cm per 80–100 years and parallels in regional pollen changes (Willis 2007) to extrapolate a hypothetical temporal sequence from the AMS date.

Sediment analyses revealed considerable quantities of organic matter, carbonate concretions and small ferrous concretions. These sediment markers, together with ferrous stains indicative of oxidation and reduction cycles, are the consequences of slow moving water, developing floodplain sedimentation and intensive vertical groundwater movement. Changes in magnetic susceptibility through the profile, in conjunction with varying quantities of organic matter and carbonates, indicate that the lake changed from oligotrophic (low organic content, low productivity) in the early Holocene to eutrophic (high organic and mineral content, high productivity) by the middle Neolithic and mesotrophic (intermediate level of productivity) later on. These changes indicate many movements in the water levels during the Holocene. Increasing organic matter and sedimentation eventually formed a marshland here during the Bronze Age (Salisbury *et al.* 2013a, Sümegi 2012).

Geophysical, geochemical and archaeological surveys in the study area are aimed at identifying the processes of change in the use of space and patterning of artefacts and

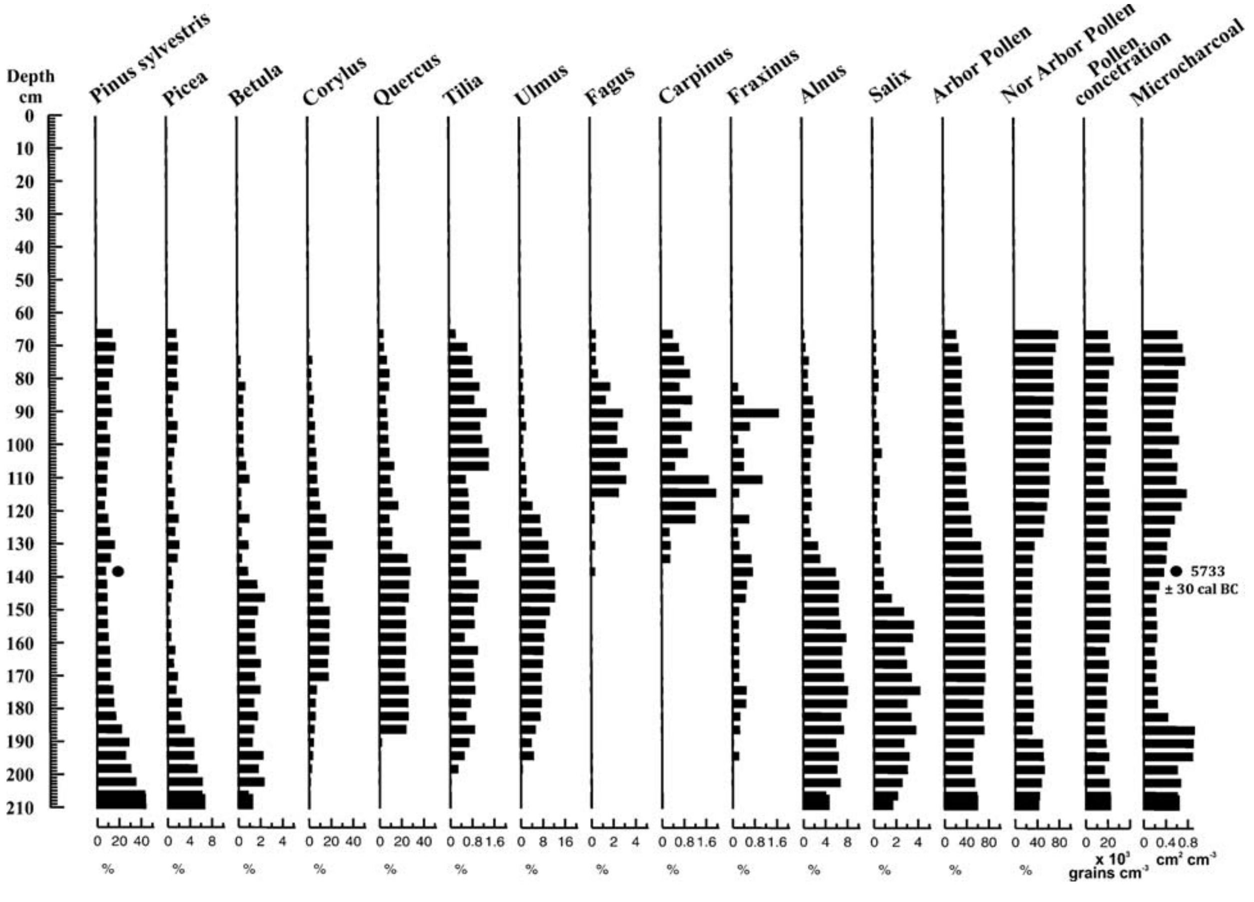

FIGURE 3. Csárdaszállás pollen diagram of tree and shrub pollen percentage plotted against depth. Modified from Sümegi (2012).

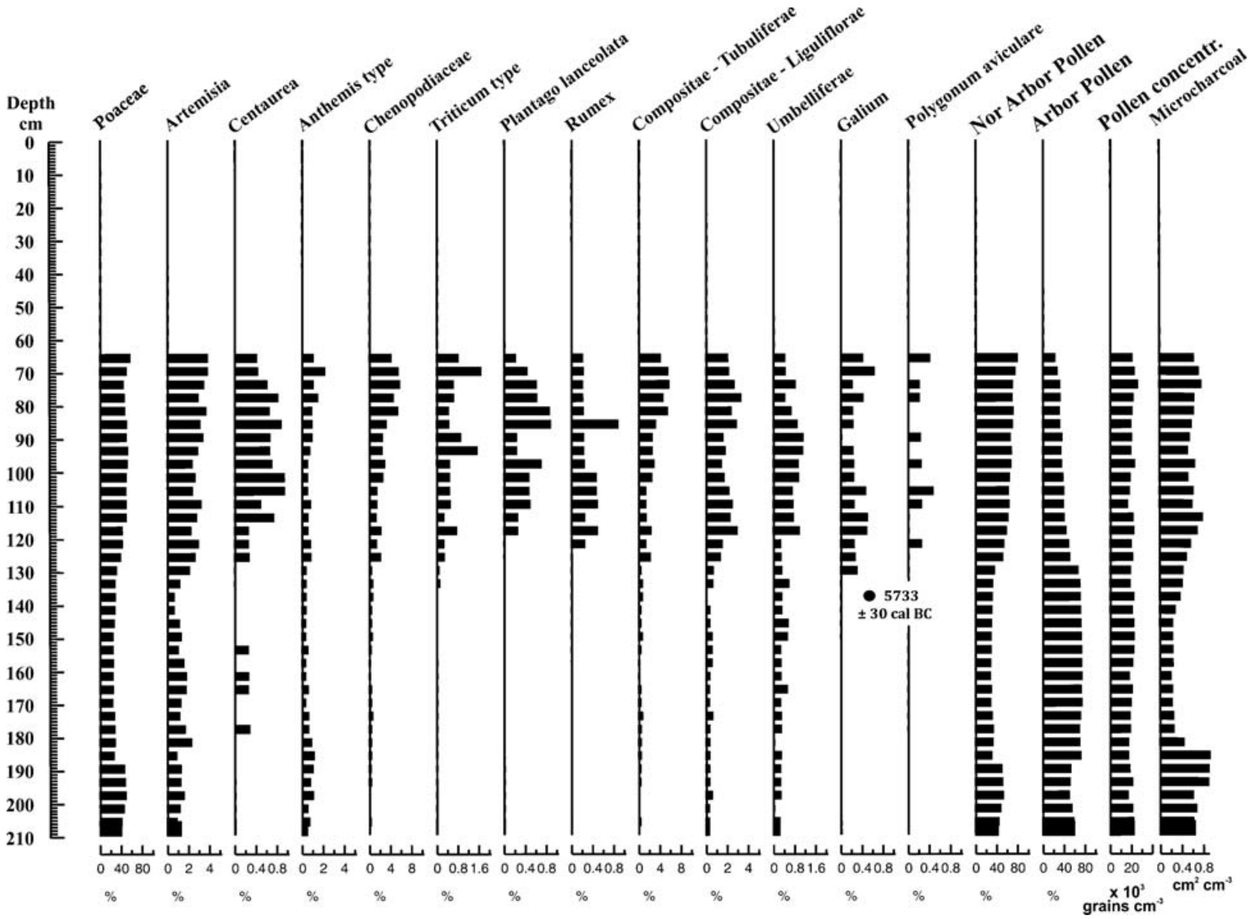

FIGURE 4. Csárdaszállás pollen diagram of herbaceous pollen percentage and micro-charcoal distribution plotted against depth. Modified from Sümegi (2012).

ecofacts throughout the Neolithic. These changes can then be linked to environmental changes. Surface collection confirmed previous reports (MRT; Salisbury 2010) that these sites date to the Late Neolithic Tisza culture; diagnostic ceramics suggest an early Late Neolithic occupation. Magnetic survey revealed at least three longhouses and several pits at Csárdaszállás 8 (*Figure 5*). Jankovich *et al*. (1998) reported evidence for at least one house at Csárdaszállás 8, and we identified several daub clusters during surface inspection, but we did not anticipate finding so many longhouses and pits, with only partial magnetic coverage. At the northern settlement, what we thought was a small site with two occupation layers (Salisbury 2010) turned out to be an enclosed settlement mound (*Figure 6*). Pits and the partial outlines of several houses correspond loosely with results of soil probes and soil chemical analysis, but the ditch was completely unexpected (Salisbury *et al*. 2013b).

Soil phosphate survey at the loose cluster of houses in the southern site revealed elevated levels of phosphate outside of the houses and to the south, away from the palaeochannel. Exceptions to this are several pits located between the houses and the channel, which contain high phosphate enrichment in the fill. The phosphate evidence indicates the edges of the channel were kept clear of organic waste, and that people had space to spread out along the palaeochannel.

At the northern site, soil phosphate patterns are bounded by the ditch, although the existence of the ditch was not known when soil samples were collected. Distribution of surface material at the northern settlement is likewise contained within the enclosure (Salisbury *et al*. 2013b), and low frequency magnetic susceptibility (χLF) at the northern site is elevated within the site centre, again dropping off abruptly outside of the ditches. The pattern roughly corresponds with multi-element

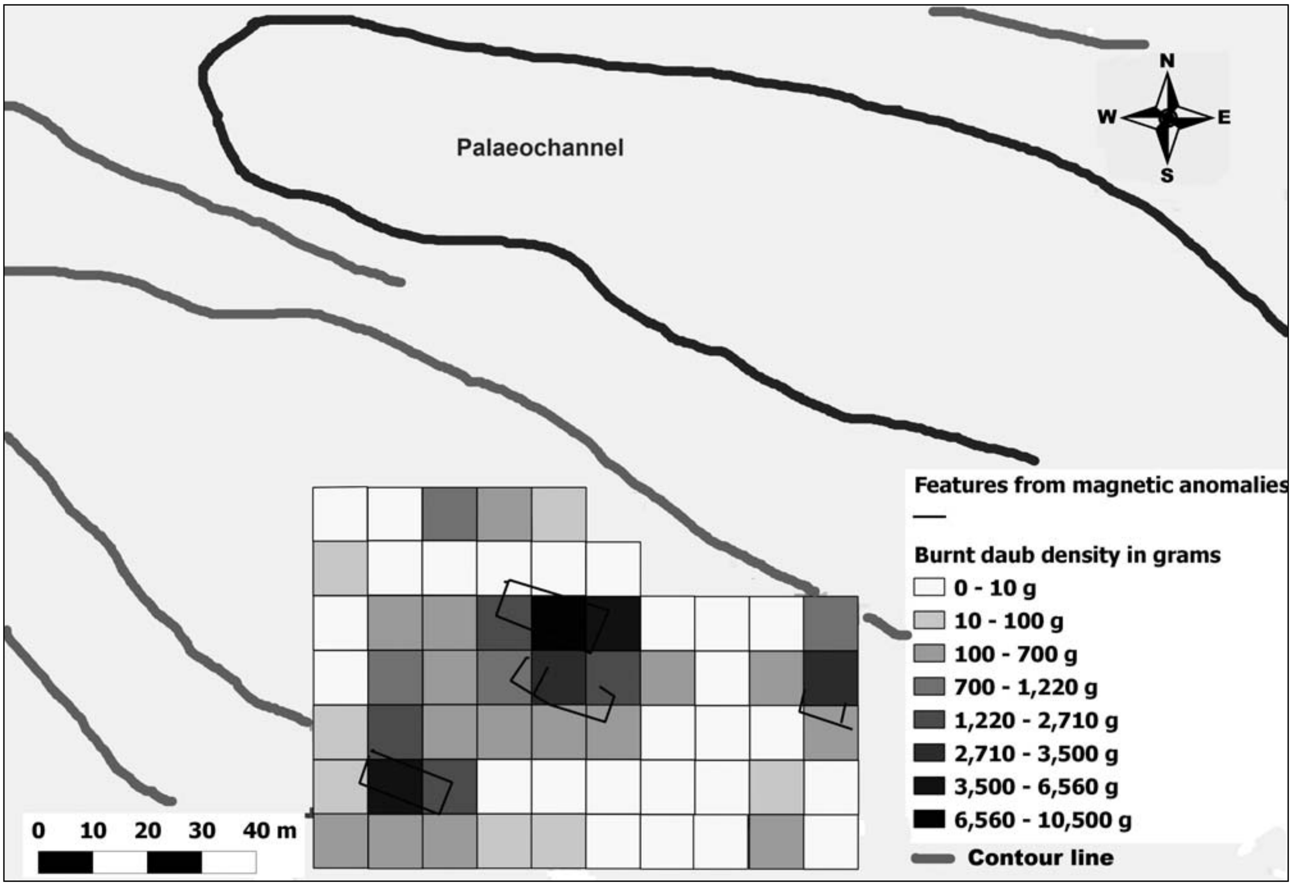

FIGURE 5. Interpretation of magnetic anomalies with burnt daub density at the Late Neolithic site of Csárdaszállás 8, showing contours and palaeochannel (original 1:10 000 scale).

chemical results (Salisbury 2010), although, and again, the presence of the enclosure was not known when the multi-element and susceptibility measurements were taken. These results suggest an incipient settlement mound, or the earliest phases of settlement nucleation that mark the Late Neolithic Tisza culture (Horváth 1987).

INTERPRETATIONS

Although these results are preliminary, and the interpretations therefore somewhat speculative, the integrated analyses allows for several important predictions. First, diagnostic ceramics from the settlements suggest that they are early Tisza, placing them at the very beginning of the period of settlement mounding that marks the Late Neolithic Classic Tisza phase (Horváth 1987). However, palynological evidence for changes in local plant communities follows right after the c. 5733 cal BC radiocarbon date from the environmental monolith, suggesting a nearby Early Neolithic settlement. Visible human impacts on the local environment began with these earliest farmers in the region, and increased over time. Forest clearance increases, as indicated by decreasing tree pollen over time, whilst grass (*Poaceae*) and weed pollen indicative of human land-use increase (e.g. *Artemisia, Chenopodiaceae*). Trees were probably removed from the gallery forests along the streams and palaeochannels and used for construction and firewood, and newly opened areas used for garden plots. Note too that the first evidence for wheat (*Triticum*) appears immediately after the c. 5733 cal BC date (*Figure 4*).

Second, we have evidence for human induced increasing sedimentation in the local oxbow lake throughout the Holocene. People were most likely part of the cause for changing trophic status of the lake,

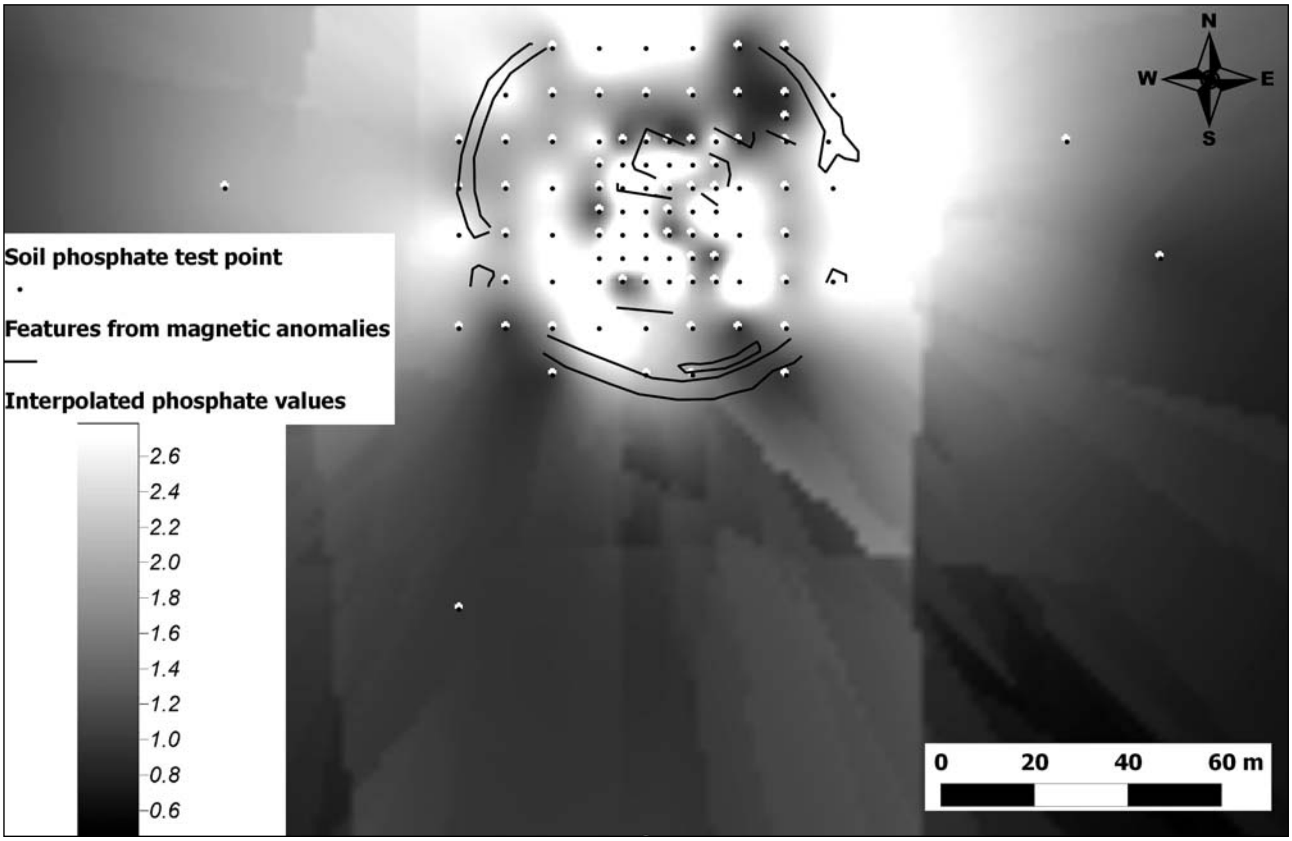

FIGURE 6. Interpretation of magnetic anomalies with interpolation of soil phosphates at the Late Neolithic site of Csárdaszállás 26.

which by the Bronze Age had become a marshland. This increasing sedimentation could result from deforestation and erosion, the addition of organic matter, and runoff from clay used as building material. Clay was the main source of material for construction during the Neolithic and Copper Age in this region, with ovens, kilns, house walls and floors all being constructed of clay. The increasing eutrophication of the lake would have increased its bio-productivity, thereby increasing the range of resources it afforded, albeit also potentially decreasing its value as a source of drinking water. Riverine and marshland resources that might thrive in a eutrophic lake and that were favoured by Neolithic populations include reeds, fish, shellfish and waterfowl, among others.

Third, fluctuating groundwater levels at Csárdaszállás, evidence for which comes from the sediment analyses of our monolith, is consistent with results of palaeoenvironmental evidence from other nearby sites. At Ecsegfalva, located approximately 30 km northeast of Csárdaszállás, data from palaeoenvironmental cores indicate human impacts beginning in the Early Neolithic and increasing over time, with decreasing tree cover and increasing sedimentation and organic deposition in the nearby oxbow lake (Sümegi, Molnár 2007, Willis 2007). Malacological and archaeological data from the Late Neolithic settlement mound at Szegvár-Tüzköves, about 60 km southwest of Csárdaszállás, suggest a significant increase in floods and a correlated increase in the use of shellfish and other riverine resources. These changes to the riparian environment were most likely the result of climatic fluctuations (Gulyás, Sümegi 2011).

Fourth, there are multiple and relatively thick occupational layers at Csárdaszállás 26, with evidence from the soil probes for multiple infilling and levelling episodes, evidence from the magnetic survey for multiple overlapping houses, and multi-element geochemical evidence for overlapping activity areas. Settlements in the earliest phase of the Tisza culture were composed of loose clusters of houses. These clusters slowly coalesced into nucleated villages with multiple settlement phases marked by house reconstruction episodes (Horváth 1987, Gulyás, Sümegi 2011), which would yield the patterns we see at Csárdaszállás. The reasons for this change have been the subject of much debate, generally falling into one of two camps that can loosely be defined as environmental determinism (major climatic disruptions, e.g. Járai-Komlódi 1968, Kosse 1979) or socio-economic disruptions (e.g. Makkay 1982, Korek 1987). The advantage of a Historical Ecology approach is that it provokes us to examine the relatedness of economic and environmental pressures, and consider how cultural resiliency might explain the kinds of changes we see. These observations lead us to suspect the initial stages of mounding, perhaps as a reaction to rising groundwater levels.

We suggest that naturally occurring changes in groundwater levels combined with human induced changes in this archaeological landscape. Groundwater levels would have changed across the Körös region, and indeed perhaps across the Hungarian Great Plain. The effect would have been felt most at small farmsteads with dug wells to access fresh water, located on low ridges immediately adjacent to oxbow lakes or backswamps. In other words, at exactly the kind of places we are discussing here. The combined effect would be a different set of possibilities, or even ecological stress. Fresh drinking water and dry land for habitation and agriculture may have been more limited during certain periods. Remembering that the region is dominated by hydromorphic soils, areas suitable for cultivation may have been a limiting factor if groundwater moved too far up the soil column. This stress would not only be felt by people, but also by domesticated and wild animals, by domesticated and wild plants, by fish, shellfish, water birds and all of the species people access on a daily basis. Population aggregation and building settlements on the highest elevations, for example on top of previous settlements, are possible social responses to this stress. Increased or decreased reliance on riverine resources, or preference for cattle rather than sheep are possible economic indicators of these responses. In our case study, evidence for these indicators must await data from excavated contexts, but the results presented here do provide intriguing hypotheses.

Questions also arise from our research. Most importantly, we do not have good chronological control over these anthropogenic ecological changes, which means we can only loosely associate them with specific cultural groups. We have evidence for Early Neolithic agriculture, but vegetation and sedimentation changes appear to be most pronounced after the Middle Neolithic (Salisbury *et al.* 2013a). Are the differences in human influences between the Early and Middle Neolithic simply one of scale, i.e. increased human population and activity, or is there a difference in the kind of activities taking place? We know relatively little about the Early Neolithic occupation in this settlement cluster: the nearest Early Neolithic site, southeast of Csárdaszállás 8, has not yet received serious attention. Therefore, we cannot compare the internal settlement structure or subsistence activities to our data. Another set of questions centres around the incipient settlement mound at Csárdaszállás 26, and the lack of a tell settlement or evidence for Classic Tisza occupation of this section of the Körös River. We also do not have sufficient chronological control over the changes in groundwater levels. This is perhaps the most difficult methodological problem, because we require data for this microregion and comparative data for areas with intensive Neolithic settlement mounding. The next phase of research should include full-coverage magnetic survey using mechanised systems, more surface collection, airborne laser scanning and additional environmental coring as well as test excavations.

CONCLUSIONS AND FURTHER SPECULATIONS

In their everyday activities, people made numerous changes to their environment. They changed the soil landscape; they created a cultural soilscape by altering the vegetation and drainage patterns, adding and removing soil, and increasing the deposition of organic matter. Some of these changes were deliberate and some were the unintentional result of other activities but all have left remains that we can collect, measure, weigh, scan, classify, save or discard, preserve or destroy. With the exception of the artefacts we examined during the surface survey, all of this archaeology was done with soil or ecofacts within the soil. Our first conclusion is that we need to treat soil as a cultural artefact.

Our second conclusion is that human-environmental interactions result in an archaeological record that is too complicated for broad statements affirming or denying environment causes of culture change. In fact, what we are finding at Csárdaszállás is a long trajectory of subtle and often unintentional human-induced alterations to the local ecosystem, and people's responses to the new possibilities afforded by the "new" environment.

At the same time, it appears that there were ongoing changes in the environment, most apparently in ground water levels and shifts in the trophic status of the nearby palaeochannels. Our environmental data indicates fluctuations in both throughout most of the Holocene. This is the change that required some form of mitigation, perhaps by building settlement mounds, or even by moving to a different location. Focusing on the possibilities afforded by this relatively flat and marshy environment, we can see that slight changes in groundwater levels could have a profound effect on human habitation areas. Feedback, as a diachronic element, occurs through the increasing sedimentation of the oxbow lake adjacent to the settlements. Our second and third conclusions remain tentative, but we speculate that Neolithic farmers maintained most cultural traditions in part by adjusting their settlement system to accommodate changes in local water tables.

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