Rice fields, water management and agricultural development in the prehistoric Lake Taihu region and the Ningshao Plain

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Abstract

The Lake Taihu region and the Ningshao Plain are important in the development of prehistoric rice farming in China. Because of differences in hydrological regimes, soil conditions, availability of natural resources and socio-economic traditions, these two regions saw different developmental trajectories for rice farming. In the Ningshao Plain, even though rice was consumed at a very early date, the cultivation and domestication process was slow, and hunting and gathering remained important to the local subsistence economies. In the Lake Taihu region, a tendency towards rice farming intensification can be witnessed during the transition from the early (c. 5000–4000 BC) to late (c. 4000–3500 BC) Majiabang periods. Archaeological evidence for this process includes the construction of rice paddy fields of increasing size, and more complex in-field facilities for water management, along with greater control of wet–dry alternations in the fields for irrigation and drainage. The latter, according to some research, induced ‘water stress’ to force higher yields of rice. In these two regions, we can see that rice farming, water management and social development were becoming more intricately intertwined, but such relationships varied, depending on local environmental and socio-economic conditions.
Introduction

The landscapes of the rural areas around the present Lake Taihu are dominated by the so-called poldered or dyked fields. These are paddy fields that are demarcated by artificial dykes inside large water bodies to prevent floods in the fields (Figure 5.1). Poldered fields were constructed during the medieval period (c. seventh century AD), if not earlier, and have been continuously maintained for rice farming (Bray 1984: 114) (Figure 5.2). Taking the local hydrological and soil conditions into account, this simple yet efficient means of water management has played a crucial role in the successful operation of these poldered fields (Lu et al., 2005) and has greatly promoted the growth of rice farming. Unfortunately, traditional knowledge of water management, soil ecology and sustainable farming is fast disappearing because of

Figure 5.1  Lake Shijiu and the poldered fields and small lakes surrounding it. Note the poldered fields of various shapes on the left and the small lake to the south of the Shijiu Lake, half of it already disappeared. Source: authors
Figure 5.2 Historic poldered fields in the Lower River Yangtze recorded by Wang Zhen (AD 1271–1333) in his book Wang Zheng *Nong Shu* (after Bray, 1984: 115)
the increasing obsession with modern, advanced technologies in the context of rapid urbanisation. These technologies, often derived from or invented in entirely different environmental and cultural contexts, have indeed been accelerating urbanisation and economic growth on an unprecedented scale in the past few decades. Their ecological and environmental outcomes, however, have been largely neglected. Although this chapter does not directly examine the ecology and water-management strategies of these poldered fields, the questions raised above are relevant to the issues facing the study of both historical and contemporary poldered fields. The studied regions, the Lake Taihu region and the Ningshao Plain (Figure 5.3), have unique geomorphology, soil conditions and hydrological regimes, which were shaped by Holocene marine and alluvial activities. These conditions in turn fundamentally define the developmental patterns of water management and rice farming in these regions. I investigate the evolution of rice-farming systems and water-management practices during the Majiabang period (c. 5000–c.

Figure 5.3  The Lake Taihu region and the Ningshao Plain region and locations of sites mentioned in the text. 1 Hanjing; 2 Shunshanji; 3 Longqiu Zhuang; 4 Shendun; 5 Luotuodun; 6 Chuodun; 7 Caoxieshan; 8 Chenghu; 9 Majiabang; 10 Luojiqiao; 11 Maoshan; 12 Kuahuqiao; 13 Shangshan; 14 Xiaohuangshan; 15 Hemudu; 16 Tianluoshan; 17 Jiahu. The red rectangle is the area shown in Figure 5.1. Source: authors
3500 BC) of the Lake Taihu region, and the contemporary Hemudu culture (c. 5050–c. 3050 BC) in the Ningshao Plain, when and where settlement size and rice farming were expanding and the construction of rice fields was transforming the landscapes. Despite a pronounced lack of systematic investigation, the Majiabang and Hemudu cultures, especially in their later phases, can be seen to represent a period of considerable investment in rice farming and water management. I examine and compare how water management related to local hydrological and geological conditions, how the technologies of water management evolved, and how prehistoric societies gradually modified and transformed their landscapes for and with rice farming, and the associated water-management strategies in these two regions.

**Geomorphology, soils and local environments**

Despite it being primarily deposited on the Loess Plateau of North China, mosaic patches of loess can be found in the Lake Taihu region of South China. The so-called Xiashu loess was carried by strong westerly winds that reached this region during the Last Glacial Maximum (X. S. Li et al., 2001; Wu, 1985). This loess deposition resulted in the formation of small and sometimes isolated loess hills or tablelands. These small landform units became the key pre-lacustrine landscape that was then further transformed by active Holocene marine and alluvial geomorphological processes. The Yangtze Delta and many regions along the eastern coast experienced steady sea-level rise after the early Holocene, which reached their peak around 5000–4500 BC (Zong, 2004). As well as bringing marine sediments to the inland regions, and thereby significantly contributing to the formation of the Yangtze Delta, this high sea-level stand also caused long-standing inundation of low-lying areas. The evolution of Lake Taihu was a direct outcome of this geomorphological process. The western part of the lake, around 9000 BC, was a typical estuarine environment, fed by brackish water and covered by saltmarsh plants, while the eastern part only became submerged when the regional water level reached its highest c 4500 BC. Around 3000 BC, both the western and eastern sections of this area were inundated by freshwater, mainly from rivers and surface run-off (Han, 1998; Hong, 1991; Jing, 1985; Q. Wang and Chen, 1999; Zong et al., 2012) (Figure 5.4).

The Lake Taihu region was dominated by mosaics of wetlands during the middle to late Holocene. Pollen assemblages, derived from
palynological studies at a number of Majiabang culture sites, were dominated by non-arboreal species, especially aquatic plants that grow in or near the edge of natural water bodies and wetlands (Ding, 1999; K. F. Wang et al., 1980; K. F. Wang et al., 1984). The presence of arboreal pollens indicates that there were forests or woodlands growing not far from these natural water bodies and wetlands. Though many sites look like mounds, as they are higher than their immediate surroundings, some scholars have pointed out that the palaeo-surfaces during the occupation of these sites would have been much lower than their surroundings (L. Sun and Gao, 2006). The Majiabang-period archaeological sediments
are often found at the bottom of these mounds, up to 11 m deep (e.g., at the Caoxieshan site). Thus, it is important to take into account the palaeo-environmental conditions at the time of occupation. To date, there are between 60 and 70 Majiabang culture sites found in the Lake Taihu region. They are mainly located in three kinds of local environments: slopes next to natural water bodies, alluvial plains immediately adjacent to rivers which are buried underneath the current surface or submerged in the water, and foothills (L. Sun and Gao, 2006). Affected by the high sea level, vast areas of the Ningshao Plain were inundated during the early to middle Holocene. From 5000 BC onwards the seawater gradually retreated, but the regional groundwater table remained high, which led to the formation of a widespread peat horizon (Shi et al., 2008; L. Wu et al., 2012). Palynological studies suggest a similar pattern of Holocene vegetation in the Lake Taihu region, with sub-tropical species predominating (Qin, 2006; Tan, 2015). Of the 40–50 Hemudu culture sites that have been found (Liu and Chen, 2012: 204), around 10 have been excavated (G. P. Sun, 2013). The majority of these sites are buried very deep, indicating that they were located on low-lying areas during their occupation.

Two distinctive types of late Pleistocene/Holocene sedimentary sequences are present in the two studied regions. In places with late Pleistocene loess deposition of the Lake Taihu region, the loess formed the base of the late Pleistocene/Holocene sequences (X. S. Li et al., 2001; Yang et al., 2007). As can be seen in the stratigraphy at the Chuodun site, what sits on top of the loess deposits are loess or reworked loess and alluvial sediments (Chen and Zhang, 1994; Shen et al., 2006; Yang et al., 2007) (Figure 5.5). Contrary to such loess–alluvium sequences, the late Pleistocene/Holocene sediments in the low-lying areas of the Ningshao Plain are characterised by clayey, often organic-rich, alluviums and marine sediments (C. M. Lin, 1997; Shi et al., 2008). Loess is well known for its water drainage ability, which is due to its porous properties (Y. Zhuang et al., 2016), while clayey deposits are normally good at water retention. Such a contrast in soil properties would have had a significant impact on prehistoric rice farming and water management, which is discussed below.

### Holocene rice cultivation, domestication and expansion

The consumption of rice in the Lake Taihu, Ningshao Plain and surrounding regions can be traced back as far as the beginning of the Holocene. At some Shangshan culture sites (c. 9000–6500 cal. BC; Jiang, 2013,
but cf. Zuo et al., 2017 for a more conservative determination of the date, 7450–6500 cal. bc), not only was rice consumed but rice chaff was often used as tempering material in pottery production (Jiang, 2007). In the following period, at Xiaohuangshan (7000–5700 cal. bc) and Kua-huqiao (6000–5000 cal. bc), rice grains were consumed and rice chaff was used in ceramic temper (Y. F. Zheng et al., 2004; Y. F. Zheng et al., 2007). However, as many scholars have pointed out, subsistence strategies at these early Holocene sites were rather diverse: they included the consumption of a wide range of wild plants, notably aquatic plants, and wild animals. Rice accounted for only a small proportion of people’s diet.
at this time (L. Qin, 2012). Also, in the light of recent discoveries, until 8,000 years ago the River Huai to the north of the Lake Taihu region was another important region for the early development of rice economy. At the Hanjing and Shunshanji sites (L. G. Lin et al., 2014), for instance, not only has the discovery of carbonised rice remains pushed the date of the beginning of rice consumption in the region to before 6000 cal. BC, almost as early as the dates of some other important discoveries (e.g., Jiahu located further north), but the presence of domesticated-type rice spikelet bases (L. N. Zhuang et al., 2017) also clearly indicates cultivation and/or intentional field management.

While careful measurement of the carbonised rice grains has revealed an analytical distinction between wild and possibly cultivated rice, the process of cultivation and domestication remains controversial. Debates on how to disentangle the domestication syndrome have become heated among scholars who examine rice remains from the Hemudu culture sites (Fuller et al., 2007; Liu et al., 2007; Zuo et al., 2017). The debate on when and how rice was domesticated is ongoing, and much of this debate concerns the lack of understanding of domestication as a lengthy evolutionary process. For the two to three thousand years of continuous cultivation experiments, there would have been plants under cultivation that had some morphological traits that characterise domestication but cannot be regarded as domesticated, and that are hard, if not impossible, to determine through archaeobotanical research (C. Stevens, personal communication). If this viewpoint is adopted, either Shangshan or Hemudu rice is fully domesticated. In spite of these controversies, it is certain that rice was becoming increasingly important in the diet of the Hemudu communities. This trend can best be demonstrated by the detailed archaeobotanical research conducted by Fuller and colleagues at the Tianluoshan site (Fuller et al., 2009). They identified rice spikelet bases with rough rachises, indicative of domestication, which appeared early (c. 4900 cal. BC). However, the overall percentage of rice in the total archaeobotanical assemblage was low at this time. The percentage of rice in the archaeobotanical samples continued to increase through time, while there was a corresponding decrease in other plant remains such as water chestnuts (Fuller and Qin, 2010). Thus, the Tianluoshan case in the Ningshao Plain provides a convincing illustration that rice domestication was a slow process.

In the Lake Taihu region, rice farming expanded rapidly during the Majiabang period. Luojiajiao (5300–4900 cal. BC) is one of the earliest Majiabang culture sites. Abundant pottery sherds, animal bones, plant remains and wooden architectural structures were discovered during
the excavation. Rice remains include several hundred (c. 500) carbonised rice grains and rice chaff found inside pottery sherds as tempering material (Zheng et al., 2007; Zhu, 2004). Some of the carbonised seeds still had awns attached to the surface of the seeds (Zhu, 2004). Zheng and colleagues recently examined 100 rice spikelet bases from Luojiajiao and suggested that 50 per cent of them were from the cultivated *japonica* species (*O. sativa* L. subsp.), while the rest belonged to wild rice (Zheng et al., 2007). But this identification is not without a problem as it does not include immature spikelet bases, which might explain why the site generated so much higher a percentage of domesticated rice than Tianluoshan. At a site contemporary with Longqiuzhuang (which lasted into much later periods, 5000–4300 and 4300–3500 BC), located to the north of the Lake Taihu region, rice remains have been recovered, via flotation, from many excavated features (Longqiuzhuang Archaeological Team, 1999). In line with the trend observed in many contemporary or earlier sites (e.g., Tianluoshan), rice remains increased while the importance of gathered wild plant foods such as water chestnuts gradually diminished.

As suggested by L. Qin (2012), the tipping point between the opposing trends of rice and wild plant foods in the prehistoric diet occurred around 4000 BC, when rice farming experienced a leap forward in terms of technological development. By the late Majiabang period rice farming was significantly intensified. This take-off of rice farming benefited from improved farming practices and intensified water management. These processes stimulated pronounced social-economic changes, as illustrated by the increasing number of settlements, the peopling of the lowland areas and the considerably larger scale of rice farming. The number of late Majiabang culture sites increased to more than 30, much larger than the 10 and 17 of the early and middle phases respectively. Given that some late Majiabang culture sites may be buried underneath late Holocene alluviums, the actual number may be higher. By the late Majiabang period, with more lands emerging around Lake Taihu because of the combination of a falling lake level and increasing sediment supplies, settlements were located all over this area, with a particularly noticeable expansion towards the eastern alluvial plain. In the Ningzhen Plain, an even more pronounced increase in the number of settlements can be seen from the early (5000–3900 BC, about 10 sites) to late (3900–2900 BC, nearly 40 sites) Hemudu culture periods. These late Hemudu culture sites were distributed over a much larger region (Liu and Chen, 2012: 204).
Rather like the classic settlement structure excavated at the Hemudu site in the 1970s (Liu and Chen, 2012), the many contemporary Hemudu and Majiabang settlements were characterised by the so-called ganlan (raised-floor) wooden structure above the ground (Ji, 1983; G. P. Sun, 2013) as well as above-ground houses. Such above-ground houses can be found, for instance, at the Shendun and Luotuodun sites, where some houses measure almost 60 m² and have large storage jars located immediately outside (L. G. Lin et al., 2009; Tian et al., 2009). Because of a lack of systematic archaeobotanical investigation, only limited rice remains have been discovered at a few late Majiabang and Hemudu sites to date (Stevens and Fuller, 2017). However, the initial intensification of rice farming around 4000 BC is supported by the discovery of several paddy fields.

Construction of Neolithic rice fields

By examining microfossil plant remains and charcoal discovered at the Kuahuqiao site, Zong et al. (2007) were able to suggest that the Neolithic community was practising cultivation of rice c. 5700 cal. BC. Although controversy regarding the sampling location and the interpretation of the data persists (Shu et al., 2013), the modification of wild habitats of rice plants in the swampy wetlands and the management of blackish water formed a significant step in rice farming for the Kuahuqiao community (also see J. W. Sun et al., 2010). Domesticated-type spikelet bases are present (<10 per cent), which points to significant morphological changes in some rice plants, even though the numbers are very low compared with wild rice (Zheng et al., 2016; Zuo et al., 2016; Zuo et al., 2017). The rice fields at Tianluoshan are among the earliest rice fields to have been excavated. Similarly to those at Kuahuqiao, the Tianluoshan rice fields were located on or along a swamp, as confirmed by a systematic coring survey, from which phytolith samples were analysed (Zheng et al., 2009). They were located near the raised-floor houses (Figure 5.6). These fields can be dated to two periods, c. 4650–4490 cal. BC and c. 3340–3090 cal. BC, and were buried c. 2 m and c. 0.95–1.7 m below the surface respectively. Some wooden and bone tools were found in the fields, including ‘dibble sticks’ and spades (G. P. Sun et al., 2007). The soil is characterised by dark clayey particles (Figure 5.7) and is rich in organic matter, and, as noted by the excavators, ‘no evidence of an irrigation system, which should include ditches, field ridges/bunds for controlling drainage and water retention, was found’ (Zheng et al., 2009: 2613). This may indicate that the ecology
of rice farming at Tianluoshan remained ‘crude’, without intensive modification of the local environment, resembling that found at Kuahuqiao. We should therefore call these ‘rice fields’ rather than ‘paddy fields’. The main difference between these two categories is that there is a lack of investment in the labour of building bunds and clearing irrigation ditches in early rice fields. This situation is quite different from that in the early paddy fields found in the Lake Taihu region, where one can see considerably more effort being invested in building and maintaining the fields.

Caoxieshan is situated next to Lake Yangcheng and is surrounded by wetlands. The site measures c. 45 ha, according to the excavator. However, it is important to note that it is a multiple-period site and the extent of the Majiabang period deposits may be smaller than is estimated. The site is poorly preserved, except for the central part, where several mounds still stand on the ground. An area of more than 1,000 m$^2$ of the site was excavated in the 1970s, while the paddy fields were excavated in the 1990s by a joint Sino-Japanese team. A total of 44 (1,400 m$^2$) Majiabang-period paddy fields were unearthed through the excavation (Figure 5.8). These
fields, which were generally small and of irregular shape, can be divided into three phases. The early-phase fields were situated in the low-lying area. They were slightly larger than later-phase fields, but the lack of associated facilities for water management, such as water outlets, seemed to suggest that they were built without considerable labour investment. The middle-phase fields were built directly over early-phase fields after they had become flooded and silted up. For this middle phase, more effort was invested in building water outlets, sluices, wells and pathways across the fields. After the middle-phase fields were abandoned, the surface became higher. The sizes of the three phase fields ranged greatly, from several square metres to more than 10–20 m\(^2\). They are mostly of single units, but some are comprised of multiple units. As well as digging into the surface to build the fields, labourers dug ponds and wells to facilitate water management. Steps can be found inside some of the wells at Caoxieshan (e.g., well no. J34); similarly, pots were found at the bottom of the wells that were used as water containers. In addition, a small pier structure was excavated. A wooden plank (1.1 × 0.7 m) found next to an area with steps led towards one of the ponds (Gu et al., 1998). All these discoveries

Figure 5.7  Early-phase rice fields at Tianluoshan. No clear archaeological features related to the field system are preserved. Note the dark clayey deposit (after Zheng et al., 2009)
indicate increasing investment in the fields and in related facilities for water management.

Chuodun is another important site at which Majiabang-period paddy fields have been excavated. It is located on a narrow strip of land between Lakes Yangcheng and Kuilei. It is a site with multiple cultural-period occupations, measuring c. 40 ha, but the size of the Majiabang-period settlement remains unclear. A total of 46 paddy fields were unearthed in two excavation seasons (Figure 5.9). From a recent geoarchaeological survey it is clear that the fields were built on the low-lying areas of the site (Cao et al., 2007). These fields were small (averaging 1 to 10 m²) and of irregular shapes. Simple structures such as small water outlets, ditches and small ponds were built for water management (Gu, 2003).

Figure 5.8  Distribution of paddy fields at the east excavation area, Caoxieshan. Note that the fields in this plan are divided into two phases (after Gu et al., 1998)
While the Caoxieshan and Chuodun paddy fields have similarities in their distributional patterns and structures, at a paddy field site from a later period (the Songze culture period, 3520–3260 cal. BC), Chenghu, more changes to the field structure can be seen, indicative of the further intensification of rice farming. The Chenghu site is situated next to Lake Chenghu. It is divided into a residential zone and a production zone. A ditch (no. G2) was dug between the residential and production zones. This ditch on the one hand served as a sewer for the residential area, and on the other received water from the River Xixupu, which was fed by the River Wusong before releasing water to the fields. The paddy fields were located around an artificial pond. These irregularly shaped fields vary greatly in size, from only about 1 m$^2$ to more than 100 m$^2$ (Ding, 2004). The latter demonstrates an unprecedented increase in size of the paddy fields in the region.

Figure 5.9  Plans of the paddy fields at the Chuodun site, redrawn by C. Stevens
Water management and intensification of rice farming

While irrigation is always key to rice growth, on many occasions drainage is more vital to rice farming, especially during the harvesting season as lengthy saturation or waterlogging is extremely detrimental to rice plants in the growing stage of grain milking and filling. Indeed, effective drainage remained one of the biggest challenges in early rice farming.

The fields in the eastern part of Caoxieshan can be divided into several groups. Each group was surrounded by wells and connected with ditches and water outlets. Although the topographical differences between these features were minor (often less than a metre), they played a key role in channelling, diverting and draining water in the fields. When monsoonal rainfall is heavy, as it often is today in the summer (July–August especially), it accumulates very rapidly in the fields. A good understanding and efficient micro-management of the local topography by these early rice farmers would have enabled them to build and cultivate the paddy fields more effectively. The excavations have shown that at the low ends of the fields there were several shallow pits, into which water flowed via ditches and related features. In the western part of the sites, instead of being connected to wells the fields were connected to several ponds via water outlets. These ponds have a much larger volume than wells for holding and absorbing water. Thus, these features represented a significant development in water management, in that drainage remained crucial yet challenging. A phytolith study conducted by Weisskopf and colleagues provides supportive evidence for this emphasis on drainage at Caoxieshan. By grouping phytoliths into different categories based on comparisons with modern rice fields with known farming practices, they have found that the phytoliths collected from the Caoxieshan paddy field ‘have many more fixed morphotypes that are consistent with the drier signatures’. This drought-stress farming regime was likely to ‘induce water stress and produce more flowers and grains’ of rice plants (Weisskopf et al., 2015; also cf. Fuller, 2011).

Geophysical analysis of soil samples collected from the Chuodun paddy field has confirmed decreases in magnetic susceptibility and in the percentage of clay particles from c. 2 to 1.3 m below the surface. This trend is considered to be the result of long-term drainage in the field, which causes the downward leaching of clay particles (Yang et al., 2006; Yang et al., 2007). The existence of such farming practices, which emphasise the importance of drainage, is supported by a pollen study which found that the pollen assemblage was dominated
by *Gramineae* and *Cruciferae* species, with very few aquatic pollens (*Cyperaceae*, *Typhaceae*, etc.) present (Li et al., 2006). Although other factors may also be responsible for this low percentage of aquatic species in an otherwise wet environment, according to Li et al. (2006) this may be related to deliberate drainage management.

By the Songze period, the paddy fields at the aforementioned Chenghu site, for instance, had a clear division between high fields and low fields. The large pond (425 m$^2$) beside which the fields were located had a very skewed surface at its bottom. The difference in height between the western and eastern parts was c. 1.7 m. In addition, the eastern part was linked to a river (Ding, 2004; Figure 5.10). This pond had multiple functions. It provided water to irrigate the high fields, and two small pools situated right next to the high fields were used to lift water from the pond. More importantly, it served to drain water quickly from both high and low fields into the river. The use of the Chenghu paddy fields coincided with a period around 3000 BC when lakes and other natural water bodies were expanding because of increased precipitation and temperature (Ding, 2004).

**Figure 5.10** Large paddy fields at the Chenghu site (after Ding, 2004)
Concluding remarks

In the Ningshao Plain, rice was consumed as early as the beginning of the Holocene. While cultivation or experimental farming carried on into later periods, rice did not become the dominant staple in the diet of local communities until the late Hemudu period, at the earliest. Rice fields at the Tianluoshan site were used without much labour investment in building irrigation facilities during the middle to late Hemudu period, but to what degree the rice fields were intensively cultivated, and the nature of the ecology of water-management strategies, if any, remain to be demonstrated. Liu and Chen (2012: 203–4) have rightly pointed out that the increase in the number of settlements, from around 10 in the early Hemudu period to nearly 40 in the late Hemudu period (see above), is indicative of population growth and dispersal, especially to the areas to the south of the Ningshao Plain. The role of rice farming in this late Hemudu dispersal is unclear, however, because of a lack of archaeobotanical and other environmental evidence. In the Lake Taihu region, by the early Majiabang period paddy fields had already been established at several settlements, and it is clear from excavations of related archaeological features and from interdisciplinary research on water-management practices that more labour was invested in building the larger fields and that more careful control of in-field water situations was practised. From the Majiabang period to the Songze period, we can see a clear intensification process in rice farming, characterised by both the quantity and the size of the paddy fields at the sites discussed above. We can tentatively term this intensification of rice farming ‘the late Majiabang expansion’. There are several reasons for these two different developmental trajectories of rice farming in the prehistoric Lake Taihu region and the Ningshao Plain.

First, the clayey soil in the Ningshao Plain meant that it would have been more laborious to build large paddy fields with complete water-management infrastructures and to till these fields. Xie et al. (2015) compares the efficiency of stone and bone digging tools for earth working in the Ningshao Plain through an experimental study. They have found that while bone and stone tools function equally well in soft soils, stone tools ‘provide significant and easily perceived advantages’ when soils are hard, as the clayey soils in the prehistoric Ningshao Plain are. Bone digging tools seem to have been the main digging implements at the Hemudu culture sites (Huang, 1999). This may have constrained the inhabitants’ ability to construct and maintain large-scale paddy fields as well as other earthen projects. Unlike the Hemudu culture sites, many
Majiabang culture sites were situated on higher ground, and soil conditions were much less clayey and heavy because of the loess-like parent material, which contains coarser particles and more porous and looser structures. Such soils would have been easier to cultivate and more productive, regardless of what types of tools were applied (the Majiabang culture sites seemed to contain fewer bone digging tools; see Wu, 1999).

The most important factor determining the trajectories of rice farming was the local subsistence economies, as they were restricted by the availability and seasonality of resources in the local environment. Research has shown that some of the Hemudu culture sites (e.g., Tianluoshan) were in optimal locations for hunting and gathering (L. Qin et al., 2010). The rich animal and plant resources of the sub-tropical forests and wetlands delayed the Hemudu communities’ commitment to full rice agriculture; that is to say, rice did not play a predominant role in food production. Indeed, gathered wild foods remained an important component of the diet at Tianluoshan for most of the Hemudu period (L. Qin et al., 2010). In the Majiabang culture of the Lake Taihu region, natural resources were not as rich as in the coastal Ningshao Plain, and from the early Majiabang period onwards they had already developed the ‘water-stress strategy’ to induce greater agricultural yields. This, to a large extent, accelerated the development of rice farming throughout the Majiabang period.

By the Liangzhu period (3300–2300 BC), these divergent pathways of rice farming seem to have merged, with the dramatic increase in scale and intensity of rice farming that can be clearly illustrated by the excavation at the Maoshan site (2700–2200 BC) (Y. Zhuang et al., 2014). Here one single paddy field reached a size of 2,000 m² during the late Liangzhu period. This dramatic increase in the scale of farming came together with greater control of the in-field hydrology and methods of soil amendment as demonstrated by geoarchaeological and archaeobotanical investigations (Y. Zhuang et al., 2014; see also Weisskopf et al., 2015). The rice farming at Maoshan certainly is closely related to, and contributed economically to, the development of social complexity during the Liangzhu period. It is worth noting that this development was built upon the foundation laid down in the preceding Majiabang–Hemudu period.

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