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Rising social complexity, agricultural intensification, and the earliest rice paddies on the Loess Plateau of northern China

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ABSTRACT

Geoarchaeological studies of landscapes immediately adjacent to archaeological sites can contribute information on the direct impact of small-scale societies on their associated landscapes. This direct connection allows us to understand aspects of the motivations, economic decision-making and agricultural strategies and how they affected local site catchments. The origin and spreading of farming communities onto the Loess Plateau of northern China provides a good example of this. We recorded sediment profiles that were immediately adjacent to the site of Huizui in the Yiluo River Basin. Here we identified evidence for human land-use beginning with the early Mid-Holocene deposits which are consistent with stable hillslope soils, indicating that the first mixed forager-millet farmers of the Peiligang Neolithic had a very light ecological footprint on the landscape. This is in contrast to the later middle Neolithic Yangshao Period farmers. Sediments from the Yangshao Period revealed paleolandscape and phytolith evidence for the earliest Neolithic paddy farming well outside of the natural habitat of wild rice. In addition to evidence for massive deforestation and soil erosion, a 15 m deep sediment sequence containing sets of gravels (beginning ca. 7200 cal BP) and gleyed soils dating from ca. 6600 cal BP, contained rice phytoliths, archaeological waste suggesting manuring, and micromorphological data indicating trampling. These signs of intensive landscape management go hand-in-hand with rapidly increasing social complexity.

1. Introduction

The shift from a subsistence focus on hunting–gathering to one of primarily sedentary farming brought with it an exponential change in the ability of human communities to alter their natural environments. Although small-scale mobile foragers of the Pleistocene impacted their environs through means such as the use of fire, moving plants and animals between ecological zones, and propagating economically useful plants either unintentionally or intentionally with low-level cultivation (Smith, 2001; Zeder, 2012), the human footprint on environments was exponentially increased with the advent of sedentary farming villages across the globe. This can be clearly documented in the archaeological and paleoenvironmental records of northern China. Here, increasing human impact throughout the Early to Mid-Holocene is demonstrated by archaeology with studies of rising population density with the expansion of sedentary villages (Liu et al., 2002–2004), by paleoecology through analyses of pollen cores showing deforestation (Yi et al., 2003; Makohonienko et al., 2004; Atahan et al., 2008), by geomorphological studies (Bullard, 1985; Xu, 1998; Saito et al., 2001) as well as atmospheric sciences (Ruddiman et al., 2008). These important lines of evidence provide us with a picture of general trends which chart the increasing intensity of human impact on the landscape of China, and which must be considered in our understanding of larger issues of global environmental change and the concept of the Anthropocene.

However, these studies consider human groups at a large scale as a monolithic entity, and rarely deal with the smaller-scale of human-ecological dynamics at a community level. It is at this scale that we can approach the question of intentionality which will help us hypothesize about human economic decision-making, subsistence planning, and the motivations that ultimately lead to more

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widespread human impact on their environments. It can also contribute to our understanding of landscape stewardship in past societies with the goal of finding models of good practice that can serve as examples for our own interactions with rapidly changing rural environments.

In recent years there has been much interest in tracing the earliest evidence for farming in China and the way people used their environments for subsistence which led to the cultivation of crops such as rice and millet (Jiang and Liu, 2006; Lee et al., 2007; Liu et al., 2007; Fuller et al., 2009). Most of this research has focused on south China with the search for the first traces of cultivation and ultimately the earliest signs of fully domesticated rice (Crawford, 2006; Fuller et al., 2007; Liu et al., 2007). Archaeobotanical remains from early Neolithic Peiligang sites in northern China have revealed that the earliest farming there was millet-based, and well-suited to the more arid conditions of that region (Lee et al., 2007). Recently, early dates on starch and carbonized seed remains from the site of Donghulin show that early farmers in northern China were already domesticating foxtail millet (*Setaria italica*) by ca. 10,000 cal. BP (Hubbard, 1980; Hulme and Barrow, 1997; Crawford, 2009). For the most part millet farming continued through the Late Peiligang Period (ca. 8100–7700 cal. BP) by mixed hunter/farming societies living in small sometimes mobile Peiligang Period settlements dated to around 8000 cal. BP (Hu et al., 2006; Lee et al., 2007; Barton et al., 2009).

To date, little is known about the early introduction of more intensive rice-based agriculture in the drier semi-arid zones of northern China, the reasons for its spread into this region far from the natural environmental zone of either wild or cultivated rice, or its impact on the natural environment of the semi-arid zones of northern China. At the site of Huizui in Henan Province, we identified and analyzed sediment sections containing the remains of Neolithic field systems that are directly linked both stratigraphically and temporally with a Middle Neolithic Yangshao village site. Radiocarbon dates, soil micromorphology, and phytolith analyses have demonstrated that these ancient fields represent the earliest paddy fields in northern China. These sediment deposits provided a unique opportunity to study off-site paddy farming strategies of Yangshao Neolithic communities as well as the possible impact they had on local landscape transformations, allowing us to examine the introduction of new farming systems into this semi-arid region, at the small-scale level of a Neolithic farming village.

2. Environmental setting

The Neolithic site of Huizui is located on the Liujian River within the catchment of the Yiluo River system in an area which today receives about 600 mm of rainfall, primarily in the summer months (Fig. 1). The mean annual temperature is 11 °C. The Liujian River is a small perennial stream which is set within a narrow and deeply incised valley that cuts through Pleistocene loess and reworked alluvial silt deposits. This site was occupied primarily from the Middle Neolithic Late Yangshao Period (5500–5000 cal. BP) through the Early Bronze Age Erlitou Period (3900–3500 cal. BP).

Middle Holocene climatic change was highly significant for the developing Neolithic farming systems in this region of China. Evidence for significant environmental changes in northern China throughout the early, middle and late Holocene comes from proxies such as pollen, phytoliths, soils, loess sequences and geomorphology(Li et al., 2003; Feng et al., 2004; Peng et al., 2005; An et al., 2006). The most detailed paleoclimatic data come from a growing number of studies of high-resolution Oxygen and Carbon isotopic records from cave speleothems. There are several key caves in central China which have yielded important records for the Loess Plateau. These isotopic records have been calibrated to reflect rainfall fluctuations related to shifts in the strength and intensity of the East Asian Southern Monsoonal (EASM) systems. Two important records for this region come from Sanbao Cave (Dong et al., 2010) and Jiuxian Cave (Cai et al., 2010).

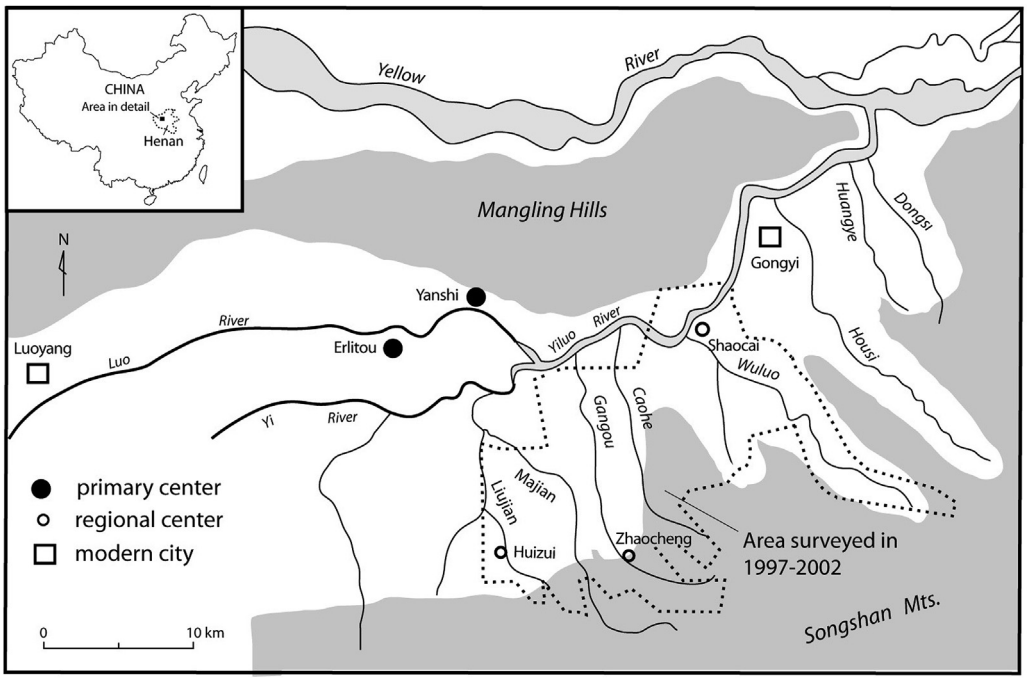

Fig. 1. Map showing study area (After Rosen 2008, Fig. 1).

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