The Geoarchaeology of River Basin Systems: An Introduction

Jamie Woodward^{1,*} and Gary Huckleberry^{2,*}

¹*Geography, School of Environment and Development, The University of Manchester, Oxford Road, Manchester, M13 9PL, U.K.*

²*Department of Geosciences, University of Arizona, Gould-Simpson Building, #77, 1040 E. 4th Street, Tucson, AZ 85721*

INTRODUCTION

This journal has published a number of important papers dealing with fluvial processes and the geoarchaeology of river basin systems (e.g., Ferring, 1986; Waters, 2000; Bettis & Mandel, 2002; Lewin, 2010), but this is the first special issue devoted to this topic. River valleys and their floodplains are resource-rich landscape elements that have been exploited throughout human history. They offered strategic advantages to Paleolithic hunters, fertile soils for early farming communities, and, more recently, opportunities for the generation of water power and industrial activity. These dynamic geomorphological environments constitute an enormously rich archaeological and paleoenvironmental resource (Needham & Macklin, 1992; Brown, 1997), and river valley reaches and entire river basins now commonly form the spatial unit of study for integrated archaeological and geomorphological surveys (e.g., Waters, 1991; Barker, 1995; Welsby, Macklin, & Woodward, 2002). However, an improved understanding of the taphonomic processes that influence the preservation and visibility of the archaeological record in different fluvial settings is still a major research goal. Recent progress in the study and dating of the long-term evolution of valley floor environments is leading to a better understanding of the relationship between geomorphological context and the archaeological record in river basin systems. The implications for archaeological survey and sampling are clearly illustrated by the first three papers in this special issue. The other three papers report novel approaches to the study of how past societies utilized the resource potential in river basin systems.

The papers in this special issue present research on four continents in river basins that contrast markedly in terms of their size, tectonic setting, Quaternary climate and land use history, and contemporary climate and runoff regimes. Together these papers explore records of river basin processes and past human activity across a wide range of temporal and spatial scales. In the next section we provide brief commentaries on the approaches and key findings in each paper before setting out some of the key themes that emerge from this collection.

*Corresponding authors; E-mail: jamie.woodward@man.ac.uk and ghuck@email.arizona.edu.

THE PAPERS

The first paper is an international collaboration involving Ian Buvit, Karisa Terry, Viktor Kolosov, and Mikail Konstantinov. They present new stratigraphical and geochronological data for the Paleolithic site of Priiskovoe in the Transbaikal region of Siberia. Paleolithic sites with well-preserved lithic and faunal assemblages stratified within alluvial sediments have been recorded from numerous locations in the river valleys of the Transbaikal. Geomorphological mapping in these valleys has identified a series of Late Pleistocene terraces; these provide a stratigraphic framework for the Middle and Upper Paleolithic sites of this region. The Priiskovoe site is located in the Chikoi River basin, an important tributary of the Selenga River, and the Selenga basin contributes almost half of the inflow to Lake Baikal. The age of the deposits at Priiskovoe, in particular, has generated much debate. Previous work has argued that the archaeological assemblages at this site formed part of the region's Middle Paleolithic tradition. However, using new stratigraphical and geochronological evidence, alongside a careful evaluation of the archaeological, stratigraphical, and geochronological data from other Paleolithic sites in the region, the authors make the case for an Upper Paleolithic age for the Priiskovoe site.

Lisa Maher has reconstructed the Late Pleistocene and Holocene evolution of the Wadi Ziqlab, a small (106 km²) river system in semiarid Northern Jordan that drains westward to the main Jordan Valley. This wadi contains Middle and Upper Paleolithic and later artifacts in a variety of depositional contexts. Detailed archaeological survey has been carried out along with systematic investigation of the Quaternary sediments and landforms throughout Wadi Ziqlab. This has provided important insights into the factors that influence the long-term preservation and exposure of the archaeological record. The wadi contains a sequence of river terraces and massive travertines and coarse-grained alluvial fills. A deeply weathered red soil, commonly associated with Epipaleolithic material, forms a distinctive element of the stratigraphic record. This paper shows very clearly how an understanding of geomorphological processes is of fundamental importance for the interpretation of the archaeological record of changing settlement history, especially in such high-energy river basin systems, where large flood events can remodel and remove substantial portions of the valley floor. The absence of sites of late Epipaleolithic and early Neolithic age, for example, is attributed to extensive erosion during the Younger Dryas. As Maher points out, a single wadi system is unlikely to yield a complete record of regional settlement history.

Jared Beeton and Rolfe Mandel describe spatial and temporal variability in surficial geological processes within a medium-sized (ca. 5000 km²) river basin in the central Plains of North America. Through analysis of soil stratigraphy, lithostratigraphy, and geochronology, Beeton and Mandel are able to recognize patterns in erosion, deposition, and soil formation that not only influence the preservation and visibility of the archaeological record (the focus of their investigation) but also have important implications for the complex relationships between post-glacial climate change and geomorphic response in low-relief landscapes (Mandel, 2008). Different parts of the river basin respond differently to a given climate change, such that different-aged deposits, soils, and cultural evidence have a tendency to be located

in certain parts of the fluvial landscape. Thus the most effective surveys and intellectually productive analyses of site patterns consider the geomorphic context of the archaeological record within their hydrological basins.

Fred Nials, David Gregory, and Brett Hill take a large-scale approach in their investigations of river basins in the North American Southwest, where they link the location of pre-Columbian agricultural settlements to important geomorphic and hydrological variables. Some of the earliest geoarchaeological research in North America linking fluvial geomorphology and archaeology took place in the Southwest, where historic arroyo-cutting provided extensive exposures of floodplain stratigraphy and revealed evidence of past alluvial cycles and climate change (Waters & Haynes, 2001). Nials, Gregory, and Hill analyze medium to large ($>50,000 \text{ km}^2$) river basins in arid and semiarid environments of Arizona and New Mexico using remote sensing, GIS, and ground-truthing to establish criteria for identifying “reach boundaries.” Such boundaries mark segments of the floodplain where conditions tend to be favorable for irrigation farming, as supported by spatial analysis of reach boundaries and prehistoric agricultural sites. Their model provides a framework for relating floodplain dynamics and indigenous agriculture and may have potential for locating buried early agricultural riverine settlements in drylands across the globe.

The next paper considers a rather different aspect of river basin resource exploitation by early farming communities. Kent Fowler, Mostafa Fayek, and Emma Middleton explore the strategies employed in the acquisition and processing of clays for the production of pottery in the Thukela River basin (ca. $29,000 \text{ km}^2$) of eastern South Africa. By comparing modern and ancient strategies utilized in clay sourcing and processing, their aim is to better understand ceramic production systems and the choices made by both modern potters and those working in the Early Iron Age societies of the first millennium A.D. Their observations of 40 modern Zulu potters in the lower and upper reaches of the Thukela River show that various sources of clay were utilized and that all of these potters collected clays exposed at the surface of active stream channels. This large river basin is geologically complex and offers various sources of clay, each with different mineralogical and textural properties. By employing XRD and SEM methods, Fowler and his colleagues also compare the mineralogical and grain size properties of modern ceramics to those produced by Early Iron Age potters. The paper tests a number of hypotheses on the sourcing and processing of clays by farming communities in a large river valley system. The authors highlight the importance of studying modern production strategies in such contexts to achieve a better understanding of the local archaeological record before attempting large-scale comparative study of ceramic production systems.

The final paper reminds us that the human settlement and exploitation of valley floor environments goes hand in hand with the management of the flood hazard. Mar Génova, Juan Ballesteros, Andres Díez-Herrero, and Begoña Martínez-Callejo report a highly novel investigation of historical flooding in the River Eresma basin of central Spain. Here, the Royal Segovia Mint was founded in 1583 by King Philip II to mechanize the production of coinage in Spain. The large industrial complex was built on the floodplain of the River Eresma to harness water power via a series of canals to drive 14 giant water wheels. Recent archaeological investigation of the

old canals has revealed the presence of wooden decks that were repaired or replaced following large and destructive flood events. Dendrochronological dating of the timbers used in the repair work has allowed a record of historical flood events to be compiled for the period between 1583 and 1771. This has been compared to documentary records of past flood events to extend the flood series for the Eresma River basin. The Segovia Mint is a UNESCO World Heritage Site that has recently been extensively restored. The work reported in this paper highlights the practical value of such research because the newly extended flood series will form part of the flood risk assessment for the Segovia Mint Museum.

SOME KEY THEMES

A number of themes emerge from this collection of papers, and these can be briefly summarized as follows:

1. In comparison to most work conducted just a few decades ago, a salient feature of recent research is the effort expended in the improvement of dating control for the fluvial record. This is reflected both in the number of dates obtained and in the variety of dating methods now applied in fluvial contexts (e.g., AMS radiocarbon, uranium series, luminescence). We now have a much better understanding of the key drivers of environmental change in river basins and how these can impact upon processes of erosion and deposition at the reach and catchment scale. Although natural and cultural responses to climate change can be complex and nonlinear, the creation of much more robust geochronological frameworks for the fluvial record is allowing long-standing ideas to be tested more rigorously (e.g. Macklin and Woodward, 2009).
2. Over the same period, we have also seen a step change in the resolution of proxy climate records for the Late Pleistocene and Holocene, allowing ideas about cause and effect in fluvial systems to be examined much more thoroughly. It is now clear that very significant (often abrupt) climate changes have taken place during the Holocene, and river systems have reacted to those changes.
3. Once three-dimensional river basin-scale studies of the Quaternary sedimentary record have been carried out, it is shown that the cultural records in a given area are rather less fragmentary than initial surface surveys have indicated. This has important implications for the design of archaeological surveys in a range of fluvial settings. Research in the Thukela River basin has highlighted the value of an ethnographic perspective in the exploration of past resource use at the river basin scale.
4. More generally, this area of geoarchaeological research has matured to the extent that fully integrated and well-dated studies of culture history and landscape evolution at the river basin scale are now emerging from various parts of the world. This builds on pioneering large-scale approaches in the American Southwest (e.g., Waters, 1991) and elsewhere and bodes well for future research.

The case examples presented in the papers of this special issue show how dynamic valley floor environments can be and how they pose both opportunities and hazards

for human societies. At a very basic level, coarse bed load materials have provided raw materials for the production of Paleolithic stone tools and, in suitable depositional settings, the finer portion of the river's sediment load has provided fertile alluvial soils as well as clay extraction sites for potters (past and present). The soil and water resources of valley floors create attractive locations for farming—although these activities can be vulnerable to erratic stream flows and salinization in semiarid environments. As technology advanced during the course of the historical period, stream flows were harnessed to generate power, sometimes on a grand scale. The final paper in this collection shows how people worked to overcome a flood hazard to maintain the power supply to the Segovia Mint in Spain. This paper provides a tantalizing glimpse of an emerging world economy in the 16th century when gold coins were mass produced as symbols of power and to finance intercontinental trade networks. High-resolution records of river basin processes are attainable for the historical period, and they can have enormous practical value. This is clearly illustrated through the creation of an extended flood history for the River Eresma, which can be utilized in a risk assessment to develop a flood hazard management strategy for the Museum of the Old Mint of Segovia, a UNESCO World Heritage Site.

We are delighted to present this collection as a special issue, and we would like to thank the authors, Vance Holliday, Hector Neff, Barry Taylor, and all the referees for their help and enthusiasm in putting this collection together.

REFERENCES

- Barker, G. (1995). *A Mediterranean valley: Landscape archaeology and annales history in the Biferno Valley*. London: Leicester University Press.
- Bettis, E.A., & Mandel, R.D. (2002). The effects of temporal and spatial patterns of Holocene erosion and alluviation on the archaeological record of the central and eastern Great Plains, U.S.A. *Geoarchaeology*, 17, 141–154.
- Brown, A.G. (1997). *Floodplain geoarchaeology*. Cambridge: Cambridge University Press.
- Ferring, C.R. (1986). Rates of fluvial sedimentation: Implications for archaeological variability. *Geoarchaeology*, 1, 259–274.
- Lewin, J. (2010). Medieval environmental impacts and feedbacks: The lowland floodplains of England and Wales. *Geoarchaeology*, 25, 267–311.
- Macklin, M.G., & Woodward, J.C. (2009). River systems and environmental change. In J.C. Woodward (Ed.), *The physical geography of the Mediterranean* (pp. 319–352). Oxford: Oxford University Press.
- Mandel, R. (2008). Buried Paleoindian-age landscapes in stream valleys of the central Plains, USA. *Geomorphology*, 101, 342–361.
- Needham, S., & Macklin, M.G. (Eds.). (1992). *Alluvial archaeology in Britain*. Oxford: Oxbow Press.
- Waters, M.R. (1991). The geoarchaeology of gullies and arroyos in southern Arizona. *Journal of Field Archaeology*, 18, 141–159.
- Waters, M.R. (2000). Alluvial stratigraphy and geoarchaeology in the American Southwest. *Geoarchaeology*, 15, 537–557.
- Waters, M.R., & Haynes, C.V. (2001). Late Quaternary arroyo formation and climate change in the American Southwest. *Geology*, 29, 399–402.
- Welsby, D.A., Macklin, M.G., & Woodward, J.C. (2002). Human responses to Holocene environmental changes in the northern Dongola reach of the Nile, Sudan. In R. Friedman (Ed.), *Egypt and Nubia: Gifts of the desert* (pp. 28–38). London: British Museum Press.