THE EMERGENCE OF WALLED TOWNS AND SOCIAL COMPLEXITY IN THE TAOJIAHU-XIAOCHENG REGION OF JIANGHAN PLAIN CHINA

by

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The especially early emergence of Neolithic walled towns in the Jianghan Plain is widely used as an indicator of social complexity. In recent decades, research on walled towns has focused on their role in the origin of Chinese civilization and in the formation of early states in China. Several models have been suggested to explain the emergence of walled towns: inter-regional conflicts between the Central Plain and the Jianghan Plain, intra-regional conflicts among walled towns in the Jianghan Plain, and control of flooding in the Neolithic period. The trajectories of developing social complexity of these earliest walled towns and the relationships that existed among them have not previously been systematically investigated from the perspective of demographic distributions. The full-coverage systematic regional survey presented here included two of the earliest walled towns in the Jianghan Plain: Taojiahu and Xiaocheng. It was designed to illuminate their social trajectories and by extension those of their counterparts elsewhere in the Jianghan Plain and areas adjacent to it.

The regional survey revealed spatial and temporal variations in the settlement patterns of an area of 58 km^2 from 3900 BCE to 600 CE. Population distribution patterns were documented

for each period in this time span to investigate the dynamic forces behind social and settlement changes. Different approaches to understanding the emergence of early walled towns were evaluated through the analysis of population distribution and its relationships to environmental variables.

The conclusions of the research include the following. First, the emergence of the Taojiahu and Xiaocheng walled towns was a process of the *in situ* population increase from initial small communities rather than pulling together people spread throughout the landscape in different communities. Second, throughout their histories, Taojiahu and Xiaocheng contained the vast majority of the population of their territories; there was little or no hinterland population or settlement hierarchy around them. Third, economic activities and the development of economic interdependence involving both subsistence and non-subsistence products were of particular importance at Taojiahu and Xiaocheng. Fourth, Xiaocheng might have served as an economic outpost of Taojiahu focused on the production of rice and other goods.

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1. INTRODUCTION

Complex society in many regions all over the world followed different pathways towards large scale social formations. How and why human societies started to develop distinctive inequality systems in separate regions are still unanswered questions for understanding social change (Carneiro 1981; Drennan and Uribe 1987; Earle 1991; Johnson and Earle 1987; McIntosh 1999; Price and Feinman 1995; Redmond 1998; Sanders and Webster 1978). It is agreed that successful chiefs were able to effectively bind followers to their factions by way of legitimizing political institutions. However, strategies followed by chiefs to take and maintain power are widely diverse, falling in the categories of economy (Gilman 2001; Stanish 2004; Welch 1996), ideology (Aldenderfer 1993; Earle 2001b; Marcus and Flannery 2004) and warfare (Carneiro 1990, 1998; Earle 1991; Flannery and Marcus 2003; Webster 1998).

The unique characteristics and pathways exhibited in each society are believed to be affected by particular local environmental and socio-political conditions. Such constraints played a very important role in molding social complexity and enabling us to understand the emergence of social complexity (Drennan 1991, 1995; Earle 1991, 1997; Price and Feinman 1995; Spencer 1987, 1998). Drennan (1995: 331) points out that the physical environment, social and cultural constraints, and the resources available to competitors for power have greater potential for advancing knowledge of the emergence of social inequality than do the specific strategies employed in these processes. It is the trajectories in different regions that make complex societies vary considerably from each other. In this sense, the appropriate reconstruction of the social change within individual complex society, the interpretation of the emergence of social complexity and the comparative observation of those trajectories would help us generalize about the common characteristics and consistencies among the cases in which social complexity developed; as a result, we would better understand the social and natural conditions and strategies for building political power. Archaeological research in this direction would broaden the scientific interpretation of the forces of social change and advance conclusions at a more general level (Drennan 1991, 1995).

1.1 THE EMERGENCE OF WALLED TOWNS IN NEOLITHIC CHINA

The Longshan culture or Longshan period refers to the late Neolithic culture ranging from the middle to lower Yellow River Valley (Yan 1981, 1992). The Longshan period is generally divided into two sub-periods: (1) Early Longshan, which is also referred to as Miaodigou II in western Henan, southern Shanxi, and the Shaanxi provinces (2800-2500 BCE), and (2) Late Longshan (2500-2000 BCE). Pottery typological analysis shows that the Longshan culture can be further divided into several sub-cultures, which are named for the provinces where they are located, such as the Shandong Longshan culture, the Henan Longshan culture and the Hubei Longshan culture. With enriched archaeological discoveries, the term Longshan has been extended to cover regional Neolithic archaeological cultures from 3000-2500 BCE within China, including the Miaodigou II culture, the Dahecun V culture, the late Qujialing culture, the late Liangzhu culture, the Laohushan culture and the Majiayao culture (Banshan and Machang phases) (Liu 1996; Yan 1992).

The Longshan period was characterized by remarkable social transformation from more egalitarian societies in the earlier Yangshao period to the earliest states of China, which follow Longshan times. Archaeological evidence demonstrates that an entire set of social transformations was involved in the emergence of social complexity. Walled towns suggested widespread social conflicts and warfare (Underhill 1989, 1994); copper and bronze were used for making small items (An 1993; Yan 1981); burial goods signaled the presence of social hierarchies (Yan 1992:46-47; Liu 1994:184-236; Pearson 1981, 1988); writing systems may have been invented; ritual objects may have been exchanged among elites across regions (Liu 1994:184-236); regional cultures spread more broadly and had more frequent interaction; and the increasing complexity of Neolithic cultures built the foundation for earliest states and Chinese civilization (Chang 1986:234, Liu 1996).

More than 80 Longshan walled towns have been identified as one of the most important indicators of social complexity in Neolithic China (see Figure 1.1). These walled towns, which manifested crucial feature of socio-political complexity, functioned as regional centers. First, the Longshan walled centers clustered in several geographic regions: the Central Plain, the Daihai Region, the Haidai Region, the Bashu Region, the Jianghan Plain and the lower Yangtze River Plain (Taihu Region) (Ma 2002). Second, the walled areas of these sites demonstrate considerable variability. Among the Longshan walled towns, four have areas greater than 1 km^2, and twenty-two have areas over 0.2 km^2 (Zhang 2012). Moats have been clearly identified within some of those walled towns. For example, some parts of the walls of the Chengtoushan site are more than 4-5 m above ground level, and some parts of the moats are 35 m wide and 4 m deep. Third, the arrangement of walled towns was planned, with different structures that can be divided into defensive structures, production workshops, elite palaces, daily use facilities, ritual places and burials.

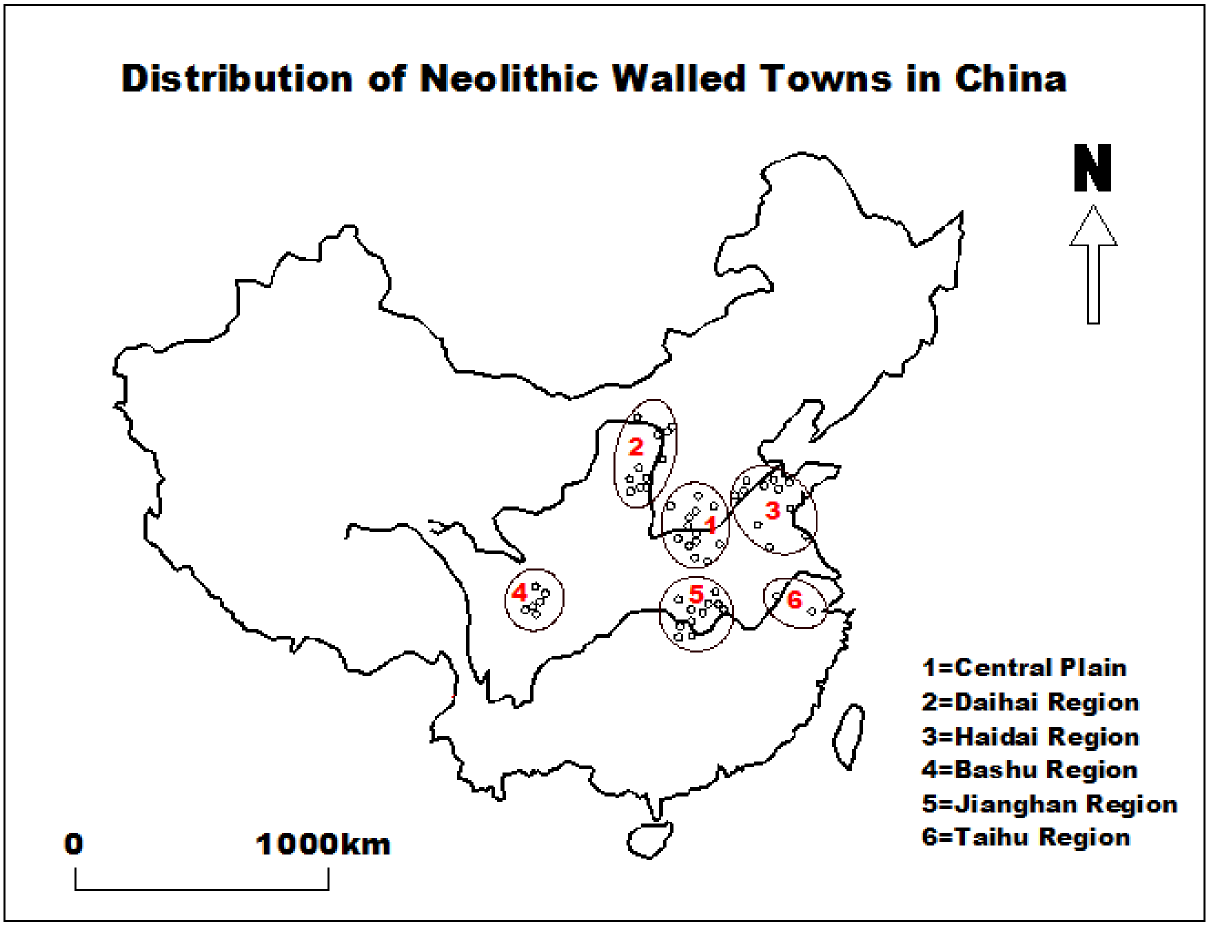

Figure 1.1. Distribution of Neolithic walled towns in China

The defensive structures consist mainly of walls, ditches and natural barriers (rivers, slopes, cliffs, highlands, etc.). For example, most of the towns in the Jianghan Plain were located on the piedmont near rivers and were surrounded by walls and ditches, such as the Bashidang and Shijiahe sites (Hubei 1999; Hunan 1999). Pottery kilns, jade workshops, stone tool factories and possible bronze workshops suggest specialized craft production. For instance, excavations in the Shijiahe site in the Jianghan Plain have revealed piled up pottery cups and figurines, clustered jade working residues and possible bronze residues and slag. Some walled centers also reveal palaces for the elite class. The palace in the Liangzhu site in the lower Yangtze River Plain was centered in the walled area surrounded by fifty sites with different functions (Liu 2007). The facilities include houses, storage pits, wells and drainage features. Excavation in the Xishan site in the Central Plain has unearthed more than 200 houses and 2,000 storage pits. In the Pingliangtai site, a drainage system made of pottery water pipes was found. Walled towns have also yielded ritual places, such as a series of connected pottery cylinders in the Shijiahe site and a large public platform in the Liangzhu site. Within walled towns, burials in carefully planned areas reveal a hierarchy in terms of grave goods and size. For instance, elite burials carefully organized in the southeastern part of the Taosi walled town in the Central Plain contained elaborate grave goods, such as pottery vessels decorated with dragon designs, lacquered objects (including kitchen boards, tables, wine containers and instruments) and jades; however, the graves of commoners had only poorly made pottery vessels and sometimes no grave goods at all.

Perhaps most important, walled towns such as the three-tiered settlement system of the Shijiahe walled towns in the Jianghan Plain (Hubei 1999) and the Liangzhu walled town in the lower Yangtze River Plain (Ma 2002), are seen as regional centers surrounded by sub-regional centers with satellite villages. Systematic regional surveys have revealed the settlement patterns around walled towns for some regions. In general, Longshan walled towns are described as the heads of two-to-three-tiered settlement hierarchies in different geographic regions (Liu 2004). The Taosi site in the Shanxi Province, a single walled town that controlled a hinterland of more than 3300 km^2, had a three-tiered hierarchy during its early period. In the late phase, the region held two competing centers, each with a hinterland of more than 1600 km^2.

According to archaeologists, the settlement patterns of the above regions show competitive relationships between polities, possibly involving climate change, population migration and late long distance change. Another fortified site in the Shanxi Province, the Zhoujiazhuang site in the Yuncheng basin, grew and developed, dominating its rivals in size and population; as a result, it extended its political and possibly economic power over its neighbors to a distance of at least 50 km in a hinterland with over 40,000 inhabitants (Drennan and Dai 2010). The walled towns in the northern and central Henan Province present a different settlement pattern characterized by competitive multiple centers. The average distance between central places was 44 km in northwestern Henan and 40 km in central Henan. The average hinterland size was 1519 km^2 in northern Henan and 1256 km^2 in central Henan (Liu 2004: 198). A regional survey of the Rizhao region in Shandong Province documents two co-existing Longshan centers, Yaowangcheng and Liangchengzhen. Each center is a four-tiered settlement hierarchy with centralized control over economic resources, tribute, ritual and craft specialization. The Liangchengzhen center's hinterland reached approximately 20 km with strong centralization; the Yaowangcheng center extended its control to secondary centers over 8 km away in a more dispersed system (Underhill et al. 2008).

A chronological comparison shows that the earliest known walled towns appeared in the Dongtinghu and Jianghan Plain (Jianghan Region) in the middle Yangtze River Plain during the late Yangshao period (5000-3000 BCE). Walled towns emerged somewhat later in the Central Plain and Haidai regions of the Yellow River Plain during the early Longshan period (Figure 1.2). Most research on the earliest walled towns suggests that these walled towns are indicators of the early state formation of China. Although little research focuses on the social forces responsible for their emergence in a time of increasing social complexity, it is presumed that those earliest walled towns might be antecedents of the later Longshan and Erlitou centers. Several regional surveys that primarily examined later walled towns in the Central Plain (Liu 1996) and the Haidai region (Underhill et al. 2008) have been very enlightening. However, more systematic regional settlement information about the territory and additional settlements around the earliest walled towns (particularly in the Jianghan Plain) would be very useful. Such research around the earliest walled towns in the Jianghan Plain might make similar contributions. Currently, such information is scarce.

Periods	Regions					
	Central Plain	Daihai Region	Haidai Region	Bashu Region	Jianghan Region	Taihu Region
Late Yangshao	Absence	Absence	Absence	Absence	Presence	Absence
Longshan I	Absence	Absence	Presence	Absence	Presence	Presence
Longshan II	Presence	Presence	Presence	Presence	Presence	Presence
Longshan III	Presence	Presence	Presence	Presence	Presence	Presence
Longshan IV	Presence	Presence	Presence	Presence	Presence	Presence
Longshan V	Presence	Absence	Presence	Absence	Absence	Absence

Figure 1.2. **Schematic outline of emergence of walled towns in the six regions**

The later Longshan walled towns are not only indicators of the remarkable social transformation from the more egalitarian Yangshao period to the chiefdom-like Longshan period, but also progress to what is often considered the earliest state in China. This progression is embodied in the Erlitou walled town (customarily identified with the "Xia" dynasty), which is characterized by a four-tiered settlement hierarchy, palace foundations, bronze vessel workshops, bone tool workshops, pottery kilns, hierarchical burials, storage facilities, jade carvings, stone artifacts, bone artifacts and pottery (Liu 1996; Liu 2004; Liu and Chen 2003). Researchers have used the Yiluo Basin regional survey results to argue that highly integrated social systems developed in circumscribed and semi-circumscribed conditions, while more decentralized social organizations developed in the non-circumscribed lowlands of the Central Plain. Competition between decentralized polities characterized by political independence and small territories culminated in the integration of the first state in the Central Plain (Liu 1996; Liu 2004). Compared to the role of walled towns in later large-scale state societies, the nature of the earliest walled towns in different regions remains quite unclear. On the one hand, some scholars have observed that walled towns emerged on top of already existing settlements. They have proposed that the emergence of Longshan walled towns resulted from increasing productivity and private ownership, which intensified the social conflicts of these settlements (Cao 1996; Pei 2004; Qian 2003; Ren 1998; Sun 1999). Other scholars have advanced the contrasting view that the emergence of walled towns in the Yangtze River drainage was an effect of efforts to control frequent flooding during the Neolithic period (He 2002; Wang 2003).

1.2 GEOPHYSICAL CONDITIONS OF PROPOSED STUDY AREA

In order to contribute to a better understanding of the social trajectory of the earliest walled towns in Neolithic China, the research presented here focused on the Taojiahu and Xiaocheng walled towns, which are among the earliest walled towns in China; they are located in the Jianghan Plain within the middle Yangtze River Plain. The middle Yangtze River Plain is mainly composed of the Jianghan Plain, situated in the northern part of the Yangtze River drainage basin, and the Dongtinghu Plain in the southern part of the Yangtze River drainage basin. The Jianghan Plain, the largest part of the middle Yangtze River Plain, encompasses a total area of about 55,465 km^2 with seven main geomorphological zones: the lacustrine alluvial plain with an altitude below 26 m above sea level; the low alluvial with an altitude ranging from 26 to 31 m above sea level; the high alluvial plain with an altitude ranging from 31 to 37 m above sea level; the plain hillocks with an altitude ranging from 37 to 56 m above sea level; the piedmont with an altitude of 56-84 m above sea level; hills with an altitude from 84 to 171 m above sea level; and mountains with an altitude more than 171 m above sea level (Deng et al. 2009). Most walled towns in the Jianghan Plain were located in the high alluvial plain zone, the plain hillock zone and the piedmont, with altitudes from 31 to 85 m above sea level. The Jianghan plain has a subtropical monsoon climate with an annual precipitation of 1000-1500 mm, and a mean annual temperature of 16.5^{o}C. The zonal vegetation formerly consisted of evergreen broadleaf forests and deciduous and evergreen broadleaf mixed forests. The Jianghan Plain also contains a large number of bodies of water including lakes, rivers and streams; these provide abundant water for agriculture, drinking, irrigation and aquaculture (Fang et al. 2005).

1.3 RESEARCH BACKGROUND OF WALLED TOWNS IN THE JIANGHAN PLAIN

Sporadic excavations and reconnaissance surveys reveal that by the seventh millennium BCE, settled agricultural subsistence had been established in the middle Yangtze River Plain (Pei and Xiong 2004; Yan 1982; Zhang 1996; Zhang 1998). The Neolithic period of the Jianghan Plain starts with the Daxi period (4400-3100 BCE) and continues through the subsequent Qujialing (3100-2500 BCE) and Shijiahe (2500-2000 BCE) periods. The societies of the Neolithic period were characterized by a rapid development in sociopolitical complexity, as seen in probable population growth, the rise of settlement hierarchy, wealth differentiation and the emergence of walled towns (Guo 2009).

In the Daxi period, sedentary agricultural settlements were sparsely distributed in the western Jianghan Plain. From the late Daxi period, social inequality is discerned from sharp contrasts between burials, particularly in terms of burial goods. Some burials contained up to sixty-three offerings, including ceramic vessels and stone tools; others had few burial items (Guo 2005). Storage pits within houses suggest that household units owned property (Guo 2005; He 2004). He (2004) further argues that the small local communities were perhaps organized around kin groups, he notes that there is no indication that they were integrated into any political organization that transcended the locality. In the late Daxi period, walls were built around the Chengtoushan site in Hunan.

By the Qujialing period, about thirteen walled towns had emerged and served as regional centers (Figure 1.3). For example, the largest walled town, Shijiahe, has rammed earth walls as high as 6-8 m, while a ditch around the town as wide as 60-100 m encloses 120 ha (Beijing 1992). Smaller unwalled settlements, together with the walled towns, formed a two-tiered settlement hierarchy. Well-organized communal ritual sites, craft workshops and burials were also found around the towns (He 2004). Such settlement hierarchy has been connected to leadership and complex organization via notions of management, mobilization and power (Drennan et al. 2010).

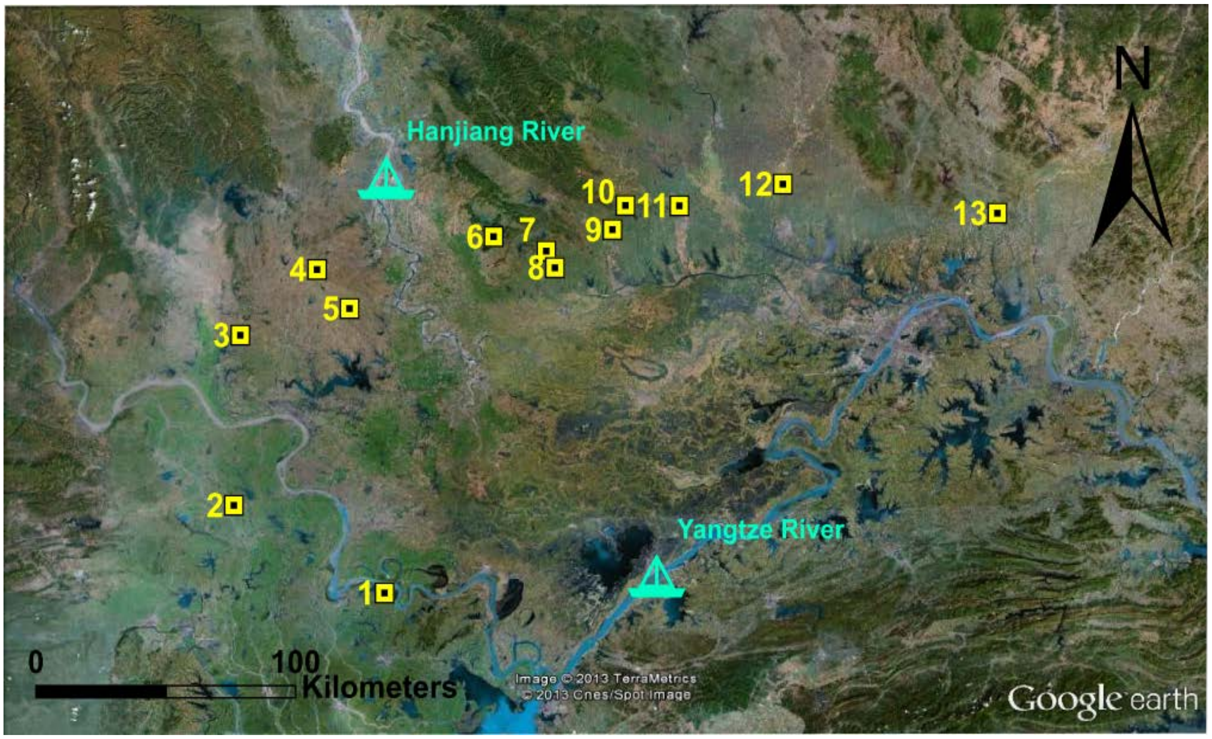

Figure 1.3. Distribution of walled towns in the Jianghan Plain (*9 represents the Xiaocheng Walled town and 10 represents the Taojiahu walled town*)

Pei (2011) proposes that the expansion of the largest walled town, abandonment of several towns and adoption of a three-tiered settlement system during the Shijiahe period might indicate a trend of socio-political consolidation in a much larger region. The center was arranged with communal ritual sites, burials and craft workshops, all of which illustrate the institutionalized social hierarchy. Sites with bucket-shaped cylindrical pottery mortars, intentionally broken red pottery goblets and graves with jade ceremonial objects suggest ritual places. Well-designed kilns and piled stone spindle whorls confirm workshops (Hubei 1999).

Walled towns in the Jianghan Plain have attracted much attention since they were found, with most of the interest directed toward them as a cultural contribution to early Chinese civilization and state formation. The emergence of the Jianghan Plain towns has resulted in heated debates, particularly on causal dynamics. By investigating the distribution of artifact styles in the Jianghan Plain and the Central Plain, some researchers have tried to connect the emergence of walled towns to inter-regional conflicts between polities of the Central Plain and those of the Jianghan Plain (He 2004; Li 1988; Meng 1997; Yu 1980; Zhang 1992). These researchers have drawn on the legend of *yu fa san miao* 禹伐三苗, which records wars between the Huaxia ethnic group from the Central Plain and the *san miao* group from the Jianghan and the Dongtinghu Plains. Some archaeologists believe that the *san miao* group created the walled towns of the Qujialing culture and the Shijiahe culture.

While other researchers also recognize the significance of conflicting perceptions, they still argue that the emergence of walled towns was a response to intra-regional conflict arising from competition for diminishing resources caused by climate change in the middle Daxi period. This climate change, which diminished the amount of agricultural land, occurred when the middle Yangtze River drainage underwent a cooling climate and rising flood levels led to less favorable conditions for rice cultivation (Guo 2005; Pei 2011). The situation further validates that walled towns might be the product of resource competition, particularly between the Qujialing and Shijiahe groups. Conflicts between the two groups finally produced the political integration of the Jianghan Plain. From a regional settlement research perspective, some other questions should also be raised in order to better understand these social trajectories. For example, one might ask the following: (1) Which factors from among the various factors that people think were central place functions in later walled towns that served as capitals of chiefdoms and more complex states began in the earliest walled towns in the Jianghan Plain? (2) What were the antecedents (in terms of regional organization) of the Jianghan Plain's walled towns? And (3) Were there earlier centralized town-like settlements without walls that have been less noticed, but that seem central places because regional settlement clustered around them? If so, what were the special functions of these earlier central places.

The walls themselves are usually considered as public works whose remarkable remains lead archaeologists to envision complex social organization for mobilizing construction labor. Ever since they were reported, the walled towns of the Jianghan Plain have been seen as indicators of the trajectories of development of regionally complex hierarchical social organizations. Research also makes it seem likely that these complex hierarchical societies experienced some sort of decline or collapse. For chiefdoms, basic small social units tend to be integrated into larger scale societies covering a larger area. That also means that a hierarchical chiefdom society would gradually integrate more people, a finding that an archaeological excavation or survey could discover. However, social units would form different clusters or communities based on how intensively they interacted with each other. In this sense, the trajectories of hierarchical chiefdom societies would also provide some clues for archaeologists in delineating local and supra-local communities and further estimating the strength of the social centripetal forces. Because numerous different forces might play roles in social centralization, varied specific elements can be important in different chiefdom societies. A productive archaeological agenda, then, can probe into complex society trajectories seeking to find out the relative importance of and interrelationships among various variables.

Departing from Service's (1962) evolutionary sequence of four societal types (band, tribe, chiefdom and state), the focus of research on social complexity has shifted from identifying universal social patterns to studying variability in evolutionary trajectories (Earle 1991). Trajectories of complex societies and how chiefs seize and maintain power widely differ, falling in the range of economy (Gilman 1991, 2001; Stanish 2004), ideology (Aldenderfer 1993; Earle

2001b; Marcus and Flannery 2004) and warfare (Carneiro 1990, 1998; Earle 1991; Flannery and Marcus 2003; Webster 1998). In investigating the emergence and development of the hierarchically and centrally organized social systems of walled towns, the research presented here will mainly focus on the regional economic and social function of walled towns.

Economic factors in the evolution towards centralized societies can be reflected in how people located themselves in communities. For sedentary agricultural societies, a fundamental locational factor is the distance to farmland. Although farmers benefit from residing close to the land that they farm, other factors, such as the land tenure system and different ways of organizing and controlling labor, might undermine this positive. The organization of labor and the exchange of surplus represent other economic factors that play important roles in population distribution in a region. Individual households might be vulnerable to natural disasters or harmful human activities, while residing together could protect residents from danger and facilitate productive exchange. In addition, considering sedentary rice cultivation as the central subsistence activity in the Neolithic Jianghan Plain, access to irrigation water might be a special factor for population distribution in this case. Such factors intertwine to produce demographic distributions and form communities at both local and supra-local scales. By looking into social trajectories, archaeologists can hope to find out how these factors worked together and which ones played more important roles in social centralization. Furthermore, the relationship between the residences of the elites and the distribution of different resources may provide clues as to how many important resources the elites controlled.

Carneiro (1970, 1990 and 1998) presents a coercive model to account for the emergence of chiefdoms, arguing that frequent warfare creates a situation in which inter-village alliance is desirable and predictable. In this sense, a simple level of political organization (alliance) would then upgrade to institutionalized political organization by engaging in a higher level of warfare. His model also emphasizes how other factors such as circumscribed socio-environmental contexts and resource pressure from increasing population density are also relevant to the outbreak and duration of warfare and social complexity. This is one example of an approach that makes us want to know more about the profile of regional-scale demographic change associated with the emergence of the predecessors of walled towns. With the presence of walled and ditched settlement in the Jianghan Plain, the role of warfare in the emergence of walled towns is also worth a systematic evaluation from the perspective of the relationship between population density and social-environmental and resource contexts.

Based on the given theory about development of social complexity, in order to contribute to a deeper understanding of the social trajectories of the earliest walled towns in the Jianghan Plain, the research presented here focused on two of the earliest walled towns in the Jianghan Plain—the Taojiahu and Xiaocheng walled towns (Figure 1.3) and the territory surrounding them.

1.4 RESEARCH QUESTIONS

(1) What were the central place activities carried out in the walled towns but not in their hinterlands? Craft production? Storage of agricultural staples? Elite residences? Rituals? Political administration?

(2) What were the sizes of the populations that lived in the Taojiahu and Xiaocheng walled towns and their hinterlands?

⑶ Was the growth of the walled towns largely a question of in-situ population increase, or was it produced by immigrants moving in from the hinterland?

⑷ Did demographic centralization start before the emergence of walled towns, or did they represent the initial demographic centralization in the region? Which of the central place functions of the Taojiahu or Xiaocheng walled towns can be detected in any predecessor?

⑸ Towards what environmental resources were the distributions of the regional population oriented? Rivers? Fertile farmland? Transportation routes? Mineral deposits for wealth products or other special items?

1.5 RESEARCH PLAN

The research presented here began in the field with a full-coverage systematic survey in the Tangchi-Zaoshi region including the Taojiahu walled town, the Xiaocheng walled town and at least part of their hinterlands with a total area of about 58 km^2 (Figure 1.4). Regional survey in the Tangchi-Zaoshi region followed a methodology of systematic, full-coverage, pedestrian survey familiar from regional surveys carried out in the Upper Daling Valley and the Chifeng Region (Chifeng 2011; Peterson et al. 2014) as well as other parts of the world, derived ultimately from methods applied in the Basin of Mexico and the Valley of Oaxaca (Blanton et al. 1982; Kowalewski et al. 1989; Sanders et al. 1979). Survey teams of three or four people walked systematically back and forth across the landscape to record the locations and spatial extents of all surface scatters of artifacts and discernible archaeological features such as walls and ditches, the principal indicators of ancient human occupation in this area.

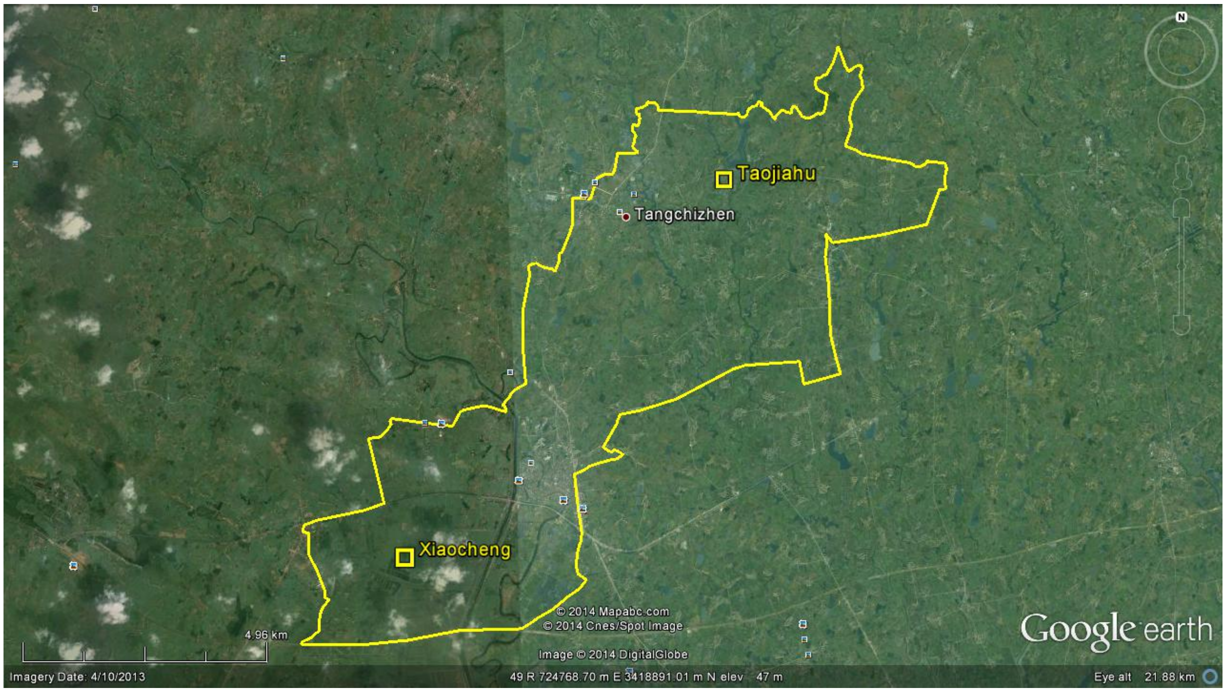

Figure 1.4. Map of survey area

The regional survey recorded materials dating to all periods between the beginning of the Neolithic period around 4400 BCE and the end of the Tang period about 907 CE, after which time no serviceable classification scheme for archaeological ceramics is available. The Neolithic occupations from the Youziling period to Shijiahe period (3900-2000 BCE) are central to this research. The spacing between survey team members as they walked across the landscape was 50 m. All localities with surface artifacts were divided as necessary into units no larger than 1 ha, and a separate surface collection of artifacts was made in each one. Roads, field borders and other such convenient and visible surface features served as boundaries. The locations of all units were recorded in the field by drawing their limits directly on high resolution satellite imagery printed at a scale of 1:10,000. A systematic collection circle with a radius of 1.8 m (so as to have an area of 10m^2) was drawn on the ground near the center of each 1 ha unit. If careful collection of surface artifacts within the circle produced fewer than 10 sherds (1 sherd per m^2), then a general collection was made from the entire 1 ha sector in an effort to collect at least 40 sherds. If the circle produced more than 10 sherds but fewer than 40, then it was enlarged to 20, 30, or 40 m^2, as needed, until a sample of 40 sherds was acquired. This systematic collection procedure makes it possible to quantify surface sherd densities and further facilitates making demographic estimates for all periods (Drennan et al. 2003). This regional survey data are generally comparable data from other regional surveys in Chifeng (Chifeng 2011), Henan (Liu et al. 2004) and Shandong (Underhill et al. 2008).

The central place functions of the walled towns were investigated in terms of their locations and the nature of artifacts found there in higher proportions than at smaller hinterland sites. For example, a location central to the most productive agricultural soils would suggest the management of agricultural production and/or storage and exchange of agricultural products. A high proportion of artifacts like spindle whorls or kiln wasters would indicate specialized textile or ceramic production at the walled town. A high proportion of sherds from finely made and elaborate ceramics would intimate a concentration of elite residence. A high proportion of sherds of ritual vessels would suggest a concentration of religious activities.

Population estimates were based on the assumption that more artifacts mean more ancient inhabitants. An area-density index of sherds in a1-ha collection unit was calculated to evaluate how population was distributed on the landscape during a given period (Chifeng 2003). The demographic trajectory of central place and hinterland and the interaction between them illustrate the community growth patterns. For example, a continual increase of population of one village and relative stability at others might indicate that a relatively independent or self-driven community growth pattern. A trajectory with a continuing increase of population in one village and a gradual dwindling population in the adjacent area would suggest a population drawn inward from hinterland to center. The chronological relation between walls and population growth can be observed by looking at when population started to concentrate. Population growth before the construction of walls would reveal the prior emergence of a center with a centralized population for reasons that did not involve the walls themselves. If such population concentration did happen earlier than wall construction, then related archaeological activities as mentioned at the beginning of this paragraph would provide clues to the social function of the walled town. Site locations would indicate possible relationships between population and environmental resources, especially by the proximity of settlements to any potentially important resources, such as water, fertile farmland, transportation routes or mineral deposits. The proximity of most population to rivers would suggest a critical role of water resources in population distribution. The closeness of population to fertile farmland would indicate an emphasis on agricultural production. Such causal relationships also occur between population and other resources.

2. CERAMIC CHRONOLOGY

One of the basics of analysis for regional survey is the accurate dating of artifacts collected from the surface. The chronological identification of artifacts facilitates archaeological understanding of periods of occupation through time and helps archaeologists estimate population size in both spatial and time dimensions. Usually, sherds are the most important artifacts in this chronological analysis, because characteristics of vessel forms, decoration, firing, paste and temper are sensitive to change through time. For population estimation, as discussed in the first chapter, fired vessel parts are resistant to decay and durable even when climate changes. The abundance of sherds on the ground is one of the most important indicators of population density and size. In this sense, the examination of sherd characteristics and density through time provides reliable data for regional settlement analysis, particularly in regard to changes in population density and size through time.

Previous research has established the basis for ceramic analysis in the Jianghan Plain. Archaeologists have focused a great deal of attention on the analysis of ceramic styles during a long period of cultural historical research. Careful work on artifacts in past decades makes it possible to accurately put sherds from a regional survey accurately into periods for further quantitative regional settlement analysis. In this chapter, the sherd characteristics of each period are described. Since sherds from the Shang and Western Zhou periods are extremely scarce in the survey area, the most typical chronological indicators such as rims and bases are entirely absent. Thus, no typical features of sherds from the Shang and Western Zhou dates in the survey area will be described or illustrated in this chapter.

2.1 THE YOUZILING PERIOD

The Youziling period was named after the Youziling site excavated in 1980s (Hubei 1994). Characteristic Youziling pottery is found in the eastern part of the Jianghan Plain, centered in Tianmen where the earliest Youziling sites were found (Hubei 2008). In addition to the Youziling site and the Longzui site, excavated sites with Youziling remains include Liuhe (Jingzhou 1987), Tanjialing (Hubei 2015) and Xihuayuan (Wuhan 1993).

Surface collection only yields a few Youziling sherds. The identified types of vessels include *ding* 鼎, *weng* 瓮 and *bo* 钵. The vessels are hand-modeled from red sandy clay tempered with fragments of crushed clamshell and fine clay. Some of the Youziling sherds are gray and polished black wares, although these vessel forms are impossible to identify. In addition to polished black sherds, other sherds recovered were coated with a thick red exterior slip. In general, Youziling sherds were fired at a relatively low temperature and tend to be easy to identify. Youziling sherds are relatively easy to identify. For example, the rims of *ding* 鼎 vessels are fairly long and extend upwards (Figure 2.1:1); a thick red slip and fingertip impressions are common on tripod vessel feet (Figure 2.1:2). The main form of rim for *wan* 碗 was straight upward (Figure 2.1:3). The mouths of *bo* 钵 and *weng* 瓮 are both quite restricted (Figure 2.1:4, 5).

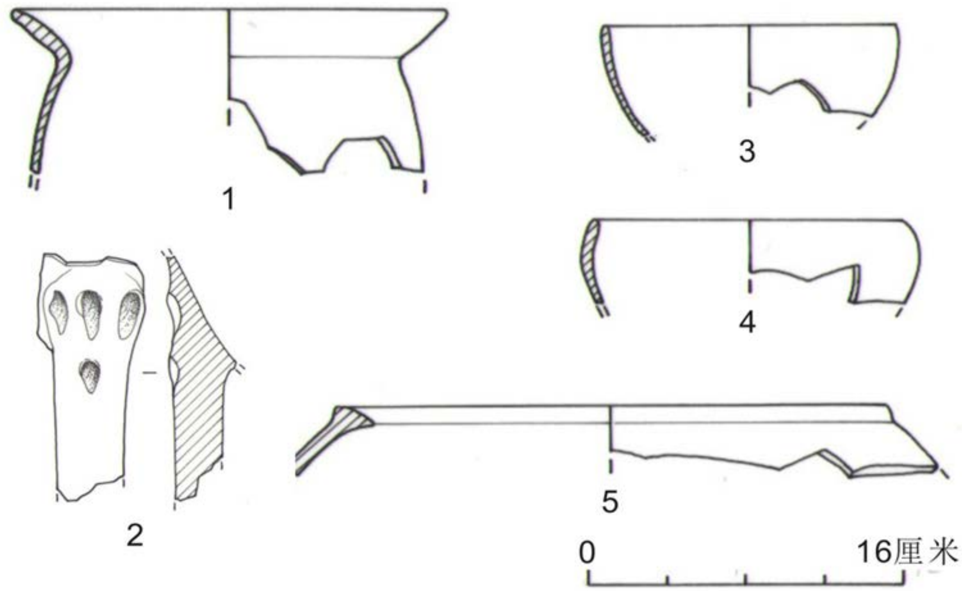

Figure 2.1. Youziling sherds

2.2 THE QUJIALING PERIOD

The Qujialing period is named after the Qujialing site in Jingshan, Hubei Province (Zhongkeyuan 1965). The distribution of Qujialing style pottery is primarily centered in the middle Yangtze River Valley, although it also expands westward to the upper Yangtze River Valley, north to the Nanyang Basin and even the Central Plain, east to the eastern edge of the Jianghan Plain, and south to the Dongtinghu Plain. Compared to the Youziling period, many Qujialing sites were found in the Jianghan Plain and adjacent regions. Besides especially central sites like Qujialing (Zhongkeyuan 1965), Zoumaling (Jingzhou 1998), Liuhe (Jingzhou 1987), and Tanjialing, Dengjiawan and Xiaojiawuji (Hubei 1999; 2003; 2011) in the Jianghan Plain, there were also the Xiawanggang (Henan 1989) and Huanglianshu (Changjiang 1990) sites in the Nanyang Basin.

Qujialing sherds are characterized by unprecedented technological progress in pottery making, such as the fast wheel technique, delicate elaborate black vessels, multiple decoration patterns, and widespread use of fine clay. Compared to the sherds of the Youziling period, far more Qujialing sherds were made of fine clay, with only a few made of coarse sandy clay. Among the fine paste sherds, most had a thin polished slip of black or gray clay; the rest were grayish and yellowish sherds without any slip. Most of the sherds of coarse sandy clay were gray; the rest were red, black and yellowish. Qujialing pottery was well made and fired at a high even temperature. Vessel forms that could be identified include *ding* 鼎, *guan* 罐, *bei* 杯, *pen* 盆, *wan* 碗 and vessel lids. The Qujialing period typically had plain pottery; only a few vessels showed elaborate decoration in complex patterns of cord marking, painted parallel lines and other patterns. Unfortunately, the thin exterior slip to which most of the decoration was applied has usually eroded away. Thus, decoration is seldom visible on surface collected sherds, leaving vessel form, and paste and temper characteristics as the main indicators for dating. For example, the mouths of *guan* 罐 are restricted and their rims flare outward (Figure 2.2:1-5).

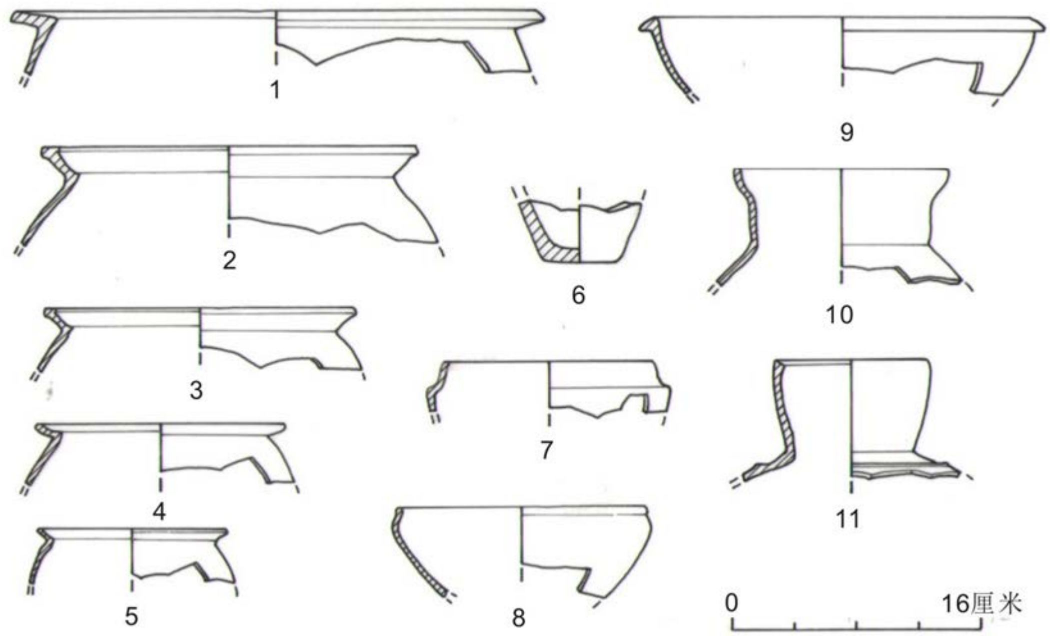

Figure 2.2. **Qujialing sherds**

2.3 THE SHIJIAHE PERIOD

The Shijiahe period is named for the Shijiahe site in Tianmen, Hubei Provence. Like Qujialing, the Shijiahe pottery distribution is centered in the Jianghan Plain and the limits of its distribution coincide with those of Qujialing pottery. Since Shijiahe pottery developed directly out of Qujialing pottery, most of the important sites with Qujialing remains also contain Shijiahe archaeological remains. Shijiahe pottery is typically gray, black and red. The reddish pottery of the Shijiahe period is quite distinctive, although not many reddish sherds were found in surface collections. Vessels with ring bases (*dou* 豆, *pan* 盘 and *wan* 碗) and tripods (*ding* 鼎) were very common in the Shijiahe period. However, very few sherds with actual fragments of ring bases or tripods were found in surface collections. Another clear indicator of Shijiahe pottery is its decoration, which was more abundant on Shijiahe than on Qujialing pottery. For example, multiple decorative patterns were applied to *weng* 瓮 and *pen* 盆 (Figure 2.3:1-5). Some vessels, such as *guan* 罐, were smaller than their Qujialing counterparts (Figure 2.3:6). *Bei* 杯, in contrast, became thicker and taller than in the previous period (Figure 2.3:8, 9).

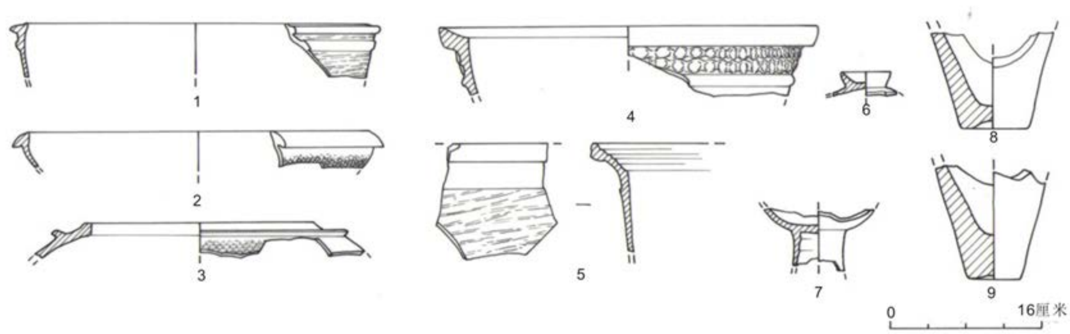

Figure 2.3. Shijiahe sherds

2.4 THE SHANG AND ZHOU PERIODS

The Shang period is borrowed from history and refers to the archaeological Erligang (Early Shang) period and Shang periods in the Central Plain. In the Jianghan Plain, very few sites of Shang date were found. Recent research has focused on regional centers and walled towns from Shang times in the Jianghan Plain, such as the Panlongcheng site and the Jingnansi site. The clearest indicator of Shang pottery is the appearance of *li* 鬲 tripods with pocket-shaped upper parts and long thin lower parts. Only a few belly and tripod fragments of *li* 鬲 were found in surface collection. The earlier Shang period *li* 鬲 shape is distinguished from the shape associated with the Western Zhou *li* 鬲, which has very short tripod feet. Most of the sherds from Shang times recovered in the survey were gray with cord marking.

Western Zhou times refer to the early Chu period in the Jianghan Plain. In past decades, research on Chu period pottery has provided abundant data for identifying the earliest Chu pottery. The most popular Chu assemblage includes *li* 鬲, *yu* 盂, *guan* 罐 and *dou* 豆, among which *li* 鬲 is considered the most common vessel form. *Li* 鬲 of the early Chu period were made of sandy red, gray and reddish brown clay, and cord marking prevailed on *li* 鬲 as well as on other vessel forms. Compared to *li* 鬲 in the Shang period, early Chu style *li* 鬲 are distinguished by taller thin solid lower tripod feet.

Eastern Zhou times refer to the middle and late Chu period in the Jianghan Plain. In the Eastern Zhou period, the Chu state was also centered in the Jianghan Plain. Compared to methods of previous periods, the techniques of pottery making during Eastern Zhou times had advanced considerably, particularly in regard to higher firing temperatures and better clay processing so as to produce stronger and more durable pottery. The inventory of vessel forms also expanded during Eastern Zhou times. The most common assemblage of vessel forms includes *li* 鬲, *yu* 盂, *guan* 罐 and *dou* 豆. Eastern Zhou sherds from surface collection include more fine paste sherds and fewer sandy clay sherds. The majority of the fine paste sherds are yellowish gray; the rest include red, black slipped and gray sherds. Sherds of Eastern Zhou times mostly had plain walls. A considerable number of sherds were decorated with cord markings and curved string impressions. Sherds of coarse sandy clay were red, yellowish, black and gray sherds. Vessel forms that could be identified include *dou* 豆, *yu* 盂, *guan* 罐 and *ding* 鼎 tripods. The upper parts of *li* 鬲 tripods were constricted to form narrow necks and high flaring rims

(Figure 2.4:1-3). *Li* 鬲 tripods were higher and thinner than those of previous periods (Figure 2.4: 10). *Yu* 盂 have clearly defined necks and flat rims that turn slightly outward. Below the necks, the bodies of *yu* 盂 were decorated with cord marking (Figure 2.4: 4, 5 and 6). Eastern Zhou *guan* 罐 with straight necks were decorated with cord marking on the lower neck (Figure 2.4: 7). *Dou* 豆, among the most common vessel forms in Eastern Zhou times, formed shallow upper containers with straighter thinner handles in the middle part (Figure 2.4: 11-15).

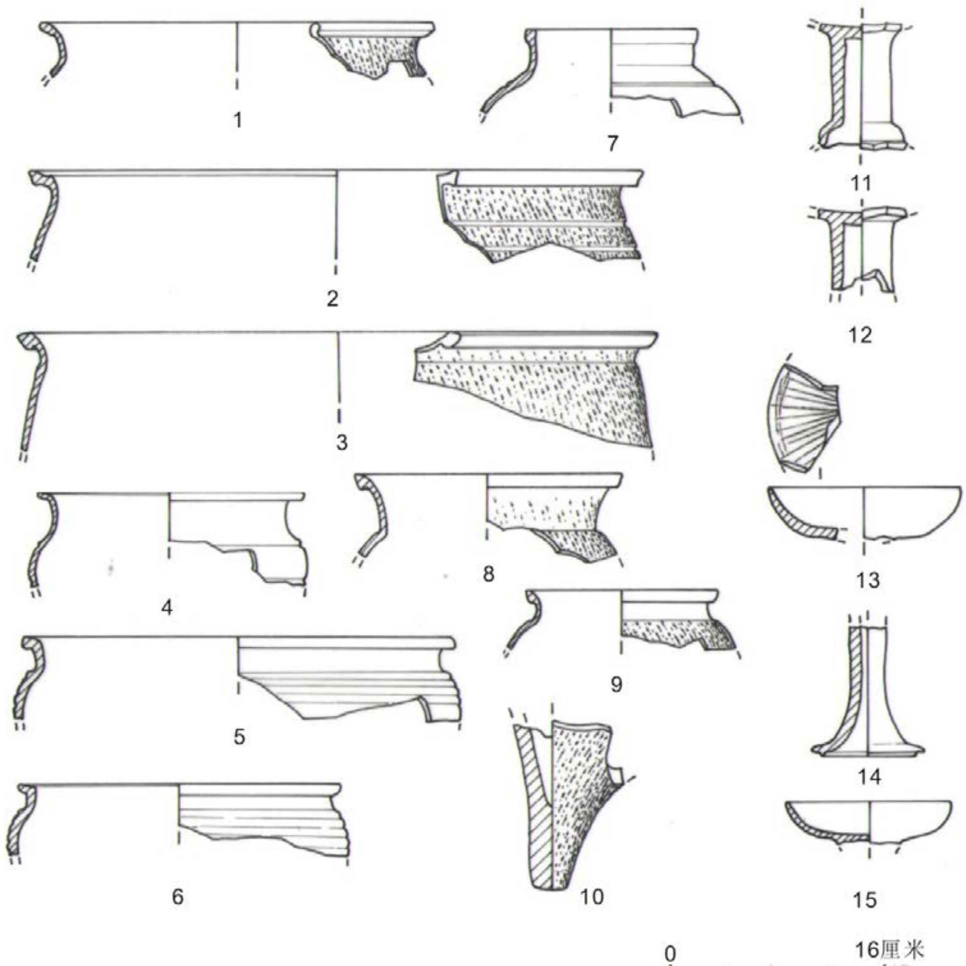

Figure 2.4. Shang and Zhou sherds

2.5 THE HAN PERIOD

The Han period refers to the historical Han dynasty. During this era, the ceramic industry had advanced greatly, as seen not only in the quality of ceramics but also the highly varied vessel forms. Compared to ceramics of previous periods, Han ceramics were stronger and more durable. Most ceramics were made with fine clay; only a few coarse sandy clay sherds were recovered from surface collection. Although most of the sherds were gray, a few grayish black and grayish yellow sherds were found. In the Han period, when compared to Eastern Zhou times, the proportion of cord mark decorated sherds had increased, although undecorated sherds still comprised a considerable proportion. Vessel forms that could be identified also increased in Han times, including *ding* 鼎, *pen* 盆, *weng* 瓮, *hu* 壶, *guan* 罐 and *dou* 豆. A clear change from Eastern Zhou happens on *dou* 豆, which have deeper upper containers and shorter handles (Figure 2.5: 4). Sherds of *weng* 瓮 (Figure 2.5: 1-3), *pen* 盆 (Figure 2.5: 6-9), and *hu* 壶 (Figure 2.5: 9) were frequently found.

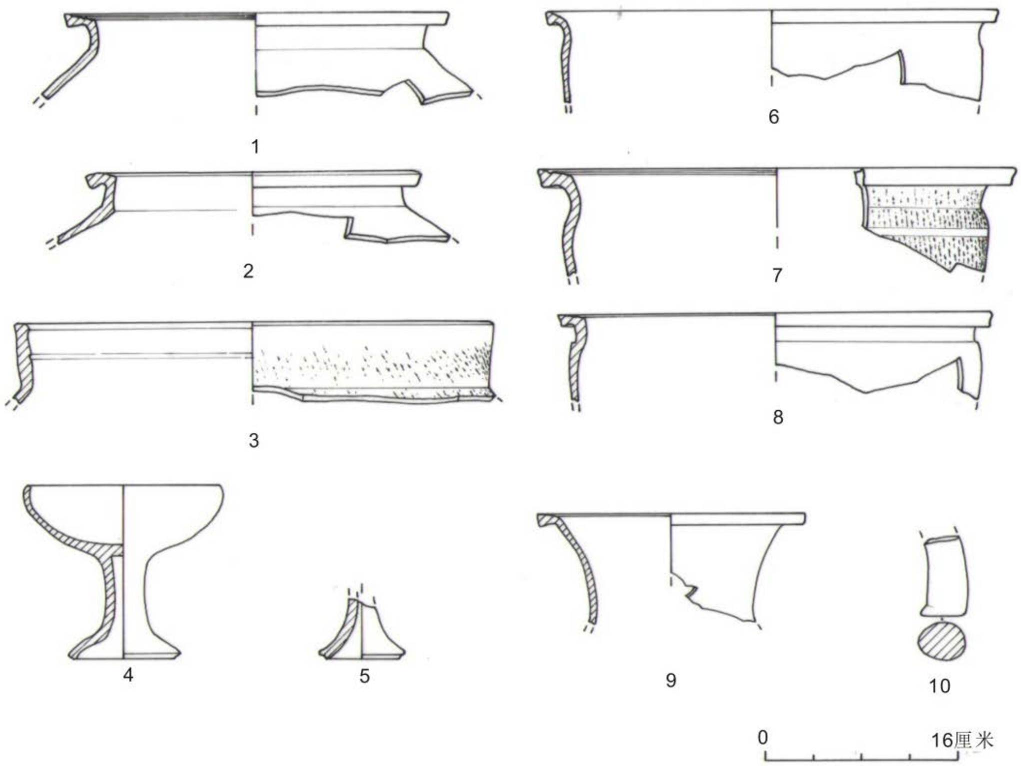

Figure 2.5. Han sherds

2.6 THE WEI-JIN PERIOD

Wei-Jin corresponds to the historical time from the Three Kingdoms period to the Sui Dynasty. Sherds from this period were mainly gray pottery with fine paste. The majority of the sherds had no decoration; only a few had stamped parallel strips. The walls of Wei-Jin pottery were thicker in general than those in earlier periods. Vessel forms that could be identified include *pen* 盆, *weng* 瓮 and *guan* 罐. Wei-Jin *pen* 盆 had straight upper walls and flat horizontal rims (Figure 2.6: 1 and 2). *Guan* 罐 vessels were made with long straight necks (Figure 2.6: 3) and thick ring handles (Figure 2.6: 6). Both the necks and middle segment of Wei-Jin *weng* 瓮 were very short (Figure 2.6: 7-9).

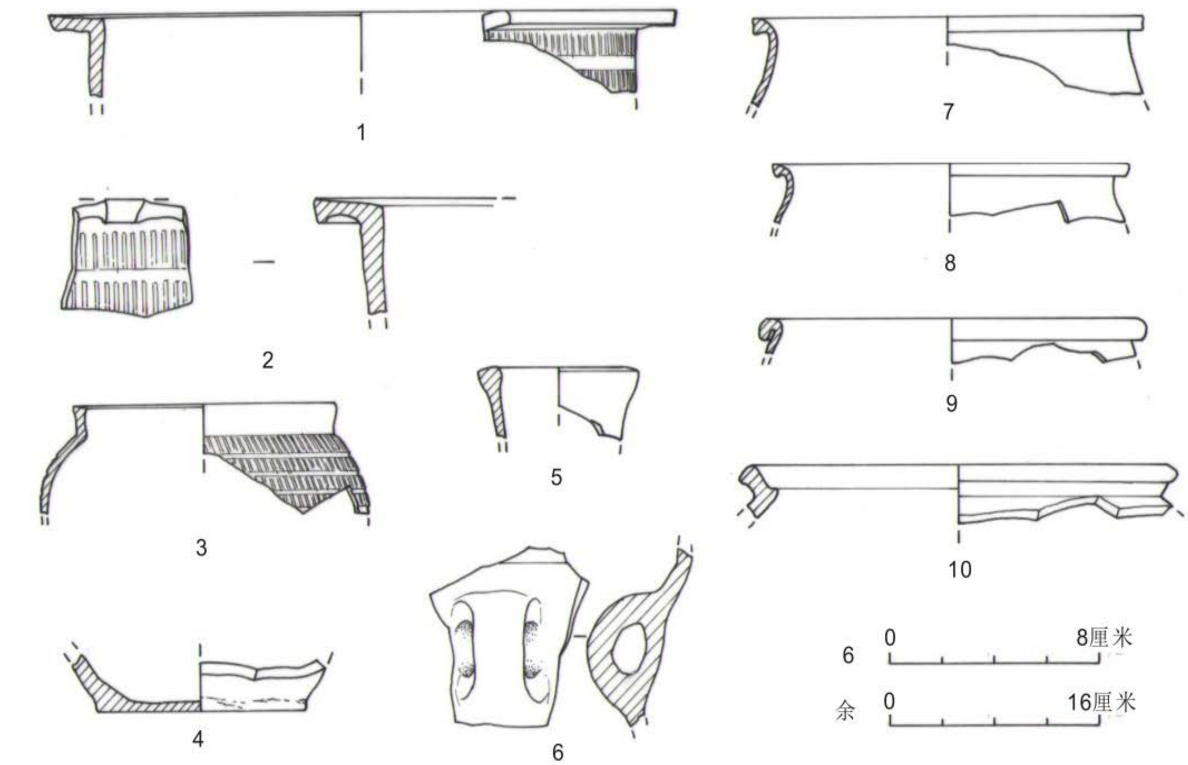

Figure 2.6. Wei-Jin sherds

3. GENERAL ENVIRONMENTAL CHARACTERISTICS AND SETTLEMENT DISTRIBUTION

The primary objective of this chapter is to discuss the trajectories of social complexity from the Neolithic to the Wei-Jin period in the survey area of the Jianghan Plain. The understanding of trajectories of social complexity is largely based on the survey results and on excavation which has been completed previously within the surveyed area and adjacent regions in the Jianghan Plain. Based on settlement analysis, the chapter reconstructs the trajectories of social complexity of the Taojiahu walled town and Xiaocheng walled town polities, and further discusses the dynamics of the social evolution of walled towns in the Jianghan Plain.

3.1 THE NATURAL ENVIRONMENT IN THE JIANGHAN PLAIN

The Jianghan Plain, located in central China and the middle Yangtze River Valley, has a total of 36072 km^2 covering the middle and southern parts of Hubei Province. The Yangtze River flows from northwest to southeast and then from southwest to northeast, cutting the middle Yangtze River Plain into two parts. The northern part is the Jianghan Plain and the southern part is the Dongting Lake Plain. The largest tributary of the Yangtze River in the Jianghan Plain is the Hanjiang River, running from the northwest to the southeast and dividing the Jianghan Plain into eastern and western sectors.

The Jianghan Plain is a closed region limited by the Tongbai Mountains in the east, the Dahong Mountains in the north, the Yangtze Gorges in the west and the Yangtze River in the south. The Yangtze River itself has served as a major channel linking the closed Jianghan Plain with regions farther east and west. In addition, two major routes connect the Jianghan Plain to the Central Plain and to the Nanyang Basin in Henan Province. One is the Suizao Corridor in the northeast going north to enter the southern part of the Central Plain and the Nanyang basin. The other route is the Hanjiang Corridor in the northwest of the Jianghan Plain going north and connecting to the Central Plain by the Hanjiang River.

The terrain of the Jianghan Plain is relatively flat in its southern heartland and gently rolling in the northern margins, reaching toward mountains farther north. The elevation of the heartland of the Jianghan Plain is below 100 m above sea level, and most areas are below 40 m above sea level. The elevation of the marginal eroded hills ranges from 200 to 300 m (Liu 1994).

The climate of the Jianghan Plain is subtropical. The gross radiation intensity ranges from 440 to 470 kj/cm^2. The annual frost-free period is 243-275 days. The mean temperature in January is between 2 and 4˚C; the mean temperature in July is above 28˚C. In the Jianghan Plain, the annual precipitation is between 980 and 1300 mm, of which 70% falls between April and September. Abundant rainfall produces and fills a large number of rivers, lakes and ponds, which occupy 18% of the surface area of the Jianghan Plain. The total lake area is 1605.4 km^2. This large volume of surface water provides abundantly for cultivation of rice and other plants. Over the long term, plentiful rainfall and runoff have caused soil movement from marginal higher elevations to lower elevation. The aggregation of fine sand, clay, silt and organic matter in areas of lower elevation provides much fertile land for agriculture, and especially for rice cultivation (Liu 1994).

The Taojiahu-Xiaocheng survey zone is located in the eastern part of the Jianghan Plain and covers a total of 58 km². Its elevation is below 80 m above sea level. The Zaoshi River cuts the survey area into a northern part with elevation ranging from 30-90 m above sea level and a southern part with elevation mostly below 30 m. The northern part of the survey area is at the junction of the Dahong Mountains in the north and the heartland of the Jianghan Plain in the south. In the northern part of the survey area, the Taojiahu River flows between two north-south ridges where the Dahong Mountains extend out into the survey area. Because of this extension of the mountains, the northern part of the survey zone is composed of gently rolling land, while the southern part is relatively flat.

3.2 CLIMATE CHANGE IN THE PAST 10,000 YEARS

Climate change in the past potentially played an important role in population change in the process of social complexity. Since the 1960s, researchers have paid comprehensive attention to climate change in the past in order to reconstruct its sequence and further interpret its relation with social complexity. A considerable amount of research has been conducted to reconstruct the patterns of climate change in the Jianghan Plain (Li et al. 2011; Wang 1998; Xie et al. 2006; Zhu et al. 1997; Zhu et al. 1997; Zhu et al. 2007). In spite of this increase in publications, the reconstruction of past climate and environmental change are still very general in terms of both time and space, making it extremely difficult to correlate environmental sequences with social, political and economic trajectories of human communities. Also, efforts to reconstruct past climate and environmental condition frequently produce contradictory results, which cause hesitation among archaeologists to apply them to research on specific social trajectories. This review of climate change in the Jianghan Plain is presented with recognition of such difficulties. However, since a number of studies of social trajectories in the Jianghan Plain have applied results from paleoenvironmental research, that sequence is summarized here so as to consider the implications of the settlement survey for correlations that have been suggested between climate change and social trajectories.

Current research on climate change and environmental conditions in the past 10,000 years is mainly based on pollen samples, soil grain size, magnetic susceptibility, and Rb/Sr ratios from natural or cultural strata in or around archaeological sites. These data are distributed across the whole Jianghan Plain and have a much larger extent than the survey area, but the climate and environment change in the survey zone were a part of this larger picture. Paleoenvironmental research yields a chronology covering from 5800 BCE to 1500 CE through which it is possible to reconstruct climate change and the environment conditions of the survey area.

3.2.1 The Chengbeixi period

It is believed that most parts of China experienced a warm period beginning about 6500 BCE (Tang and Shen 1992; Yang 1996). The spore-pollen spectrum indicates that the beginning of the Chengbeixi period is the hottest stage of the Holocene around 7700 BCE, with abundant precipitation. The period between 8,000 and 5000 BCE is the period of highest sea level, corresponding with high temperature and humidity. The number of known sites along the banks of the Yangtze River increased, particularly in the southwestern part of Jianghan Plain. The pore-pollen Zone IV of the Dajiuhu Basin indicates this mid-Holocene warm and wet period with maximum spore-pollen concentration during the Chengbeixi period (Li et al. 2011). Higher temperatures and precipitation are accompanied by enhanced summer monsoon patterns and an increased flow rate in the Yangtze River and its tributaries (Guo 2005). Abundant precipitation in this period caused frequent flooding. Wang (1998) believes this period is the first of the four prehistoric flooding periods (5500-5000 BCE).

3.2.2 The Daxi period

The Daxi period corresponds to the continuation of the mid-Holocene warm and humid period, which is propitious and beneficial for the development of agricultural subsistence, particularly for rice cultivation (Li et al. 2011). The discovery of a skeleton of Elephas maximus (Asian elephant) in the Xiawanggang site, a species only seen in tropical forest today, suggests that the temperature in this period was 2-3°C higher than today (Xiang 1995). Given research agrees that sea level had been fluctuated in Neolithic, causing several major flooding periods which had greatly impacted human activities. The periods of higher sea level had a depositional effect upstream, raising the water table and the river level and producing a large number of lakes, ponds and swamps. The vast fertile floodplain, nourished by sediment from the Yangtze River and watered by the summer monsoon rains, supported the early development of agriculture. Wang (1998) further contends that abundant precipitation also caused the second of the four frequent flooding periods (3800-3500 BCE). Soil samples from Miancheng in the Jianghan Plain suggest that numerous lakes formed between the Yangtze River and the Hanjiang River (Zhu et al. 1997).

3.2.3 The Qujialing period

Qujialing (3100-2500 BCE) is also in the mid-Holocene warm and humid period. Analysis of the spore-pollen sequence suggests that xerophyte, aquatic herb and fern spore concentrations increased sharply during this period (Li et al. 2011). The oxygen isotope record of the SB10 stalagmite from the Shanbao Cave indicates a period of abundant precipitation (Shao et al. 2006). During the flooding period, the smaller lakes between the Yangtze River and the Hanjiang River started to merge into the massive Yunmeng Lake (Zhu et al. 1997). Soil samples from the Qujialing site have a relatively high content of Rb, but with a decreasing trend; in contrast, the content of Sr is low but increased later. Frequent flooding also characterizes the warm and wet climate in the early Qujialing period (Wang 1998). The ratio of Rb/Sr gradually dropped with fluctuations, indicating weathering effects. Such fluctuations suggest a drier and cooler trend in the late part of this period (Shi et al. 2009). It is at this time that Yunmeng Lake started to shrink.

3.2.4 The Shijiahe period

Shijiahe (2500-2000 BCE) is also in the Holocene warm and humid period, but conditions were becoming cooler and drier, still with fluctuations after 2200 BCE. Analysis on magnetic susceptibility and Rb/Sr ratios from the Qujialing site strata suggests that climate presents fluctuations towards drier conditions in the late Shijiahe period, which is also the fourth frequent flooding period which caused expansion of Yunmeng Lake (Guo 2004; Wang 1998). During this period, high sea level caused high lake and river levels in the Jianghan Plain and led to rapid sedimentation and frequent flooding (Mo et al. 2009).

3.2.5 The Shang-Zhou period

During this period of time, the content of Rb in soil samples from the Qujialing site decreased, while the content of Sr increased. The ratio of Rb/Sr kept decreasing. In addition, most pollen from the samples is herb pollen; only a very small proportion is tree pollen. These traces indicate weaker weathering effects and drier and cooler climate (Shi et al. 2009). The Chu period (770-278 BCE) corresponds to spore-pollen zone V of the Dajiuhu basin, which suggests warm and dry conditions (Li et al. 2011). From 2000-1000 BCE, with the increasing water table, lakes in the Jianghan Plain expanded again; the low area near rivers submerged into lakes and swamps. From 3500-3000 BP, the Jianghan Plain witnessed another frequent flooding period (Xiao 1991).

3.2.6 The Han-Tang period

After 1th century BCE, the ratio of Rb/Sr in soil samples from the Qujialing site underwent a relatively substantial increase. Tree pollen also increased. In this period, the climate started to become warmer and wetter than in the previous period (Shi et al. 2009).

3.3 SETTLEMENT AND DEMOGRAPHIC DISTRIBUTION AND CHANGE

3.3.1 Population estimation

Reconstruction of population change through time is one of the major objectives for the study of regional social complexity. Some of diverse approaches are potentially effective in estimating demographic change through time in the Jianghan Plain. For a site with full scale excavation, it may be possible to estimate population by counting individual structures and rooms, summing them up, and then multiplying by an occupancy rate (Hill 1970; Longacre 1976; Xi'an 1988). Site areas (Adams 1965; Drennan and Boada 2006; Fang et al. 2004) and total quantities of ceramics (Kohler 1978) are also used as indicators for population estimation. The settlement pattern study in northeastern China (Chifeng 2003; Chifeng 2011) has systematically incorporated these methods, based on calculation of site areas and estimation of surface ceramic densities for different periods. Surface ceramic densities were taken to be equivalent to different within-site occupational density categories in terms of inhabitants. The equivalencies in terms of the numbers of inhabitants were based on estimates of occupational densities derived from residential structures at excavated sites of different periods (Chifeng 2011). In the research presented here, two approaches are applied for making population estimates within the survey area. One is that used in the Chifeng region (Chifeng 2003; Chifeng 2011), and the other is that used in the Rizhao region (Fang et al. 2004). The results of the two approaches yielded for the Taojiahu-Xiaocheng survey area will be compared.

The Chifeng project used the area and density of sherd scatters as the main variables for estimating population. First, it is assumed that larger populations produce more garbage on the landscape, other things being equal. Occupational areas are considered to have had more inhabitants per hectare in a given period if surface ceramics of that period occur at higher densities. Densities can also be affected by other variables, the most important variable of which is the temporal duration during which surface ceramics accumulated. A second assumption is that the small Neolithic and Early Bronze Age residential structures of northeastern China were nuclear family houses, for which 3 to 6 inhabitants are estimated on average. The Chifeng project used five Neolithic sites in northeastern China, including Baiyinchanghan, Zhaobaogou, Jiangzhai, Laohushan and Sanzuodian, where individual house structures were counted as a basis for population density estimation (Chifeng 2011). However, in the Jianghan Plain, such information does not exist. Complete exposed residential sites are also not empirically available for most places in the world. Without such information from nearby, I assume that the area and density of garbage (sherds) left on the landscape per person per year in the Jianghan Plain is, when averaged over long periods of time and across large populations, roughly similar to the area and density of garbage (sherds) left on the landscape per person per year in Chifeng, also when averaged over long periods of time and large populations.

In the Taojiahu-Xiaocheng survey methodology, a 100 by 100 m (1 ha) collection unit was the theoretical ideal. However, collection units ranged in size from 0.08 to 1.76 ha, with an average of the 456 collection units at 0.58 ha. For a systematic collection unit, surface ceramic densities were recorded by counting the number of sherds for each period collected in a dog-leash circle and dividing by the area of the circle (usually 10 m^2). For example, if 20 Qujialing sherds were found on the surface within the circle, then the entire collection unit represented by the circle would be taken to have a sherd density of 2 sherds per m^2 representing Qujialing occupation (20 sherds/10 m^2 = 2 sherds per m^2). If 15 Shijiahe sherds were found on the surface in the circle, then the entire collection unit would be taken to have a sherd density of 1.5 sherds per m^2 representing Shijiahe occupation (15 sherds/10 m^2 = 1.5 sherds per m^2).

However, before analysis, sherd density measurements from systematic survey must be carefully examined to see if there are extreme numbers from sherd hot spots in the field, caused by things like holes from trees falling over or recently dug ditches. Extremely high sherd numbers from phenomena of this sort could have a large and unreasonable impact on population estimates that must be avoided. In order to investigate this possibility, extremely high numbers identified in a stem-and-leaf plot were reviewed with the original data from the field records. Figure 3.1 is the stem-and-leaf plot of sherd densities from the 132 systematic collection units. Outliers were identified (Table 3.1) as values more than 12.2 (two midspreads above the median value of 4.2 sherds per m^2)

Stem and Leaf Plot of Variable: DENSITY, N = 132

```
0   58
1   235567999
2   011111223444667899
3 H 000001111222223344444445667888999
4 M 1122224566777888899
5   012255669
6   355566789
7 H 002688
8   114477788
9   128
10   369
11   12457
* * * Outside Values * * *
14   3
15   8
16   4
18   15
19   6
22   2
76   9
```

Minimum	0.5
Lower Hinge	3.0
Median	4.2
Upper Hinge	7.0
Maximum	76.9

Figure 3.1. Stem and leaf plot of sherd densities from systematic collections

Table 3.1. Outliers of sherds densities from systematic collection

Collection Units	Sherd Density
A379	76.9
B35	22.2
A181	19.6
A318	18.5
A107	18.1
C219	16.4
A344	15.8
A182	14.3

A re-examination of the field records revealed that sherds from A379 were collected in a hole from a recent tree fall, producing a clearly unreasonable value. Sherds from collection units B35, A181, A318, A182 and C219 were from fishponds where dirt was dug out and piled on the banks. It is reasonable to treat these collection units as artificial artifact hot spots as well. A344 was on a riverbank and A107 was on recent ditch bank where dirt was also piled up. It seems that sherds from both of these collection units were also from artificial artifact hot spots. It turns out collection units with sherd density values above 12.2 are all very suspicious outliers pulling the sherd density measurements for using the Chifeng method to unrealistically high levels. These extreme values have all been replaced in the dataset for analysis with the adjacent non-outlier value, which is 11.7.

For general collection units, the calculation of surface sherd density values is different. The idea to make a general collection instead of systematic collection was based on a subjective estimation that a systematic collection might not yield as many as 5 sherds (5 sherds per 10 m^2 = 0.5 sherds per m^2). In reality, it was expected that some surveyors made mistakes in subjective judgment about the boundary between systematic collection and general collection. For example, general collection units would sometimes be made where the sherd density turned out to be greater than 0.5 sherds per m^2. In this sense, for general collection units with the largest numbers of sherds, it is reasonable to assign density values above the theoretical threshold of 0.5 sherds per m^2 in order to improve the general accuracy of the dataset. By the same token, for general collection units that yielded very few sherds, it is reasonable to assign density values lower than the 0.5 sherds/m^2 threshold.

The frequency distribution of the total sherd count in general collection units can be seen in Figure 3.2. Based on this histogram, the distribution of sherd counts can be divided into 5 categories: ≥50 sherds, 30-49 sherds, 15-29 sherds, 10-14 sherds, and 1-9 sherds. The aim of such arbitrary division is to create a useable approximate way to deal with the variation in the numbers of sherds in general collections. A higher density value will be assigned to general collection units with a larger number of sherds, while a lower density value will be assigned to general collection units with a smaller number of sherds. For collection units with more than 50 sherds, a systematic collection should likely have been made (Chifeng 2011), so a sherd density of 1 sherd per m^2 was assigned. A density of 0.5 sherds per m^2 was assigned to general collection units that yielded between 30 and 49 sherds; 0.25 sherds per m^2 was assigned to general collection units that yielded between 15 and 29 sherds; 0.125 sherds per m^2 was assigned to general collection units that yielded between 10 and 14 sherds; and 0.06 sherds per m^2 was assigned to general collection units that yielded between 1 and 9 sherds. Following this procedure for general collections automatically avoids extremely high values for sherd density, thereby reducing concerns about outliers.

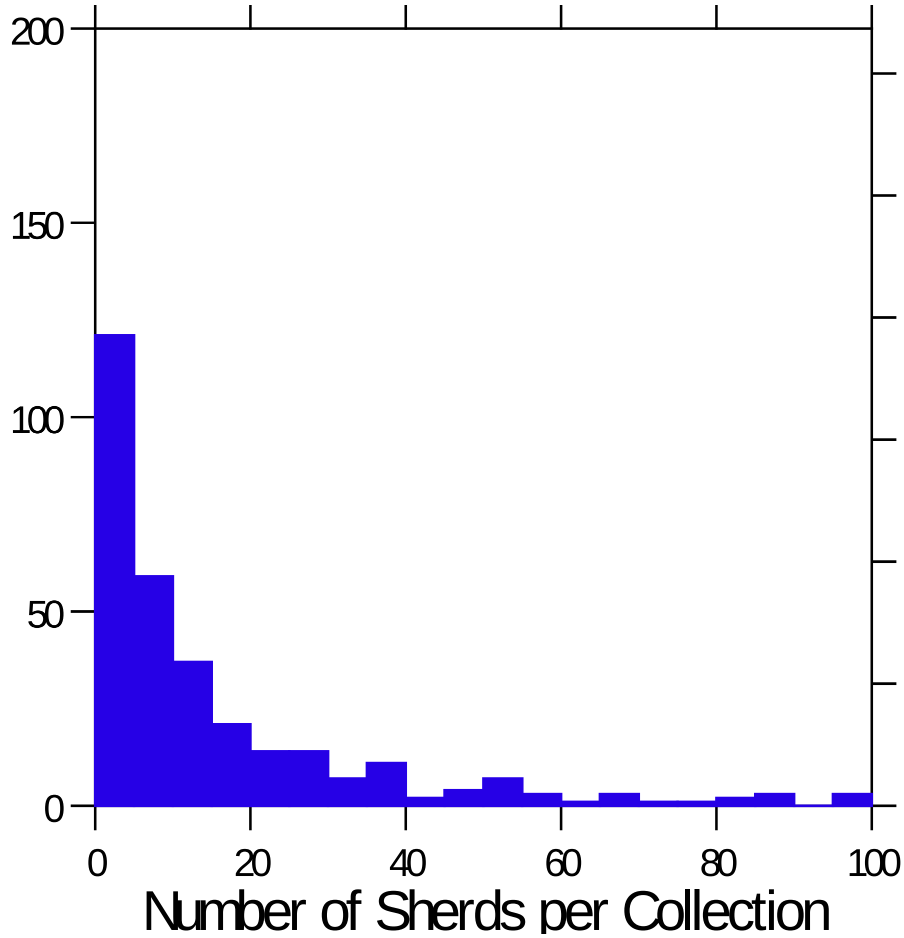

Figure 3.2. Histogram of numbers of sherds from general collection units

For greater precision, an area-density index was introduced to population estimation. In order to combine areas of collection units and surface ceramic densities into a period-based demographic index, it is necessary to calculate the percentage of identified sherds in the collection units from each period. Then, the percentage is multiplied by the surface sherd density for the collection unit to get a surface sherd density for each period. The surface sherd density is further multiplied by the total area of the collection unit to arrive at an area-density value for the collection unit for each period (Chifeng 2003; Chifeng 2011).

For example, a systematic collection in collection unit A228 yielded 65 sherds, so it has a surface density of 6.5 sherds per m^2. Among those sherds, 1 was identified from the Shijiahe period, 24 were identified from the Eastern Zhou period, 32 were identified from the Han period and 8 were identified from the Wei-Jin period. The percentages of the periods are thus 1.54%, 36.9%, 49.2% and 12.3%, respectively. Therefore, 1.54% of 6.5, or 0.1 sherds per m^2; 36.9% of 6.5, or 2.4 sherds per m^2; 49.2% of 6.5, or 3.2 sherds per m^2; 12.3% of 6.5, or 0.8 sherds per m^2 are attributed to the Shijiahe, Eastern Zhou, Han and Wei-Jin periods, respectively.

The area of collection unit A228 is 1.44 ha. If we take the systematic collection circle to represent the ceramics in this entire collection unit, it means that we count 1.44 ha of Shijiahe occupation at 0.1 sherd per m^2, 1.44 ha of Eastern Zhou occupation at 2.4 sherds per m^2, 1.44 ha of Han occupation at 3.2 sherds per m^2 and 1.44 ha of Wei-Jin occupation at 0.8 sherds per m^2. Then, if we multiply the density for each period by the area of the collection unit, we can get an area-density index: 0.14 for Shijiahe, 3.46 for Eastern Zhou, 4.6 for Han and 1.2 for Wei-Jin.

The demographic index arrived through the above method provides a relative population estimate for different periods of time. However, this value can be affected by the different duration of each period, as the same number of people will leave more garbage in the region during a long period than a short period. In order to have a better understanding of demographic change through centuries, then, the area-density index should be divided by the number of centuries in the period. As the above example demonstrates, the value of 0.14 for the Shijiahe period represents 500 years accumulation (2500-2000 BCE); therefore, dividing it by 5 would produce the final time-adjusted population proxy for this collection unit in Shijiahe times.

This relative index still needs to be bridged to an absolute demographic estimate, by multiplying a figure approximating how many people are required to leave a density of surface ceramics averaging 1 sherd per m^2 across an area of 1 ha in one century. In the Chifeng project, the minimum and maximum population estimation scales used were 500 and 1000, which means that the area-density index reached above will be multiplied by 500 to translate into a minimum population estimate and multiplied by 1000 to translate into a maximum population estimate (Chifeng 2011). Table 3.2 shows the estimated population for each period in the survey area. When interpreting these values, it is important to remember that they are very approximate; it appropriate to round them off as a general reminder. For example, the Youziling population estimate calculates out to 51-102, which is easily rounded off to 50-100. For the Qujialing period, the population estimated calculates out to 6704-13,407, best cited as 7000-14,000 persons, since a few hundred people one way or the other in this approximation make little difference in understanding population levels above 7000 persons in this period. Correspondingly, for the Shijiahe period, the population estimate is 7000-14,000 persons; for the Shang period, fewer than 10 persons; for Western Zhou, it is 1000-2000 persons; for Eastern Zhou, it is 12,000-24,000 persons; for the Han period, it is 6000-12,000 persons; and for the Wei-Jin period, it is 6000-13,000 persons.

Table 3.2. Scales of population estimation in different periods by applying Chifeng method

Periods	Estimated Population	
	Minimum	Maximum
Youziling	51	102
Qujialing	6704	13407
Shijiahe	7003	14006
Shang	3	7
Western Zhou	879	1759
Eastern Zhou	11761	23522
Han	6121	12242
Wei-Jin	6487	12975

The other method used to estimate population is the method applied in the Rizhao survey (Fang et al. 2004). Given the scarcity of measurements of size, sherd density and number of residential structures for the Neolithic period, some archaeologists have used modern settlement in the local area as means to estimate ancient population, since modern rural population densities and housing facilities are similar to past patterns. For example, archaeologists have used the modern natural village, which is the smallest basic human community, as a reference to calculate modern rural occupation densities in the Rizhao region (Fang et al. 2004). A set of 100 natural villages in the Rizhao region averaged 7.2 ha in area, and 520 persons on average lived in each natural village. The occupation density for these villages, then, averages 72.2 persons per ha (520 persons per village/7.2 ha per village). This result is very close to the occupational density of 72.6 persons per ha in Shandong Province from the national census in 1985.

Assuming that this natural village occupation density of 72.2 persons per ha ls similar to that of ancient Jianghan Plain settlements, the figure of 72.2 persons per ha can be used to estimate ancient population in the survey area (Table 3.3). These estimates should also be rounded off to avoid a false impression of precision. The rounded off data for the periods in the survey area sequence come to 400, 3000, 9000, 50, 900, 10000, 7000 and 6000 (Table 3.4).

Table 3.3. Estimated populations in different periods by applying Rizhao method

Periods	Population Number
Youziling	383
Qujialing	2729
Shijiahe	9032
Shang	65
Western Zhou	859
Eastern Zhou	10346
Han	7458
Wei-Jin	6339

Table 3.4. Comparison of estimated population produced by Chifeng method and Rizhao Method

Periods	Estimated Scale of Population (Chifeng Method)		Estimated Population (Rizhao Method)
	Minimum	Maximum	
Youziling	50	100	400
Qujialing	7000	14000	3000
Shijiahe	7000	14000	9000
Shang	5	10	50
Western Zhou	1000	2000	900
Eastern Zhou	12000	24000	10000
Han	6000	12000	7000
Wei-Jin	6500	13000	6000

The idea of using both the Rizhao method and the Chifeng method, relying on different assumptions, is to see how well the two approaches agree with each other. Table 3.4 shows the comparison of estimated population by the Chifeng and Rizhao methods. As seen in the table, the Chifeng method produces a minimum and a maximum estimate for each period, while the Rizhao method yields a single figure as the estimated population in each period.

For the Youziling and Shang periods, the results produced by the Rizhao method exceed the maximum estimate from the Chifeng method. For the Youziling period, the Rizhao method arrives at a population estimate twice as large as the maximum of the Chifeng method estimate. However, both population estimates agree that there were very few inhabitants in the survey area—less than 400. So saying that in the Youziling period, the estimated population in the 58 km^2 survey area is no more than 400 which is consistent with both results. For the Shang period, both methods agree that fewer than 100 persons lived in the survey area. The two methods thus tell a similar story in general.

For the Qujialing, Western Zhou, Eastern Zhou and Wei-Jin periods, the results from the Rizhao method are less than the minimum estimate by the Chifeng method. The two sets of figure for the Qujialing period especially do not match well. The population estimated by the Rizhao method is about 3000 persons—much smaller than the minimum estimate of 7000 persons from the Chifeng method. For the other three periods, the results from the Rizhao method are much closer to the minimum for the estimates by the Chifeng method. The difference of less than 1000 people would not change overall population conclusions much at all. In the Shijiahe and Han periods, the results from two methods match fairly well. The estimated population of 9000 for the Shijiahe period by the Rizhao method falls into the range between the minimum and maximum estimates by the Chifeng method (7000-14,000).

The discrepancy of results for the Qujialing period needs to be further explored. The result from the Rizhao method is much lower than the result from Chifeng method. There was thus either some factor pulling the estimate by the Rizhao method down or some factor pulling the estimate by the Chifeng method up—or both at the same time. The discrepancy cannot be a result of outlier values for densities since measures were taken to deal with outliers from both systematic and general collections.

A careful look reveals that most of the collection units with Qujialing sherds were located within the two walled towns (Figure 3.11, Figure 3.12 and Figure 3.13). The number of collection units with Qujialing sherds is 117, of which 88 (75%) were within the walled towns. The total area of collection units within the walls is 20.7 ha, compared to a total of 17.1 ha outside, a distribution by area of 55% inside the walls and 45% outside. Thus, the 75% of the collection units inside the walls only accounts for about half of the total area of occupation. If the walls were built in the Qujialing period, the walls can be used as a community boundary to calculate population by the Rizhao method. This estimate of population would be 4837 persons (72.2 persons per ha * 67 ha) which can be rounded off to 5000 persons (Table 3.5). This estimate is closer to the result by applying the Chifeng method.

Table 3.5. Comparison of adjusted population estimation produced by Chifeng method and Rizhao method

Periods	Estimated Scale of Population (Chifeng Method)		Estimated Population (Rizhao Method)
	Minimum	Maximum	
Youziling	50	100	400
Qujialing	7000	14000	5000
Shijiahe	5500	11000	9000
Shang	5	10	50
Western Zhou	1000	2000	900
Eastern Zhou	12000	24000	10000
Han	6000	12000	7000
Wei-Jin	6500	13000	6000

The Rizhao method relies entirely on the area of sites to calculate population, as 72.2 persons per ha is used as a constant occupation density in population estimation. This method is effective to estimate the absolute population in a large region with a constant occupation density. But it fails to make allowances for variations in occupational density at a community scale, and this can make substantial differences, especially in contexts of concentrated populations such as walled towns. In contrast to the Rizhao method, the Chifeng sherd density based method is fairly sensitive to such micro-patterns of population distribution, since it takes sherd density in each collection unit into account. Looking further, we see that 79.1% of the Qujialing sherds (3070 out of 3880) were found within the Taojiahu and Xiaocheng walled 20.7 ha; while only 20.9% of the Qujialing sherds come from the 17.1 ha outside the walls. The walled area is very close to the occupied area outside the walls, but it yielded many more sherds than outside of the walled towns, which suggests that the population within the walled towns is much denser than its counterpart outside the walls. Making population estimates both by calculating an area-density index and residential area are inherently complementary. The area-density index of the Chifeng method is more sensitive to population density and works more effectively to investigate population patterns within communities; while residential area works just as effectively in estimating a general population with an equal density distribution.

Figure 3.3 shows why population estimates based on only area by applying the Rizhao method differ in exactly the ways that they do from the population estimates based on the area-density index of the Chifeng method. When the averaged density (divided by centuries of each period) is very low, the area-density estimate is substantially lower than the area based estimate (Youziling and Shang periods). When the average density (divided by centuries of each period) is very high, the area-density estimate is much higher than the area based estimate (Qujialing period). When the average density (divided by centuries of each period) is medium, then the area-density estimate is close to the area based estimate (Shijiahe, Western Zhou, Eastern Zhou, Han and Wei-Jin period). As revealed in the graph, average sherd density is much higher in the Qujialing period. Also, most of the collections units and sherds are from walled areas as noted above. This means that population in the Qujialing period was more tightly packed in the walled area. The very high population density in the enclosed area tells a very important story about settlement patterns in Qujialing times. This is the period when people first crowded together into the walled towns, and their settlements were smaller but with higher population density. The population estimate based on an area-density index discloses this important tendency in the Qujialing period; while area-only based estimates will not reveal such social dynamics by not taking sherd density into consideration. An area-density index thus not only tends to produce more reasonable and accurate population estimates, but also reveals more clearly the dynamics of settlement development, particularly at a very local scale.

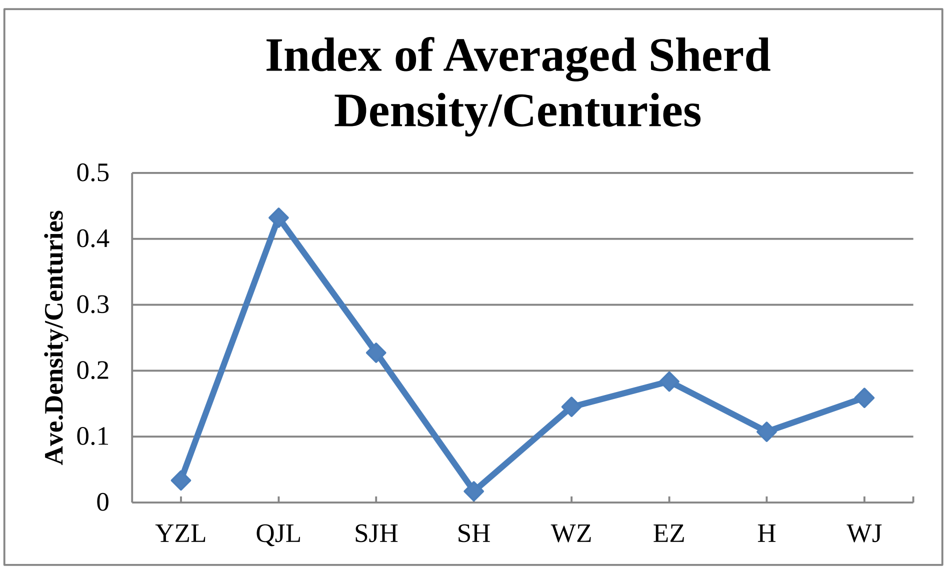

Figure 3.3. Averaged sherd densities/centuries of each period

3.3.2 Settlement and demographic distribution and change

3.3.2.1 Youziling (3900-3100 BCE)

In the survey area, collection units containing Youziling sherds totaled 15 collection units yielding 57 sherds. Most of the collection units produced fewer than 10 sherds except one. Collection units with Youziling sherds mostly were found in the northern zone of the survey area; only one was discovered in the southern zone (Figure 3.4). Of the Youziling collection units, 13 are located on the floor of the Silong River valley which would provide relatively fertile farmland for rice planting, as well as water for irrigation and daily use. The tendency of proximity to rivers for human occupation has been widely seen in many parts of world.

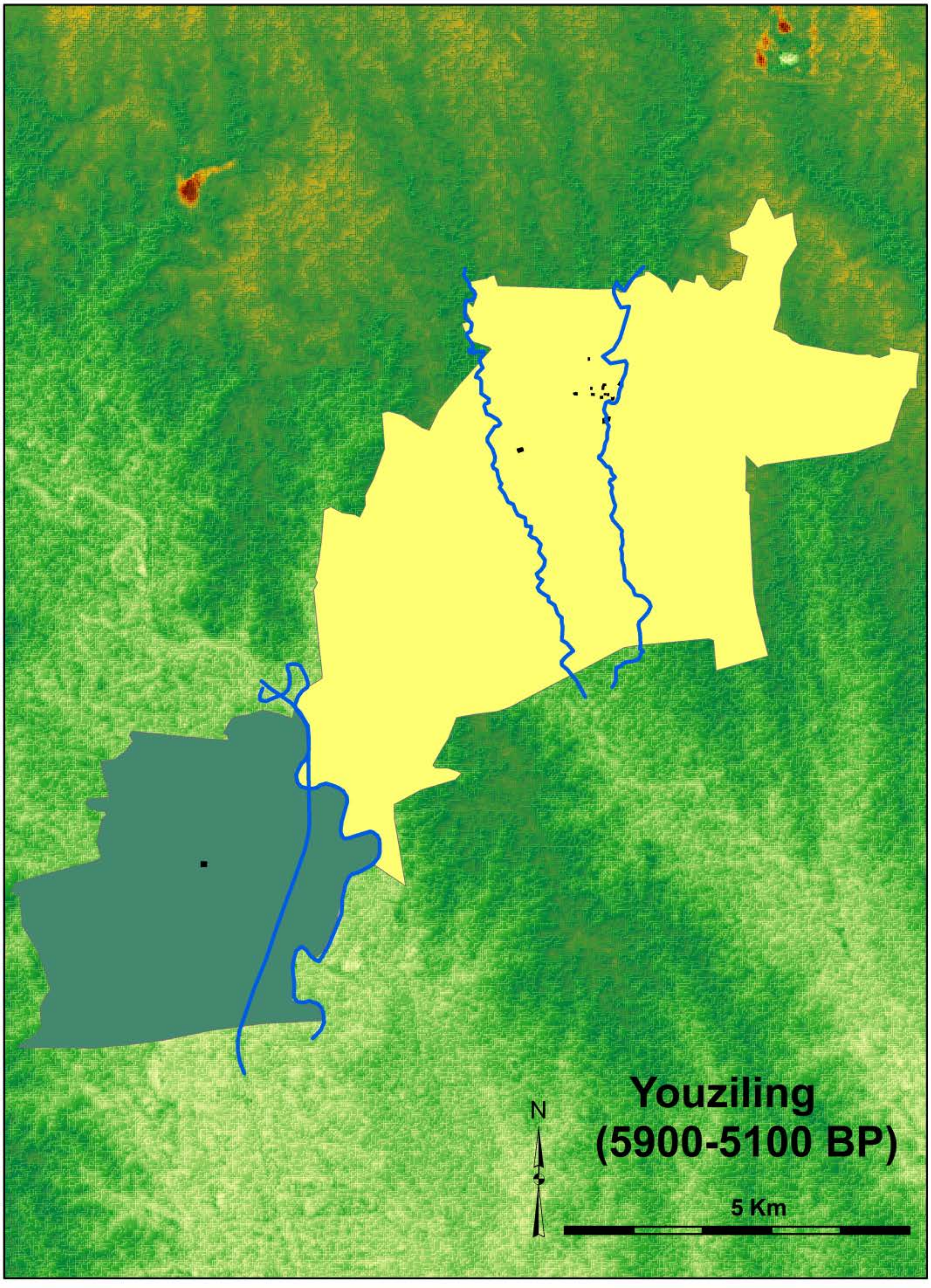

Figure 3.4. Distribution of Youziling occupation in the survey area

Among Youziling collection units, only one occurred in the far southern zone and the other 14 collection units were found in the northern zone. Two single collection units are isolated from the others and most likely represent single family homesteads, or a very few households living together for just a part of the Youziling period. The other 13 collection units are all within about 1 km of each other and might form a much dispersed local community located in the northern survey zone (Figure 3.5 and Figure 3.6). Although somewhat large for a local community, spread across 1 km, it cannot be divided into smaller sub-clusters and is more like a small dispersed Neolithic village rather than a supra-local community. The two sets of population estimates yield 50-100 persons and 400 persons (Table 3.5). Although we do not know how many people lived in each homestead, it is reasonable to conclude that most of the population was located in the small cluster, and only a few households were dispersed in the south survey zone and northwestern zone. The population estimate based on sherd density is 50-100 persons which is an estimate of the average population in the Youziling period through the centuries. The momentary population in certain short periods might be higher or lower than this estimate.

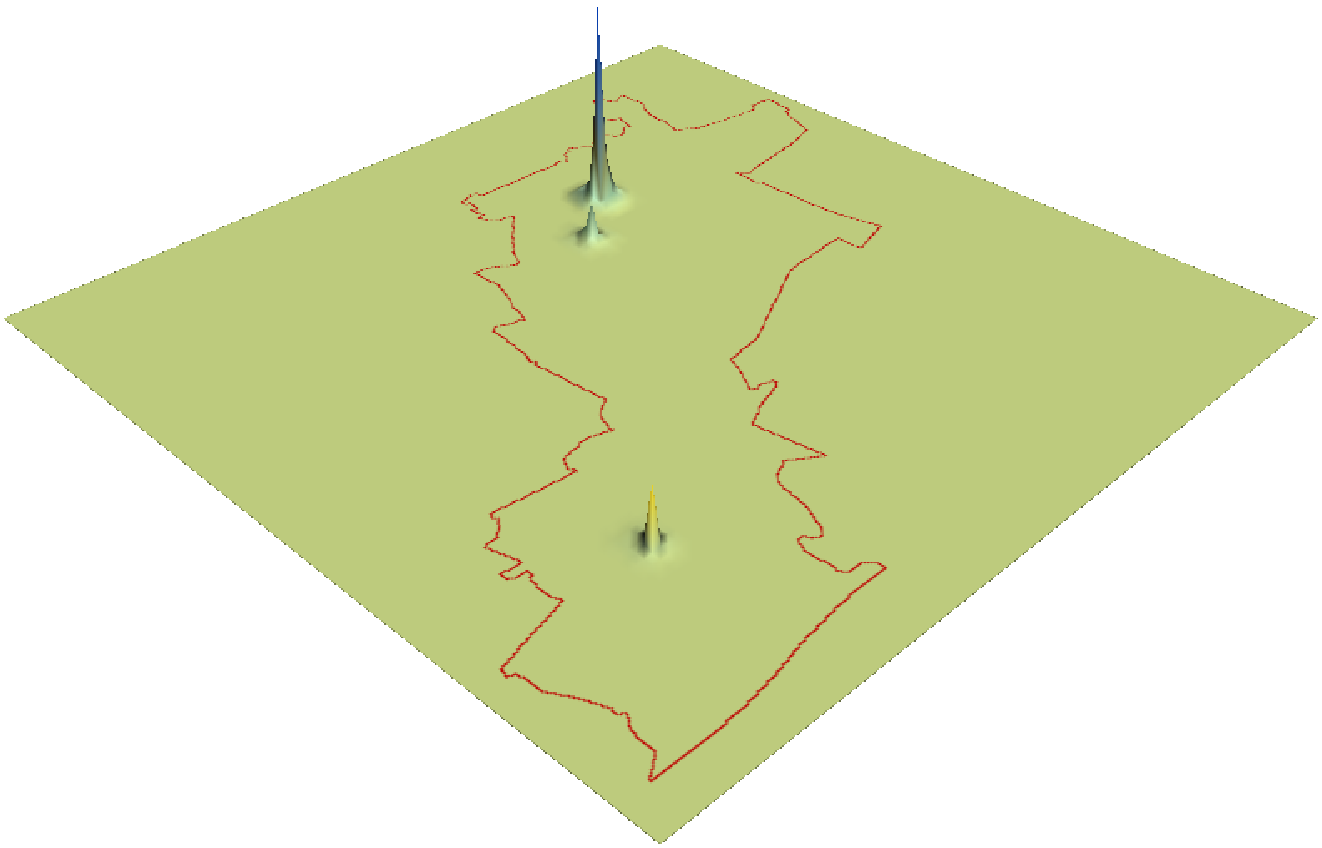

Figure 3.5. Unsmoothed density surface for Youziling occupation

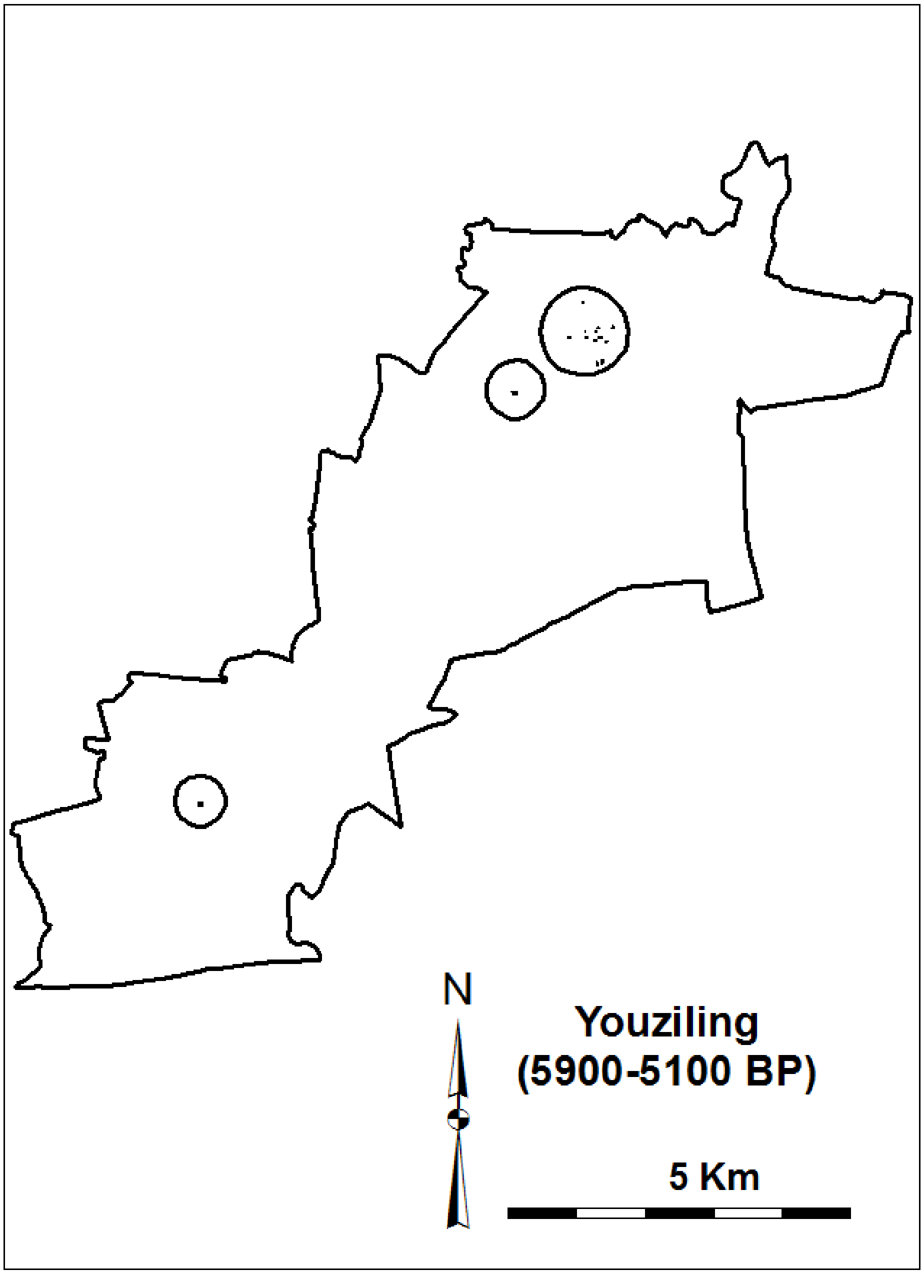

Figure 3.6. Delineation of Youziling local communities by cutoff contour from the unsmoothed density surface

For collection units within the walled area, the field collection methodology had been adjusted by reducing the area of collection units for greater precision; and population estimation based on sherd density tends to produce a more reasonable result (as discussed above), suggesting that 78% of the population lived in the walled area. The cluster defined by the unsmoothed surface (Figure 3.5) demonstrates that the clustered occupations might function as the local center with dominated population in the entire survey area. It can also be seen in the smoothed surface (Figure 3.7) that one highest peak exceeds the other two individual collection units and involves the nearer small peak into the lager cluster. However, the cluster only extends across a distance of around 1 km, and with very small population size and hardly any surrounding subunits, it is more reasonable to identify the cluster as a local community, rather than a supra-local community with a larger territory.

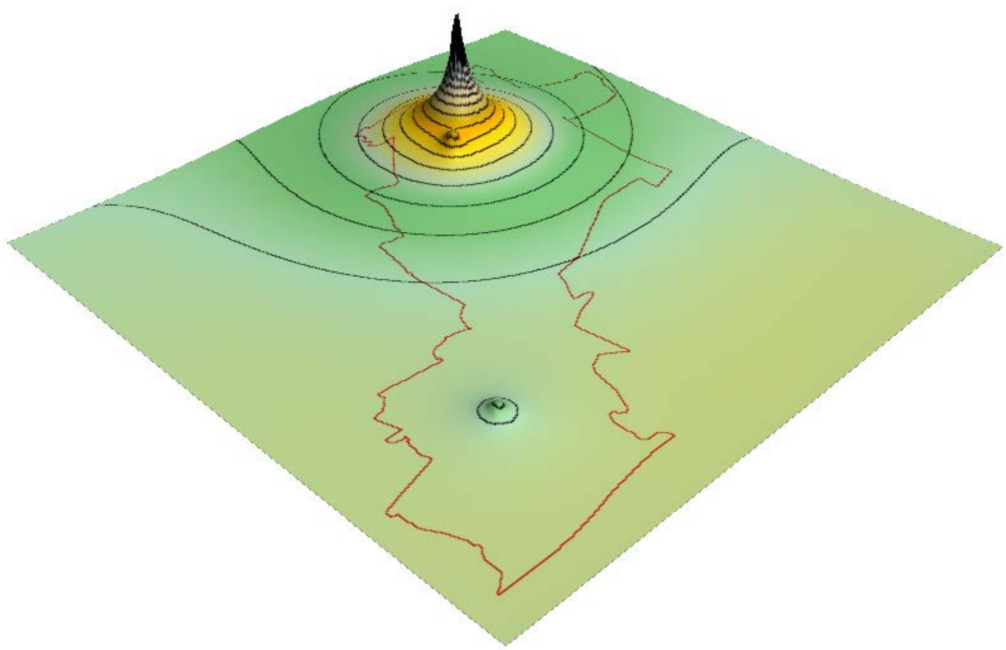

Figure 3.7. Smoothed density surface for Youziling occupation

The rank-size plot for Youziling local communities shows a strong concave pattern (A= -0.301, Figure 3.8), which we would expect for a period when the local community and homesteads through the survey area were politically or economically centralized and well integrated. However, since the Youziling settlement consists only of a single village of modest size, which is the only real local community in the survey area, it is more accurate to say that there is really no supra-local community structure at this time. It is thus not reasonable to talk about a highly integrated regional settlement system which superficial interpretation of the rank-size graph might lead to.

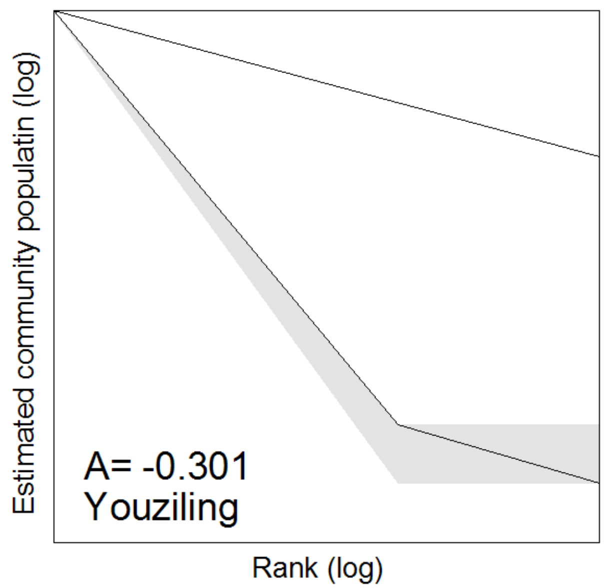

Figure 3.8. Rank-size graph for Youziling local communities (error range for 95% confidence)

The Youziling period (3900-3100 BCE) is believed approximately contemporaneous with the middle and late Daxi period (Meng 1997). In the Holocene Daxi period, the Jianghan Plain was warm, humid and propitious for the development of agricultural subsistence, particularly rice cultivation (Li et al. 2011). Zhao (1992) argues that higher sea level had caused a depositional effect upstream toward sources of rivers and further producing fertile sedimentary soil for rice planting. The widely distributed lakes, ponds and swamps also provided abundant fresh water resources such as fish. However, Wang (1998) argues that abundant precipitation caused frequent flooding. If this was the case, possible flooding during this period would have prevented people from directly cultivating the wet and narrow valley floor. However, the elevation map suggests that the Youziling occupations were located in the relatively low river valleys. Figure 3.9 shows that in the northern zone, Youziling occupations were located in the Silong River valley with a width of about 1.5 km and an elevation between 30 and 40 m above sea level. In the southern zone, only one collection unit was located in the much wider Zaoshi River valley with an elevation of about 20 m above sea level. All the occupations were distributed in very low elevation river valley setting or just adjacent to the valley floor, and the distances from occupations to the nearest rivers are less than 500 m, except for the southern zone occupation. Considering that the elevation of the southern occupation is about 10-20 m lower than the northern occupation, the meandering Zaoshi River and its high groundwater table might have provided abundant lakes or swamps not far from the southern occupation.

Strong preference for locations near rivers and lakes suggests that possible flooding was not so severe as to stop Youziling people living in river valleys and living close enough to rivers and lakes to exploit their rich resources. In the Daxi period rice cultivation had spread through the middle Yangtze River valley (An 1987; Lin 1992; Pei 1989, 1998; Yan 1989). A wide low river valley would have provided rice plants with favorable conditions, most importantly water. A wide spectrum of fish bones and wild animal bones have been found in Daxi sites such as Daxi, Chaotianzui, Liulinxi, Zhongbaodao, Gongjiadagou, Qingshuitan and Yangjiawan (Wang 1994; Wu 1998). Fishing and hunting tools including fish hooks, harpoons, net weights and projectile points are also widely seen in middle Yangtze River valley sites (Guo 2006; Wang 1994; Wu 1998). Mixed subsistence patterns including fishing, hunting, gathering and cultivation of rice would provide foundation for sedentary life. It is very likely that the preference for settlement locations near rivers was for the purpose of exploiting this broad spectrum of natural resources.

As one of the major research questions, the period during which the walled towns were built need to considered in light of the settlement patterns of different periods. In the Youziling period, only one collection unit was found in the southern zone; and that collection unit is about 1.1 km away from the location of the Xiaocheng walled town. It is safe to say that the Xiaocheng walled town was not built in the Youziling period. However, in the northern survey zone, most of the collection units (11 of 14) were enclosed by the walls (of uncertain period of construction) of the Taojiahu walled town. Two of the three collection units not within the walls were right next to the southern wall (Figure 3.9). The occupation cluster in the walled area is very sparse and mainly in the southern part of the walled area rather than spread throughout it. This distribution pattern does not provide evidence to conclude that the Taojiahu walls were built in this period, but it is clear that some form of centripetal force pulled people together into a dispersed village local community. The location that later became the Taojiahu walled town was already a population cluster in the Youziling period. Although it clearly was not a walled town at this point, the community had been founded that later grew and developed into a walled town.

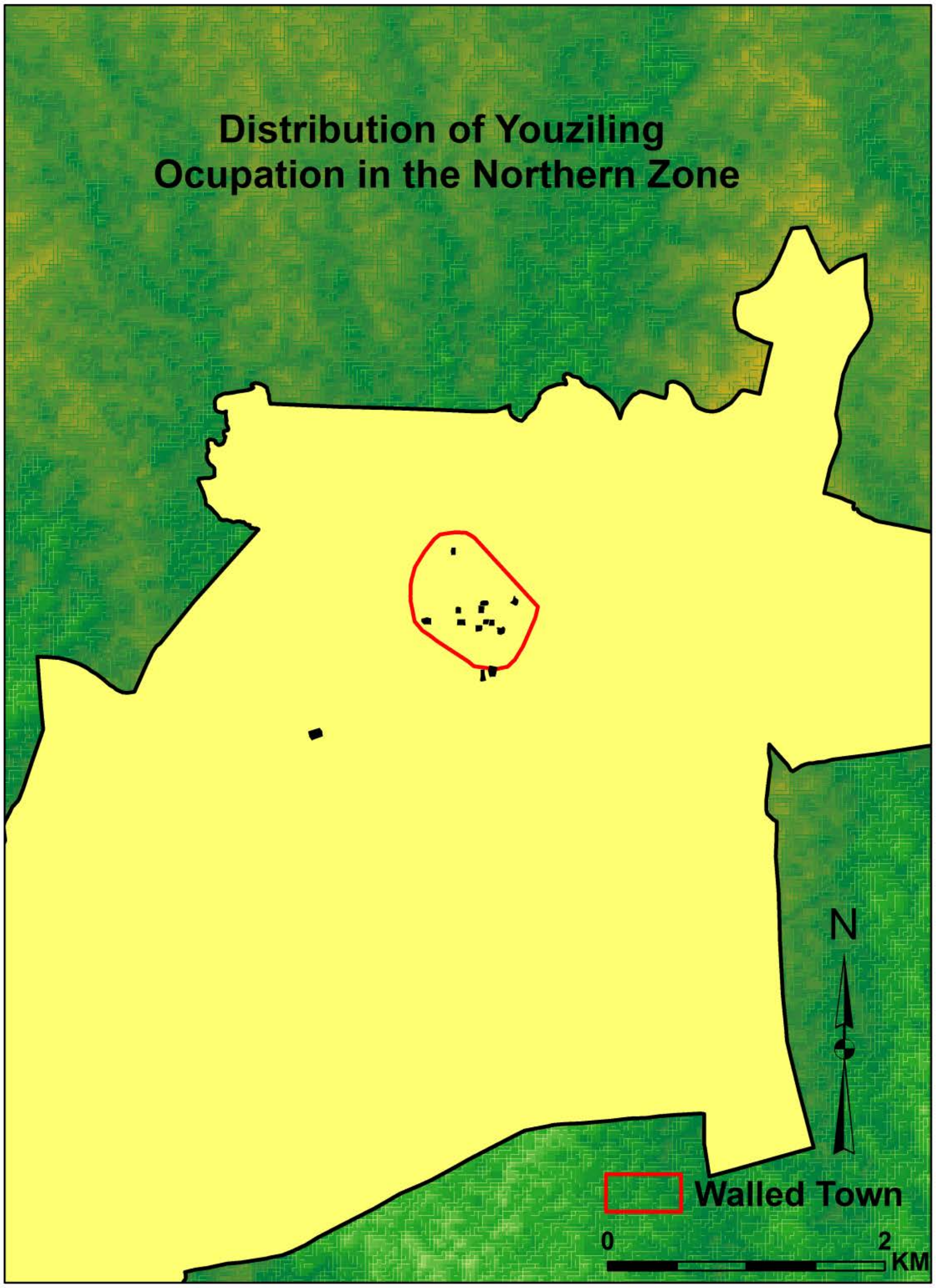

Figure 3.9. Distribution of Youziling occupation in the northern zone

3.3.2.2 Qujialing (3100-2500 BCE)

The number of Qujialing sherds recovered on survey is close to 4000, which is much larger than the number of sherds from the Youziling period. There was a total of 117 collection units in the survey area that yielded Qujialing sherds (Figure 3.10). The estimated population for the Qujialing period in the survey area is 7000-14,000 persons, which is much larger than the Youziling population of 50-100. As mentioned earlier, this estimate is for an average population through the centuries in the Qujialing period; the momentary population in certain short periods might be higher or lower than this estimate. Lab analysis shows that most of the Qujialing sherds were from the middle and late Qujialing period. This suggests that population in the early Qujialing period was probably lower than the middle and late Qujialing period, and population most likely underwent a dramatic increase from the middle into the late Qujialing period. A sharp increase in population size suggests that population in the late Qujialing period was probably larger than the estimated average and early Qujialing population was probably much lower. Occupation area in the Qujialing period has expanded dramatically, especially around Xiaocheng in the southern survey zone, but population is focused around the same sites as in the previous Youziling period, particularly in the Taojiahu area. In general, valley floor locations were preferred by the Qujialing population as had been the case in the previous Youziling period.

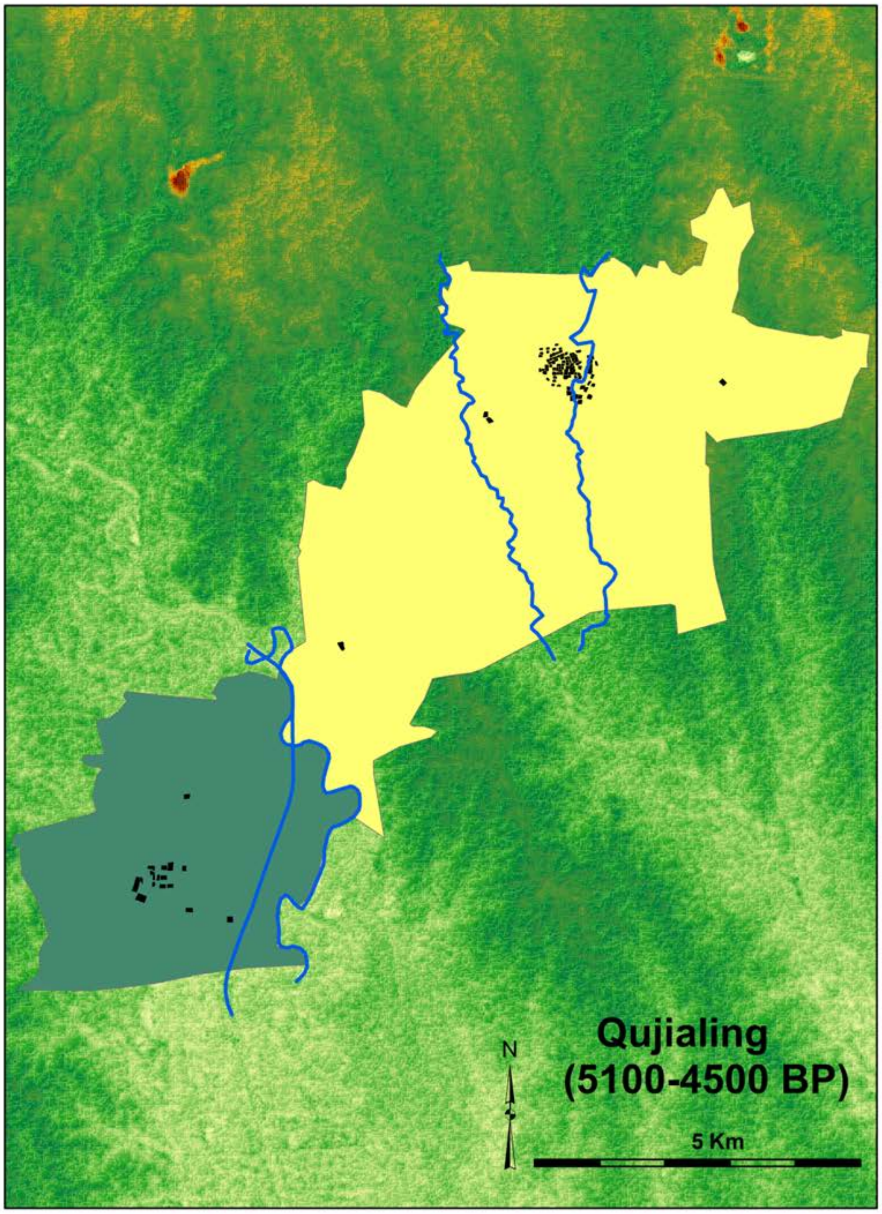

Figure 3.10. Distribution of Qujialing occupation in the survey area

Patterns of occupation in the survey area demonstrate a much more tightly clustered community in the northern zone and a relatively loosely clustered community in the southern zone. In the northern zone, most collection units are located within the walled town area and are distributed almost entirely across its extent (Figure 3.11). Only a small number of collection units are located outside the walled town, and most are very close to the walls. This distribution pattern strongly suggests that the Taojiahu walls were built in the Qujialing period. This is in accord with the suggestion from the survey carried out in 1998 (Li and Xia 2001). In the southern zone, a total of 21 collection units was found. Only 5 of these collection units were found within the Xiaocheng walled area, along the east and northeast wall. Four collection units were on the slope of the outer side of the walls (Figure 3.12). The Qujialing sherds from collection units on these outside slopes are most likely there as a consequence of later wall construction or associated disturbance, since the slope on the outside of the wall is too steep for building structures and living on, and there is a ditch surrounding the walls farther down the slope. When comes to population estimation, it is reasonable to treat sherds from these four units as from inside the walled area. The walled town is by no means entirely filled with collection units, but there is a clear cluster of settlement in the area around it. With the collection units in the walled area and the four on slope units (on the east, north and southwest outside slope of the walls), we can make a cautious suggestion that these walls were at least under construction in the Qujialing period. The local community had certainly been founded.

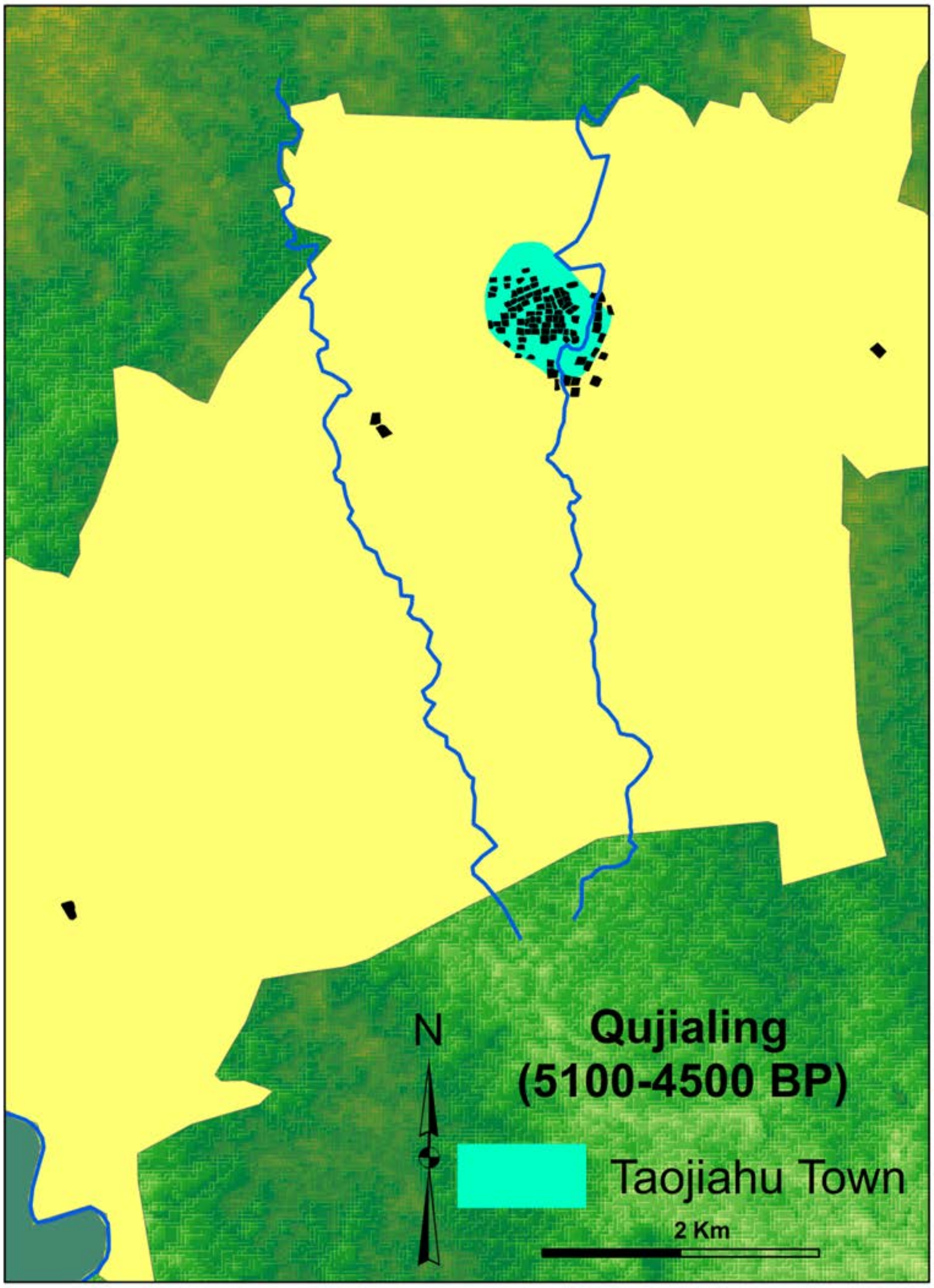

Figure 3.11. **Distribution of Qujialing occupation in the north zone**

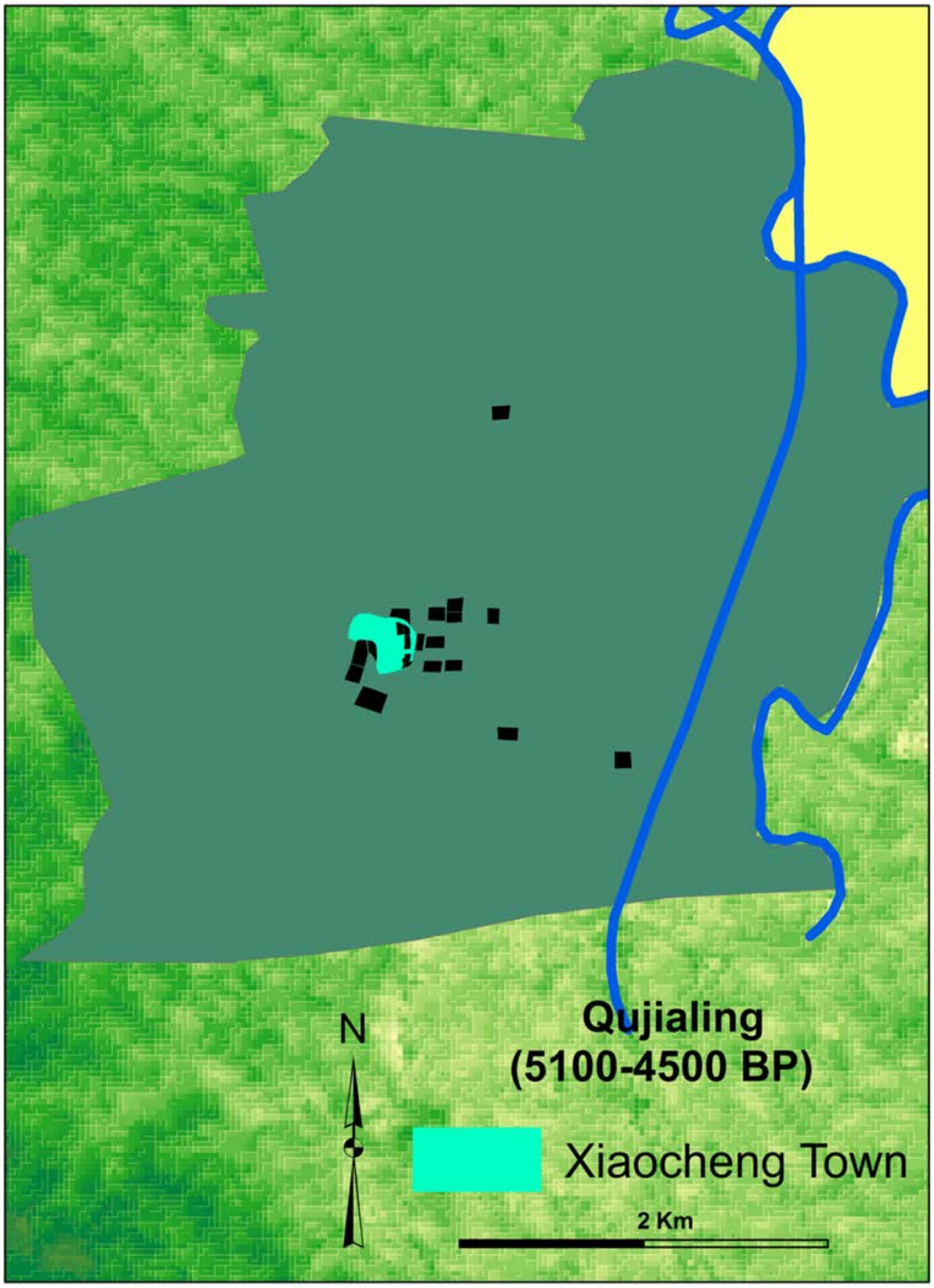

Figure 3.12. **Distribution of Qujialing occupation in the south zone**

Lab analysis indicates that the Qujialing sherds at Xiaocheng were from late in the Qujialing period. Based on the sherd distribution in the Xiaocheng walled town and on lab analysis, we can conclude that the Xiaocheng town walls were most likely built, or at least started to be built in the late Qujialing period. This conclusion also agrees with the results of excavation carried out in 2005 (Huang et al. 2007). This agreement between the results of excavation and reconnaissance survey shows that the systematic regional survey works effectively for determining when the Taojiahu and Xiaocheng town walls were built.

Population distribution in the Qujialing period clearly demonstrates two large clustered communities (Figure 3.13 and 3.14). Three high peaks represent high sherd density and population density. The Zaoshi River naturally separated two communities; the distance between the walled communities is about 10 km. In the northern survey zone, the western cluster represents the Taojiahu walled town, and the eastern high peak represents a village probably under the domination of the Taojiahu walled town. The total estimated population in the northern zone falls in the range of 6000-12,000 people. The population of the Taojiahu walled town is between 4500 and 9000, which is about 75% of the total population in the northern survey zone. The eastern cluster in the northern survey zone represents a population in the range of 700-1400 people, which is about 46% of the total population outside of the Taojiahu walled town. In general, Qujialing communities in the northern zone show a strong tendency to live in large communities. Although these two villages are much larger than those in the Youziling period, there are also a few smaller occupations in the southeast and far south of the Taojiahu walled town with population sizes of fewer than 30 persons. The population pattern in the northern zone shows considerable concentration around the Taojiahu walled town. Behind this settlement pattern, there must be strong centripetal forces pulling people together through the six centuries of the Qujialing period. As 75% of the north zone population is within the walled town, the walls of Taojiahu could be seen as an indicator of these centripetal forces, serving the purpose of keeping people within the walled area.

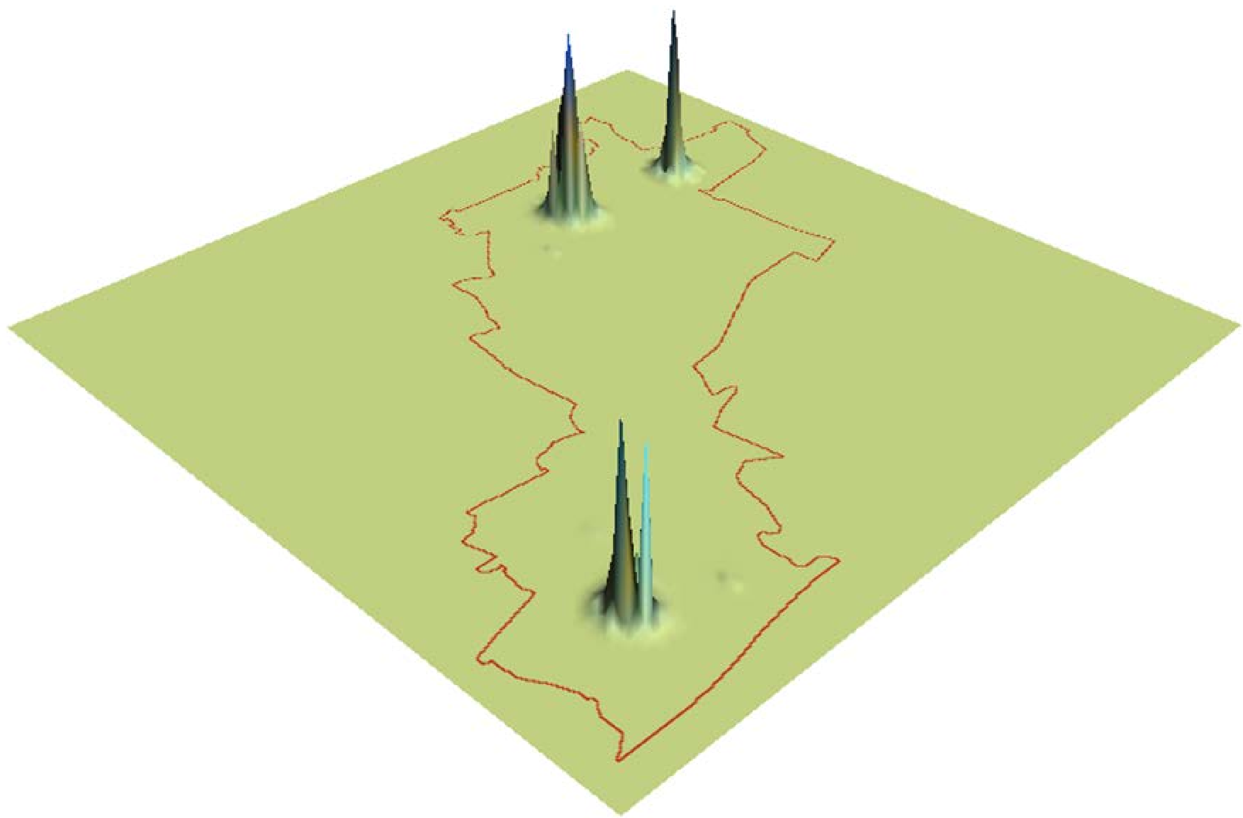

Figure 3.13. **Unsmoothed density surface for Qujialing occupation**

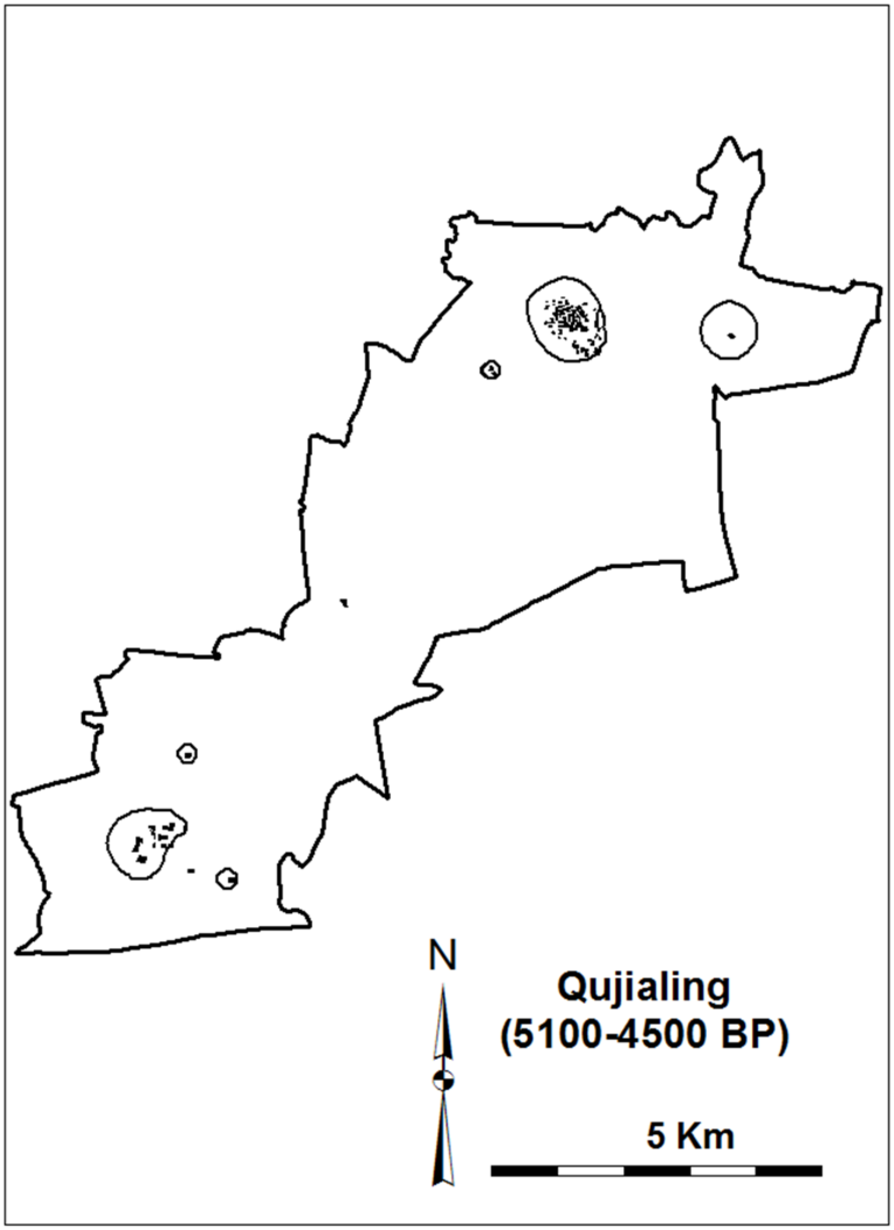

Figure 3.14. **Delineation of Qujialing local communities by cutoff contour from the unsmoothed density surface**

In the southern zone, the high peak indicates the local community around the Xiaocheng walled town. The estimated total population in the southern zone is 1000-2000 persons. The total population in the walled area is between 550 and 1100 persons, which is about 55% of the total population in the south survey zone. The total population that lived around the walled town is between 450 to 900 persons that is about 45% of the total population in the southern survey zone. As seen in Figure 3.14, the cluster in the southern zone forms a clear, concentrated but somewhat dispersed local community around the Xiaocheng walled town. The distance between the walled town and nearby clustered occupations ranges up to about 1.2 km. In general, the settlement pattern in the south demonstrates a concentrated pattern revealing centripetal forces pulling toward the walled town. Compared to the Taojiahu community, the Xiaocheng cluster is smaller in both area and population. It might relate to the smaller size of the walled town that Xiaocheng has only 55% of the total population within the walled area.

In general, population in the Qujialing period increased sharply. The population of 6000-12,000 people in the Taojiahu walled town may represent a supra-local community in the northern survey zone (Figure 3.15). The smaller population of 1000-2000 people would represent a much smaller community in the south. The rank-size plot (Figure 3.16) for Qujialing communities is concave (A=-2.272), suggesting a strongly integrated regional organization, although the smoothed surface (Figure 3.15) clearly indicates two supra-local communities. Preliminary compositional analysis of pottery carried out by Camilla Sturm reveals a possible pottery distribution network circulated pottery from Taojiahu to Xiaocheng. If such a movement of pottery did exist, this might be an indication that Taojiahu served as an economic center looked to by Xiaocheng, at least in regard to pottery production. Although we are not sure if the emergence of the supra-local community of Taojiahu was caused by the control of craft specialization, the co-occurrence of the emergence of a walled town and pottery distribution from it suggests that the emergence of the supra-local community could be related to craft production and distribution. This could be a major contribution to the centripetal forces pulling population together.

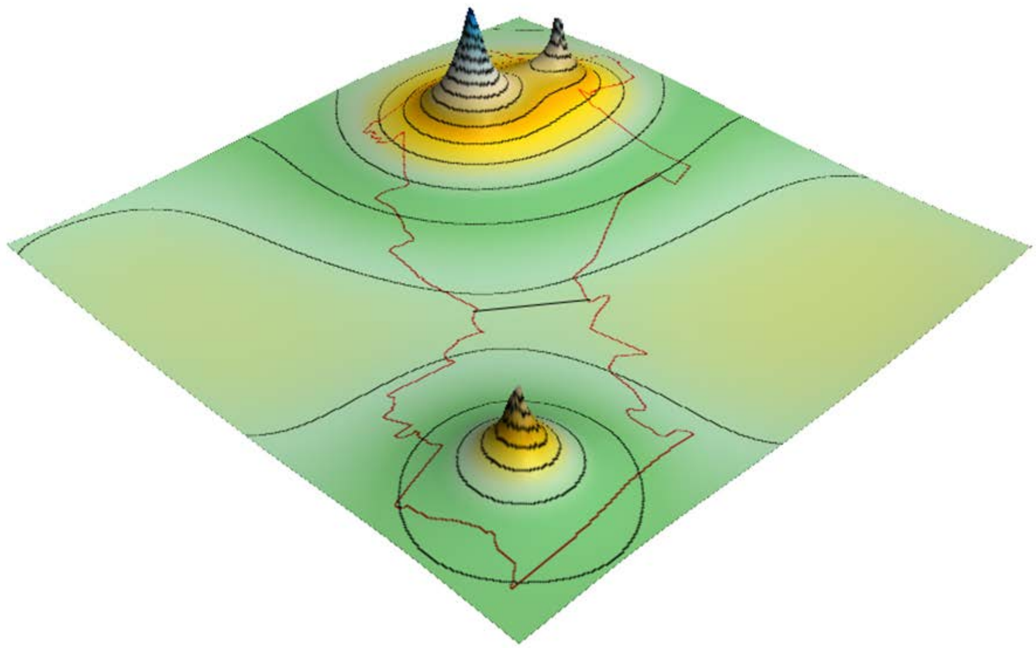

Figure 3.15. **Smoothed density surface for Qujialing occupation**

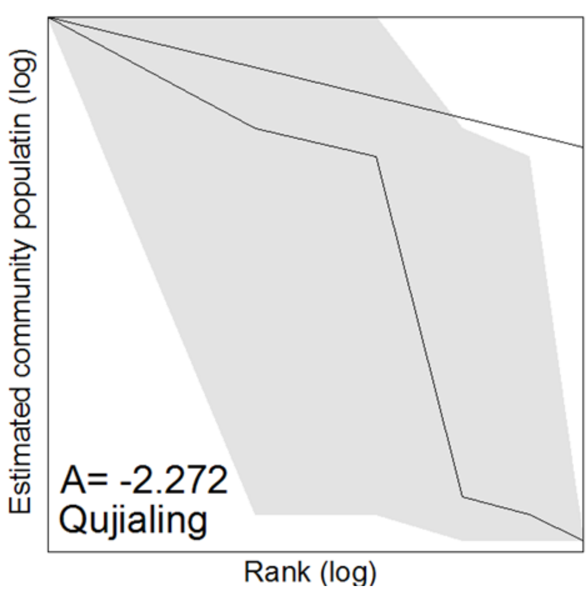

Figure 3.16. **Rank-size graph for Qujialing communities (error range for 95% confidence)**

A quantitative approach proposed by Drennan and Peterson (2008) can measure the degree of population centralization. The approach divides a supra-local community into 12 rings, each containing one-twelfth of the total area of the community. The population of each ring and its proportion are calculated. A quantitative measure of the strength of concentration would be calculated by converting these proportions into cumulative proportions and summing them. The stronger the strength of concentration, the greater the proportions of population in the inner rings will be. Extremely strong concentration strength could pull 100% of the population into the innermost ring, and the sum of cumulative proportion will come to 1200%; complete absence of concentration forces will leave 8.3% of the population in each ring, and the sum of the cumulative proportions will be 650%. Thus, the summed cumulative proportions will range from 650% for no concentration strength to 1200% for maximally strong concentration strength in theory. The sum then could be further expressed as a convenient index ranging from 0 for no concentration to 1 for maximum concentration strength by subtracting 650 and dividing the remainder by 550. This coefficient value is called B for measuring population centralization strength (Drennan and Peterson 2008).

We will use this same method to quantify demographic centralization for the Taojiahu and Xiaocheng supra-local communities divided by a clear gap of population distribution and a natural river cut between the northern and southern survey zones. Figure 3.17 shows the division of 12 concentric rings for Qujialing period Taojiahu polity in the northern survey zone. Table 3.6 shows the calculation of a B value of 0.791 for the northern survey zone, a very strong centralization illustrated in Figure 3.18. Figure 3.19 presents the 12 concentric rings of the Qujialing period Xiaocheng polity in the southern zone. The southern zone population distribution across 12 rings for the Qujialing period can be seen in Table 3.7. The B value for the southern zone is 0.992, an even stronger degree of centralization illustrated in Figure 3.20.

Figure 3.17. **The Distribution of population of Qujialing period in the north zone divided into 12 rings**

Table 3.6. Calculation *B* value for Qujialing period in the north zone

Ring	Estimated Population	Population Proportion	Cumulative Proportion
1	7290	77.75%	77.75%
2	76	0.81%	78.56%
3	2	0.02%	78.58%
4	0	0.00%	78.58%
5	1126	12.01%	90.59%
6	0	0.00%	90.59%
7	0	0.00%	90.59%
8	875	9.33%	99.92%
9	0	0.00%	99.92%
10	0	0.00%	99.92%
11	8	0.08%	100.00%
12	0	0.00%	100.00%
Total	9377	100.00%	1085.00%
***B* Value**			**0.791**

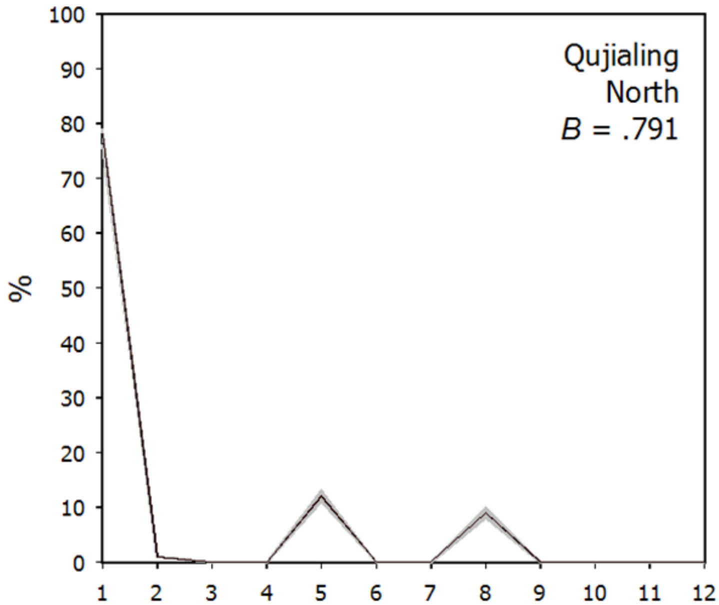

Figure 3.18. **Graph of Qujialing population distribution across the 12 concentric rings in the north zone (90% confidence zone)**

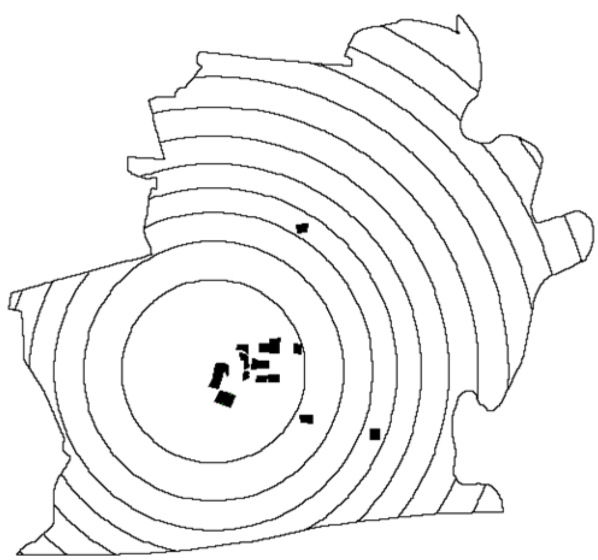

Figure 3.19. **The Distribution of population of Qujialing period in the south zone divided into 12 rings**

Table 3.7. Calculation *B* value for Qujialing period in the south zone

Rings	Estimated Population	Population Proportion	Cumulative Proportion
1	1572	97.41%	97.41%
2	27	1.65%	99.06%
3	0	0.00%	99.06%
4	15	0.94%	100.00%
5	0	0.00%	100.00%
6	0	0.00%	100.00%
7	0	0.00%	100.00%
8	0	0.00%	100.00%
9	0	0.00%	100.00%
10	0	0.00%	100.00%
11	0	0.00%	100.00%
12	0	0.00%	100.00%
Total	1614	100.00%	1195.53%
***B* Value**			**0.992**

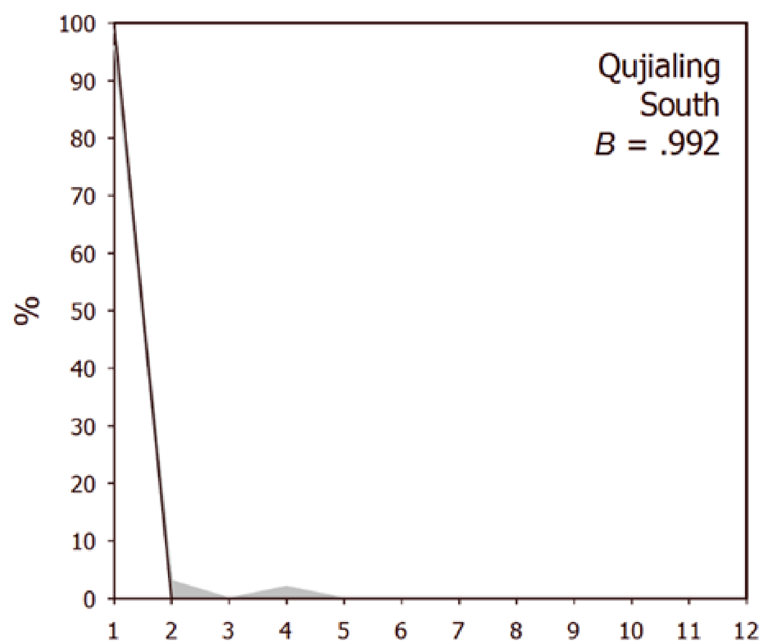

Figure 3.20. Graph of Qujialing population distribution across the 12 concentric rings in the south zone (90% confidence zone)

The Qujialing period (3100-2500 BCE) is also in the Holocene warm and humid period. The oxygen isotope record of the SB10 stalagmite from Shanbao Cave indicates a period of abundant precipitation (Shao et al. 2006). During this flooding period, the smaller lakes between the Yangtze River and the Hanjiang River started to merge into the massive Yunmeng Lake (Zhu et al. 1997). Soil samples from the Qujialing site have a relatively high content of Rb but with a decreasing trend; in contrast, the content of Sr is low but increased later. The warm and wet climate of the early Qujialing period is characterized by frequent flooding, which has been suggested as the causal factor in the emergence of walled towns (Wang 1998). However, the elevation map again implies that the Qujialing occupations remained in the low river valley, as the Youziling period demonstrates. Elevation analysis shows that in the northern survey zone, the Qujialing occupation was still located in the Silong River Valley at an elevation between 30 and 40 m above sea level. In the southern survey zone, Qujialing collection units remained on the relatively high ridge where the Xiaocheng walled town was built (see Chapter 4 for detailed analysis). However, additional occupation was located on the comparatively low Zaoshi River valley floor where the elevation is about 20-30 meters above sea level with an estimated population of 950 to 1900 persons, which is 95% of the southern population. Since most of the population located in the relatively low flat river valley despite nearby higher ground, flooding was likely not to be a serious concern for people during the Qujialing period.

From the Youziling period to the Qujialing period, the consistent use of low elevation river valley locations argues against the flooding model to explain the emergence of walled towns. People were able to live close enough to rivers and lakes for water based resources. The ratio of Rb/Sr gradually dropped with fluctuations, which indicates weathering effects and a drier and cooler trend in the late part of this period (Shi et al. 2009). Yunmeng Lake started to shrink.

The dramatic population increase in the late Qujialing period corresponds to the lowering of the water table. Again, mixed subsistence patterns including fishing, hunting, gathering and cultivating rice as well as specialized pottery making, would provide the foundation for sedentary life (Pei 2008). It is very likely that the preference for locations near rivers was still for the purpose of exploiting a broad spectrum of natural resources.

3.3.2.3 Shijiahe (2500-2000 BCE)

The number of Shijiahe sherds recovered in survey is more than 3700, which is close to the number from the previous Qujialing period. The total number of collection units with Shijiahe sherds has increased to 208 (Figure 3.21). The estimated population of the Shijiahe period in the survey area falls in the range of 5500-11,000 persons, which is a somewhat lower range than the estimate for the Qujialing period. The substantial overlap between the estimated ranges for the two periods indicates relative population stability.

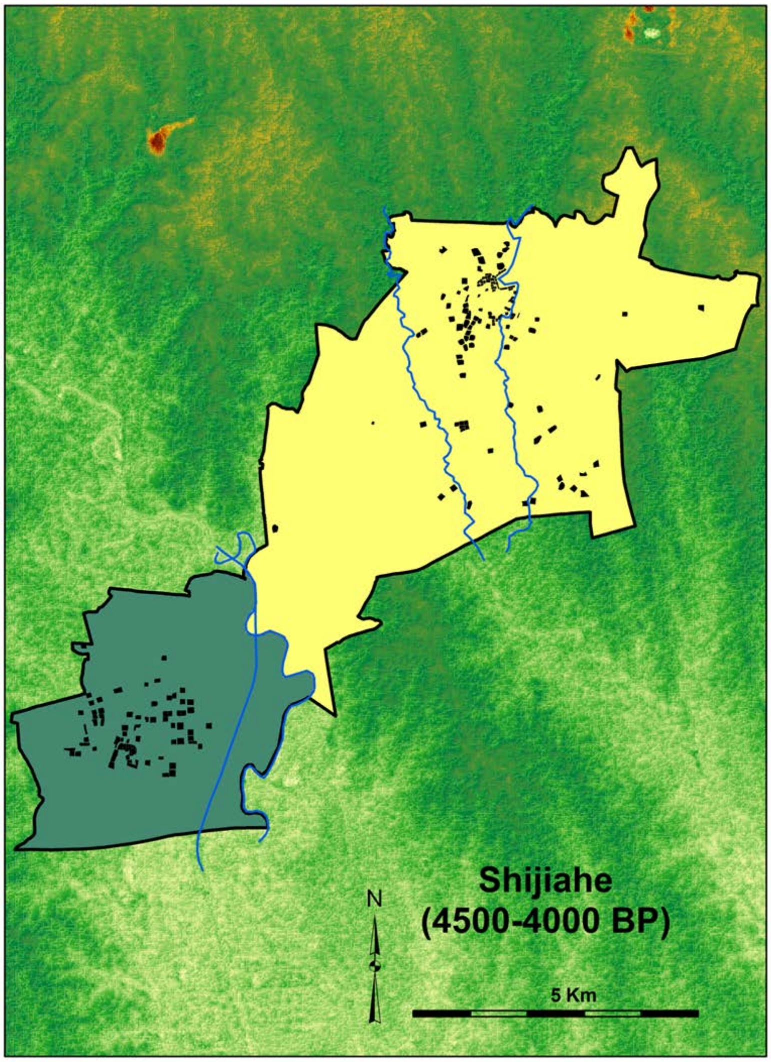

Figure 3.21. **Distribution of Shijiahe occupation in the survey area**

Occupation patterns in the survey area have changed from the Qujialing period. Compared to the previous period, the occupation in the Shijiahe period is considerably more dispersed. Walled towns were still occupied, but more occupations occurred outside in both northern and southern survey zones. In the northern survey zone, four occupation clusters were found to the north and south of the Taojiahu walled town; most of the occupations occurred outside of the walled town. A total of 49 collection units with Shijiahe sherds were located within the Taojiahu walled town; while 79 collection units were found outside toward the south (Figure 3.22). Shijiahe occupation continued inside the walled town, but was now quite sparse within the walls. Occupation within the walls was more than matched by occupation outside, although much of this continued to be in the same vicinity. In the southern survey zone, the Xiaocheng walled town was almost entirely filled in with 16 Shijiahe collection units. The total occupied area in the southern zone increased sharply to 68 collection units around the Xiaocheng walled town (Figure 3.23). Since collection units filled in the walled area, the Xiaocheng town walls had been finished at the latest in the Shijiahe period.

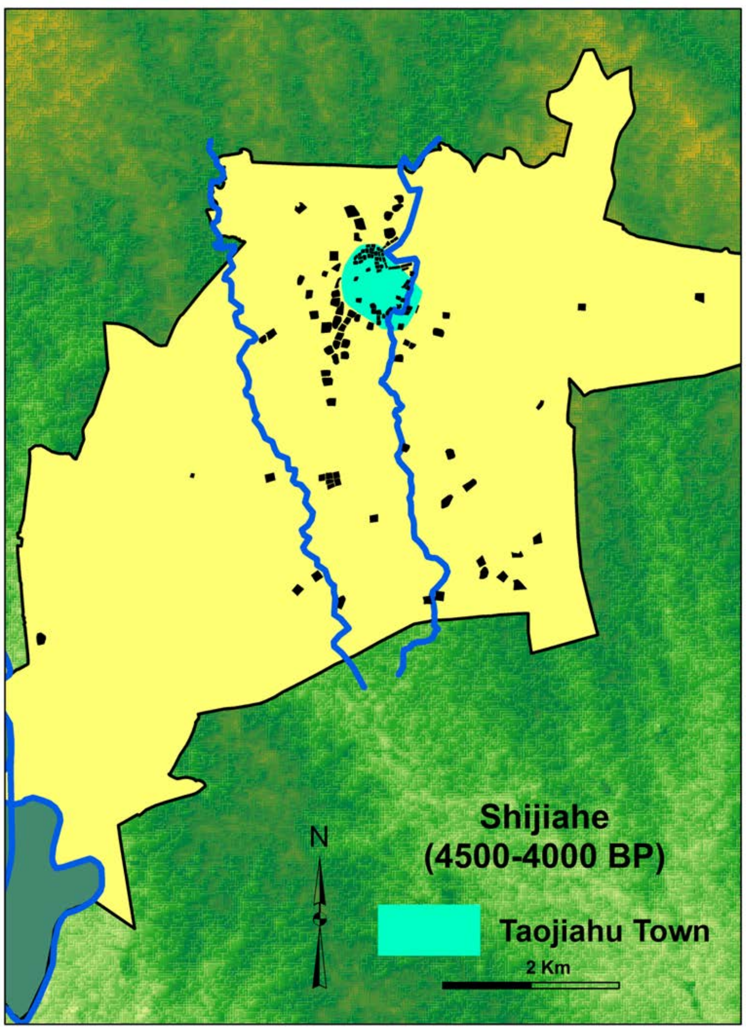

Figure 3.22. Distribution of Shijiahe occupation in the north zone

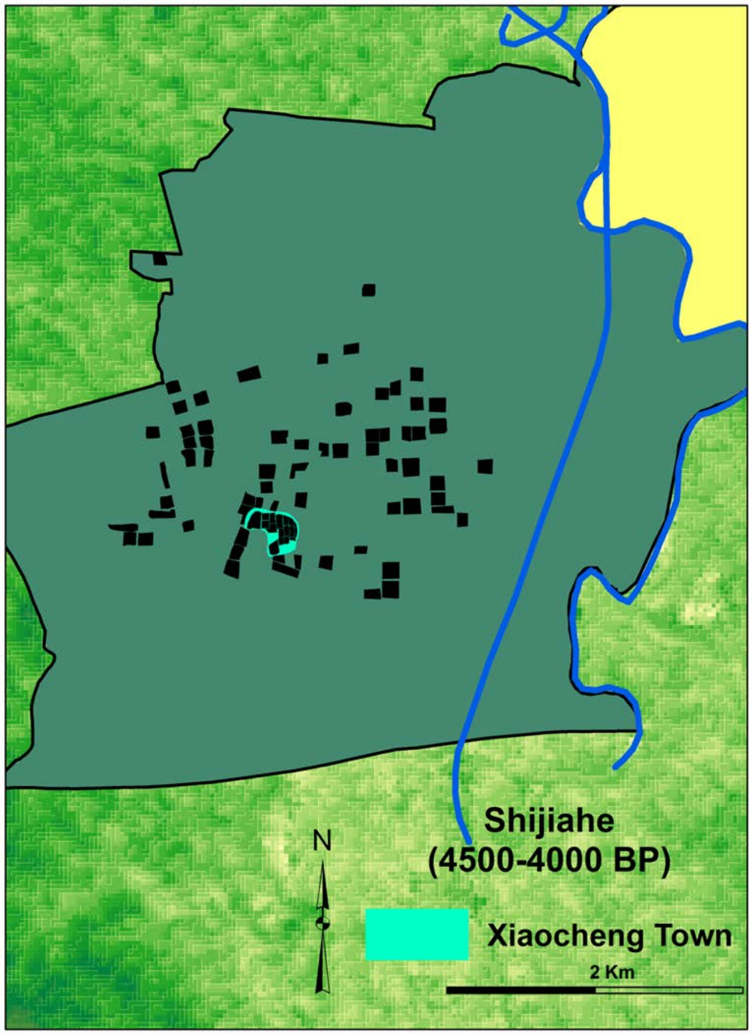

Figure 3.23. Distribution of Shijiahe occupation in the south zone

An unsmoothed surface (Figure 3.24) permitted delineation of Shijiahe local communities by cutoff contour from the unsmoothed density surface (Figure 3.25). In the northern zone, four high peaks stand out representing the highest population density local communities. One peak in the northern part of the Taojiahu walled town had the highest population density. The area near Taojiahu's north wall was heavily occupied, but the entire central sector within the walls was unoccupied (Figure 3.26). The population peak farther east was situated at the same location as a high density occupation in the previous Qujialing period.

The other two relatively high peaks occurred close outside the Taojiahu walls. The southern peak also incorporated some occupation in the southern part of the area enclosed by the Taojiahu walls with nearby ones outside the walls.

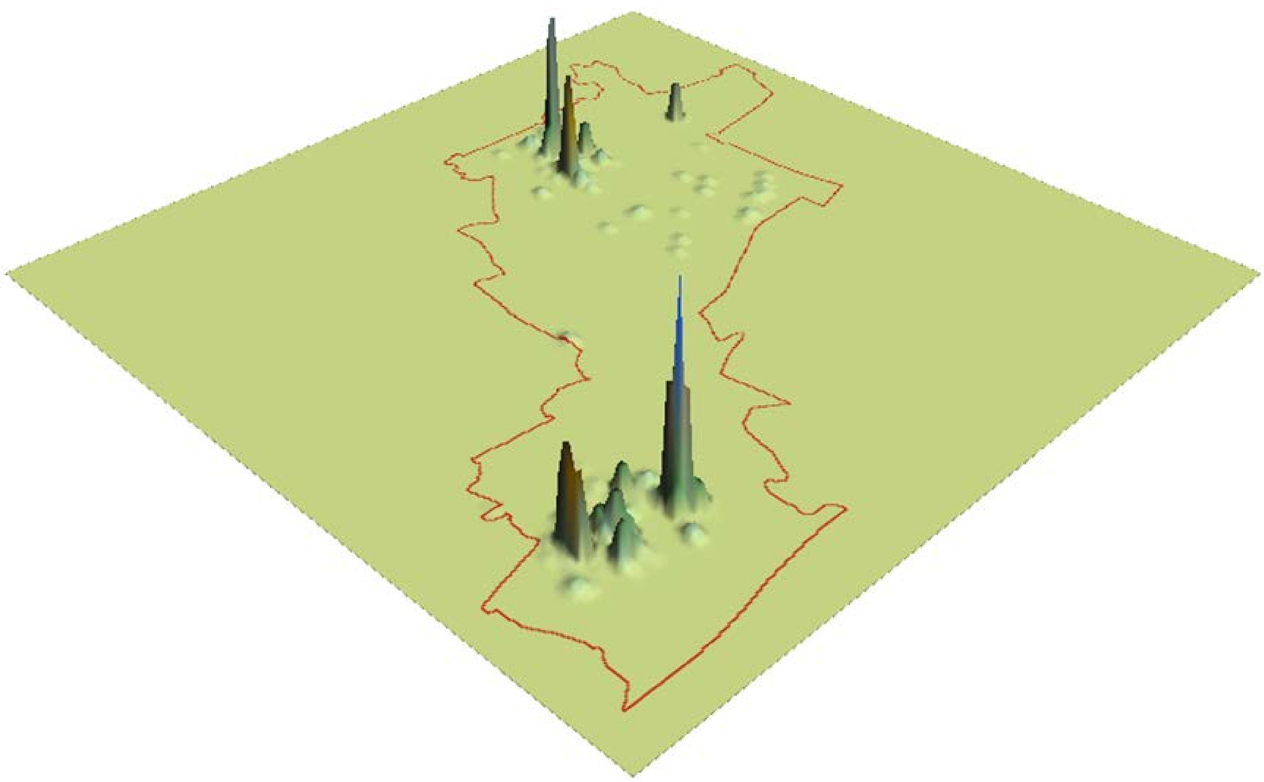

Figure 3.24. Unsmoothed density surface for Shijiahe occupation

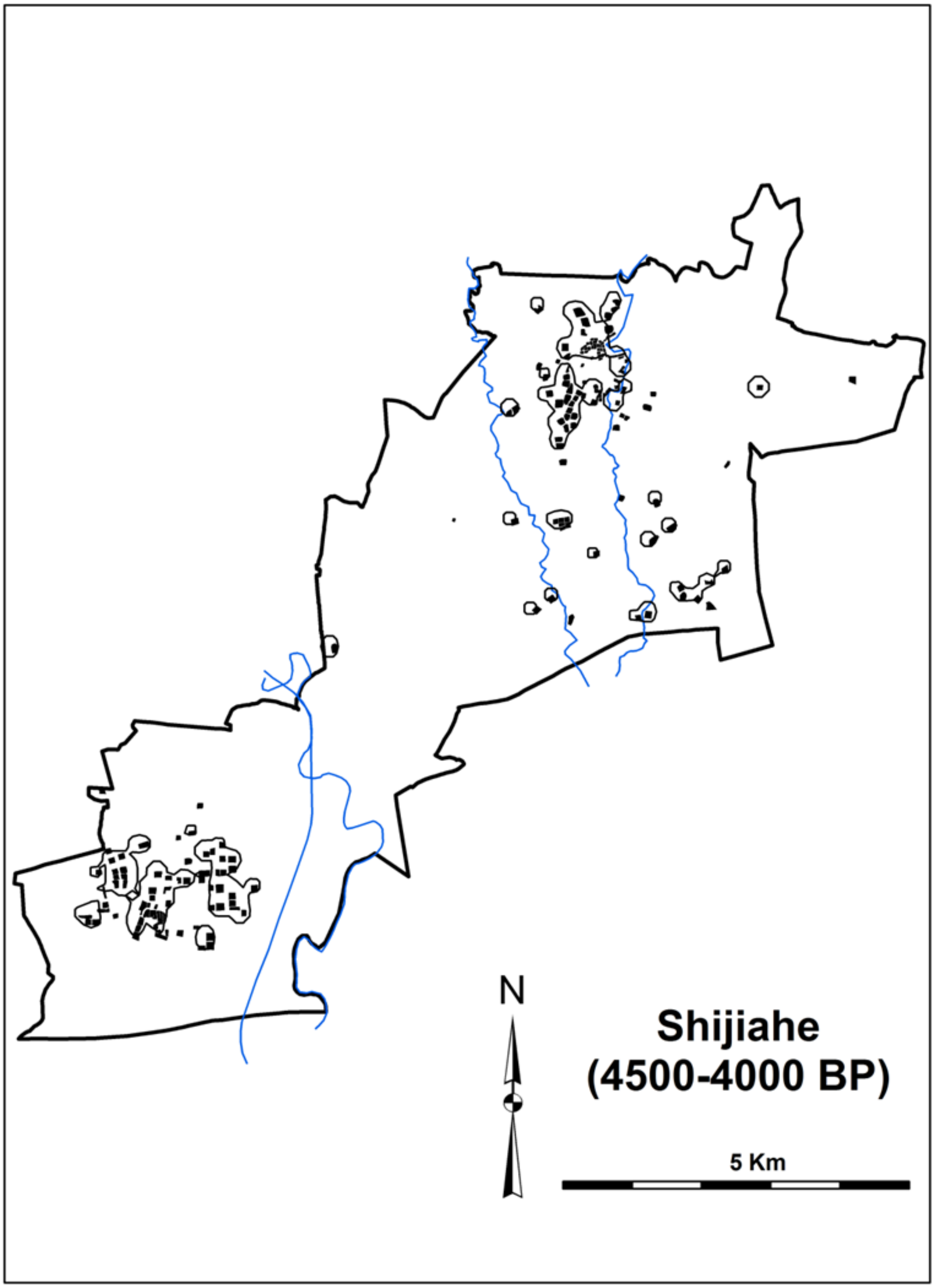

Figure 3.25. **Delineation of Shijiahe local communities by cutoff contour from the unsmoothed density surface**

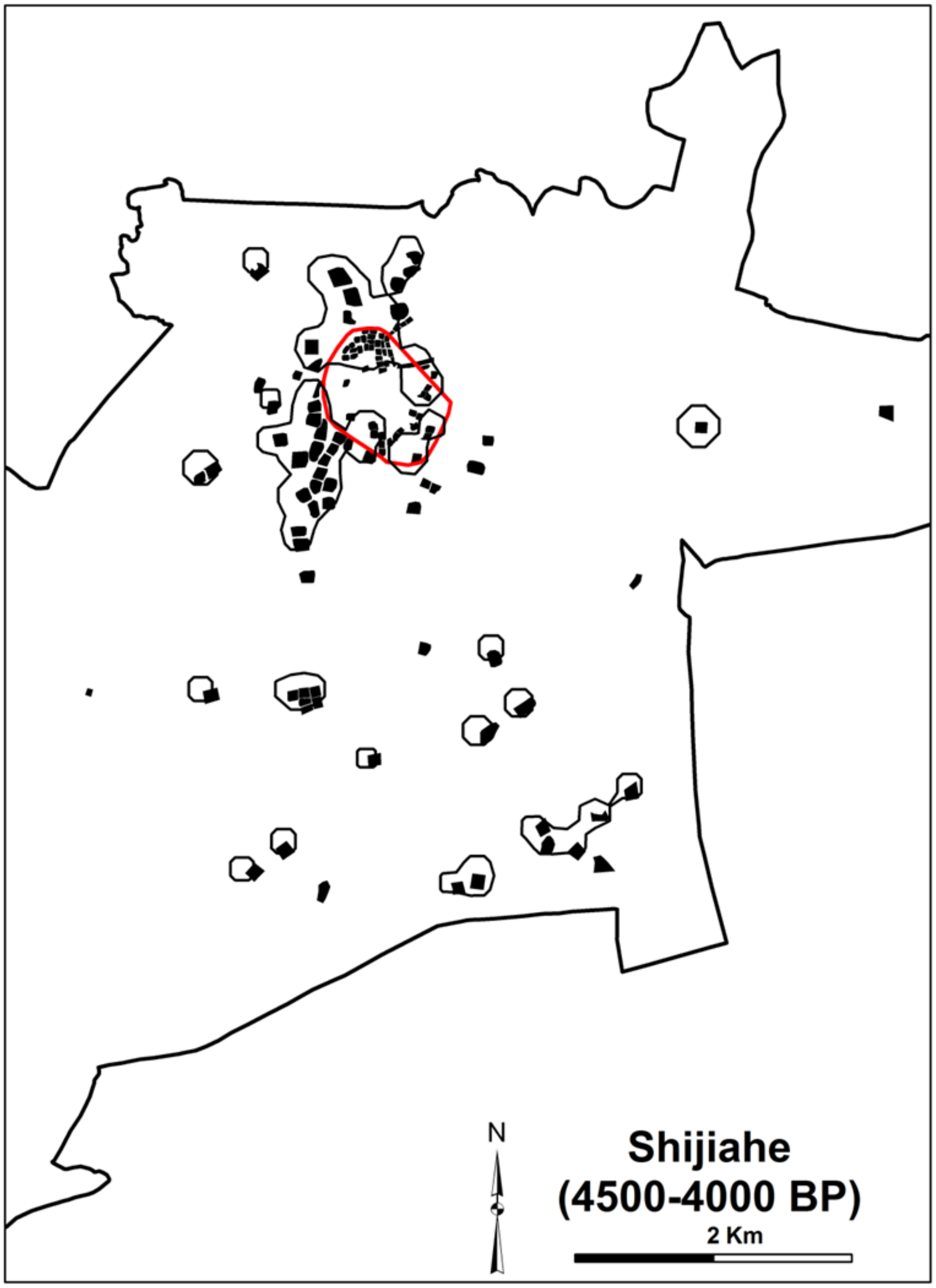

Figure 3.26. **Delineation of Shijiahe local communities in the north zone**

Population within the Taojiahu walls was about 2500-5000 persons, which is approximately 68% of the estimated total population in the northern zone. The estimated population living outside the Taojiahu walls falls in the range of 1200-2400, which is around

32% of the total population in the northern survey zone. Compared to the previous Qujialing period, the population in the northern survey zone decreased from 6000-12,000 persons to 3700-7400 persons. Within the Taojiahu walled town, the population dramatically declined from 4500-9000 persons, which is about 75% of the population in the northern zone during the Qujialing period, to 2500-5000 persons, which is about 68% of the population in the northern zone during the Shijiahe period.

In the southern zone, the Xiaocheng walled town was filled with 16 collection units and outside occupied area had expanded substantially. The unsmoothed population surface shows several peaks, among which the highest peak is located on the flat river valley floor a few hundred meters east of the walled town (Figure 3.24). Another peak outside the walls is located west of the walled town by several hundred meters. The total population in the southern zone is 1800-3600 persons. The population in the Xiaocheng walled town falls in the 900-1800 range, and estimated population around the Xiaocheng walled town is about 900-1800. Compared to the previous Qujialing period, the estimated population in the southern zone had increased both inside and outside of the Xiaocheng walled town, but particularly within the walled area, where the population size expanded from 550-1100 persons in the Qujialing period to 900-1800 persons in the Shijiahe period. Occupation around the walled town expanded toward the Zaoshi River in the north, but was still within a distance of 2 km around the walled town.

Settlement patterns and population change from the Qujialing to the Shijiahe period imply that the role walled towns played in the local settlement system changed. First, for the Taojiahu walled town, the decline of population in the walled area in the Shijiahe period probably suggests a decrease in the centripetal forces the area exerted. The splitting up of local communities around Taojiahu also reflects this decrease in centripetal forces. In addition, Shijiahe people began to occupy areas farther south.

In the Shijiahe period, the population range of 5500-11,000 persons in the survey zone suggests the presence of a supra-local community structure. The smoothed occupation surface shows one supra-local community in the northern survey zone around Taojiahu and another in the south around Xiaocheng (Figure 3.27). The rank-size plot (Figure 3.28) gives us a pattern that crosses from one side of the lognormal line to the other and yields both positive and negative components. Since the gray area above the log-normal line is smaller than the area below it, the value of the A coefficient is -0.636, which would superficially indicate a strongly integrated settlement system in the survey area. The size of the local communities ranges from individual farmsteads with fewer than 10 persons up to the largest local community with a population of 2300-4600, about twice the size of the second largest local community. More than 17 out of 24 local communities had fewer than 100 persons. The larger local communities seem to have served as regional economic and political centers.

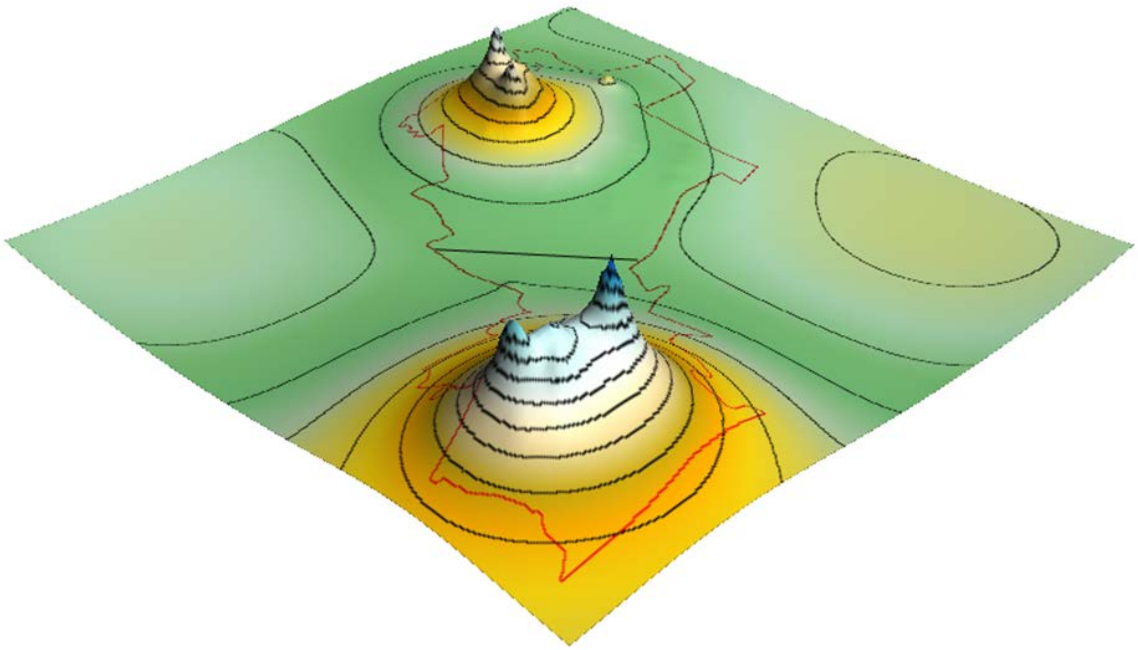

Figure 3.27. Smoothed density surface for Shijiahe occupation

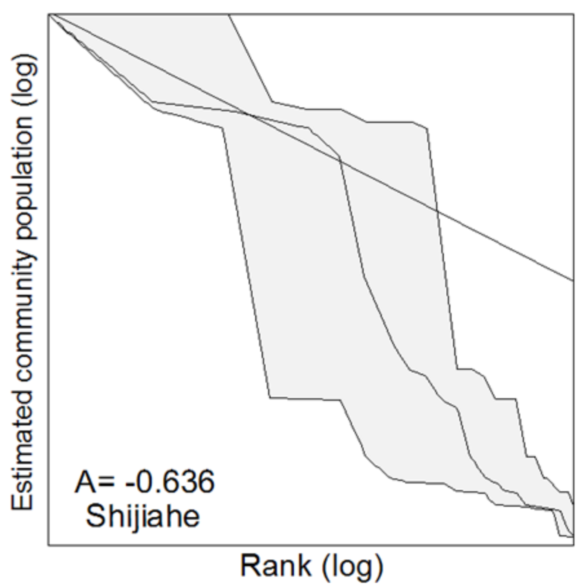

Figure 3.28. **Rank-size graph for Shijiahe communities (error range for 95% confidence)**

Demographic centralization, with a B value of 0.833 in the northern zone, measures as even stronger than in the Qujialing period. Figure 3.29 shows the distribution of population across the 12 rings in the north. Table 3.8 and Figure 3.30 show the calculation of B value. In contrast, the population centralization B value of only 0.662 in the south for the Xiaocheng polity is weaker than its counterpart in the northern zone, although it is not clear what caused of such a pattern.

Figure 3.29. **The Distribution of population of Shijiahe period in the north zone divided into 12 rings**

Table 3.8. Calculation *B* value for Shijiahe period in the north zone

Rings	Estimated Population	Population Proportion	Cumulative Proportion
1	4168	77.07%	77.07%
2	139	2.56%	79.63%
3	32	0.59%	80.22%
4	7	0.12%	80.34%
5	903	16.70%	97.04%
6	38	0.71%	97.04%
7	2	0.04%	97.04%
8	53	0.98%	98.02%
9	55	1.02%	99.04%
10	0	0.00%	99.04%
11	11	0.21%	99.25%
12	2	0.00%	99.25%
Total	5410	100.00%	1102.98%
***B* Value**			**0.833**

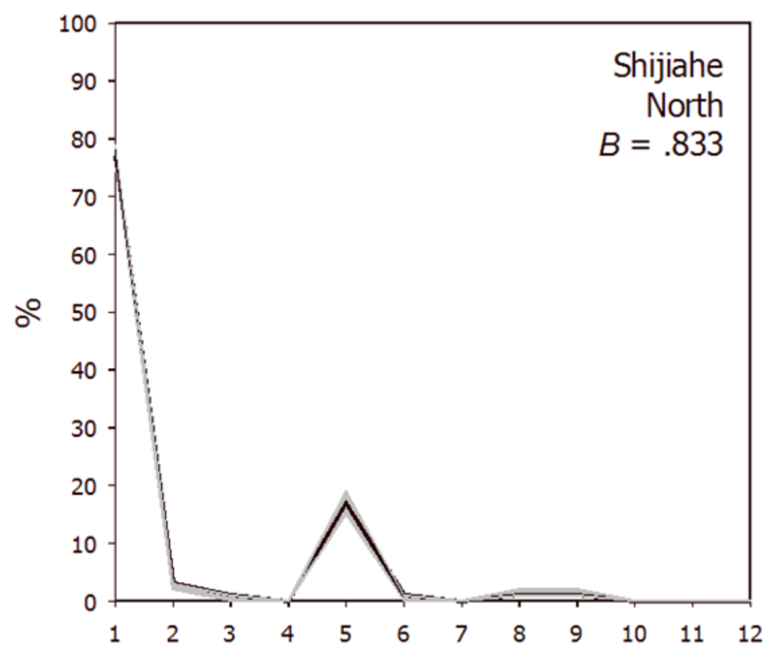

Figure 3.30. Graph of Shijiahe population distribution across the 12 concentric rings in the north zone (90% confidence zone)

In general, the supra-local communities are well integrated economically and politically. Compared to the Qujialing period, the Taojiahu and Xiaocheng polities seem more independent as well as competitive with each other. Preliminary results of pottery compositional analysis carried out by Camilla Sturm reveal a possible reciprocal pottery distribution network of exchanging pottery between the two walled towns. Although the total population remained similar in size to that of the Qujialing period, settlement patterns underwent a substantial change during the Shijiahe period. The Xiaocheng walled town consolidated and grew in population and settlement size. It is possible that the Xiaocheng polity has expanded its influence across the Zaoshi River to the northern survey zone, since one collection unit in the far south of the northern survey zone clusters with the Xiaocheng polity (Figure 3.26 and Figure 3.28). If the emergence of walled towns responded to social tension and conflict in the Jianghan Plain, this would be more consistent with the Qujialing period, since most of the population was in the walled town and well protected. In the Shijiahe period, the tendency toward outward expansion might suggest less frequent and severe social tension.

The Shijiahe period is also part of the Holocene warm and humid period, although a cooling and drying trend was underway by 4200 BP. Nonetheless high sea level nonetheless caused high lake and river levels in the Jianghan Plain and led to more rapid accumulation of sediment and frequent flooding (Mo et al. 2009). The elevation analysis shows that most of the occupations in the survey zone are still located on the flat valley floors. In both northern and southern zones, the population started to dwell in relatively higher areas about 40 m above sea level (see chapter 4 for detailed analysis). This trend seemingly matches the flooding hypothesis. However, at the same time, the Shijiahe population also began to occupy a considerable area of low elevation at 20-30 m above sea level. The two-directional expansion of occupation suggests that flooding was not so severe as to prevent Shijiahe people from living on river valley floors in low elevation ranges.

3.3.2.4 Shang (1600-1046 BCE)

In the survey zone, only 4 collection units contain Shang sherds with a total of six sherds. The four collection units were found in the Taojiahu walled town in the northern survey zone (Figure 3.31). 3 of them were located in the northern corner of the walled area, while one was in the western corner. The estimated population during the Shang period in the survey area is 5 to 10 persons. Four scattered collection units surely do not represent any community structure; instead they most likely signify single family homesteads, or perhaps a very few households living together and not necessarily for the whole duration of the Shang period. The unsmoothed occupation surface (Figure 3.32) shows these four collection units not far apart. The smoothed surface (Figure 3.33) shows the same thing, in general form like a supra-local community structure, even though that is clearly not a reasonable interpretation to suggest.

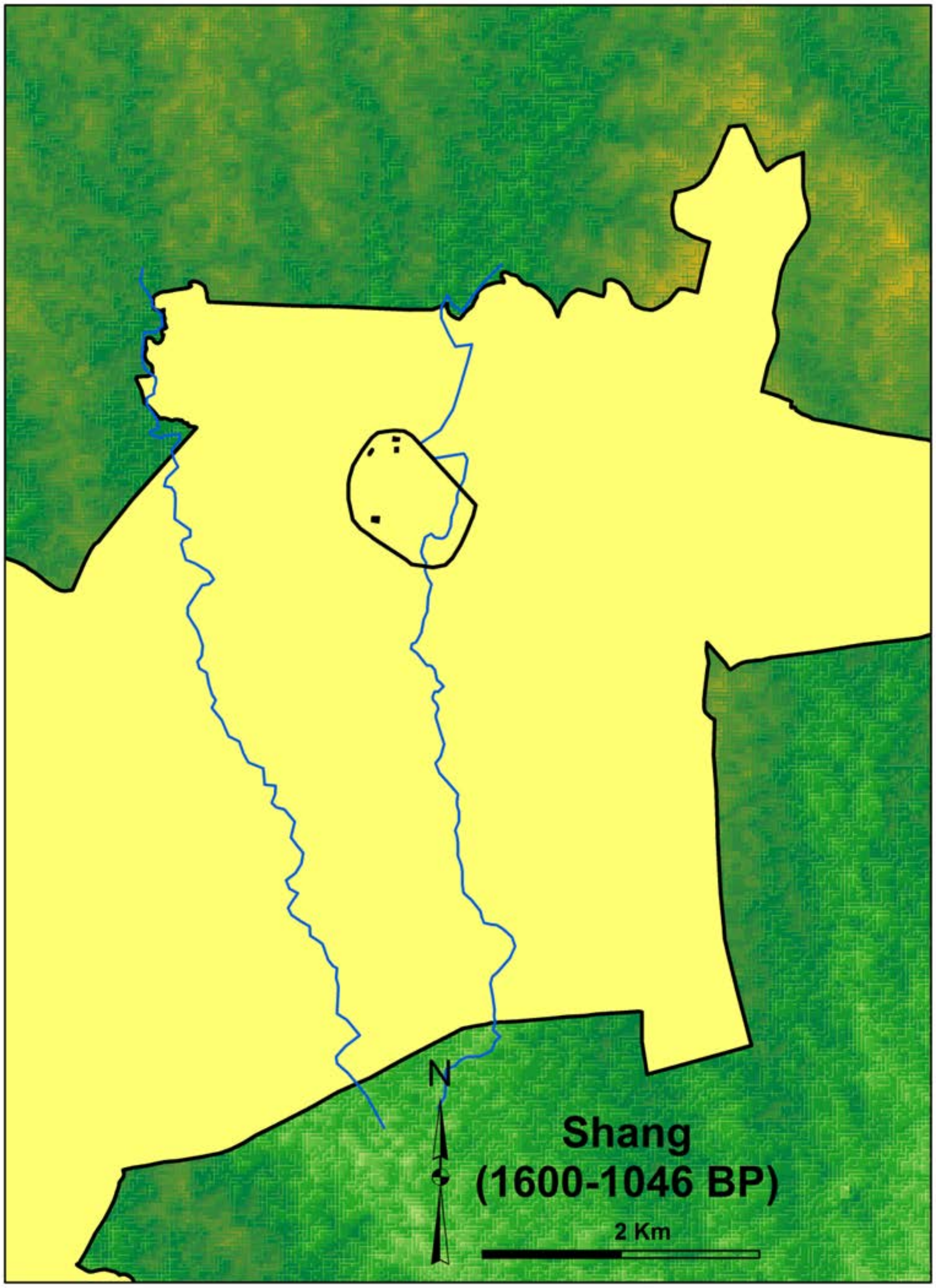

Figure 3.31. Distribution of Shang occupation in the survey area

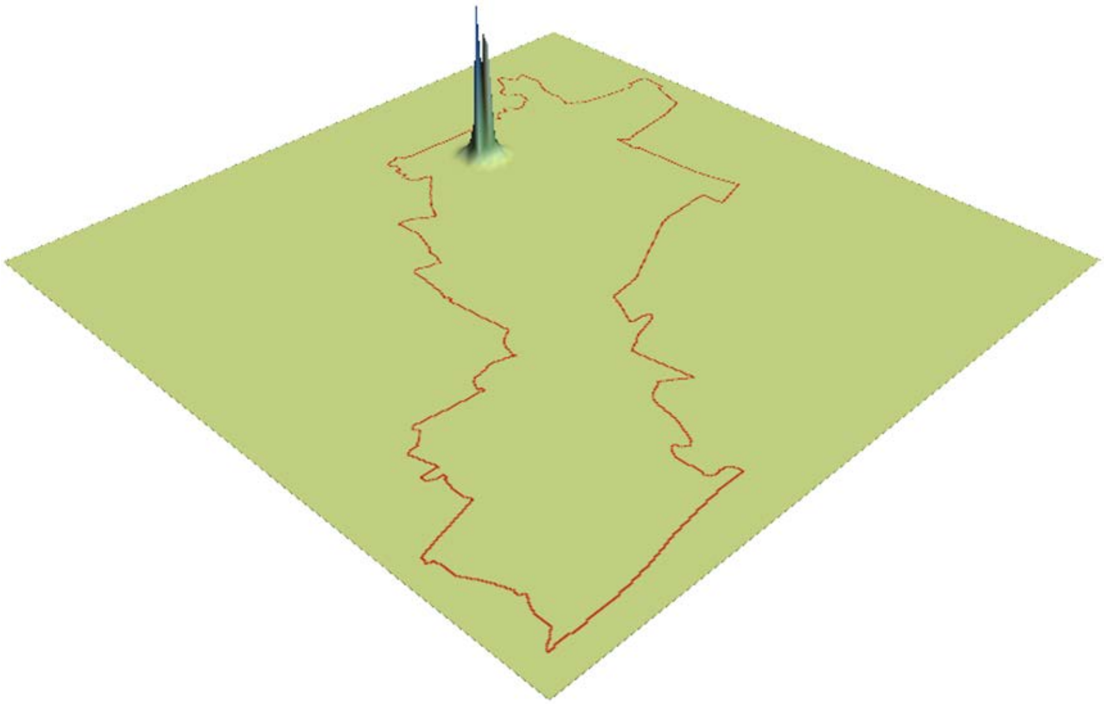

Figure 3.32. Unsmoothed density surface for Shang occupation

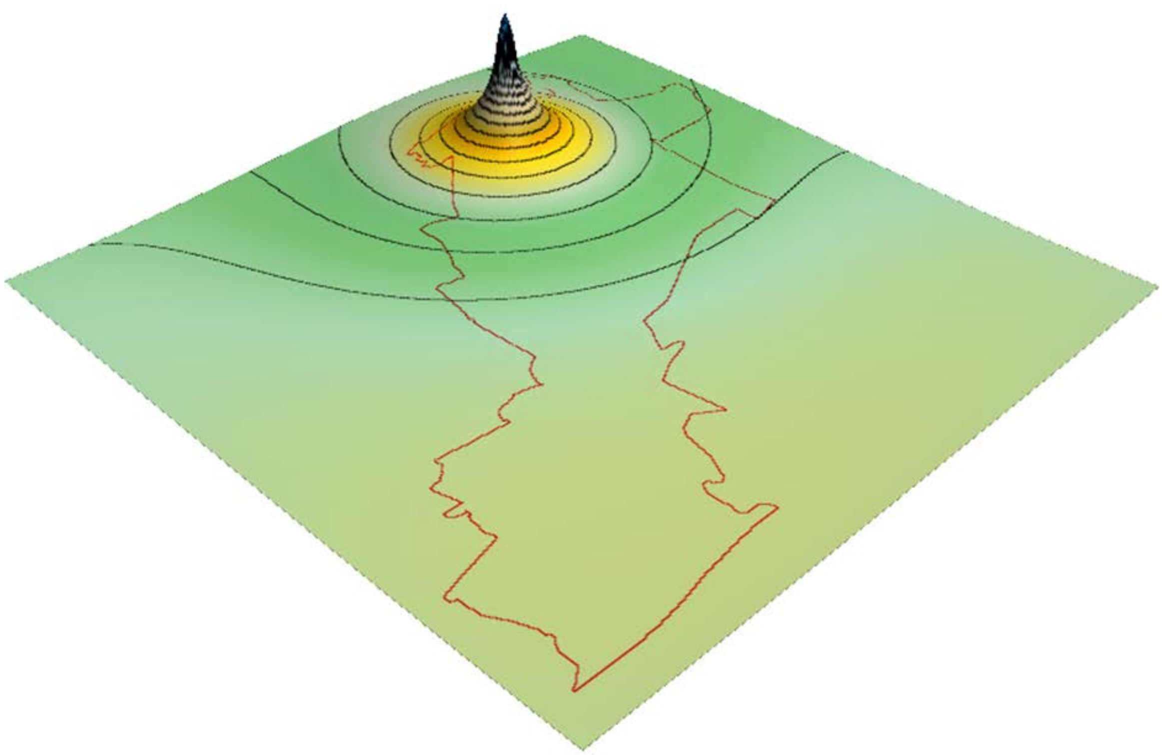

Figure 3.33. Smoothed density surface for Shang occupation

In the Shang period, the population in the survey area had undergone a substantial decline. The Taojiahu and Xiaocheng walled towns were nearly abandoned. The decline of population occurred not only in the survey area but also all across the Jianghan Plain. Soil analysis reveals episodes of flooding between 2700 and 1500 BCE (Zhu et al. 1997). Wang (1998) identified a similar stratum of flood deposition about 1 m thick above the late Shijiahe stratum at the Caitai site and a similar stratum under the late Erlitou to late Shang stratum at the Lijiatai site. It is possible that severe flooding in the period of late Shijiahe to Shang caused the abandonment of the Taojiahu and Xiaocheng walled towns, although Taojiahu had already been much reduced in occupation during Shijiahe times. The Silong River today still runs across and cuts through the Taojiahu walled town into eastern and western parts; the Silong River also cuts through the northeast and southeast walls.

Due to the lack of archaeological excavation in the Taojiahu walled town, researchers have little insight as to when the walled town was abandoned. The coincidence of dramatic population decline and climate evidence, particularly flooding evidence, suggests that the abandonment of the Taojiahu walled town likely happened around the end of the Shijiahe period. Excavation in the Xiaocheng walled town indicates that the walled town probably was also abandoned from the end of the Shijiahe period until Zhou times (Huang et al. 2007). The absence of artifacts for the period between Shijiahe and Zhou at the Xiaocheng site, reinforces the complete absence of sherds from the southern zone in general. Another trace of evidence that supports the idea of problems with flooding is that the elevation of the southern zone is lower than the elevation in the north. Nearly half of the survey area that was once occupied by Shijiahe people is below 20 m above sea level. The flooding deposit after the Shijiahe period at the Caitai site is about 28.6-29.0 m above sea level, implying that flooding might have disturbed the areas lower than 30 m above sea level. This could explain why the small amount of Shang occupation that remained was in the northern zone, which is mostly over 30 m above sea level (see detailed analysis in chapter 4). On the other hand, to argue that the northern zone was high enough to ameliorate flooding problems undermines the idea that the almost complete lack of population even in the northern zone in Shang times was a result of flooding.

3.3.2.5 Western Zhou (1046-776 BCE)

Western Zhou sherds were found in 22 collection units with a total of 82 sherds (Figure 3.34). The estimated population in the survey zone surged back up to an average population size of 1000-2000 persons through the entire period. All the collection units with Western Zhou sherds were located in the southern survey zone close to the Xiaocheng walled town. The absence of Western Zhou artifacts in the northern zone indicates that the Taojiahu walled town had been completely abandoned.

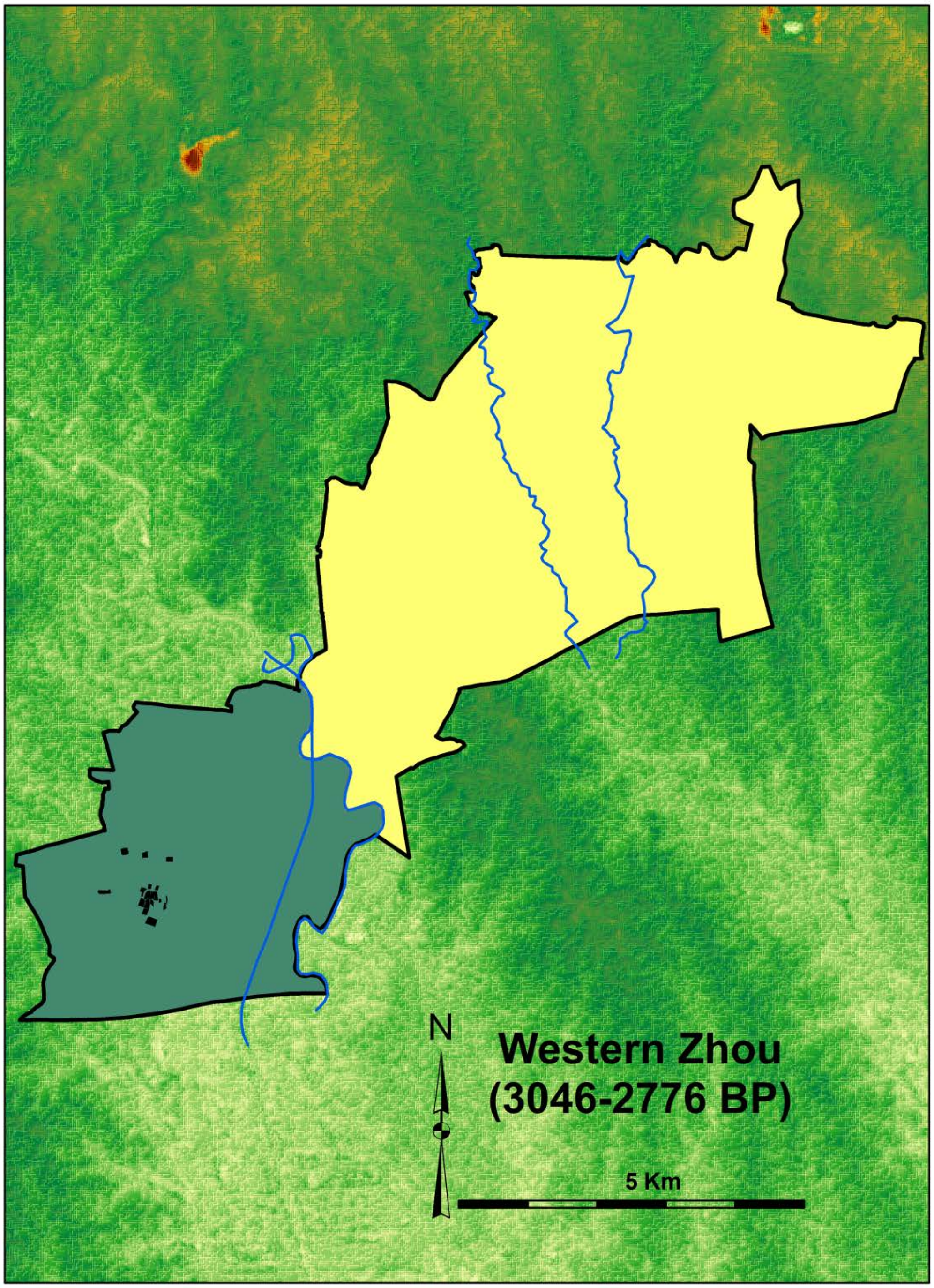

Figure 3.34. Distribution of Western Zhou occupation in the survey area

Occupations in the southern zone were distributed both within and without of the walled area. Ten collection units were found within the walled area, and 12 collection units were found outside of the walls but within distances less than 700 m away (Figure 3.35). An unsmoothed density surface shows two relatively high peaks quite close together and one much lower peak (Figure 3.36). The distribution of the peaks indicates a clear local community. The cutoff contour from the unsmoothed density surface groups the 10 collection units within the walled area and 8 collections outside; however, all units are very close to the walls, thereby forming a single large local community that contains most of the population of the survey area. Two collection units a short distance to the north and one a short way to the west form two additional local communities (Figure 3.37). Since all these local communities are within 700 m of each other, daily face-to-face interaction between the residents of all of them seems perfectly feasible. The largest local community is estimated at about 800 to 1600 people; the second largest, at about 35-70 people; the smallest one had fewer than 10 people. The Western Zhou people in the southern survey zone lived clustered tightly together in a large local community, which shows strong centripetal forces drawing the few other smaller local communities and farmsteads toward it. The rank-size plot for the Western Zhou local communities illustrates the strong concave pattern (A= -3.320, Figure 3.38) we would expect for a period when the local communities and homesteads through the survey area were politically or economically centralized and significantly integrated. The smoothed density surface also shows a well-integrated supra-local community in which population distribution shows a strong pattern of living close together around the walled town (Figure 3.39). A B value of 0.992 shows a very strong demographic centralization that also supports this reconstruction (Figures 3.40 and 3.41; Table 3.9). The resurgence of population and the reoccupation of the Xiaocheng walled town in the Western Zhou period match the results from excavation, which suggests that the Xiaocheng walled town resumed its building and occupation in the Western Zhou period (Huang et al. 2007) after a hiatus in Shang times.

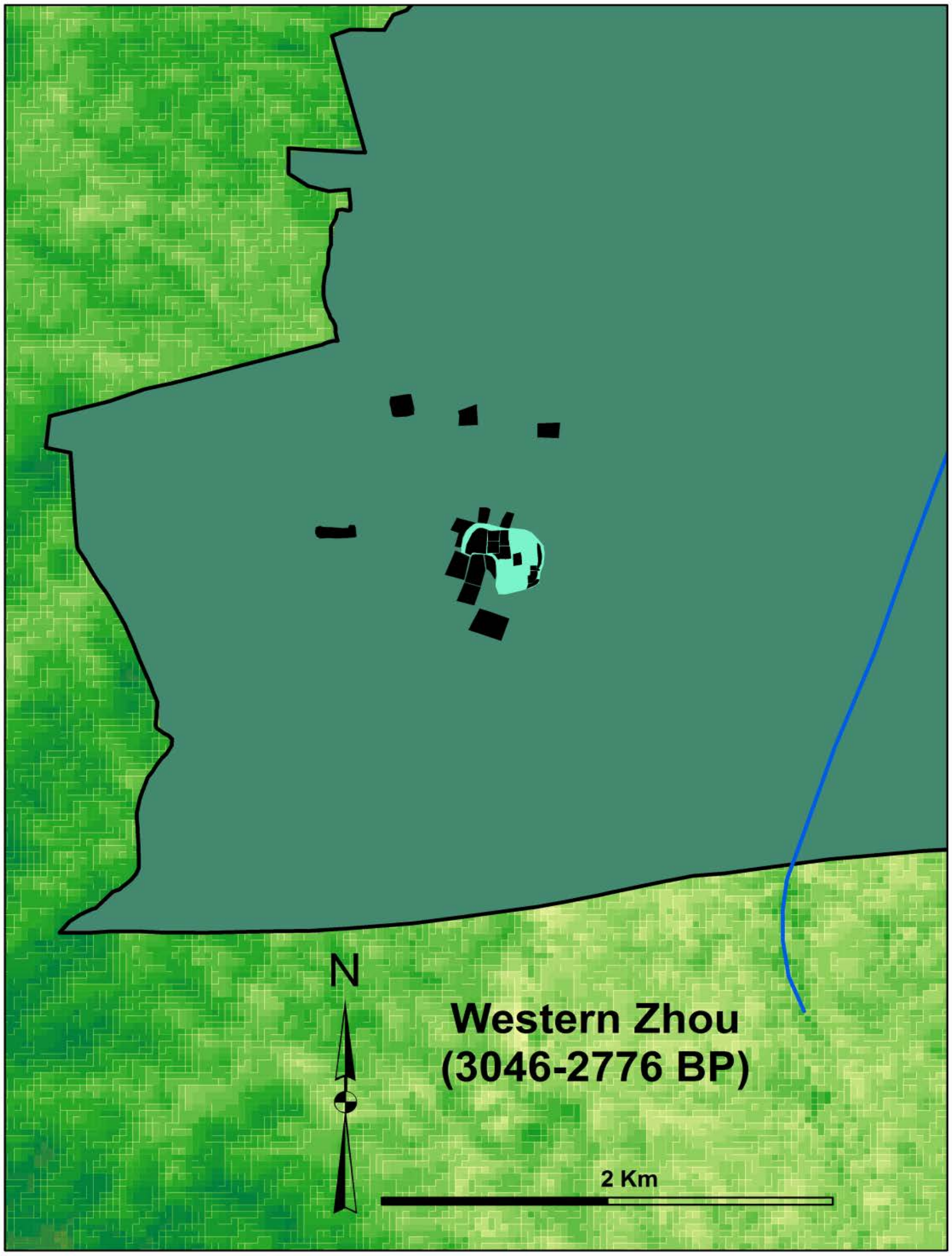

Figure 3.35. Distribution of Western Zhou occupation in the south zone

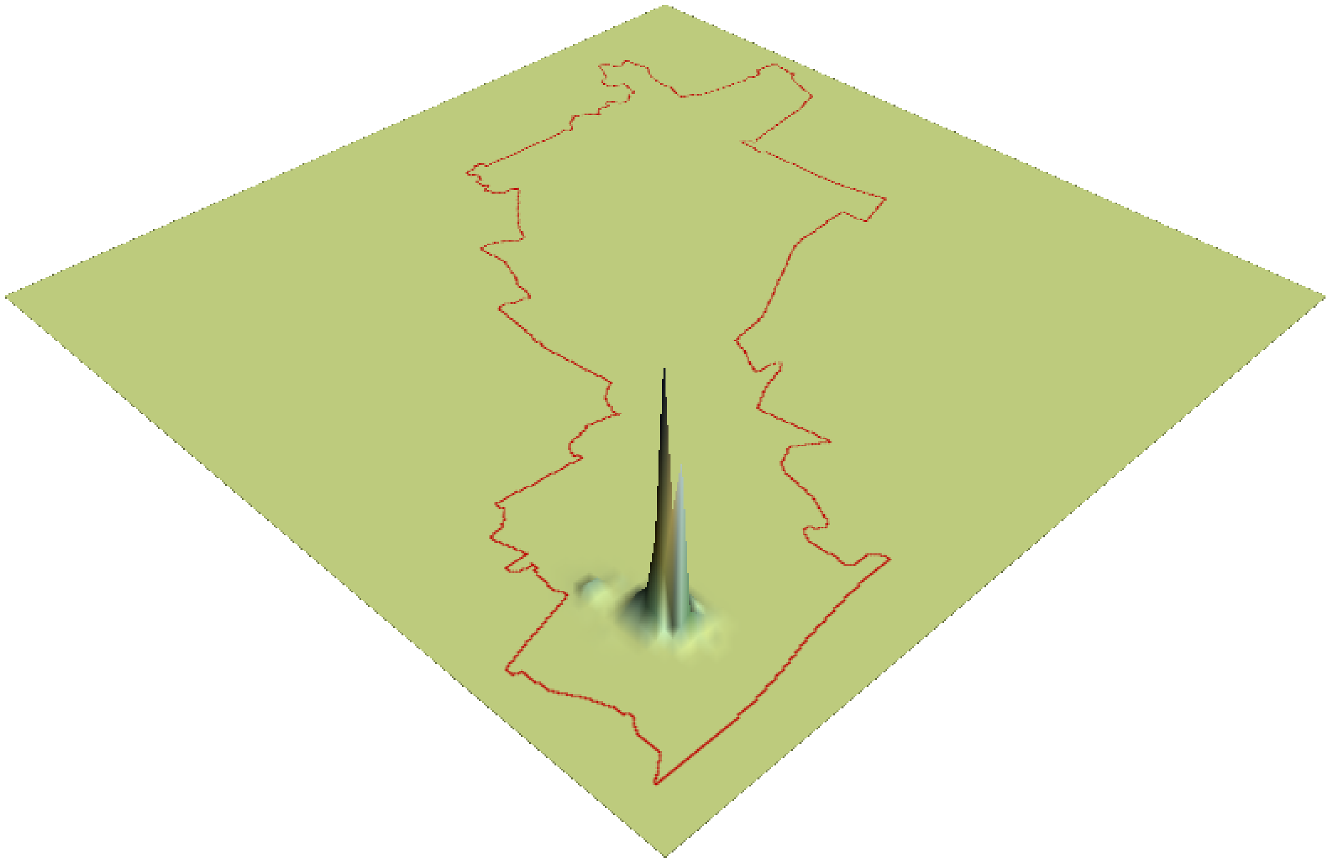

Figure 3.36. Unsmoothed density surface for Western Zhou occupation

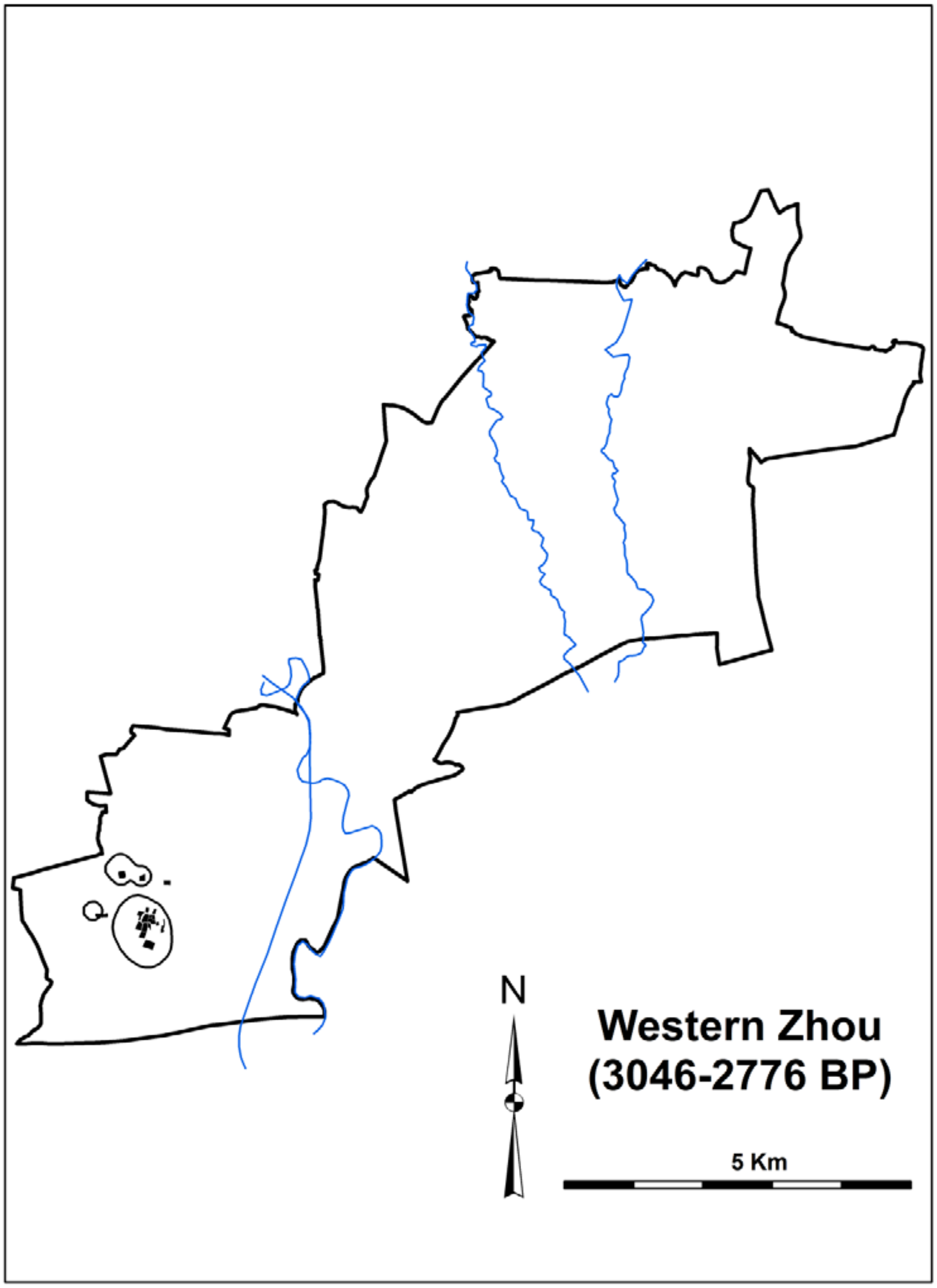

Figure 3.37. Delineation of Western Zhou local communities by cutoff contour from the unsmoothed density surface

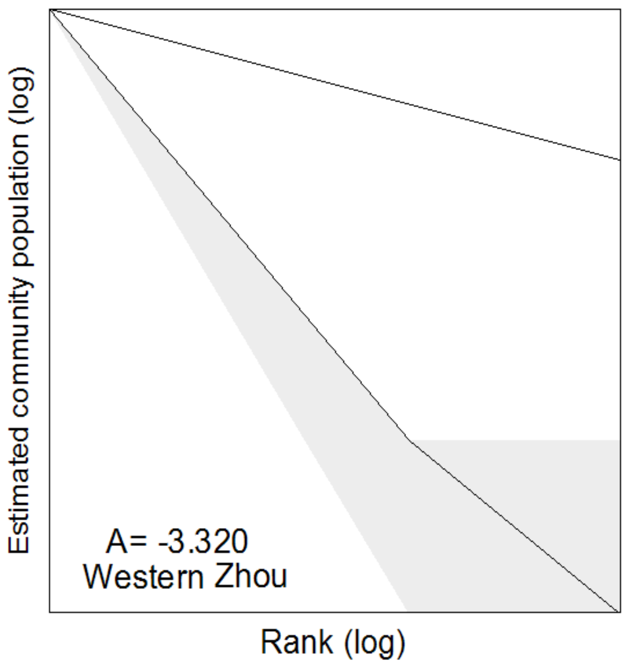

Figure 3.38. Rank-size graph for Western Zhou local communities (error range for 95% confidence)

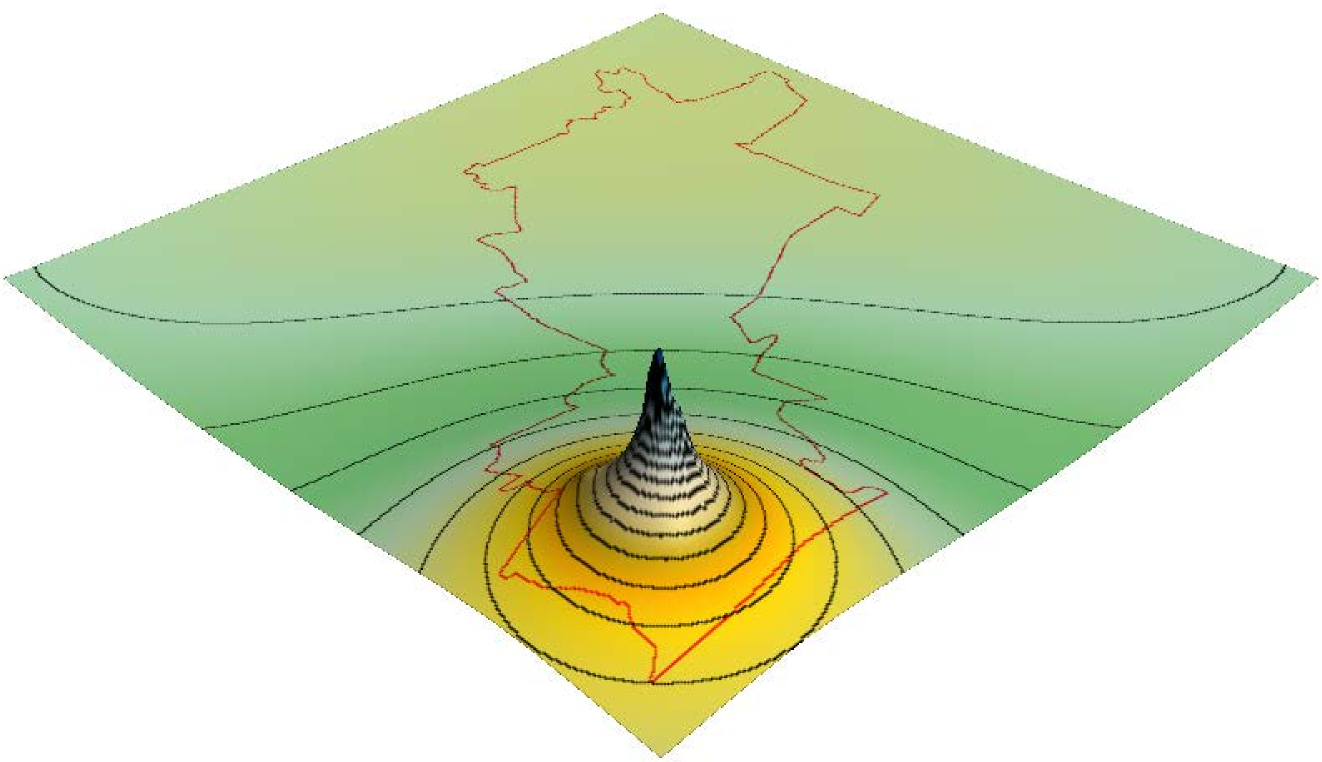

Figure 3.39. Smoothed density surface for Western Zhou occupation

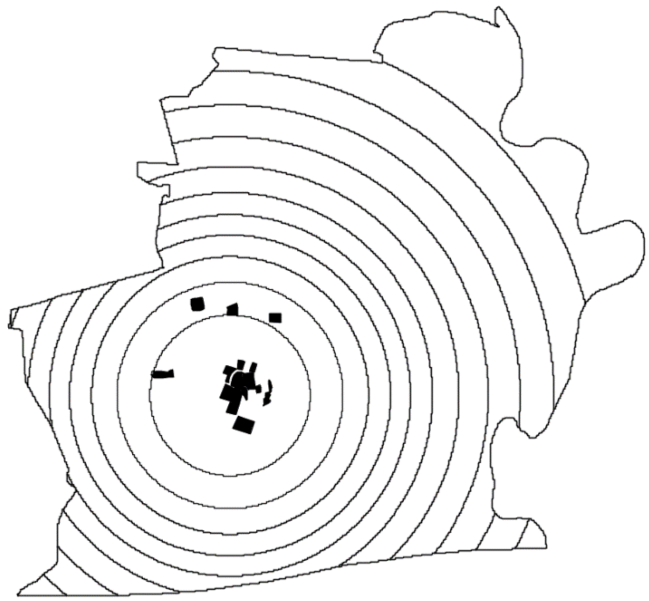

Figure 3.40. The distribution of population of Western Zhou period in the south zone divided into 12 rings

Table 3.9. Calculation *B* value for Western Zhou period in the south zone

Rings	Estimated Population	Population Proportion	Cumulative Proportion
1	1265	95.45%	95.45%
2	60	4.55%	100.00%
3	0	0.00%	100.00%
4	0	0.00%	100.00%
5	0	0.00%	100.00%
6	0	0.00%	100.00%
7	0	0.00%	100.00%
8	0	0.00%	100.00%
9	0	0.00%	100.00%
10	0	0.00%	100.00%
11	0	0.00%	100.00%
12	0	0.00%	100.00%
Total	1325	100.00%	1195.45%
***B* Value**			**0.992**

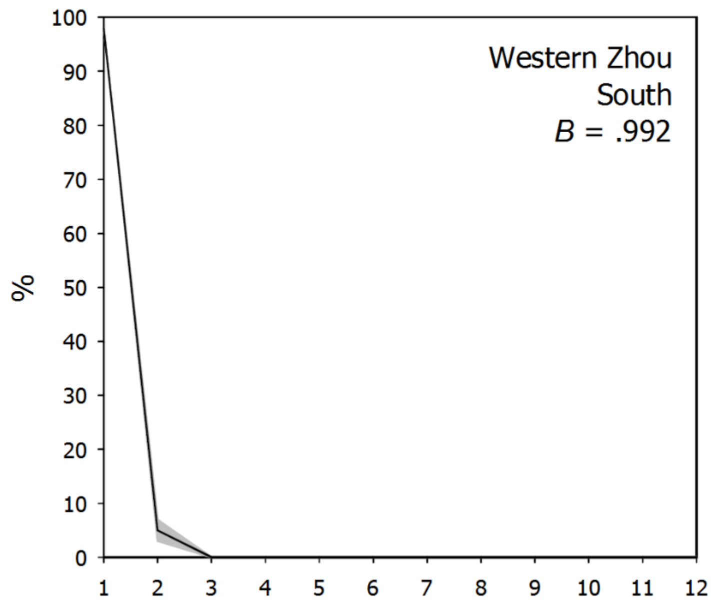

Figure 3.41. Graph of Western Zhou population distribution across the 12 concentric rings in the south zone (90% confidence zone)

In contrast to Neolithic occupations, most of the Western Zhou occupations were found on the ridges with an elevation range of 20 to 30 m above sea level, which is lower than the elevation at which the very scant Shang occupation was found (see detailed analysis in chapter 4). At the same time there was nearly no unit seen in the lower river valley, which was widely occupied in the Neolithic period. The reoccupation of the lower southern survey zone might result from the possible lowering of the water table, which was probably very high in the Shang period. From 3500-3000 BP, the Jianghan Plain witnessed another frequent flooding period, and low areas near rivers might have submerged into lakes and swamps (Xiao 1991). Today the meandering Zaoshi River still causes lakes and swamps to form in the low flat river valley near the Xiaocheng walled town. The population had to settle on relatively higher ground to avoid flooding, but at the same time not far from the river valley so as to take advantage of water for rice cultivation and fishing.

3.3.2.6 Eastern Zhou (775-255 BCE)

In the survey zone, Eastern Zhou artifacts outnumbered those of the previous Western Zhou period. A total of 3790 Eastern Zhou sherds were found in 204 collection units (Figure 3.42). The dramatic increase in the numbers of collection units and sherds in the Eastern Zhou period suggests a radical population increase. In the Eastern Zhou period, the estimated population in the survey zone reached a peak in the range of 12,000-24,000 persons. The vast majority were found in the southern zone around the Xiaocheng walled town. This population estimate, as for other periods, represents the average population through the entire Eastern Zhou period. At a given moment, the population might be larger or smaller than this estimated range. More than 95% of the collection units (196 of 204) and sherds (3724 of 3790) were from the southern survey zone, while only a few sherds were found in the northern survey zone. It is estimated that only less than 10 persons lived in the northern survey zone on average outside of the Taojiahu walled town.

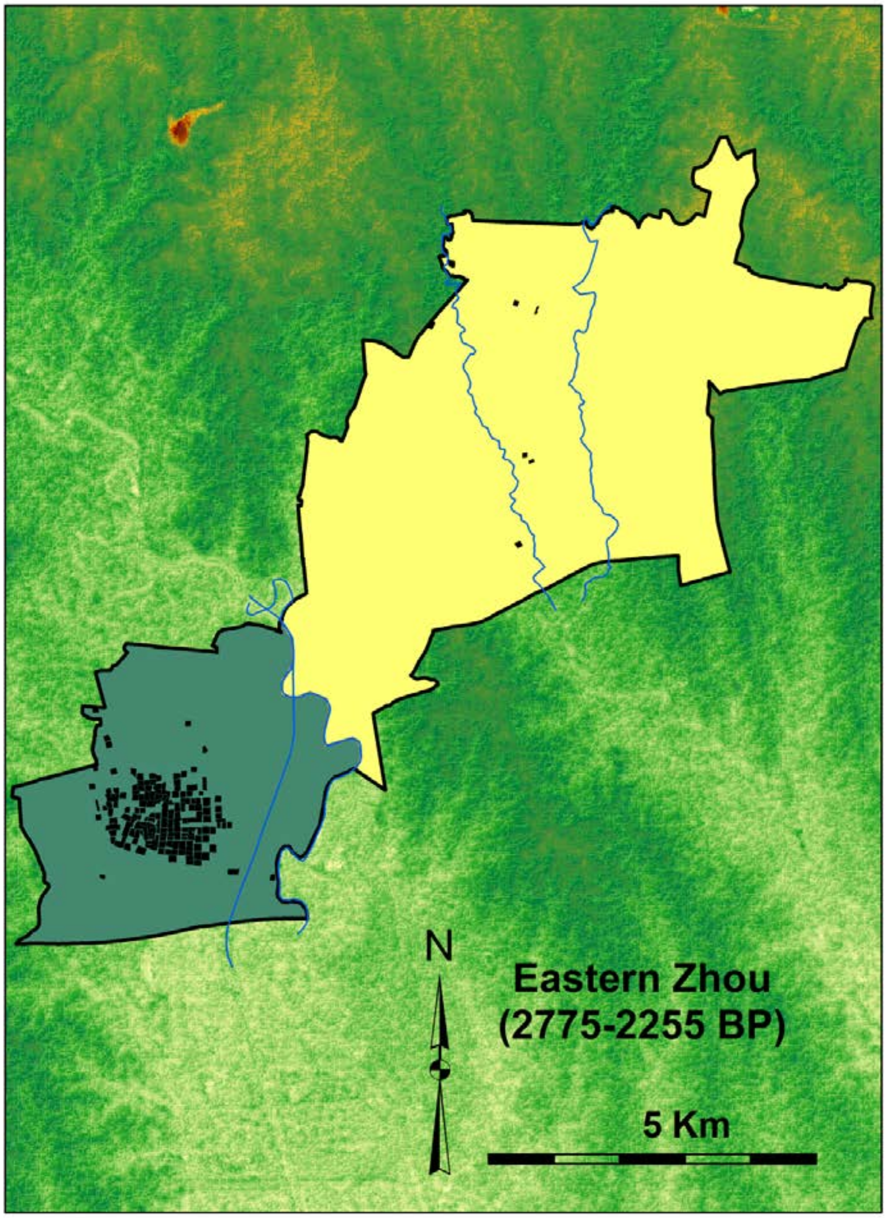

Figure 3.42. Distribution of Eastern Zhou occupation in the survey zone

An unsmoothed occupation surface shows several tall peaks representing tight clusters of collection units located close around the Xiaocheng walled town in the southern survey zone; there is no visible peak in the northern zone (Figure 3.43). The tallest peak is located right in the middle, and several high peaks are located around the tallest peak which is right next to the

Xiaocheng walled town. The estimated population in the walled town is about 1200 persons; the rest lived of the people lived close around the walled town. The smoothed contour map also shows that the most of the population in the south was located near the walled town within a distance of less than 2 km (Figure 3.44). These people around the walled town probably lived in such close proximity that they were engaged in daily face-to-face interaction. The cutoff contour from the unsmoothed density surface reveals three local communities around the Xiaocheng walled town (Figure3.45). The population of the largest community is estimated around 11,000 to 22,000 persons. The other two local communities had populations of fewer than 100 people. Several collection units with a few artifacts in the northern zone revealed some sparsely distributed households with fewer than 10 persons—too few to think of realistically as a local community. Comparing the population in the two survey zones demonstrates the dominant role Xiaocheng throughout the region. Although the contour map of the unsmoothed surface indicated two local communities, the distance of less than 1 km from the smaller to the larger one still suggests a daily interaction between them.

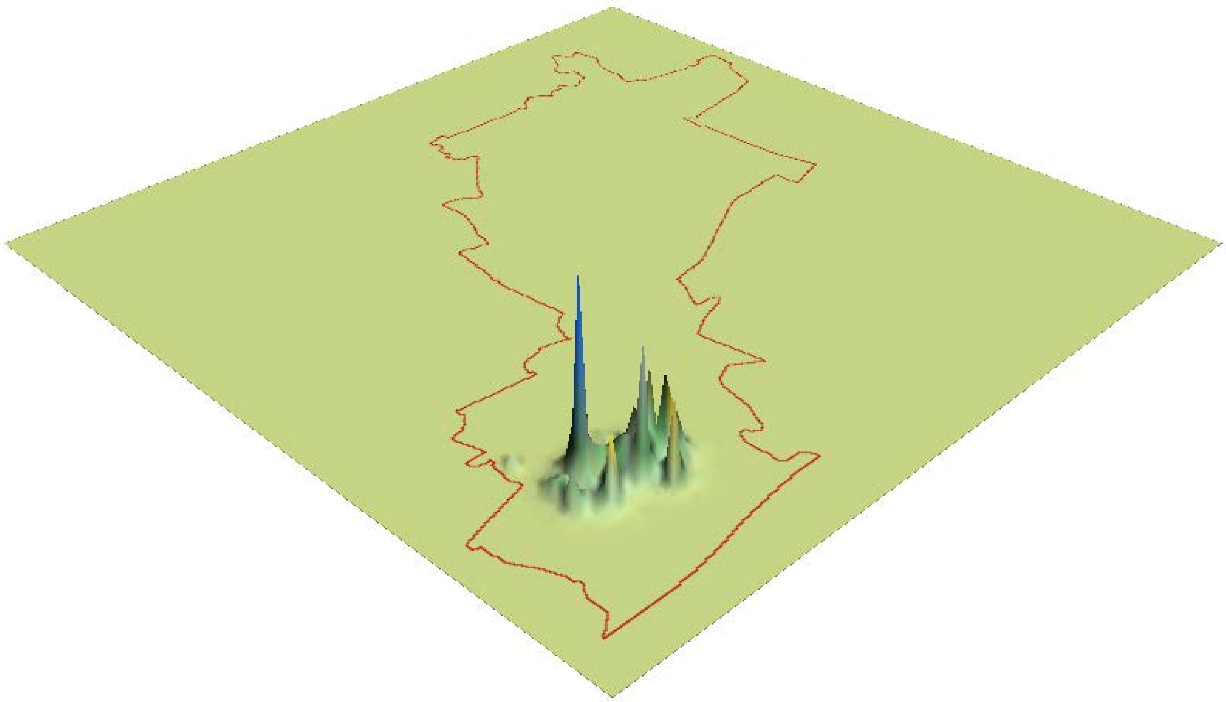

Figure 3.43. Unsmoothed density surface for Eastern Zhou occupation

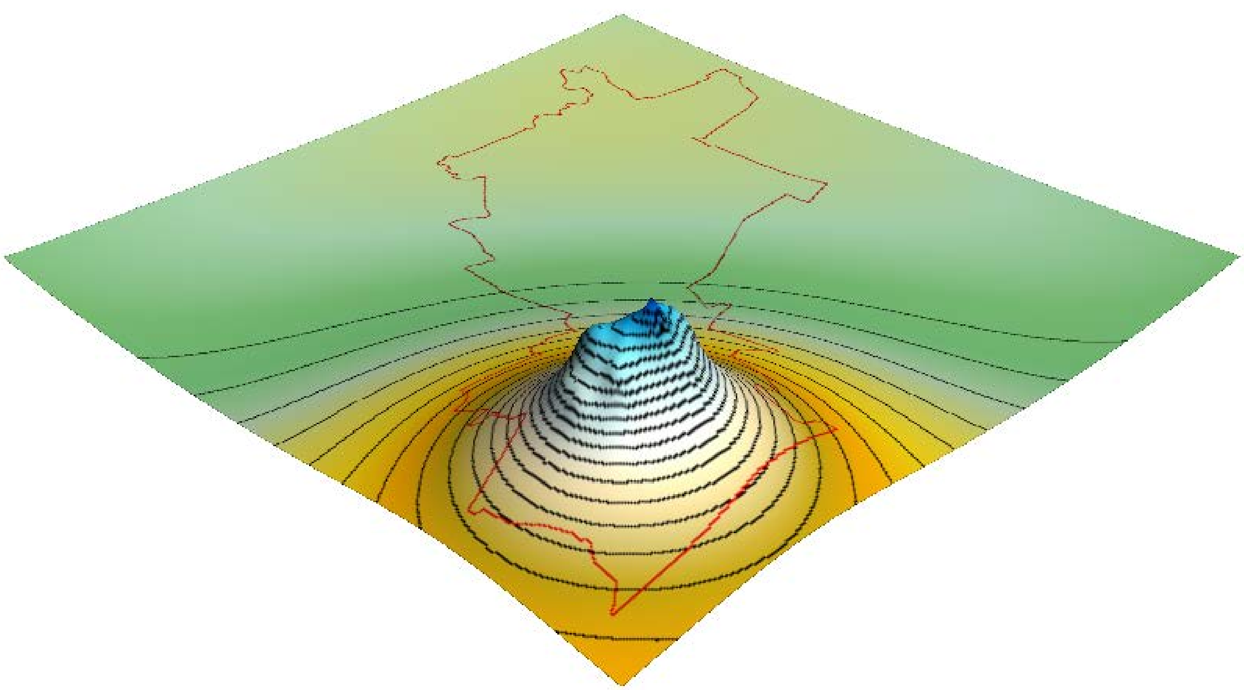

Figure 3.44. Smoothed density surface for Eastern Zhou occupation

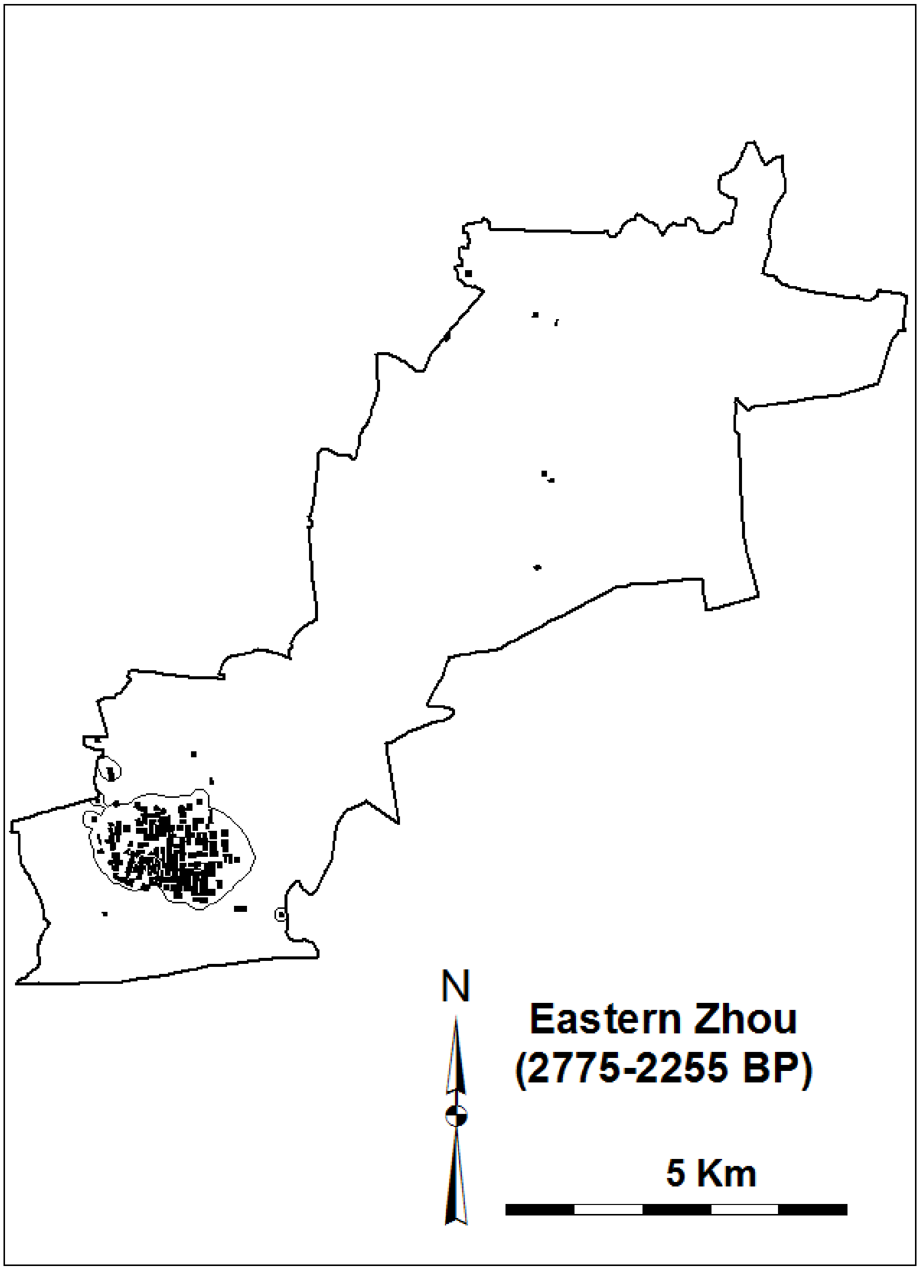

Figure 3.45. Delineation of Eastern Zhou local communities by cutoff contour from the unsmoothed density surface

Compared to the previous periods, the very tightly clustered pattern around the Xiaocheng walled town indicates extremely strong centripetal forces for the whole region. This

Rank-size analysis endorses this interpretation (*A*=-6.581, Figure 3.46). The population centralization *B* value of 0.922 suggests a highly integrated supra-local community in the southern zone centered on the Xiaocheng walled town (Figure 3.47, Figure 3.48 and Table 3.10). It seems that the role of the walled town might have changed; at least whatever defensive function it might have had weakened in this period, since most of the population was located outside of the walled town. If there were frequent military incursions, the fortified area would not contain the large population, even as a refuge. In addition, the complete abandonment of the Taojiahu walled town, which was six times larger, also suggests a low frequency of conflict.

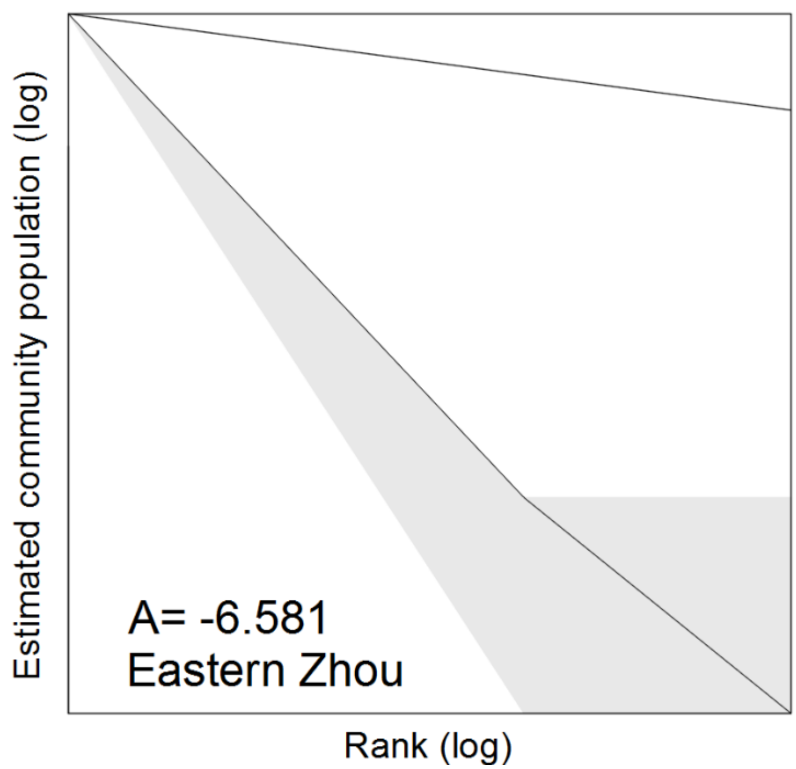

Figure 3.46. Rank-size graph for Eastern Zhou local communities (error range for 95% confidence)

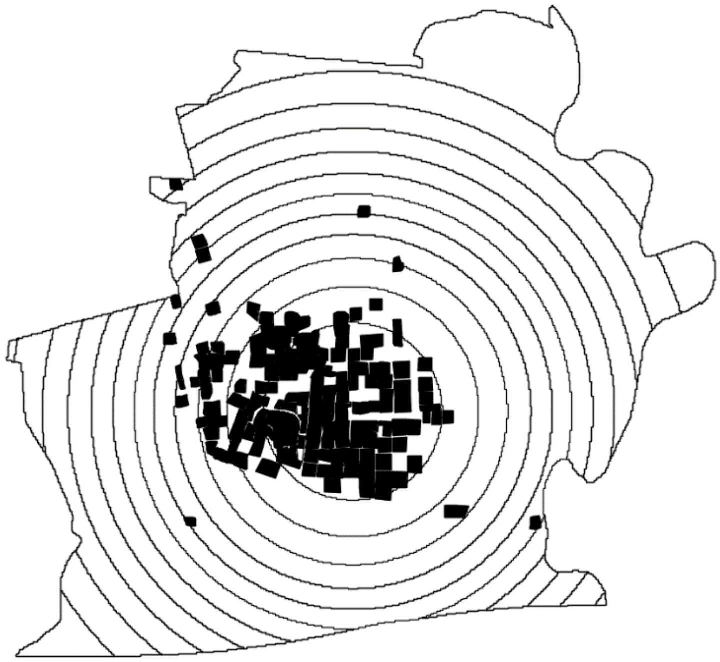

Figure 3.47. Distribution of population of Eastern Zhou period in the south zone divided into 12 rings

Table 3.10. Calculation *B* value for Eastern Zhou period in the south zone

Rings	Estimated Population	Population Proportion	Cumulative Proportion
1	12002	67.90%	67.90%
2	4189	23.70%	91.60%
3	1294	7.32%	98.92%
4	76	0.43%	99.35%
5	17	0.10%	99.45%
6	60	0.34%	99.45%
7	34	0.19%	99.45%
8	0	0.00%	99.45%
9	1	0.01%	99.46%
10	2	0.01%	99.47%
11	0	0.00%	99.47%
12	0	0.00%	99.47%
Total	17675	100.00%	1153.44%
***B* Value**			**0.922**

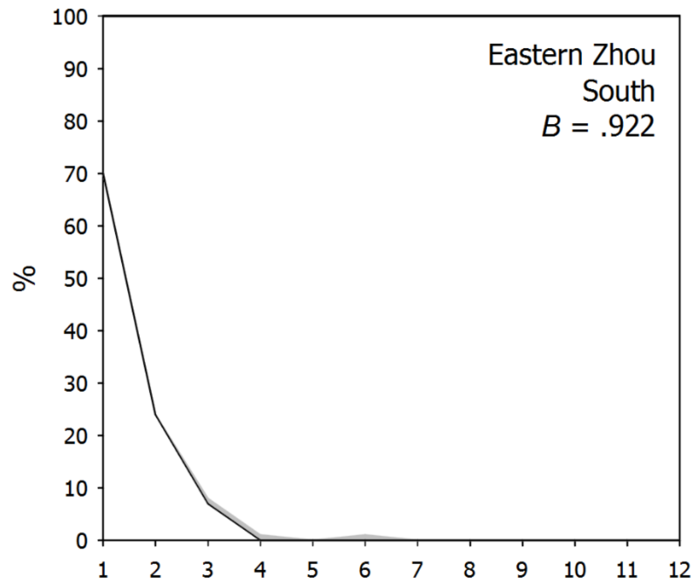

Figure 3.48. Graph of Eastern Zhou population distribution across the 12 concentric rings in the south zone (90% confidence zone)

In the Eastern Zhou period, population not only occupied higher ridges in the southern survey zone but also started to reoccupy the lower, flat Zaoshi River valley floor with an elevation range of 20-30 m above sea level (see detailed analysis in chapter 4). The Chu period (770-278 BCE) corresponds to spore-pollen zone V of the Dajiuhu basin, which suggests a warm and dry climate (Li et al. 2011). The water table might have dropped during this period, and lakes and swamps might have dropped to lower levels and decreased in size, possibly causing the re-emergence of previously flooded land in the Zaoshi River valley. With dramatic population increase, the lower flat river valley floor was reoccupied. Considering the unprecedentedly large population in the southern zone, it is likely that the Zaoshi River valley floor was heavily cultivated. Since a very large population was located quite close to the valley floor, flooding must not have been a serious problem. Apparently the reoccupation of the Zaoshi River Valley was for the purpose of utilizing its water and soil resources.

3.3.2.7 Han (202 BCE-220 CE)

From 147 collection units, the amount of Han material recovered in the Taojiahu-Xiaocheng survey is close to 1300 sherds; this represent less than a half of the amount from the Eastern Zhou period. Again, most of the sherds were collected from south zone. Total population of the survey area is estimated within the range of 6000 to12000 persons, which is about half size of the Eastern Zhou population estimation in the whole survey region. The cause of population decrease is still unknown, but the population distribution pattern is similar to that the previous Eastern Zhou period. A dominant percentage of more than 99.9% estimated population was found in the south survey zone around the Xiaocheng walled town (Figure 3.49), while the estimated amount of population in the north survey zone is less than 0.1% (less than 50 persons corresponding to a few households).

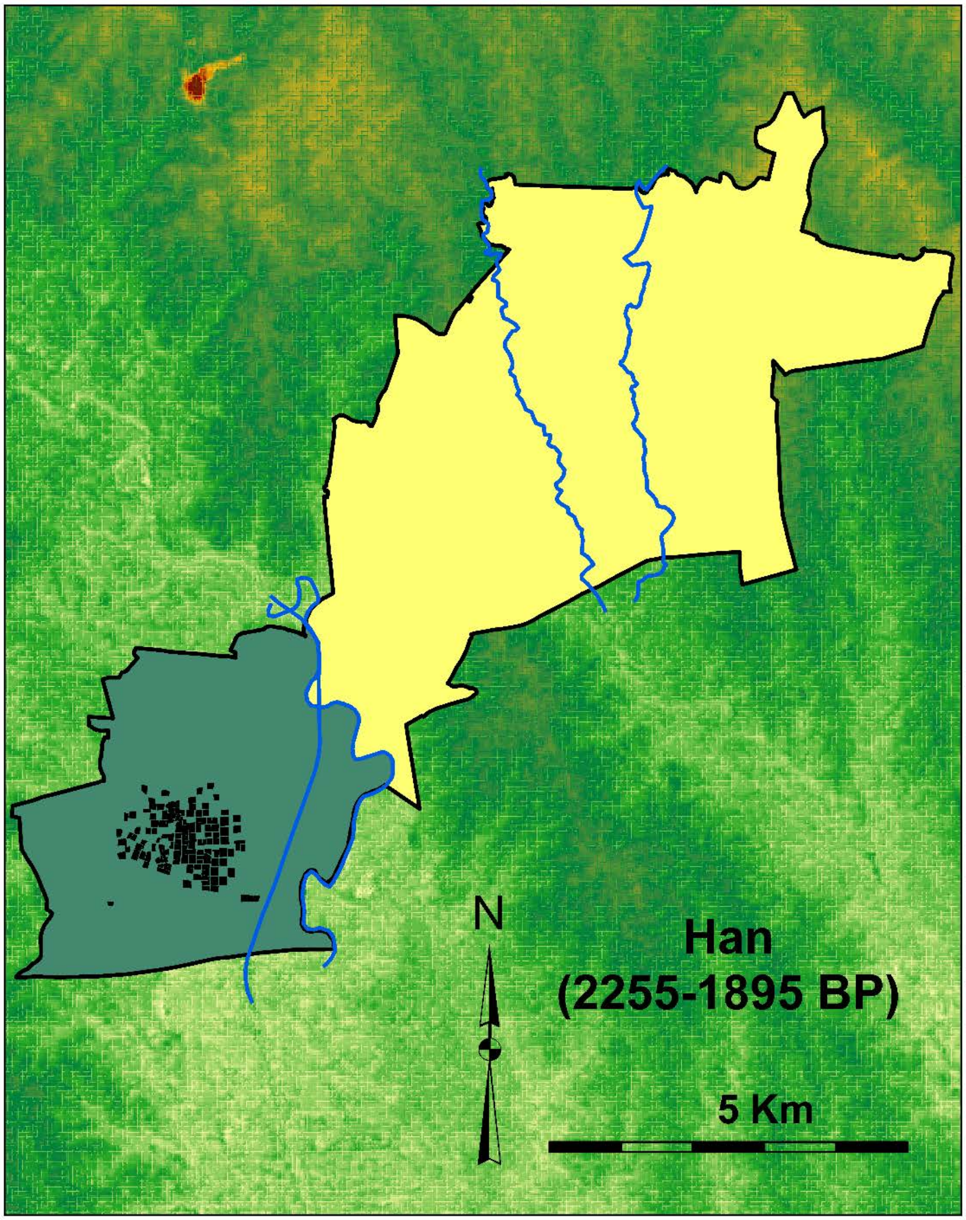

Figure 3.49. Distribution of Han Occupation in the Survey Zone

The unsmoothed density surface map demonstrates one highest peak in the east of the Xiaocheng walled town representing the highest population density (Figure 3.50). The second highest peak is adjacent to the south wall of the center. The population within the Xiaocheng walled town is estimated at a range of 650 to 1300 persons, which is about 10% of the whole population. Similar to the previous Eastern Zhou period, the smoothed density surface map shows that most of the population around the Xiaocheng walled town living in an area with a diameter of 2 kilometers and probably engaged in a face-to-face interaction (Figure 3.51). Based on the unsmoothed density surface map, the delineation of community analysis shows that two communities could be drawn for Han occupations; the larger one is around the Xiaocheng walled town with a population range of 5000 to 10000 persons, and the smaller one, which is about 600 meters apart from the larger closely clustered community, has a population of a few hundred persons (Figure 3.52).

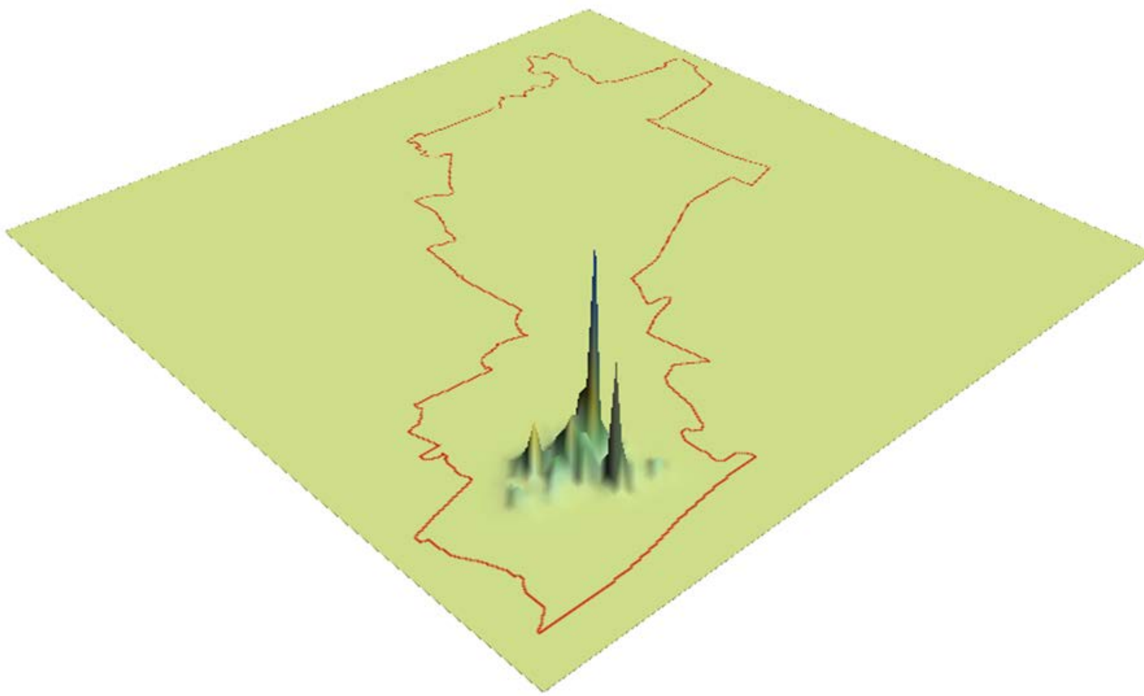

Figure 3.50. Unsmoothed density surface for Han occupation

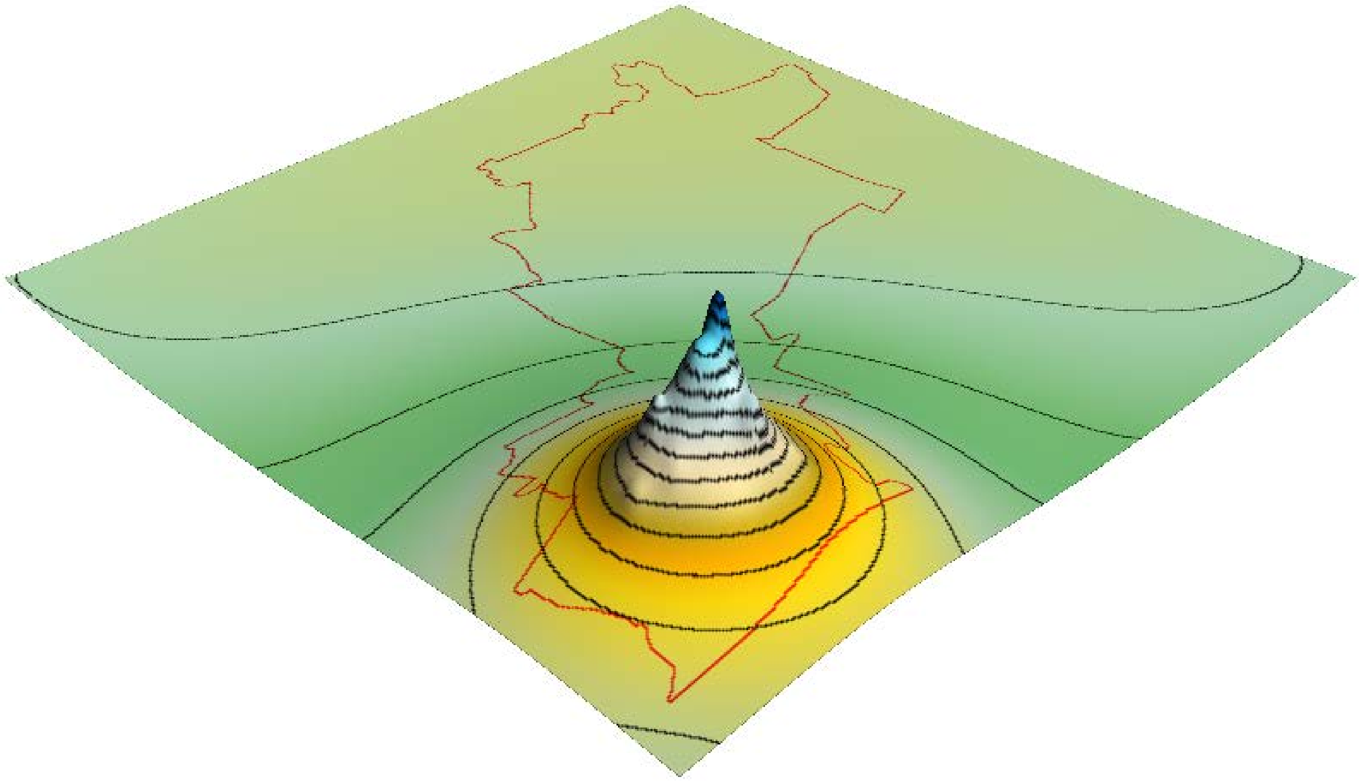

Figure 3.51. Smoothed density surface for Han occupation

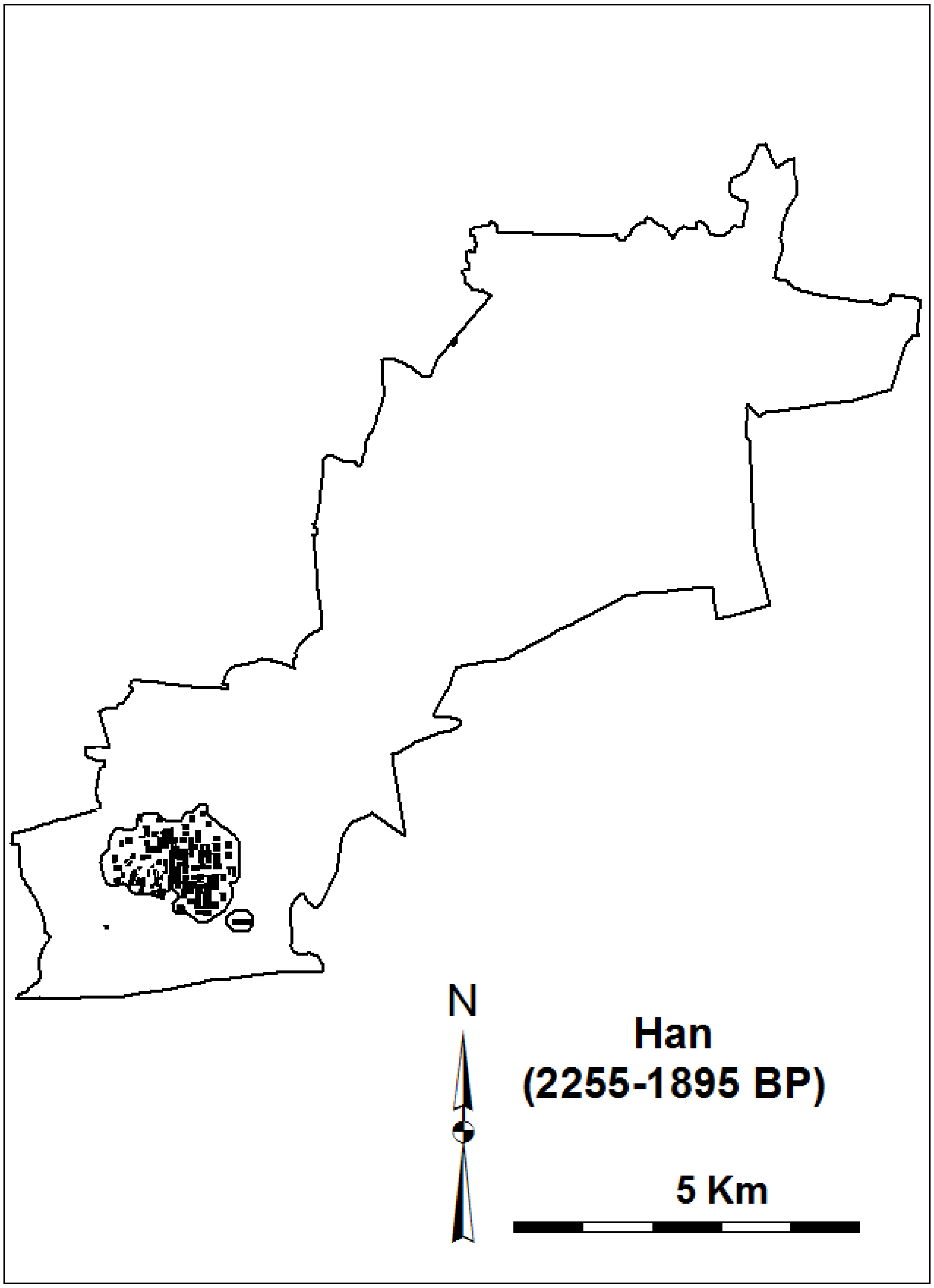

Figure 3.52. Delineation of Han local communities by cutoff contour from the unsmoothed density surface

Since the population in the whole survey region has been significantly integrated into a considerable size large supra-local community with a small village level community not far away from it, there is even no need to carry out a rank-size analysis for political and economic integration. The population concentration strength with a B value of 0.975 is slightly smaller than the previous Eastern Zhou period, but it still suggests a highly integrated supra-local community in the south zone centered with the Xiaocheng walled town (Figure 3.53, Figure 3.54 and Table 3.11). In this sense, the population distribution in the south zone and the whole region resembles that of the previous Eastern Zhou period, implying the Xiaocheng walled town served as a regional center. Similarly, the Xiaocheng walled town might have primarily functioned as a political and economic center rather than a fortified castle.

Figure 3.53. Distribution of population of Han period in the south zone divided into 12 rings

Table 3.11. Calculation *B* value for Han period in the north zone

Rings	Estimated Population	Population Proportion	Cumulative Proportion
1	10793	89.97%	89.97%
2	807	6.73%	96.70%
3	389	3.24%	99.94%
4	0	0.00%	99.94%
5	6	0.05%	99.99%
6	1	0.01%	99.99%
7	0	0.00%	99.99%
8	0	0.00%	99.99%
9	0	0.00%	99.99%
10	0	0.00%	99.99%
11	0	0.00%	99.99%
12	0	0.00%	99.99%
Total	11996	100.00%	1186.47%
***B* Value**			**0.975**

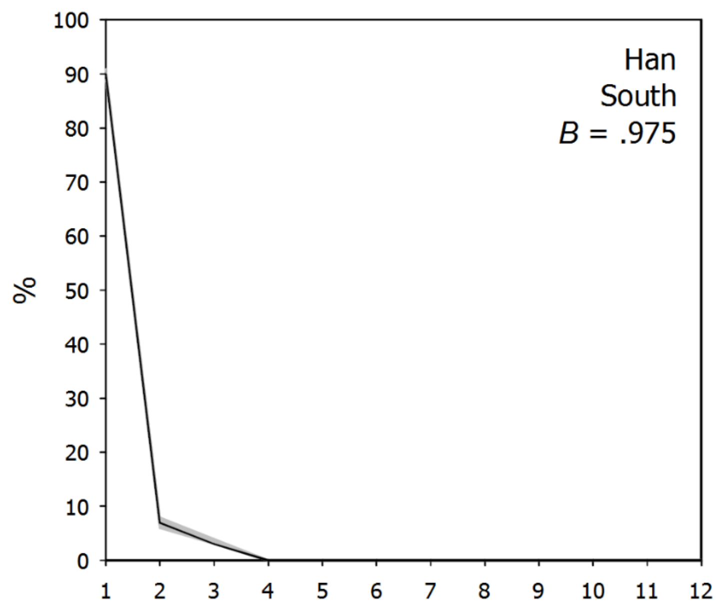

Figure 3.54. Graph of Han population distribution across the 12 concentric rings in the south zone (90% confidence zone)

3.3.2.8 Wei-Jin (220-589 CE)

From 124 collection units, more than 1200 Wei-Jin sherds were recovered from surface collection (Figure 3.55). Similarly, most of the artifacts were found in the south zone, which has been consistently occupied in historical period. The total population of the survey area is estimated at 6500 to 13,000 persons, which is slightly more than the estimation of the previous Han period. The estimated population in the southern survey zone is about 6400 to 12,800 persons, which is about 98% of the total population size; its counterparts in the north zone are only about 100 to 200 persons, which is less than 2% of the whole population estimation.

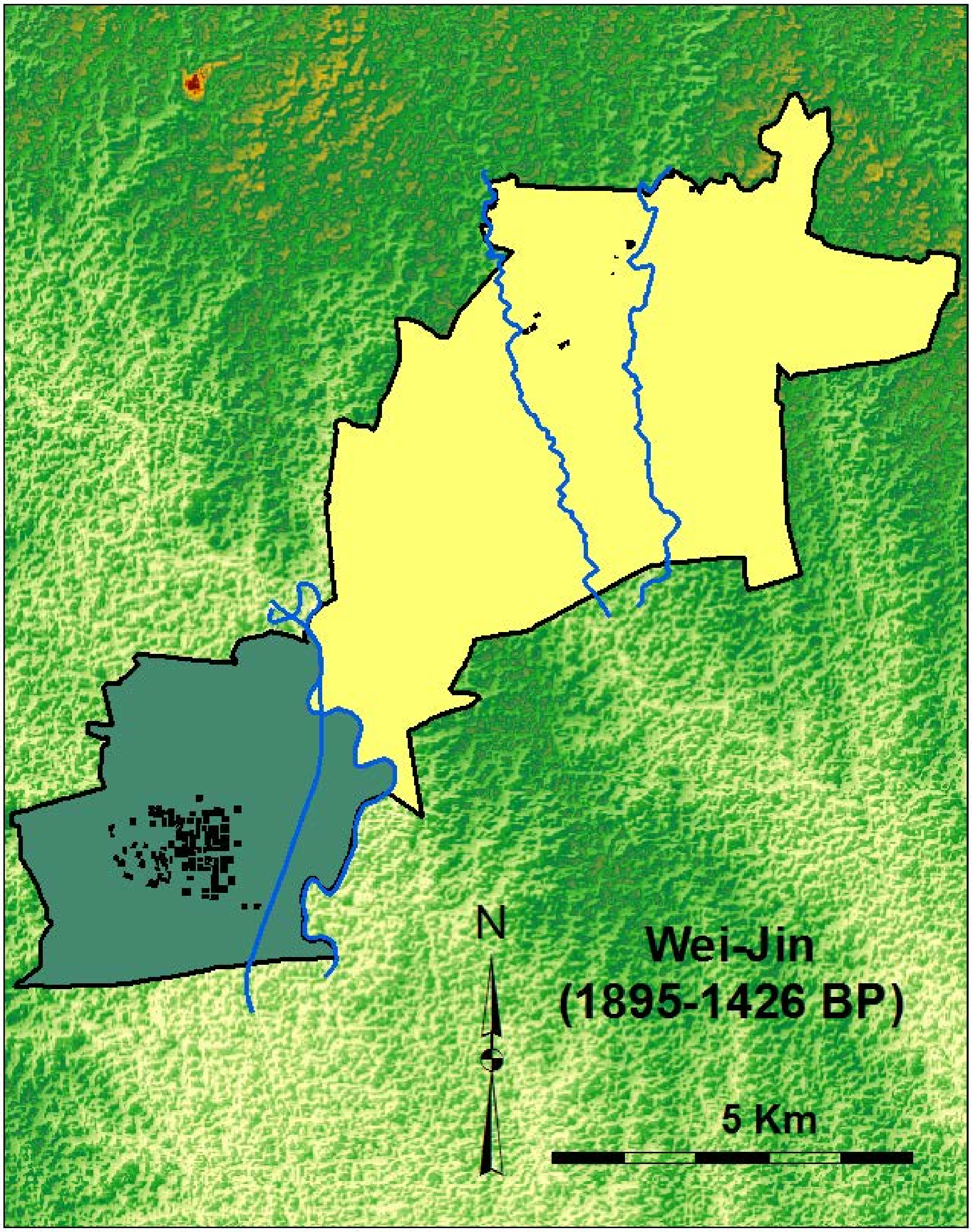

Figure 3.55. Distribution of Wei-Jin occupation in the survey zone

An unsmoothed density surface shows several tall peaks in the southern survey zone clustering around the Xiaocheng walled town. This pattern is generally consistent with that of the previous Eastern Zhou and Han periods (Figure 3.56). The smoothed surface shows the population heavily concentrated around the Xiaocheng walled town in the southern zone within an area with a diameter less than 1.5 km (Figure 3.57). Again, the population around the walled town was close enough together to easily engage in daily face-to-face interaction. The cutoff contour from the unsmoothed density surface yields one local community with 6400 to 12,800 persons in the south and three small local communities in the north with fewer than 100 persons each (Figure 3.58). Compared to the previous Eastern Zhou and Han periods, the population in the north had increased and now formed three village-size local communities, although population size was still very small.

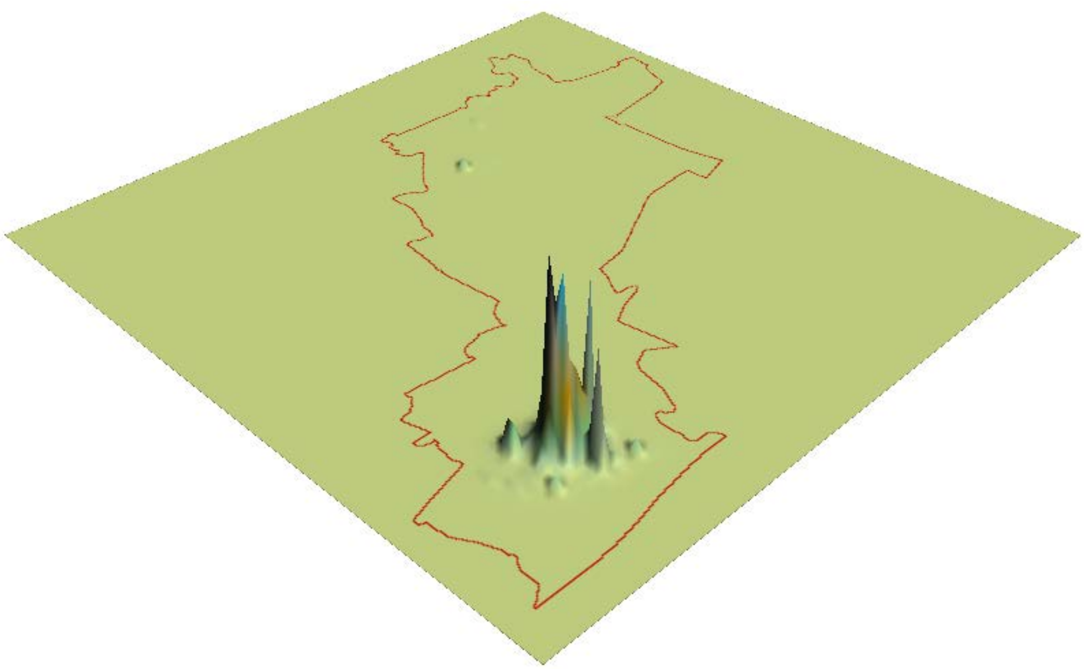

Figure 3.56. Unsmoothed density surface for Wei-Jin occupation

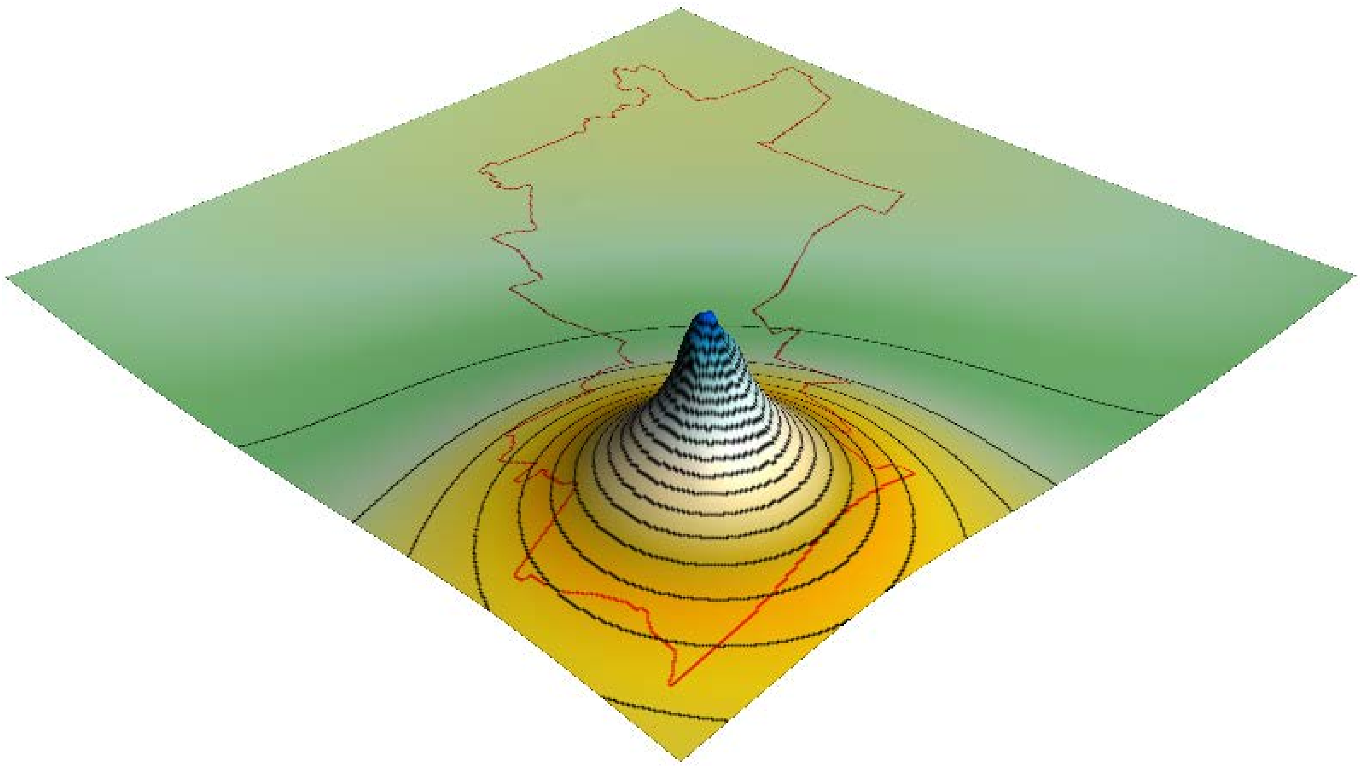

Figure 3.57. Smoothed density surface for Wei-Jin occupation

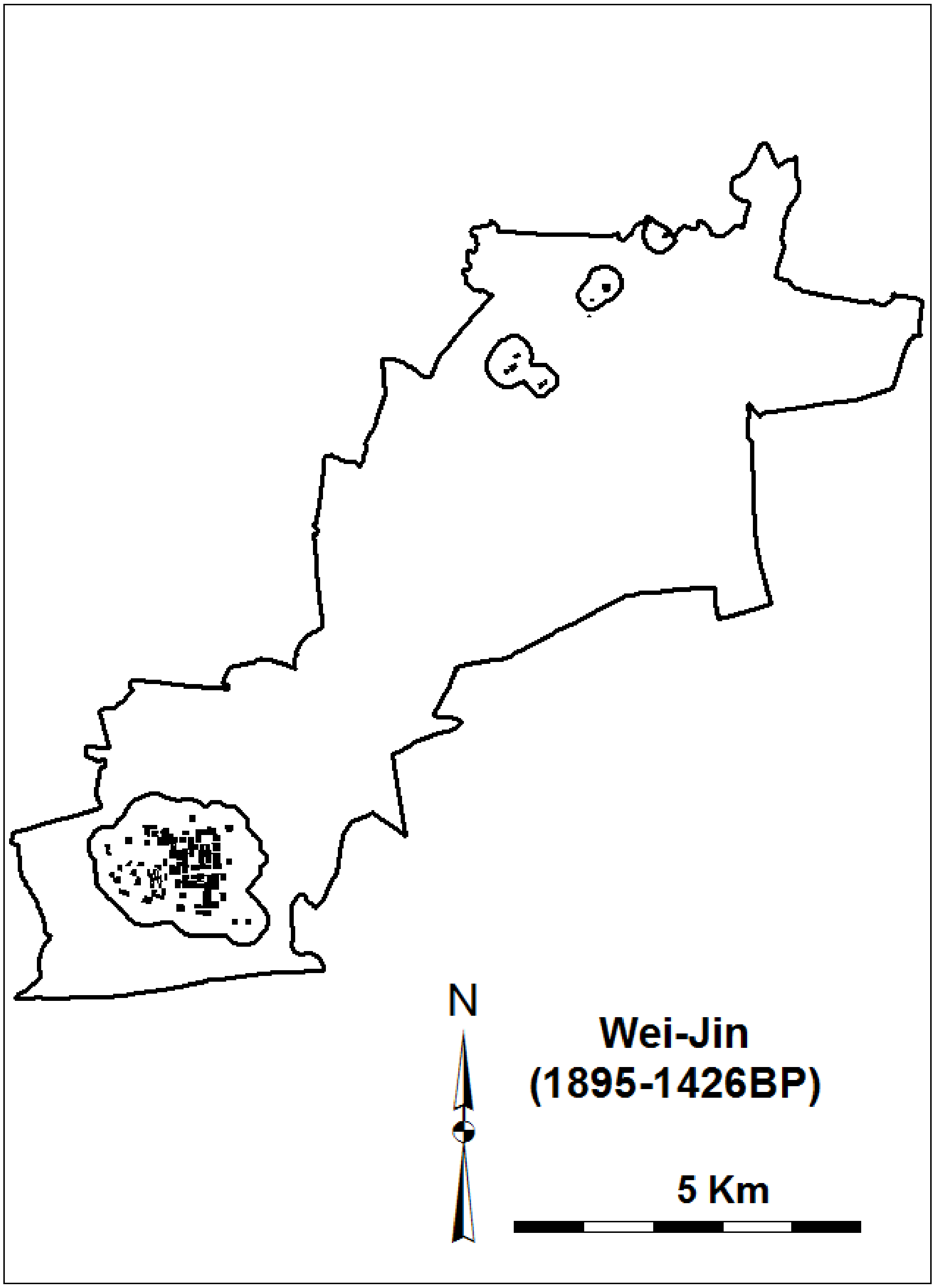

Figure 3.58. Delineation of Wei-Jin local communities by cutoff contour from the unsmoothed density surface

The rank-size pattern, which is strongly concave (A=-5.207, Figure 3.59), gives considerable support to this interpretation (A=-5.207, Figure 3.59). The B value of 0.982 indicates a very strong force centralizing the regional population (Figure 3.60, Figure 3.61 and Table 3.12). Although the walled area of Xiaocheng was still occupied, it is unlikely that it served any defensive function, since most of the population was located outside of the walls; the population inside is estimated at only 500 to 1000 persons, which is less than 8% of the population in the entire region.

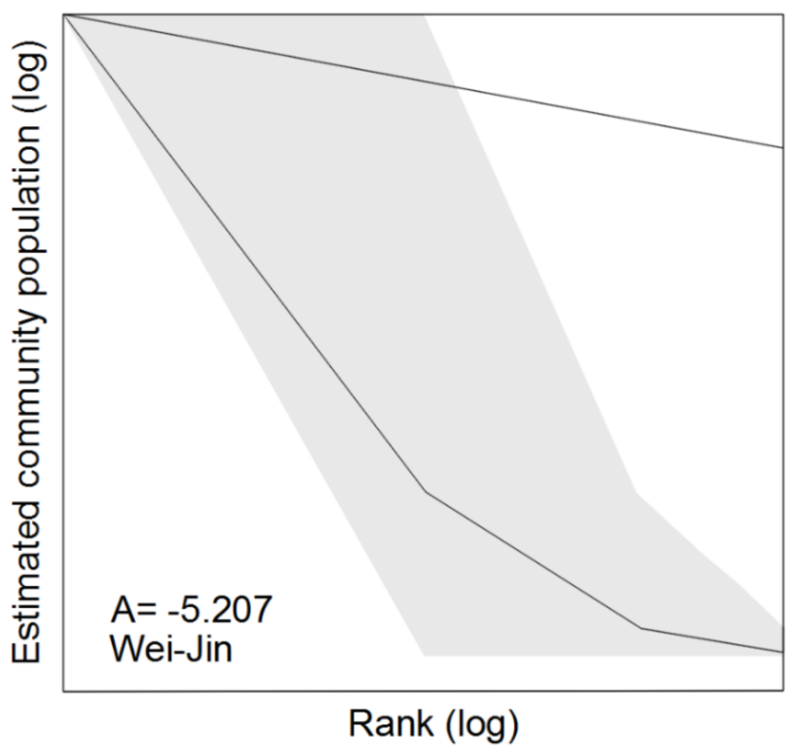

Figure 3.59. Rank-size graph for Wei-Jin local communities (error range for 95% confidence)

Figure 3.60. Distribution of population of Wei-Jin period in the south zone divided into 12 rings

Table 3.12. Calculation *B* value for Wei-Jin period in the north zone

Rings	Estimated Population	Population Proportion	Cumulative Proportion
1	6240	91.48%	91.48%
2	506	7.41%	98.89%
3	55	0.81%	99.70%
4	19	0.28%	99.98%
5	1	0.02%	100.00%
6	0	0.00%	100.00%
7	0	0.00%	100.00%
8	0	0.00%	100.00%
9	0	0.00%	100.00%
10	0	0.00%	100.00%
11	0	0.00%	100.00%
12	0	0.00%	100.00%
Total	6821	100.00%	1190.05%
***B* Value**			**0.982**

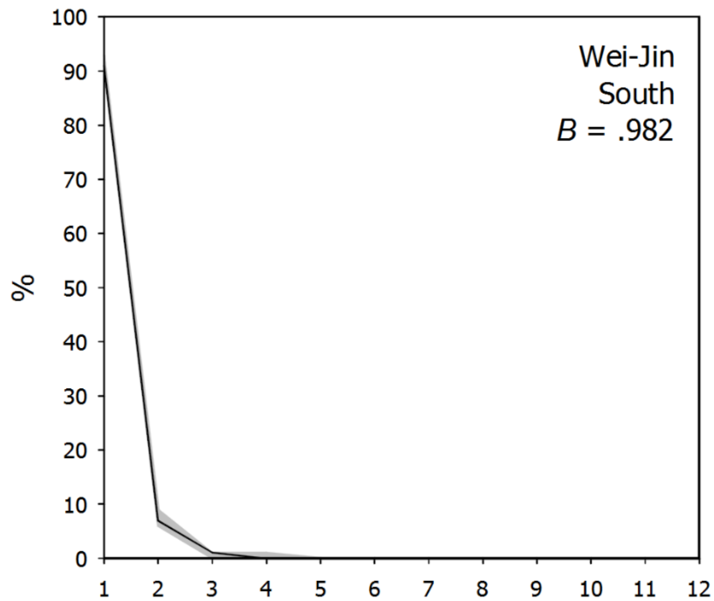

Figure 3.61. Graph of Wei-Jin population distribution across the 12 concentric rings in the south zone (90% confidence zone)

Similarly, more than 98% of the population settled in the fertile flat Zaoshi River Valley floor, which was a demographic center for the survey area, indicating a heavy reliance on this valley's soil and water resources for rice cultivation and fishing (see detailed analysis in chapter 4). The climate in the Wei-Jin period was also warm and humid, favoring rice cultivation and fishing (Shi et al. 2009). People may have reoccupied the northern survey zone in order to exploit its water resources, as the occupation was found on ridges near rivers in the northern zone.

4. RELATIONSHIP BETWEEN ENVIRONMENTAL RESOURCES AND SETTLEMENT DISTRIBUTION

4.1 BASIC ENVIRONMENTAL CONDITIONS

The relationship between environmental conditions and population distribution is investigated to reconstruct how natural resources affected people's choices about where to live. The basic consideration of environmental conditions tends to focus primarily on water, arable land, elevation, transportation convenience and soil productivity, which have usually played an important role in population distribution. Among those variables, one or some of them might be more important than others in certain periods, which means we could observe changing correlations between them and population distribution in different periods. The survey zone of this project is about 58 km^2, which is a relatively small chip in the much larger Jianghan Plain, although there are broad similarities in water distribution, arable land, soil productivity etc., all across the plain. Favored by a warm and humid climate from the Youziling period onward, human occupation in the survey zone has been characterized by settled agricultural villages and towns that might share similarities with today's villages and towns, since a considerable population still relies heavily on the same agricultural activities, such as rice cultivation and fishing. However, there are distinct variations in elevation, distance from rivers, amount of arable land for rice cultivation and transportation convenience, and these distinctions can reveal the different roles played by variables in determining agricultural habitation. The analysis presented here will examine the relationship between these variables and population distribution patterns as this relationship changed through time.

4.2 ELEVATION AND RIVER VALLEY FLOOR

One of the major objectives of the research presented here was to test the idea that walled towns emerged as a response to flooding and that their walls were, in effect, flood walls (see chapter 1.1). Toward this end, this research explored in depth the relationship between elevation and walled town locations and population distribution in general was explored in detail. This exploration was based on a topographic map with a contour interval of 5 m produced by Surfer 11 from a DEM obtained from the ASTER Global Digital Elevation Model. Population distribution was overlaid on the contour map to see where habitation was located.

In the Youziling period (Figure 4.1), the entire population was found in the northern survey zone where the elevation, except in the Silong River Valley floor, was higher than 30 m above sea level except the Silong River Valley floor. The contour map shows that half of the collection units with Youziling sherds were found in the elevation range of 30-40 m above sea level. The other half were found at 20-30 m above sea level, which is the lowest elevation range in the northern survey zone. The distance from the river to collection units is less than 500 m. In the southern survey zone, only one collection unit was found on the Zaoshi River Valley floor with an elevation range of 10-20 m above sea level.

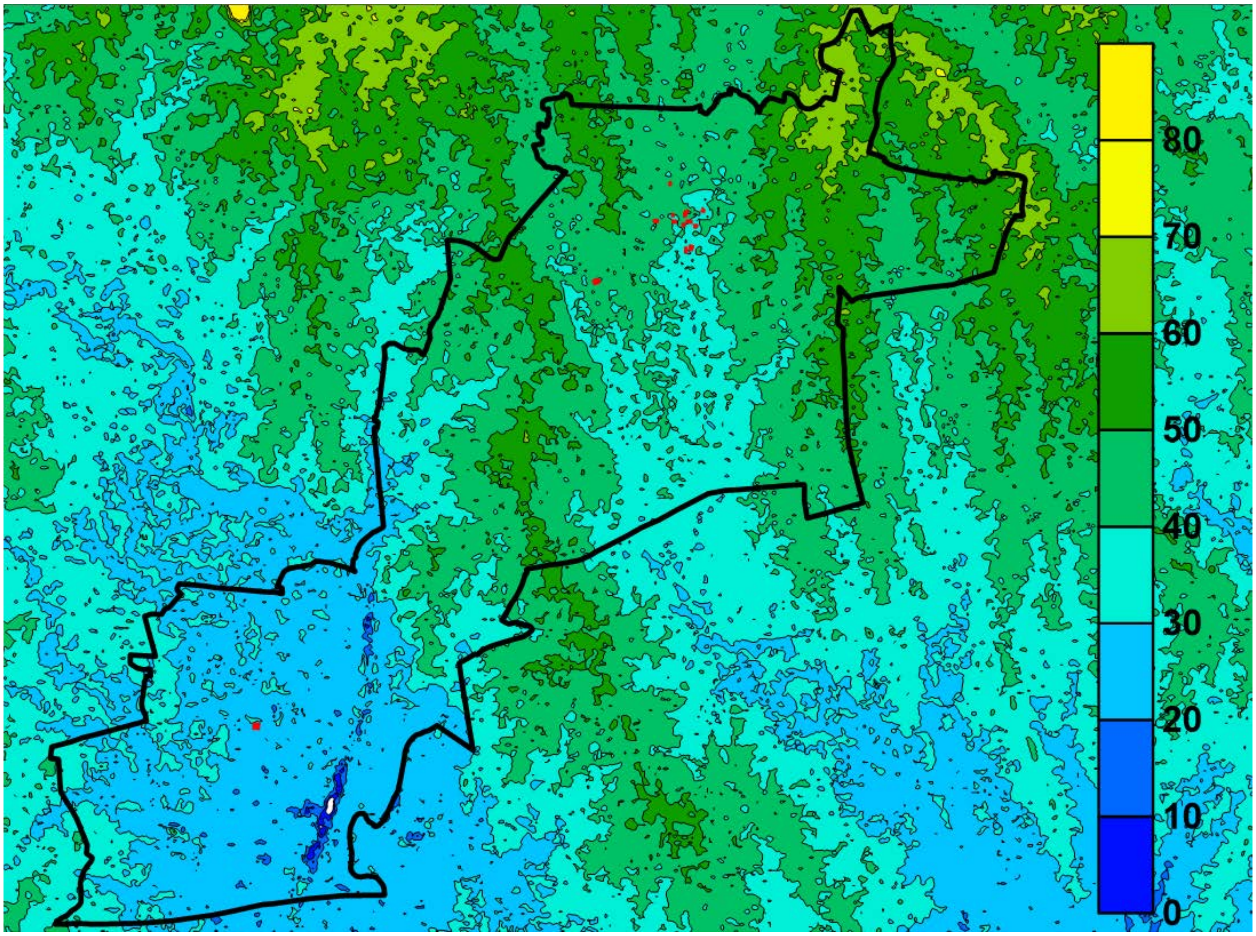

Figure 4.1. Contour map of Youziling occupation

In the Qujialing period, the elevation map shows that occupation remained in the low river valley, as was the case in the Youziling period. Figure 4.2 shows that in the northern survey zone, Qujialing occupations were still located in the Silong River Valley at elevations between 20 and 40 m above sea level. In the southern survey zone, Qujialing collection units remained on the relatively high ridge where there was an occupation at the south edge of the Xiaocheng walled town with an estimated population of fewer than 50 persons. However, more occupations were located in the relatively low Zaoshi River Valley where the elevation is about 10-20 m above sea level. These occupations have an estimated population of 950 to 1900 persons, which is 95% of the southern zone's population.

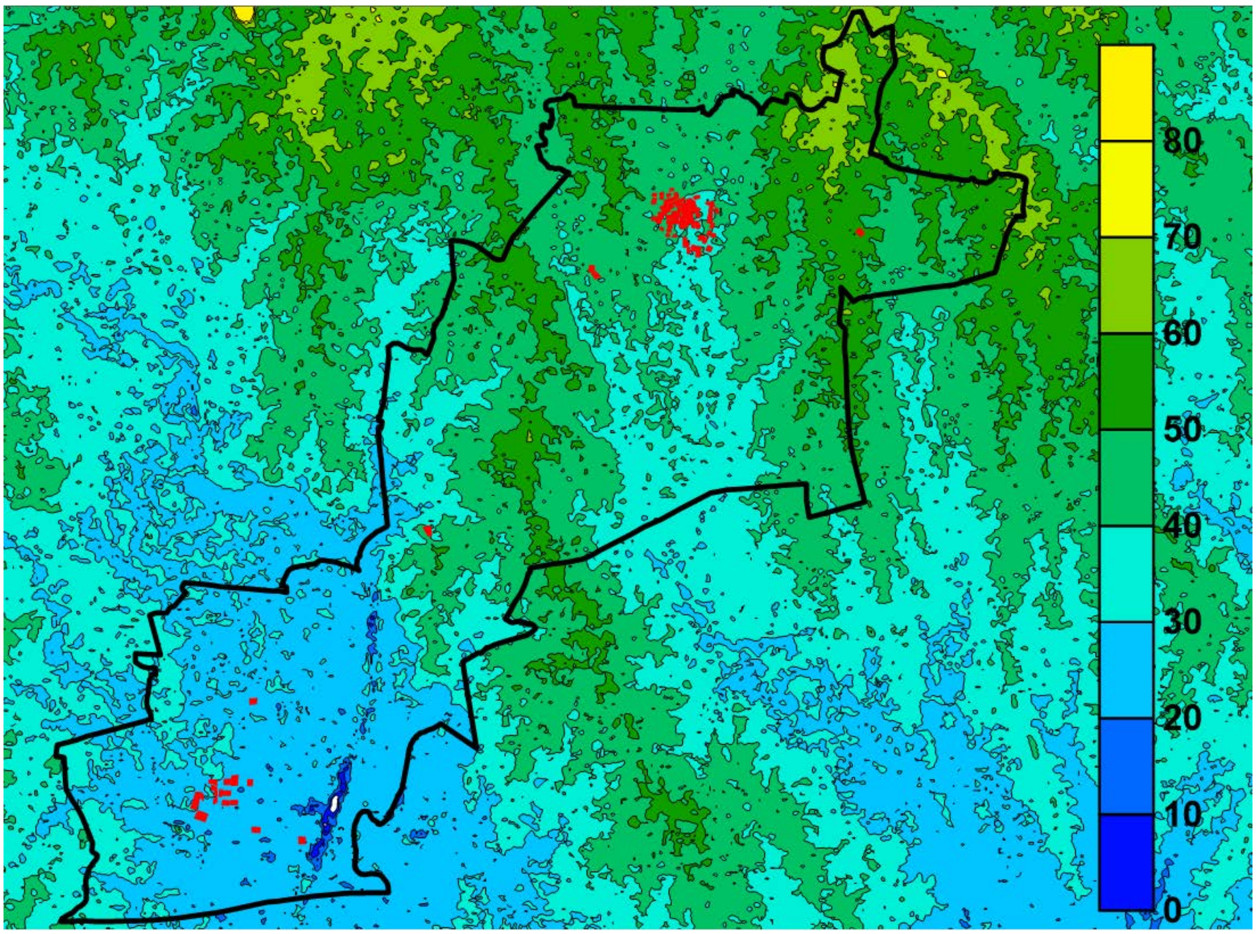

Figure 4.2. Contour map of Qujialing occupation

In the Shijiahe period residents of the northern zone started to dwell in a relatively higher area at about 40 m above sea level (Figure 4.3). This upward and downward would be consistent with the idea that flooding was a problem in Shijiahe times, but the Shijiahe population also began to occupy a considerable area of lower elevation between 0 and 10 m above sea level in both the northern and southern survey zones. This expansion of occupation both upward and downward suggests that flooding was not severe enough to prevent Shijiahe people from living on the valley floor at a very low elevation. In addition, the Shijiahe period also experienced a clear population increase in lower parts of the southern zone, so it is most likely that the new occupation not far from the two walled towns at relatively higher elevations is due to population increase in general rather than to river flooding.

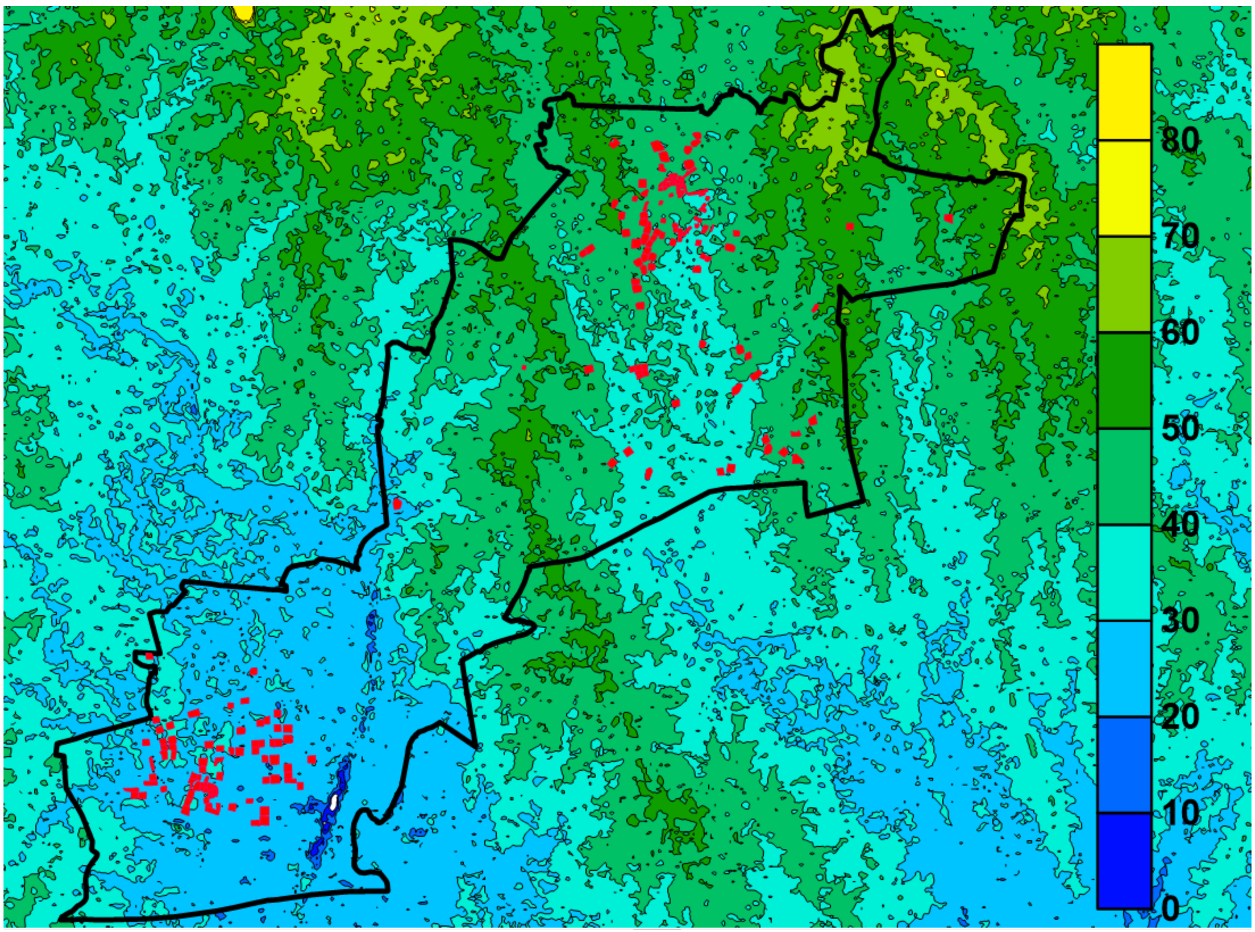

Figure 4.3. Contour map of Shijiahe occupation

In the Shang period, only a few occupations were found in the northern survey zone at elevations of 30 m above sea level; the lower locations within the survey boundary had been completely abandoned (Figure 4.4). Flooding deposits later than the Shijiahe period at the Caitai site are at about 28.6-29.0 m above sea level, suggesting that areas lower than 30 m above sea level might have been disturbed by flooding after Shijiahe period (Wang 1998). This theory would be consistent with the idea that frequent flooding threatened the Shang-period residents were threatened by frequent flooding, leading to the retreat of population from areas less than 30 m above sea level but continued occupation at relatively higher elevation locations in the northern survey zone. However, the cause for the decrease of population remains unclear both in the survey zone as well as throughout the Jianghan Plain.

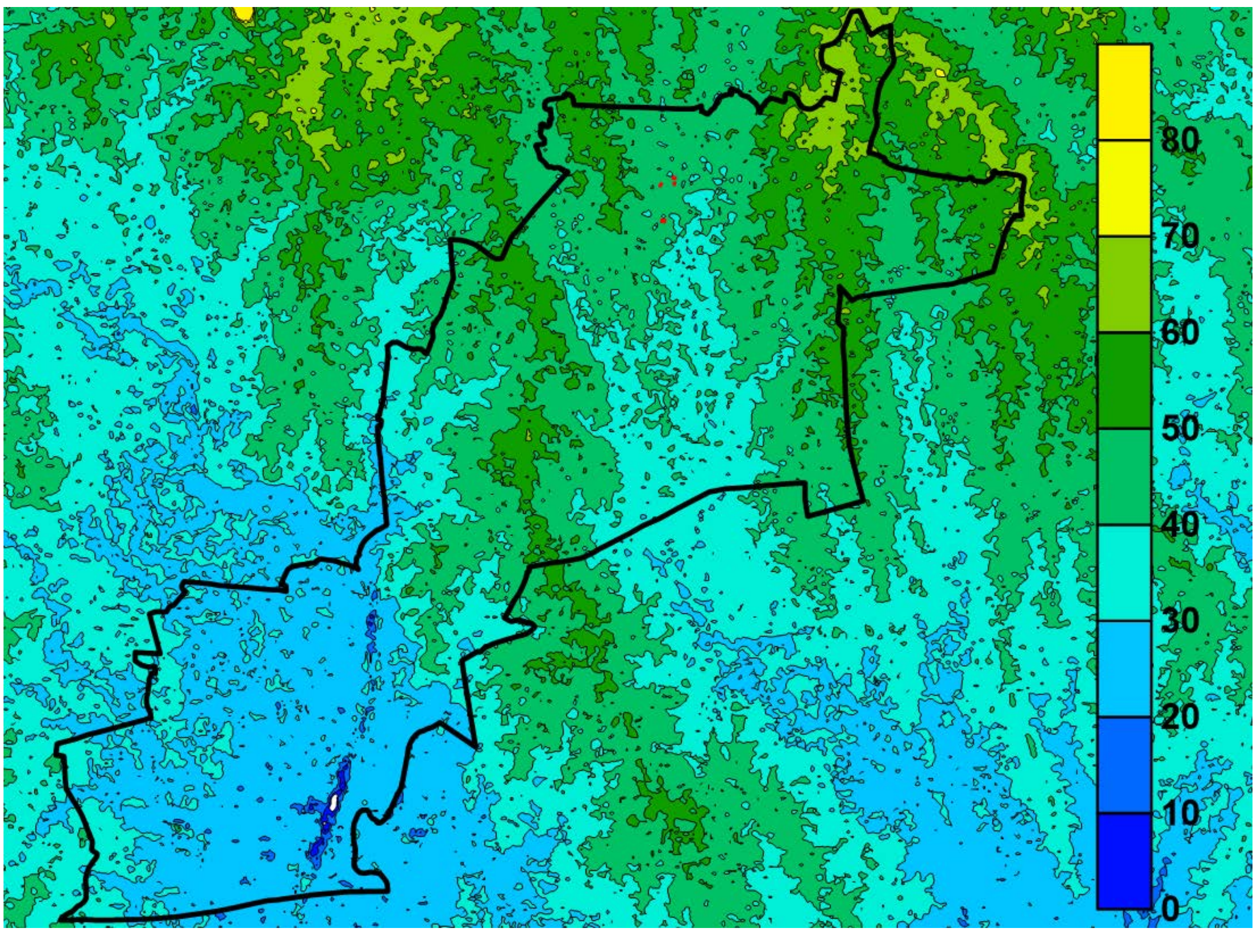

Figure 4.4. Contour map of Shang occupation

In contrast to the Neolithic and Shang occupations, most of the Western Zhou occupations were found on ridge ends, particularly clustered around the Xiaocheng walled town standing up on the western edge of the river valley with an elevation of 20 to 30 m above sea level; this is lower than the elevation where Shang occupation was found (Figure 4.5). At the same time there was no occupation in the lower river valley below 20 m above sea level, which had been widely occupied in the Neolithic period. The reoccupation of the relatively lower southern survey zone might be due to a possible lowering of the water table, which had probably been very high during the Shang period. From 350 to 3000 BP, the Jianghan Plain witnessed frequent flooding, and low areas near rivers might have submerged into lakes and swamps (Xiao 1991). The meandering Zaoshi River still creates lakes and swamps in the low flat river valley near the Xiaocheng walled town. The population had to relocate to relatively higher land to avoid flooding, but also had to remain close to the river valley so as to take advantage of water resources for rice cultivation and fishing.

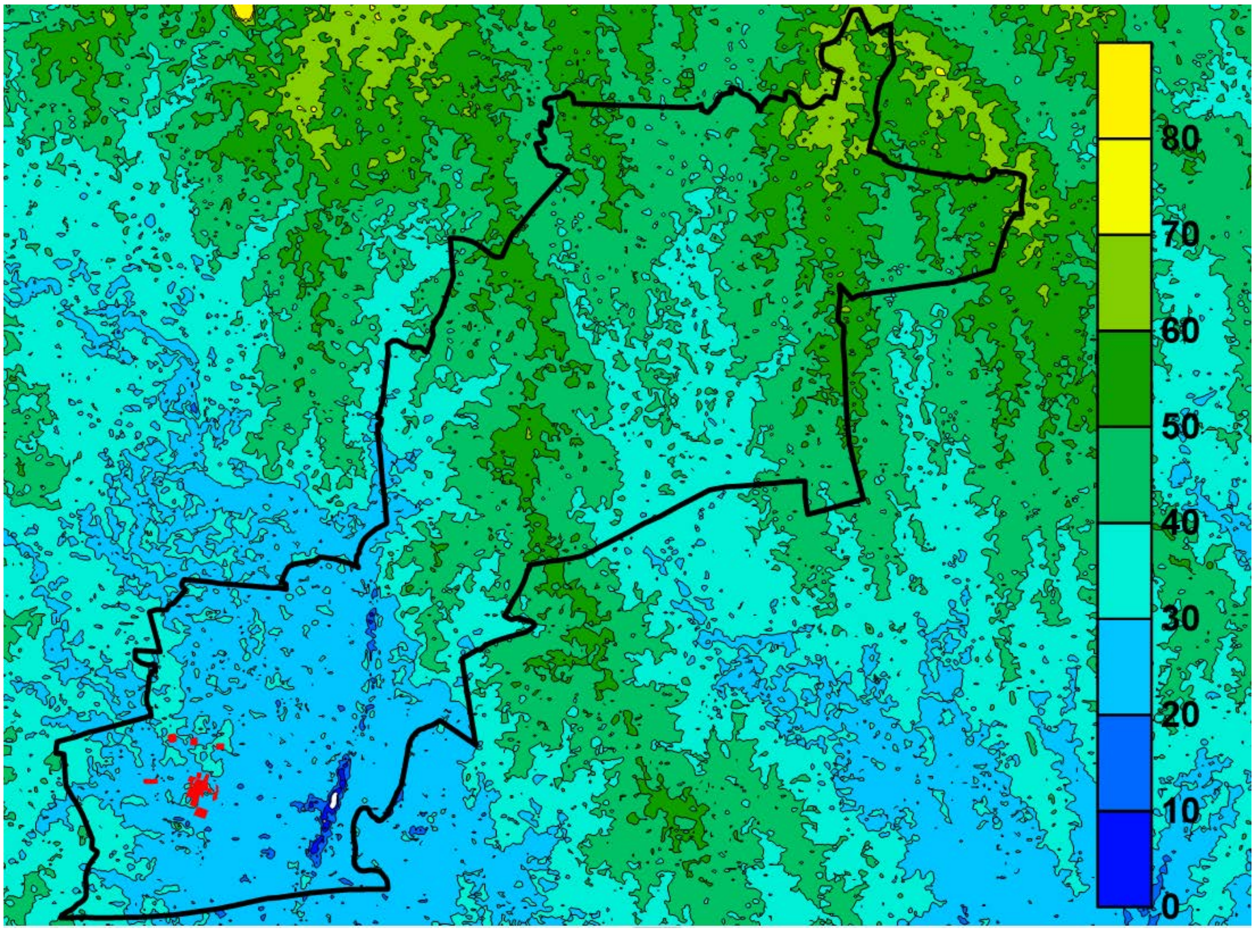

Figure 4.5. Contour map of Western Zhou occupation

In the Eastern Zhou period, population not only occupied higher ridges in the southern survey zone but also started to reoccupy the low flat Zaoshi River Valley below 20 m above sea level (Figure 4.6). The Chu period (770-278 BCE) corresponds to the spore-pollen zone V of the Dajiuhu basin, which suggests a warm and dry climate (Li et al. 2011). The water table might have dropped further in Eastern Zhou times; as the water level of lakes and swamps dropped, they shrank inward. The majority of the Zaoshi River Valley might have been re-exposed in the Eastern Zhou period. With the population expansion from Western Zhou to Eastern Zhou, the low flat river valley floor was reused for occupation. Considering that the population in the southern survey zone reached an unprecedentedly large size, it is likely that the Zaoshi River valley floor was heavily cultivated. Because a significant number of the population located close to the valley floor, river flooding was not likely a serious problem. Apparently the reoccupation of the Zaoshi River Valley was for utilizing its water and fertile soil resources.

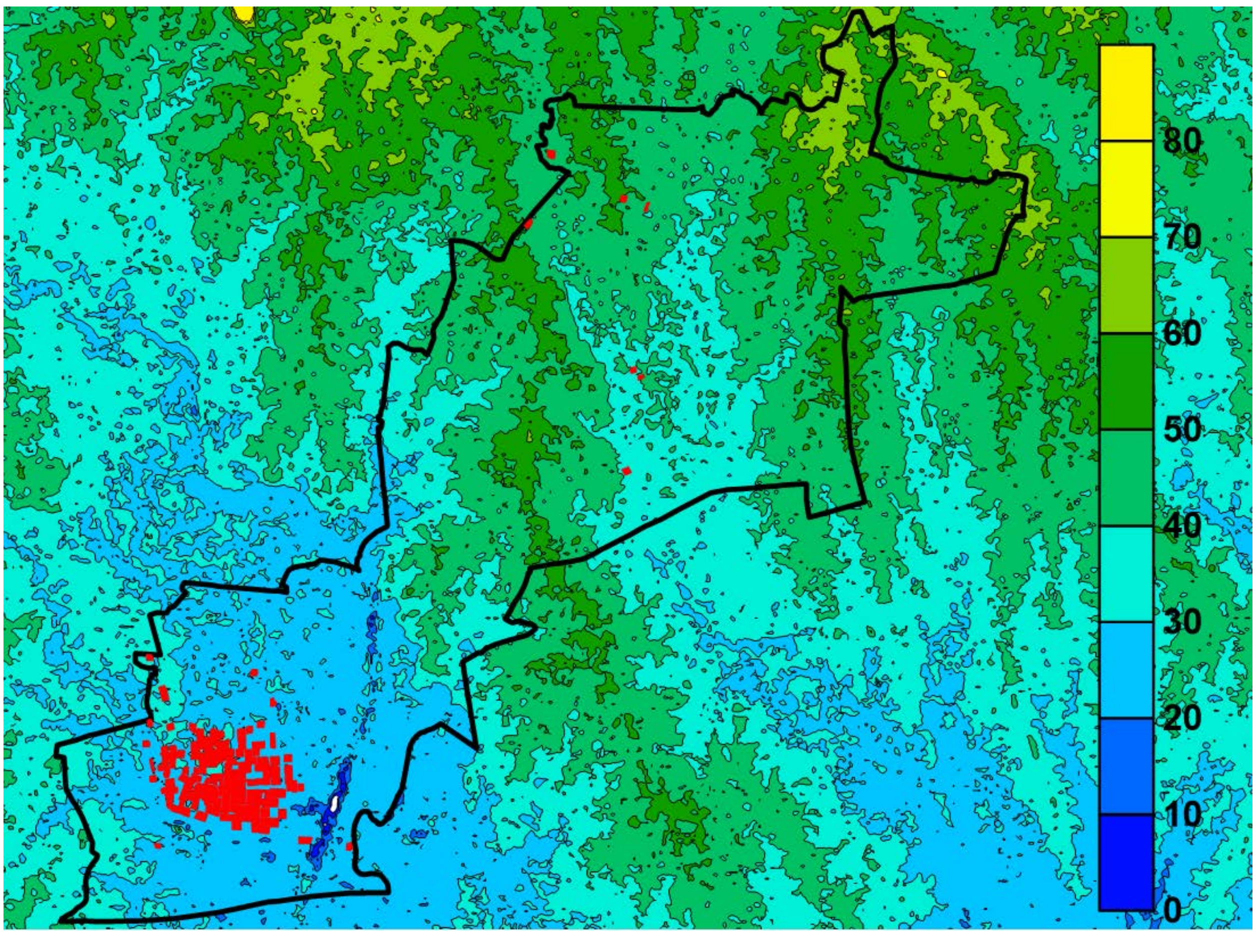

Figure 4.6. Contour map of Eastern Zhou occupation

In the Han period, population in the southern survey zone occupied both the high ridges and the flat Zaoshi River Valley floor (Figure 4.7). The highest population density peak appeared to the east of the Xiaocheng walled town, which is on the western edge of the river valley, indicating a continued heavy occupation of Zaoshi River Valley floor. Since 2000 BP, the ratio of Rb/Sr in soil samples from the Qujialing site experienced a relatively strong increase. Tree pollen also increased. During Han times, the climate started to become warmer and wetter (Shi et al., 2009). The continued close proximity to the wide flat river valley indicates a heavy reliance on water resources.

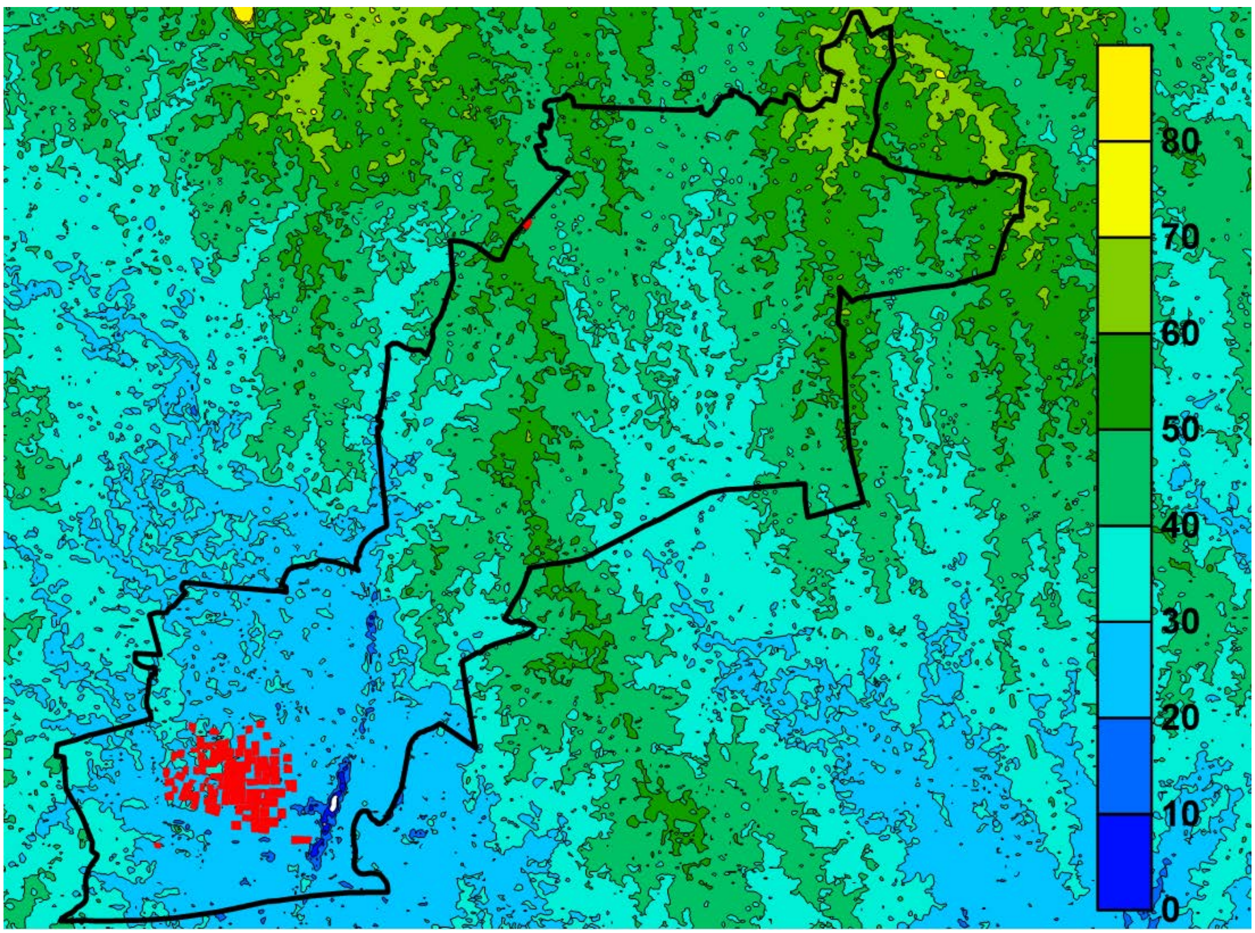

Figure 4.7. Contour map of Han occupation

In the Wei-Jin period, more than 99% of the population was located in the flat fertile Zaoshi River Valley, which was a demographic center for the entire survey area. Only a very small population was found in the north in the higher elevation zones (Figure 4.8). Such a distribution pattern indicates a heavy reliance on soil and water resources for rice cultivation and fishing. The warm and humid climate in the Wei-Jin period also tended to be warm and humid, favoring rice cultivation and fishing (Shi et al. 2009). Although the northern zone only had a very small population, even this minor reoccupation could also be a consequence of increased need for water resources, as the occupation was found on ridges near rivers in the northern zone. Again, the population distribution patterns resemble those of the previous Han and Eastern Zhou periods. Precipitation and river flooding do not seem to have challenged the Xiaocheng's residents.

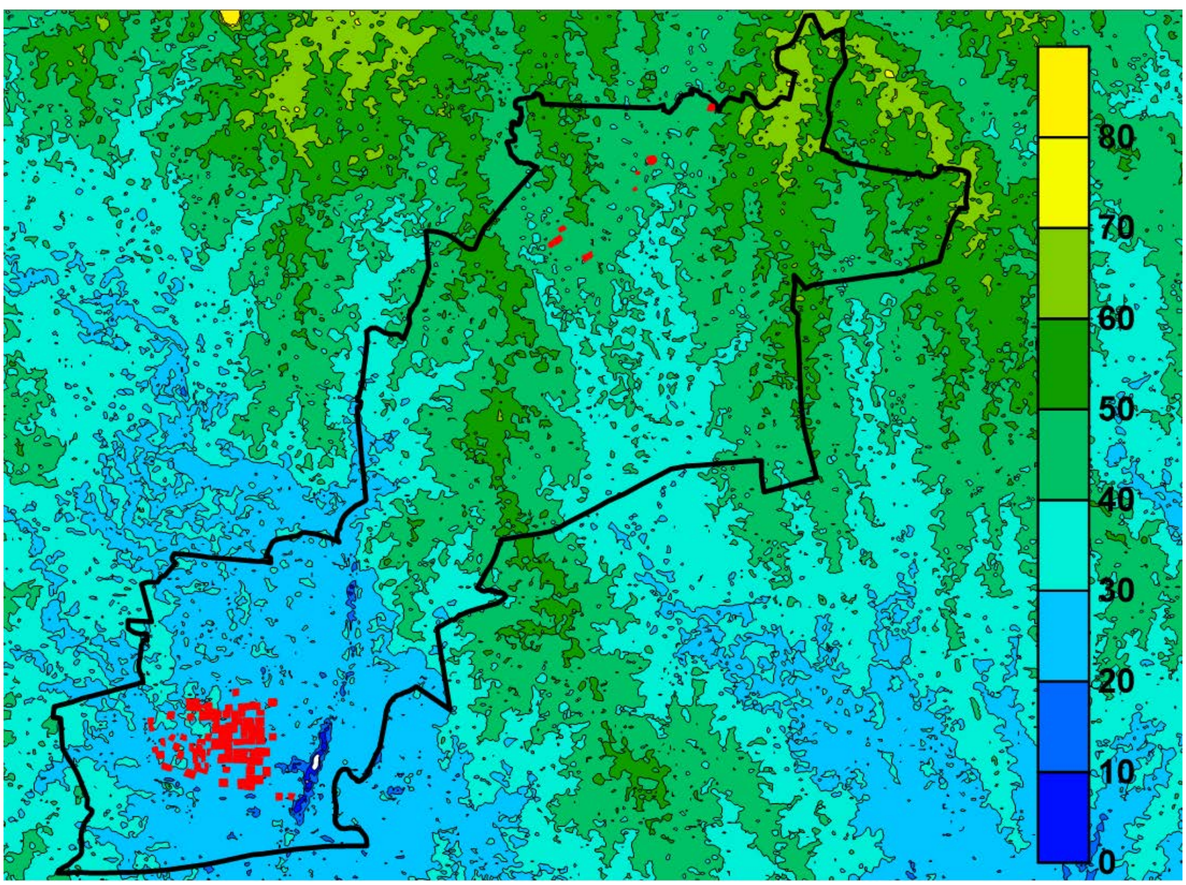

Figure 4.8. Contour map of Wei-Jin occupation

Comparing the population distribution across different elevation zones in the sequence of periods shows a trend of shifting from higher elevations (30 to 50 m above sea level) to lower elevations in the range of 10 to 20 m above sea level during the Neolithic period. This trend was stopped, possibly by frequent flooding during the Shang period, but the reoccupation of the survey area beginning in the Western Zhou period suggests a resumption of this trend characterized by the abandonment of the higher northern survey zone. From the Western Zhou to Wei-Jin period, the low, flat Zaoshi River Valley was continuously occupied. On the one hand, flooding and water table fluctuations after the Neolithic period might have caused demographic shifts between elevation zones; on the other hand, the preference for the wide flat lower river valley was quite pronounced through time. This observation contradicts Wang's (1998) hypothesis that the emergence of walled towns resulted from frequent flooding in the Neolithic period.

4.3 CATCHMENT ANALYSIS ON ARABLE LAND EXPLOITATION FOR RICE PLANTING

Researchers of the past decade of studied the early cultivation of rice in the Jianghan and Dongtinghu Lake Plains (Pei 1989, 1998, 2008). The hot and humid climate probably made rice cultivation in the Jianghan Plain not only possible but also necessary for daily sustenance. In the survey area, two major topographic zones have been identified: the low ridge plain and the flat river valley floor. Although both zones are suitable for rice cultivation, it is clear that the wide flat river valley floor was preferred, as it provides more fertile arable land, abundant water for rice and close proximity to rivers and lakes for fishing (see elevation analysis). However, with a dramatic population increase from the Youziling era to the Shijiahe period, the heavy reliance on the fertile river valley floor for rice cultivation and fishing might have caused a shortage of preferred locations. From this perspective, it is essential to understand approximately how much land was needed in each period for rice cultivation as the principal element in subsistence systems.

To make a quantitative educated guess requires an estimate of the rice yield of the farmland is needed for each period. There is no basis for a direct estimate for Neolithic periods, but an abundance of historical records about rice yields in later periods from Zhou to Wei-Jin can be used to project backwards to Neolithic times. According to the study of the *Guodian Chujian*, Chao (2002) estimated that rice yields in the Chu state (10^{th} century-223 BCE) ranged from 1295 to 1379 kg/ha. Chao's (2002), who based his calculation on Yang (1988), reached a range of 1065-1102 kg/ha. Productivity in the Neolithic period must be lower than in Zhou times, so the analysis presented here will use the average value of the second, lower estimation: 1084 kg/ha.

Estimation of rice requirements is based on an assumed average that 2000 calories/person is needed for basic daily needs. According to a diet analysis for the Neolithic Qinglongquan site in the upper middle Han River Valley, some 300 km away from the survey area, C3 plants (which is to say, rice) contributed an average of 65.5% of the daily diet (Guo et al. 2011). Considering that 1 kg rice provides about 1300 calories, this amount is almost exactly the 65.5 % of the daily 2000 calories (0.655*2000=1310 calories). Thus, about 1 kg of rice would satisfy daily consumption needs, and about 365 kg would be needed for each person each year (1kg*365 days). The estimates here of required cultivation land needed, then, are based on providing 65.5% of daily caloric needs with rice. They are thus very minimal estimates of essential land needed because they do not factor in other dietary necessities needs and because rice productivity was probably even lower than the figures used in early periods.

In the Youziling period, the estimated population range is from 50 to 100 persons. The total amount of rice needed for this population each year would be 18,250-36,500 kg (50-100 persons*365 kg). Using land yields from Chu times as a basis, the amount of rice cultivation land needed would be only 0.15 to 0.30 km^2 (18,250-36,500 kg/1084 kg per ha/100 ha per km^2). The same approach is applied to the Qujialing, Shijiahe, Shang and Western Zhou periods, with the results shown in Table 4.1. At the end of the Han period, according to *Sanguozhi* 三国志 (Chen 2006), the yield of rice cultivation land is about 3 *dan* 担/*mu* 亩 (940 kg/ha), which has declined from the Chu state in the Western Zhou and Eastern Zhou periods. Using this yield to estimate cultivated land in the Han and Wei-Jin periods leads to an estimate of 23.3-40.6 km^2 and 25-50 km^2, respectively. Agricultural productivity in the Neolithic period was considerably lower than in later historical periods due to the lack of metal tools and the raising of livestock, so more land was surely needed for cultivation from Youziling to Shang times than estimated here. Calculating just how much more is, however, not possible for lack of relevant information about Neolithic farming productivity.

Table 4.1. Estimated cultivated land for each period

Periods	Population Estimation (Persons)				Cultivated Land Needed (Square km)			
	North		South		North		South	
	Min.	Max.	Mini.	Max.	Min.	Max.	Min.	Max.
Youziling	45	90	5	10	0.15	0.30	0.02	0.04
Qujialing	6000	12000	1000	2000	20.30	40.60	3.20	6.40
Shijiahe	3700	7400	1800	3600	12.50	25.00	6.02	12.05
Shang	5	10	0	0	0.02	0.04	0.00	0.00
Western Zhou	0	0	1000	2000	0.00	0.00	3.37	6.74
Eastern Zhou	<5	<10	12000	24000	<0.02	<0.03	40.39	80.80
Han	25	50	5975	11950	0.20	0.40	23.10	46.20
Wei-Jin	100	200	6400	12800	0.40	0.80	24.84	49.68

Since people tend to live close to their farmland in settled agricultural societies in order to care for their crops, it is useful to convert the amount of land needed (as estimated above) into a buffer radius to calculate how large a catchment would be needed to provide the required amount of cultivation land. Since the population estimates were made in Chapter 3 with a minimum and a maximum, minimum and maximum catchments needed to provide farmland can be estimated. As the populations of compact regional centers in the Neolithic period grew *in situ* (see analysis in Chapter 3), the walled towns are meaningful centers to use for catchments of cultivation land. Even though the walls at Taojiahu were most likely built in the Qujialing period, much of the Youziling period population was already concentrated in a local community where the walled town would later be. The entire Youziling population of 50-100 people in the northern survey zone would need 0.17- 0.34 km^2 of rice farmland. The Taojiahu walled area built later on encloses about 0.68 km^2, and the total occupation of the Youziling period is about 0.05 km^2, which is no more than 10% of the area later enclosed in the Taojiahu walls. Even if the entire Youziling population of the northern survey zone were located within the area of the later Taojiahu walls, the unoccupied area within the walls would still provide much more farmland than the Youziling population required. For the southern survey zone, there were fewer than 10 people. The requisite catchment for this occupation would be so small that there is no need even to run a catchment analysis. The preferred wet flat rice farmland in both the northern and southern survey zones was obviously large enough to produce the amount of rice needed by the Youziling population many times over (Figure 4.9).

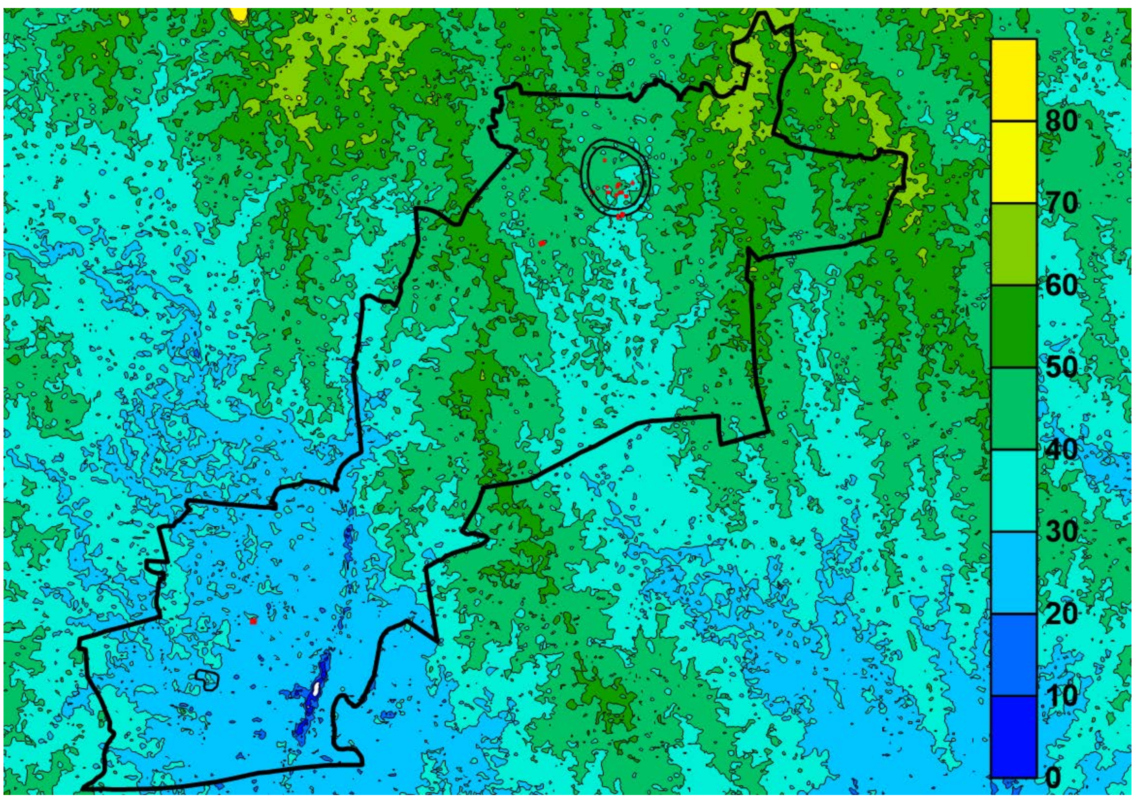

Figure 4.9. Youziling catchment map

By Qujialing times, the flat fertile river valley floor may not have provided enough preferred farmland for the dramatically expanded population around the Taojiahu walled center in the northern zone. As Figure 4.10 shows, in order to produce enough rice for a population of 6000-12,000 persons in the north, even the minimum estimate of required farm land would require a catchment extending well beyond the relatively narrow Silong River Valley's most productive land, and even beyond the boundary of the survey zone. The imbalance was probably even greater than estimated since the estimates are based on more productive Zhou period farming. Therefore, it is very possible that population growth was creating pressure on resources, at least in terms of preferred rice farming land in the area around Taojiahu in the northern survey zone.

In the southern survey zone, the Zaoshi River provides a much wider valley and a much larger area of wet arable land for rice cultivation. The population may have begun shifting from the Taojiahu walled town to the Xiaocheng walled town for better access to larger areas of the most favorable land for rice cultivation, or Xiaocheng might have been a sort of agricultural colony that provided a considerable amount of rice to Taojiahu. Rank-size and centralization analysis in Chapter 3 have shown that Taojiahu still served as a regional center in the whole survey region, suggesting that there might have been some kind of tax or tribute from Xiaocheng to Taojiahu in the form of rice to help sustain Taojiahu's large population. Compositional analysis of ceramics provides the initial suggestion that Xiaocheng-made pottery was also consumed at Taojiahu. Both rice and pottery, then, might have been goods moving from Xiaocheng to Taojiahu.

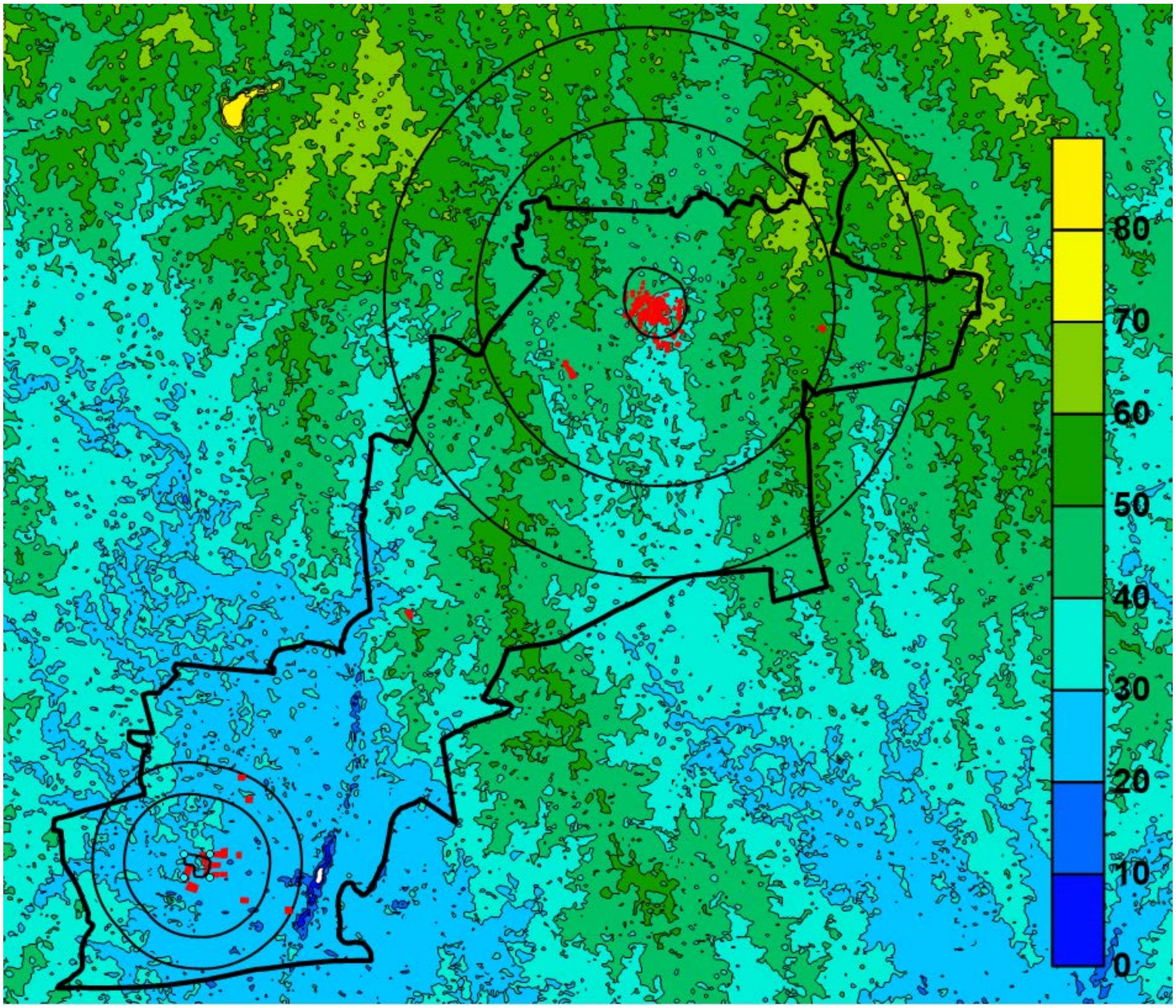

Figure 4.10. Qujialing catchment map

In the Shijiahe period, the population in the northern survey zone experienced a decrease in size and a redistribution of people, which might be the result of population pressure on farmland in the north. Figure 4.11 indicates a clear new pattern of population distribution in the northern zone, with population spreading out towards both north and south along the Silong River Valley. The population decrease from 6000-12,000 to 3700-7400 in the north would have greatly reduced pressure on farmland. Decreasing demographic centripetal forces emanating from the Taojiahu walled town would also have allowed more people to settle farther away to exploit the lower reaches of the Silong River Valley. The farmland needed to feed the population in the northern zone was now only 60% of the amount needed in the Qujialing period, which would make it easier for local production to feed the population of the northern zone.

A compositional analysis of Shijiahe pottery shows the previously frequent one directional pottery flow from Xiaocheng to Taojiahu had become rare, paralleling the decreased need of rice tribute from south to north. At the same time, the population in the southern survey zone increased, as demonstrated by newly occupied ridges close to the river valley and a spreading occupation on the valley floor near the Zaoshi River. The simultaneous increase of population in the south and the decrease in the north at the same time show a continued preference for flat fertile valley floor land and possible population migration from the north to the south, although the Taojiahu walled town still served as a regional center. However, the continuous population increase in the south and possible migration to the south would have weakened the dominant role played by the Taojiahu walled center due to the decrease of population in the north (see Chapter 3).

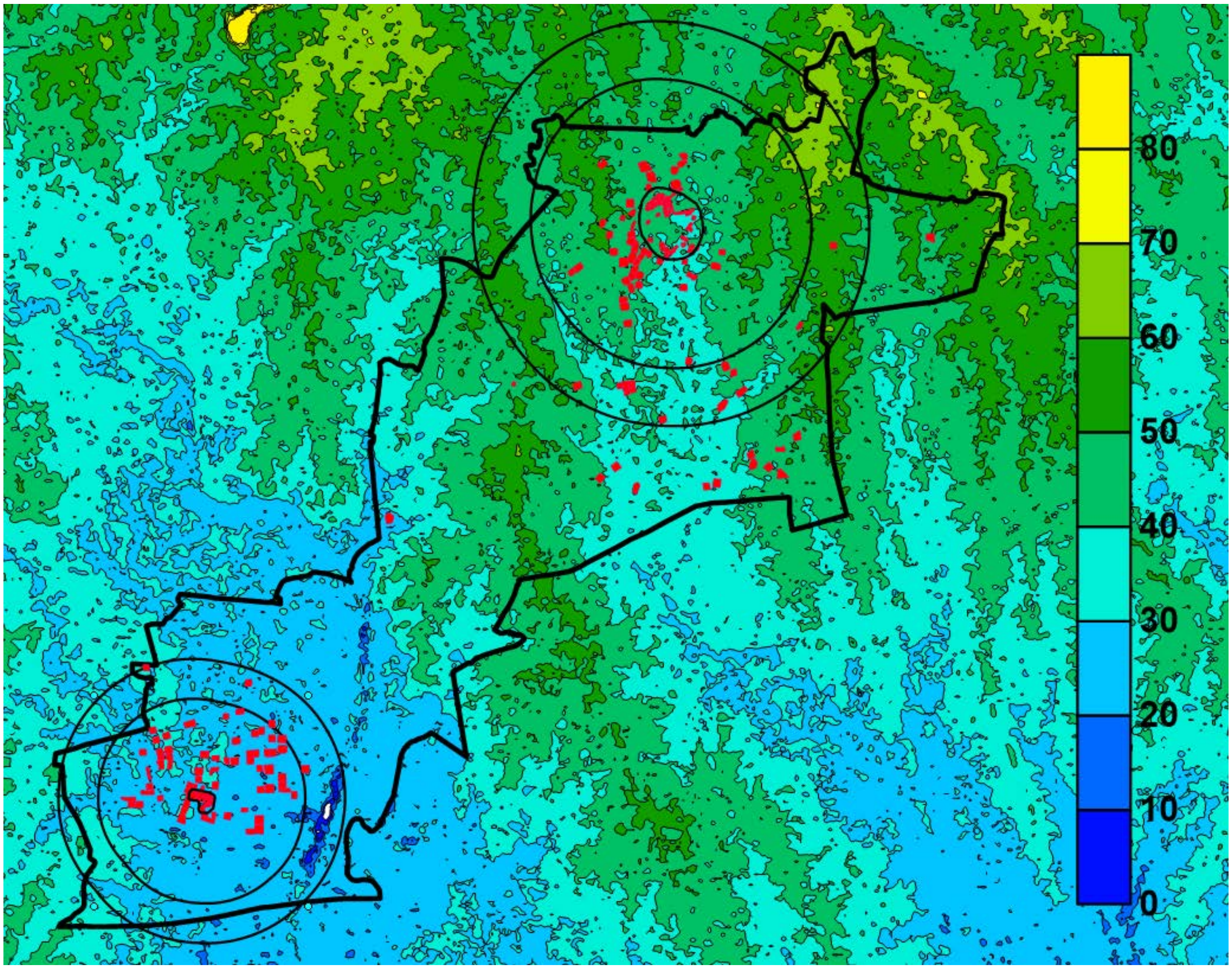

Figure 4.11. Shijiahe catchment map

In the Shang period, flooding possibly led to a sharp population decrease in this region. Only a few collection units representing fewer than 100 people were in the northern survey zone. The southern zone was completely abandoned. Although the few remaining people only occupied higher elevations, occupation was still located within the walls at Taojiahu in the Silong River Valley near relatively flat wet farmland for rice cultivation (Figure 4.12). The farm land needed for fewer than 100 people is no more than 0.1 km^2.

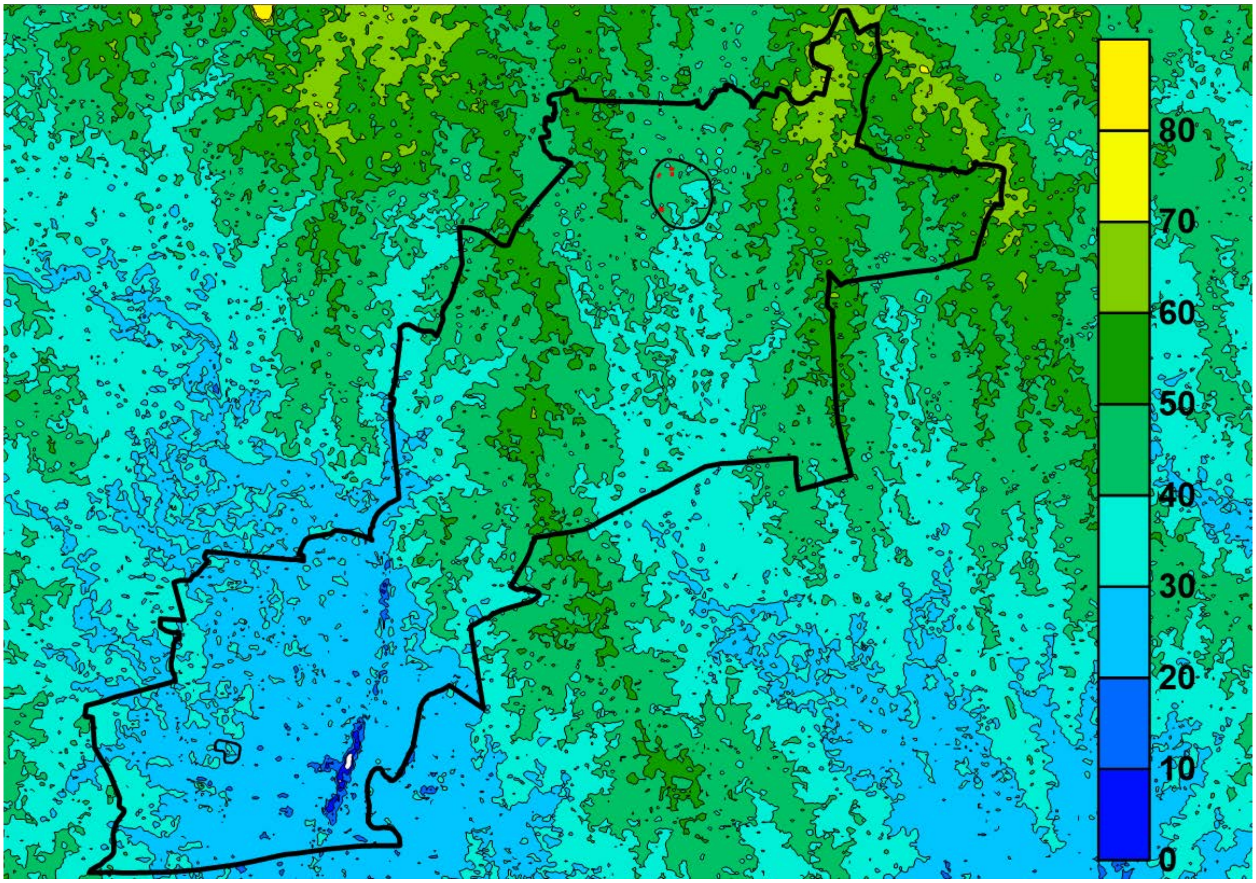

Figure 4.12. Shang catchment map

Beginning in the Western Zhou period, the dropping water table encouraged a resurgence of population in the survey area. The population was estimated at 1000-2000 people, which was much larger than the previous Shang period, but still much less than the Neolithic period. An unprecedented pattern in this period is that population was only found in the southern survey zone around the Xiaocheng walled town. From this period onward, the dominant role played by the Taojiahu walled town has been ended. The Xiaocheng walled town was close to a larger wet arable river valley, and grew to serve as a new regional center. The reoccupation of the southern zone concentrated in and around the town walls and on ridges to the north. The absence of population in the lower river valley might suggest that the water table remained high, although it might have dropped greatly from the Shang period. The new occupations were still close enough for Western Zhou people to exploit the Zaoshi River Valley to plant rice and to fish (Figure 4.13). The catchment analysis shows that 3.37-6.74 km^2 of farm land was required to meet daily rice consumption. Such an area is only a small part of the southern river valley.

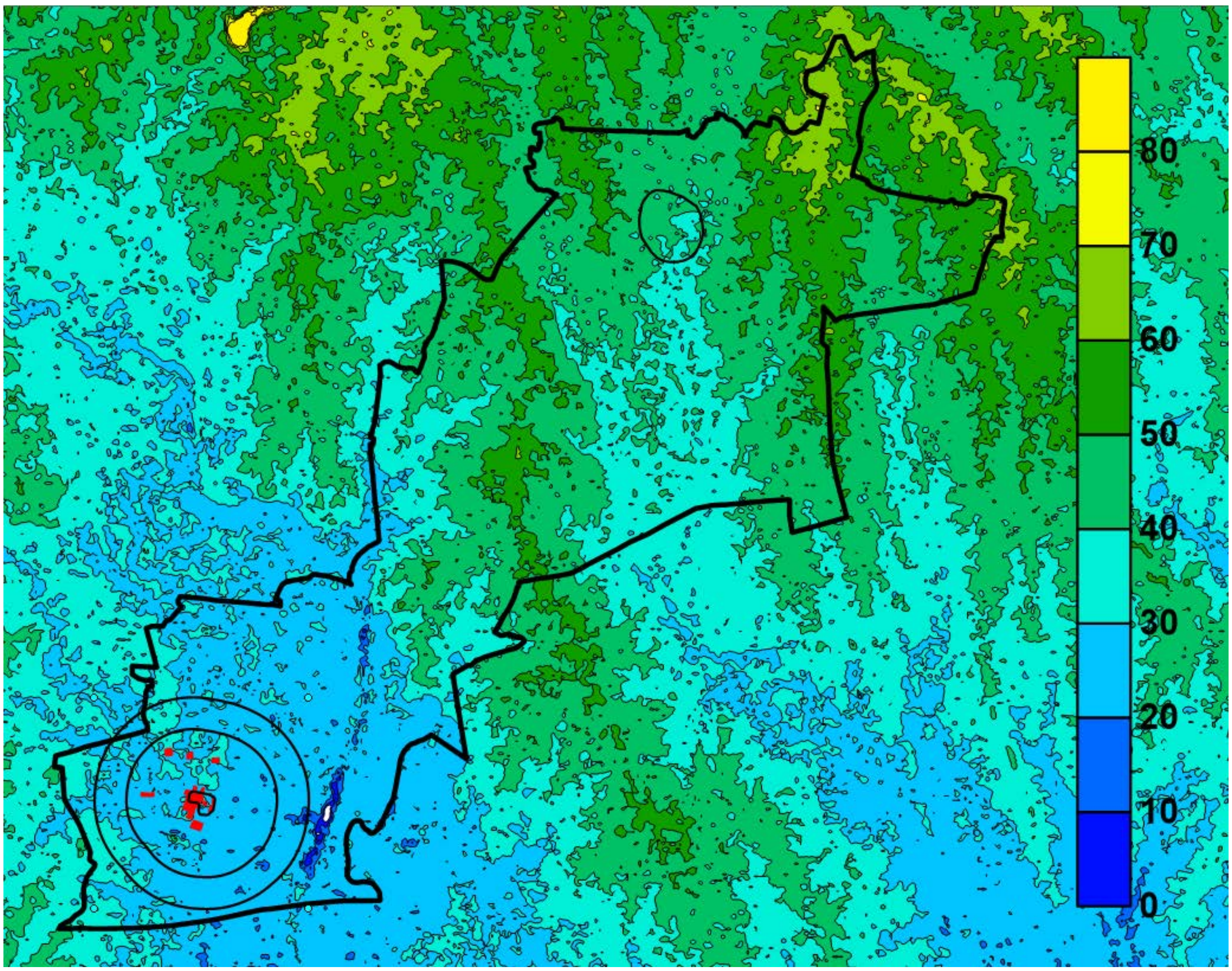

Figure 4.13. Western Zhou catchment map

In the Eastern Zhou period, population expanded to its largest size from Neolithic period, 12,000 to 24,000 people. Fewer than 100 of these people were estimated in the northern zone, which means that 99.6% of the population clustered in the southern survey zone. Figure 4.13 shows that population has closely clustered around the Xiaocheng walled town on the valley floor. Many more collection units were found on the western side of the Zaoshi River Valley. This large cluster of population suggests a heavy exploitation of wet flat valley floor for rice planting and fishing. The required land for planting rice comes to an estimate 40-80 km^2 which would have to include some non-valley-floor land. However, the wide utilization of metal tools and improved irritation techniques might have bolstered rice yields dramatically so that drier land on slopes could more easily have been exploited to offset the deficiency of wet land according to *Zhanguoce* 战国策 (Liu 2003). In addition, millet was widely planted in central China in the Eastern Zhou period, which also means that drier land on slopes could be more effectively exploited for farming. In the southern survey zone more occupations were found on relatively higher and drier ridges, suggesting exploitation of drier land. In general, it seems that population expansion in the Eastern Zhou period has caused further exploitation of more distant regions including an expansion of farming on the eastern side of the Zaoshi River Valley and possibly on drier ridges near the Xiaocheng walled town (Figure 4.14).

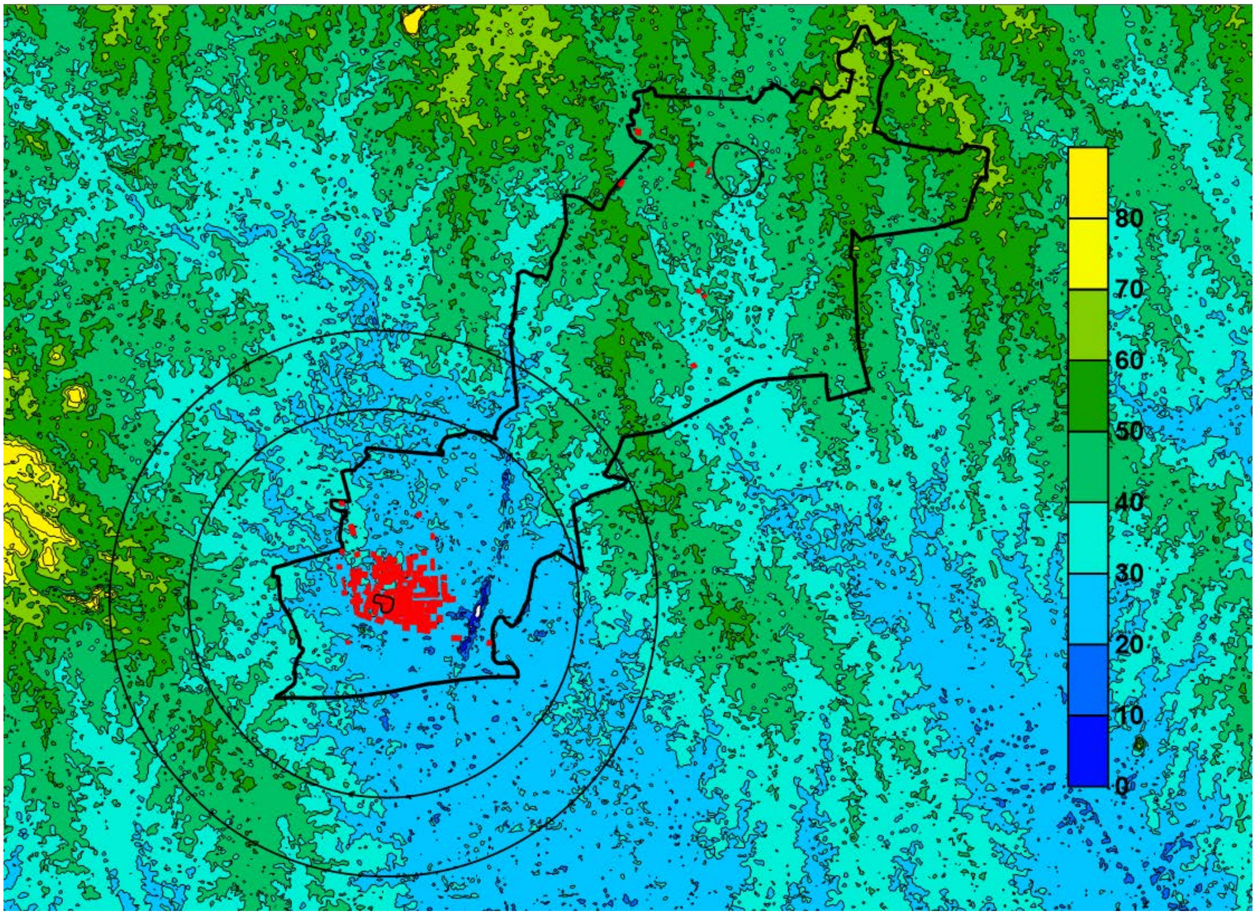

Figure 4.14. Eastern Zhou catchment map

In the Han period, population has decreased by half from the previous Eastern Zhou period, which finally led to a slight retreat of population from higher ridges to the Zaoshi River Valley (Figure 4.15). With only half the population of Eastern Zhou, the demand for farm land was dramatically decreased. The catchment in Figure 4.15 shows that population clustered on the valley floors the ends of ridges are very close to the valley, suggesting a very strong preference for wet flat valley floor land.

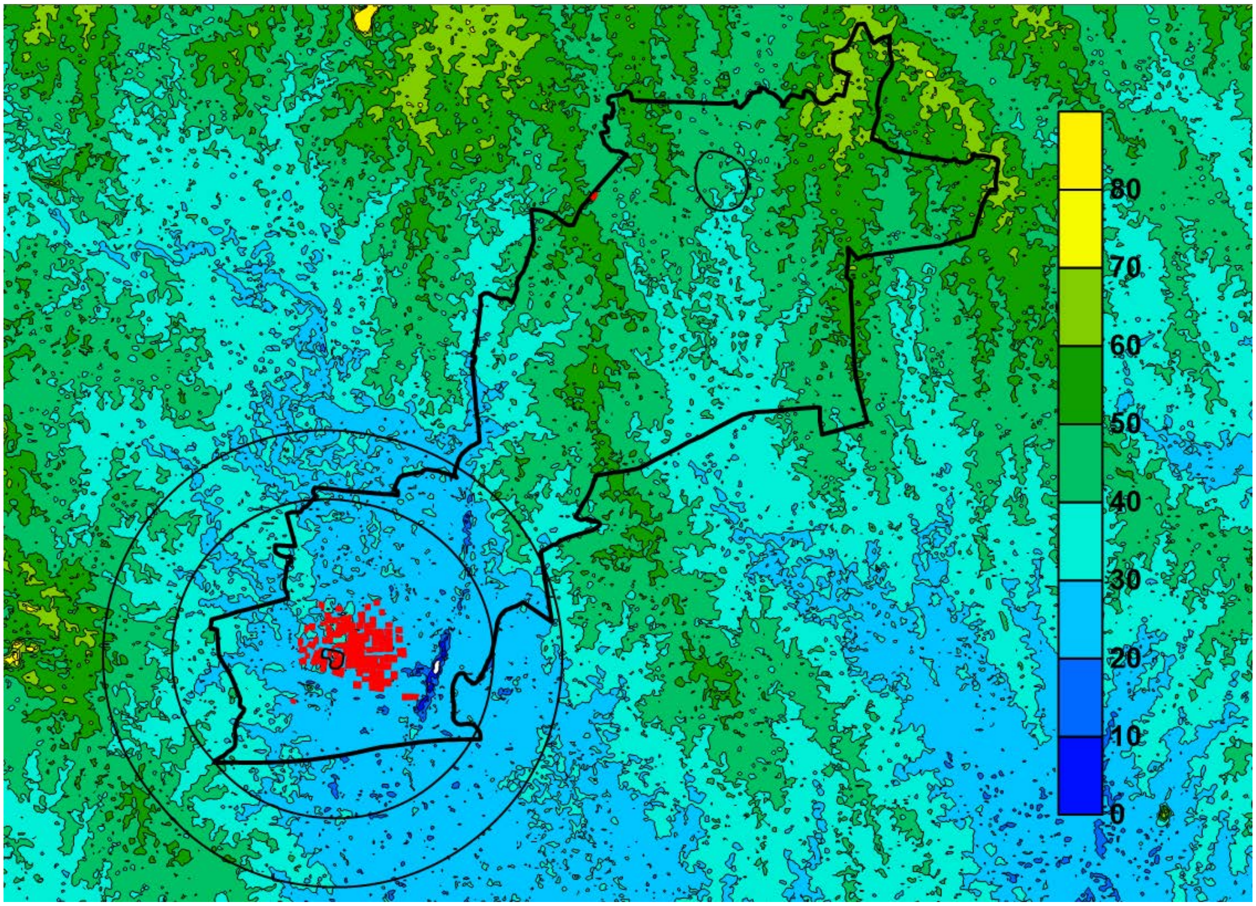

Figure 4.15. Han catchment map

In the Wei-Jin period, population remained very close to the same size as the Han period. Occupations did not change their patterns and shared the same strong preference for valley floor land. Although there was a slight increase in collection units in the northern survey zone, the estimated population in the north was fewer than 100 people, which is less than 1% of the population in the whole survey area which does not have any noticeable impact on need for farmland. The catchment map demonstrates a slight expansion from Han period, but it did not exceed the catchment in the Eastern Zhou period, thus the Zaoshi River Valley floor seems to be able to provide abundant of farm land for rice planting (Figure 4.16).

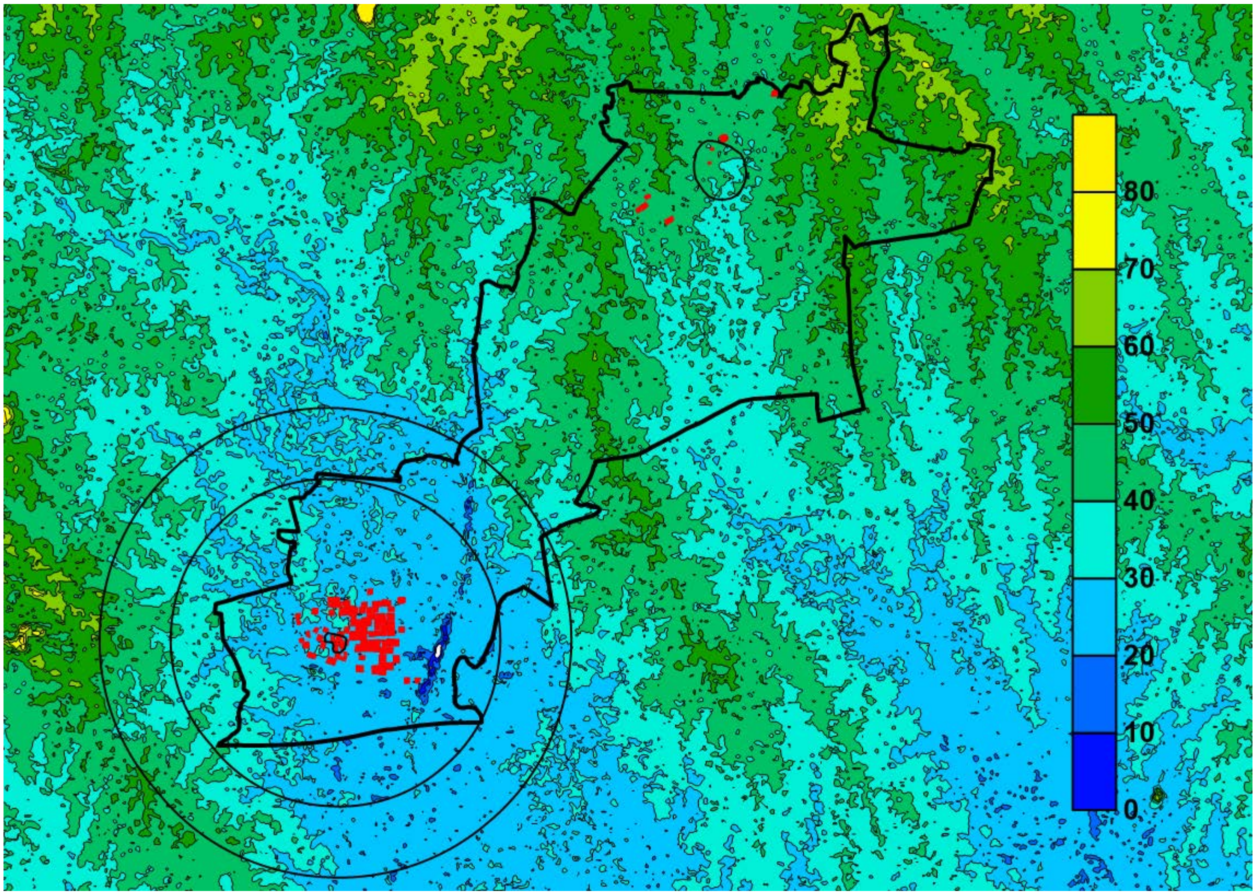

Figure 4.16. Wei-Jin catchment map

5. CONCLUSION

The research presented here aims to contribute to our understanding of both archaeological and historical periods in the Jianghan Plain. It adds to the very sparse body of information from systematic survey for south China by documenting settlement in the Jianghan Plain from the beginnings of sedentary agricultural life through the building and occupation of walled regional centers. It provides a unique dataset for comparative study of the trajectory towards sedentary agricultural complex societies in other parts of the world. As noted in the first chapter, hierarchical walled centers were built and used from Yangshao and Longshan times in the Jianghan-Dongting Lake Plain. These walled towns are often used by archaeologists as indicators of the social transformation from the more egalitarian Yangshao period to the chiefdom-like Longshan period. This chapter reviews what has been learned about the social trajectory towards more complex Longshan period and later historical periods by looking at the emergence of two very early walled towns in the Jianghan Plain.

First, answers will be presented for the research questions framed in the first chapter:

(1) What were the central place activities carried out in the walled towns but not in their hinterlands? Craft production? Storage of agricultural staples? Elite residence? Ritual? Political administration?

(2) What were the sizes of the populations that lived in the Taojiahu and Xiaocheng walled towns and their hinterlands?

(3) Was the growth of the walled towns largely a question of in situ population increase? Or was it produced by immigrants moving in from the hinterland?

(4) Did demographic centralization start before the emergence of walled towns or do they represent the initial demographic centralization in the region? Which of the central place functions of the Taojiahu or Xiaocheng walled towns can be detected in any predecessor?

(5) What environmental resources was the distributions of regional population oriented toward? Rivers? Fertile farmland? Transportation routes? Mineral deposits for wealth products or other special items?

5.1 EMERGENCE OF WALLED TOWNS AND SOCIAL COMPLEXITY (RESPONSE TO RESEARCH QUESTION 1)

One of the most striking findings of settlement survey in the Jianghan Plain is that through most of the sequence, and particularly in the Neolithic period, there was very little hinterland population at all around the walled towns. An extremely large proportion of the region's total population was almost always concentrated within and very closely around one of the two walled towns. This pattern began with local communities in these places before walls were constructed. Even in the later historical periods, although the Taojiahu walled town was almost completely abandoned, the Xiaocheng walled town and the region immediately around it were heavily populated. The forces driving the emergence of walled towns have been extensively discussed in recent decades, and several possibilities have been suggested.

Another is the flood control model, based on reconstruction of prehistoric climate change in the Jianghan Plain. From the early and middle Daxi period, the Jianghan Plain saw increasing flood levels (Wang 1998). On the one hand, periodic flooding was beneficial for forming the broad flat plain which favored large scale rice agriculture by providing fertile soil and adequate irrigation water. On the other hand, frequent flooding also caused problems of water management, which required new knowledge for stable rice cultivation. With water-laden soil as a basic condition for rice plants, farmers had to adapt to a new environment. One of the most important new skills required is the combination of water retention and drainage by building rice paddy terraces. Leveling the cultivated surface so that the rice can be equally irrigated is vitally important for rice growth. In order to deal with droughts, the construction of facilities such as canals and pools for regulating and controlling water in different seasons is also necessary (Guo 2005).

It has been argued that the ditches preceding wall construction around the earliest walled town (the Chengtoushan site) were created for water control. Rice paddies connected with possible canals and pools within the walled area have been advanced as evidence supporting the flood control model (Hunan 1999). Liu (1998) observed the spatial relationships between rice paddies other walled towns in the Jianghan Plain and argued that walled towns were close to rivers or lakes mainly to protect rice fields and manage the water they required. He further proposed that walled towns such as the Shijiahe site, the Majiayuan site, the Yinxiangcheng site, the Jimingcheng site, the Zoumaling site, the Taojiahu site, and the Menbanwan site also enclosed rice paddies, canals and pools. Lu (1999) argued that from the Daxi period to the Shijiahe period, there was a change in settlement location from lowlands to foothills, in temporal correspondence with climate change during this period, which he suggested involved increased flooding. He also argued that the preference for settlement location in broad open areas was because such locations provided good rice fields.

However, the survey data presented here strongly disagree with the flood control model. Both prior excavation and this survey show that the two walled towns of the Jianghan Plain were built in the Qujialing period, which is the second Neolithic period in the survey area. The farmland needed to provide for the basic rice consumption of the inhabitants of the two walled towns reached far beyond the walled area (Figure 4.10). This makes it unlikely that the walls and ditches of the two walled towns were built for irrigating the enclosed farmland. Eventually the populations of the two walled towns filled in enough of the enclosed area, that very little farmland would be left. For large scale rice planting, public irrigation projects such as rice paddy terraces and canals were necessary for controlling and regulating water, but these would occur in nearly farmland rather than within walled habitation sites.

Population distribution patterns in the survey area also show that the Neolithic population occupied lower river valley land continuously and progressively shifted from the higher Taojiahu walled center to the lower Xiaocheng walled center to exploit the wider and wetter alluvial valley floor there. This is just the opposite of the direction suggested by Lu (1999). Guo (2005) found that the average flood level in the Neolithic Jianghan Plain was 19 m above sea level and the highest flood level is about 30 m above sea level. The Taojiahu walled town is above 40 m above the sea level, suggesting there was no need to build walls to control flood waters. As for the Xiaocheng walled town, its elevation is about 30 m above sea level. If the flooding regularly reached the highest level, then we might expect Xiaocheng to be abandoned during the Neolithic period, perhaps in favor of Taojiahu. Xiaocheng, however, was occupied continuously through the Qujialing and Shijiahe periods right up to the end of the Shijiahe period, when higher flood levels possibly caused abandonment of Xiaocheng (and most of the survey area) in the Erlitou and Shang periods.

Another suggested explanation for the emergence of walled towns is frequent warfare. Both inter-regional conflicts among walled centers (Guo 2005; Pei 2011) and warfare between the Central Plain and the Jianghan Plain have been proposed (Fan 1998; Zhang 1994; Zhang 1998). This is a suggestion arising naturally from the default presumed defensive function of walls and ditches around settlements. Additional evidence comes from fewer than 20 burials with missing bones and fractures (Guo 2005). The idea of warfare between the Central Plain and the Jianghan Plain arises primarily from historical documents such as *Shiji* 史记 (Sima 1982). The archaeological evidence mainly studied in this connection concerns the boundaries of archaeological cultures, and regional survey in the Jianghan Plain sheds little light on this issue.

Analysis in Chapter 3 suggests that the two walled towns in the Jianghan Plain were independent of each other, since there was always a clear unoccupied buffer zone between them. In both Qujialing and Shijiahe periods, population in the Taojiahu walled town was much larger than in Xiaocheng. The distance between two walled centers is less than 10 km, which is an easy single-day round-trip distance. In analysis of the survey area as a whole, we would see strong centripetal forces exerted by the Taojiahu walled town on Xiaocheng simply because of the much larger population in the north. Catchment analysis indicates that the two walled centers were most likely connected by rice flow in the form of trade or tribute from the southern Xiaocheng walled town to Taojiahu, since there is far less of the preferred valley-floor land in the north with six times the population of the south. In the Qujialing period, this picture is amplified by evidence of pottery flow from south to north as well. The south-to-north pottery flow was potentially for rice transportation. It is less likely that the pottery flow involved trade in pottery itself, because the larger population in the north could easily have produced their own pottery *in situ* rather than trading with another walled town about 10 km away. In a context like this, economic control over staple subsistence production, particularly rice cultivation, is most likely the central element in controlling territory peripheral to the walled towns, particularly in the case of Xiaocheng.

It is also striking that in the Qujialing period more than 75% of the population in the northern zone was concentrated within the walled area, and most of the rest was distributed outside but very close to the walls. It is not clear that this concentration was a result of warfare, but it does reveal the strong political centripetal forces exerted by the walled towns. In the south, these centripetal pulls toward the Xiaocheng walled town are not as strong as in the north, since almost half the population of the southern zone lived outside the walls, and occupation patterns were generally more spread out.

In the Shijiahe period, the centripetal pulls of Taojiahu seem greatly reduced, mainly due to the increase of population in the south and the decrease of population in the north, as well as more spreading out of occupation in both north and south. Compositional analysis of pottery does not indicate one-directional pottery flow, perhaps suggesting greater independence between the two walled towns. Catchment analysis shows that the river valley in each area could likely sustain its own population since population was now better balanced between the two towns. Compared to the previous Qujialing period, the social structure of the two walled towns had greatly changed. First, the population ratio between the two walled towns was more balanced, leading to more independent polities. Second, economic control from the south had diminished dramatically due to the larger proportion of the population in the south region compared to the previous period. Third, the political administrative force of the walled towns, particularly

Taojiahu, decreased, as indicated by the small fraction of the walled area occupied, and the expansion of occupation outside the walls. The population of the Xiaocheng walled town continued spreading out to exploit the wider alluvial river valley for rice planting.

From the end of the Shijiahe period, it seems that the whole survey region was almost completely abandoned and population almost entirely vanished, possibly due to flooding. This notion is supported by widely distributed flooding deposits from Caitai (Wang 1998), Yuezhouhu, Wulinji, Lijiatai (Wang 1998; 2003) and Zhongqiao (Wu et al. 2015) on top of the final Shijiahe deposits. The elevation of these sites is 23-32 m above sea level, suggesting that those regions might have been flooded frequently from the end of the Shijiahe period.

The reoccupation of the survey area began in the Western Zhou period when population grew to around 2000 people. In the following periods, the valley floor of the southern zone was continually preferred because it was wider and wetter and thus provided more optimal land for rice planting (see Chapter 4). Another possible reason for preference of the southern zone river valley is for convenient transportation by river. According to *Shuijingzhu* 水经注 (Li 2007), the Xiaocheng walled town was then called Zaojiaoshi market. It is unclear what major products were traded in the Zaojiaoshi market in Wei-Jin times, but according to *Jingshan Xianzhi* 京山县志 (Huang 1990), the Zaoshi River was a major means of shipping rice and other food stuff from Jingshan, which was a principal locus of food production, particularly rice. This account provides an indication of the major products traded in the Xiaocheng region.

In general, the survey data indicate that the emergence of Taojiahu and Zaoshi as walled towns was mainly attributable to an economic dynamic, particularly rice planting. The walled towns served both economic and political functions. It may be that Taojiahu was initially the major economic center, and Xiaocheng may have developed as an economic colony to exploit adjacent productive rice-growing land and convenient water transportation. From Qujialing to Shijiahe times, the increase of population in the whole region probably placed much pressure on farm land, so population shifted to the southern river valley for larger amounts of wet and fertile land. The momentum of this transformation finally led to the collapse and abandonment of the Taojiahu walled town. Although this trajectory was disturbed by massive flooding in the Erlitou and Shang periods, the ensuing periods seem to have continued the previous trends. The survey results make it clear that walled towns were centers of economic control, particularly over agricultural staple production, and political administration.

5.2 DEMOGRAPHY INVESTIGATION (RESPNSE TO RESEARCH QUESTION 2, 3 AND 4)

An approach to population estimation based on occupied area and sherd density has been used in several regions in China (see Chapter 3). This approach provides a range rather than a single number. Two different approaches to population estimation were used at the very beginning of the analysis presented here. The approach based on occupied area and sherd density yields a broad general population estimate, and it also demonstrates sensitivity to micro-patterns of population distribution, since it takes sherd density in each collection unit of 1 ha or less to indicate how people distributed themselves at the local community level, which is particularly effective for comparison between center and periphery.

In the Youziling period, population in the whole region was fairly sparse, numbering no more than 500 persons. Most of the population was found in the northern zone and only a few people lived in the southern zone. The occupation in north formed village local communities. In the south, the smaller population amounted to only a few households. In the Qujialing period, population soared to 7000-14,000 persons. Of this total 6000-12,000 lived in the northern zone. More than 75% of the population in the north was packed into the Taojiahu walled town; more than half of the rest lived very close to the walls, except one cluster with 700-1400 persons about 2 km east of Taojiahu. In the southern survey zone, population distribution was less clustered than in the north. More than half of the southern population was found in the walled Xiaocheng town, and the rest are located in an area less than 1 km away from it.

In the Shijiahe period, the estimated population experienced a slight decrease from Qujialing period. A total of 6000-12,000 persons were estimated. Around 4200-8400 persons were found in the north and the proportion enclosed by the Taojiahu walls is about 68%. The proportion of population in the periphery has increased and occupation started spreading southward along the Silong River Valley. In the southern zone, estimated population was 1800-3600, half of which was in the Xiaocheng walled town, and the other half was located on the valley floor less than 2 km away. In the Shang period, possible flooding caused abandonment of most part of the region, and only fewer than 100 people were estimated in the Taojiahu walled town area.

In the Western Zhou period, population in the survey zone underwent resurgence. The estimated population in the survey zone was 1000-2000 persons, all in the southern zone. Around half of the population was in the walled town, and the rest clustered around the walled town. In the Eastern Zhou period, population reached 12,000-24,000 persons, which is the highest peak of population since the Neolithic period. More than 95% of the population was found in the southern zone around the Xiaocheng walled town. In the Han period, estimated population decreased from the Eastern Zhou period to 6000-12,000 persons, which is only half size of the population in the Eastern Zhou. The distribution pattern is quite similar to Eastern Zhou that more than 95% of the population was located in the southern zone around the Xiaocheng walled center. In the Wei-Jin period, population size remained similar to the Han period at 6500-13,000 persons. The distribution pattern resembles Han times, with the vast majority on the valley floor in the south near the walled town.

The distribution of population through time demonstrates that the growth of the walled towns happened *in situ*. Although there was a soaring increase of population from Youziling to Qujialing times, occupations were found in the same places. An initial Youziling cluster of households grew *in situ* to become the Taojiahu walled center. It was not a process of drawing in and concentrating population that had previously resided in a more dispersed pattern across the survey area. The walls were built where the Youziling occupation had been located.

5.3 ENVIRONMENTAL CONDITIONS (RESPONSE TO RESEARCH QUESTION 5)

Elevation and catchment analysis demonstrate that valley floors in the low elevation zone were preferred though time because they were well watered and fertile and thus offered favorable conditions for rice cultivation. The population in the Youziling period was quite small, and occupations occurred on narrow valley floors in both the northern and southern survey zones. In the Qujialing period, soaring population placed heavy pressure on limited fertile land in the north, and people started to move southward to the wider and wetter Zaoshi River Valley floor to exploit the larger expanse of productive farmland. This trend intensified in the Shijiahe period, with continued population increase in the south and decrease of population and political control in the north. Another possible reason leading to population concentration in the valley floor is transportation. In historic periods, river transportation was relied on to ship foodstuffs and other possible goods between regions. The southern zone would be particularly favored by the bigger Zaoshi River whereas the small Silong River Valley was almost completely abandoned.

5.4 COMPARISONS TO WALLED TOWNS IN OTHER REGIONS

As disused above, the research presented here was focused primarily on five questions about the Jianghan Plain. For a broader view, it is also worth comparing the Jianghan Plain with other regions—both nearby and farther away. The comparisons in this chapter involve only regions with walled towns where systematic regional archaeological surveys document populations outside those walled towns as well. The regions discussed include the Shijiahe region (also in the Jianghan Plain), the Yiluo Basin, the Huangtucheng region, and the Yuncheng basin in the Central Plain; the Rizhao region in eastern China; and the Chifeng region in northeastern China. In these regions settlement surveys were carried out with similar methods yielding comparable data for looking into settlement pattern changes in time and space.

5.4.1 Walled towns in the Jianghan Plain

In the middle Yangtze River Plain (the Jianghan Plain and the Dongtinghu Plain), the earliest known walled town (Chengtoushan) appeared in the Daxi period (5000-3500 BCE). At the Chengtoushan site, the area surrounded by ditches is about 9 ha. In the later Qujialing period (3500-2500 BCE) more walled towns were built in the central Yangtze River Plain. The largest walled town in the Jianghan Plain is Shijiahe with an area of 120 ha. It is widely accepted that from the Qujialing period, societies in the middle Yangtze River Plain have shown hierarchical patterns.

According to Zhang (2003), the Shijiahe walled town might have served as the primary center in the middle Yangtze River Plain and controlled a large part of the central Yangtze River Plain. This suggestion is mainly based on shared archaeological material culture in the enormous region. Among the early walled towns in the Jianghan Plain, Shijiahe has attracted the most attention. A systematic reconnaissance survey in the Shijiahe region has shown that population started to cluster around the town site beginning in the Youziling period. A regional center with ditches and walls was found in the Longzui site. In the Qujialing period, the Shijiahe walled town, with a four tiered settlement hierarchy was built. The distances between smaller sites and the walled town vary from 5 to 20 km. Sites within this system were mainly located near rivers. In the Shijiahe period (2500-2000 BCE), site numbers have greatly increased (Hubei 2009).

Some basic comparisons can be made between the Shijiahe region and the Taojiahu-Xiaocheng region, although the Shijiahe data did not come from systematic regional survey. Shijiahe is about 30 km southwest of the Taojiahu-Xiaocheng region. Populations of walled towns in both regions started growing *in situ* from the Youziling period and continually increased on through the Neolithic period. Both regions were mostly abandoned after the Neolithic period and reoccupied in the Western Zhou period. From Youziling through Shijiahe times, locations near rivers were preferred, and population seems to spread along rivers toward lower elevations in the later Neolithic period. This emphasis on lower river valleys in the Taojiahu-Xiaocheng region as well as in the Shijiahe region seems mainly due to the exploitation of fertile agricultural land. Compared to the Shijiahe region, population in the Taojiahu-Xiaocheng region is much more compact, particularly at Taojiahu, where most of the population was located within the walled area in the Qujialing period. Lack of actual population estimates for the Shijiahe region limits more systematic comparisons.

It is clear that long before town walls were built, population had begun to cluster into local communities in the Jianghan Plain in places that later became walled towns. These communities began constructing enclosing walls in the Qujialing period as population grew very rapidly and social organization became more complex. The patterns of interaction and the dynamics of relationships between these walled towns are still unknown, but shared pottery styles show that there was at least some degree of interaction. Compositional analysis of pottery also shows a flow of goods, especially from Taojiahu to Xiaocheng and possible political control of Xiaocheng by Taojiahu. These kinds of interaction are consistent with the distances of less than 25 km between Xiaocheng, Shijiahe, Taojiahu, and Menbanwan. Systematic regional survey at a larger scale and additional compositional analysis of pottery would reveal more about the dynamics of interaction between the walled towns.

Settlement patterns seem broadly similar across the Jianghan Plain in both spatial and chronological terms, and other regions farther away show contrasting patterns in their trajectories toward more complex organization. This variation suggests different central mechanisms of social change. The early agricultural societies in the middle Yangtze River Plain, like those in other parts of China, were on a path toward state formation, but this was a path with its own unique characteristics. From the end of the Daxi period, sedentary agricultural life was widely adopted in the Jianghan Plain and the Dongtinghu Plain. In some regions, population had started to cluster into substantial local communities, reflected most conspicuously in the emergence of Chengtoushan, the earliest walled town with broad wealth inequalities seen in burials. From the Qujialing period, an increasing number of chiefdom-like walled-town societies were seen in the

Jianghan Plain. Mature rice farming sustained rapid population increase and a context fostering frequent inter-regional interaction, including both conflict and trade. Walls and ditches were built around large local communities that are usually assumed to be defensive in character. Continued population increase probably came to place considerable pressure on farm land, locally at least where populations were highest. Increasing population pushed the exploitation of new agricultural land, particularly the wide flat lower river valley floors, which were prime zones for rice planting. In the Shijiahe period, population spread to larger new regions. Stone *yue* 钺 and jade artifacts in burials are often cited as evidence of social complexity.

The Shang period, shows a large area of the Jianghan Plain had almost entirely without population. The reasons for this population drop are a subject of controversy. One popular explanation is that the social trajectories towards state formation in the middle Yangtze River were interrupted by the intrusion of Xia and Shang peoples from the Central Plain. Some archaeologists even date this intrusion from the late of Shijiahe period and name a post-Shijiahe period (Meng 1997). Archaeological excavation demonstrates that the Xia pottery style has been found in the heart of the Jianghan Plain and replaced the once widely distributed Shijiahe pottery (Jingzhou 1989). Panlongcheng and Jingnansi have been interpreted as Shang colonies from the Central Plain for controlling copper mining and transportation. From the late Shang period, more local patterns suggest a retreat of the Shang (Zhang 2006). In the Taojiahu-Xiaocheng region, the complete abandonment of the southern survey zone and near-complete abandonment of the north can be seen as a response to unprecedented flooding, as discussed in Chapter 3.

In the late Western Zhou period, the Jianghan Plain was the territory of the Chu state. According to *Zhanguoce* 战国策, the Chu state had an army of more one million soldiers. This is probably an exaggeration, but it is nevertheless clear that the Chu state controlled a large territory and its population. In the Taojiahu-Xiaocheng survey area, regional population reached its maximum in the Eastern Zhou period, reflecting general population growth under the Chu state. From Han to Wei-Jin times, the Jianghan Plain as a whole had clearly been incorporated into interaction with the Central Plain. The artifacts from the survey show strong similarities with the Central Plain. According to *Houhanshu* 后汉书 (Fan 2000), by the end of the Eastern Han period, frequent warfare in the Central Plain drove large populations to migrate from northern China to southern China and settle along the Yangtze River Valley. Such a migration would have contributed to population growth in the middle Yangtze River Valley. The estimated population in the Jiangxia region including 14 counties (mainly covering the heart of Jianghan Plain) is reported at about 265,000 people. In the Wei-Jin period, in the Taojiahu-Xiaocheng region, according *to Songshu* 宋书 (Shen 1974), the population in six counties of the Jingling region, including Xiaocheng County, was about 45,000 inhabitants. This puts the average county population at about 7500 inhabitants. This number falls right in the estimated range of 6500-13,000 people for the Taojiahu-Xiaocheng region, which may be about the size of a county.

5.4.2 Walled towns in the Central Plain

The Central Plain has attracted tremendous attention to the origins of the earliest state of ancient China. Numerous excavations and surveys have been conducted by generations of archaeologists to document this history. These studies include some full-coverage regional surveys which provide opportunities for systematic comparative study among regions.

Liu (1996, 2004) has reconstructed the settlement patterns and social trajectories of the Yiluo Basin around the Erlitou site in Henan Province based on a systematic survey. She suggests that from the late Yangshao period (3500-2900 BCE), social conflict evidenced by the emergence of walled centers was partially triggered by population movement from adjacent regions (Dawenkou and Qujialing). In the Longshan period (2900-1900 BCE), intense social interaction among different ethnic groups eventually led to inter-polity conflict. The emergence and proliferation of two-tiered settlement hierarchies consisting of walled centers with relatively small territories was the result of this process. The polity centered on the well-known Taosi walled town is identified with three levels of settlement hierarchy. The satellite settlements are seen as politically and economically dominated by Taosi, the largest of them. In the Erlitou period (1900-1600 BCE), the function of walled towns was greatly strengthened. The numerous polities were reduced to two major competing forces represented by the Xia and Shang with their allied polities. This transformation was accelerated by intra-regional conflict and inter-regional competition. The emergence of the walled Erlitou site at the head of a four-tiered settlement hierarchy is taken to indicate the emergence of the first state in China (Liu et al. 2004).

In the southern part of the Central Plain, the Huangtucheng systematic regional survey was carried out in the middle Huai River Valley in Henan Province. Beginning with the Yangshao period, settlement underwent a steady increase in the survey region through the Neolithic period. In late Yangshao, a settlement hierarchy emerged with large regional centers controlling nearby smaller communities. Ren (2008) identifies this as the formation of a three-tiered settlement hierarchy. In the Longshan period, the three tiers of settlement hierarchy became more apparent. In the Erlitou period, a sharp decrease in the number and density of sites in the Huangtucheng area might indicate impact from the Erlitou political economy. In the Shang period, population slowly recovered in general, but settlement centers and locations might have shifted to nearby capitals. In the Han period, the number of settlements increased greatly, with small and large centers across the entire survey region. Through the Neolithic period, population concentrated near streams, but from the early Bronze Age it shifted inland due to the improvement of plowing technology (Ren 2008).

In the Yuncheng basin, people concentrated into large settlements in the early Yangshao period (5000-4100 BCE). At least two central villages had populations exceeding 1000 inhabitants. Smaller settlements clustered around these big villages, suggesting supra-local centripetal forces from the central villages. Religious and ritual activities might have been a major element in these centripetal forces. The middle Yangshao period saw even larger-scale population concentration in the Yuncheng basin. The population of the largest community exceeded 10,000 inhabitants, possibly pulled together by strong political administration. In the late Yangshao period (3500-2900 BCE), population of these large local communities decreased dramatically, except for the largest. Population in this period seems more widely scattered with communities ranging from the low hundreds to 10,000. During the Miaodigou II period, the number of local communities delineated in the Yuncheng basin had substantially increased. The landscape was more fully filled with settlements, and the size of the largest local community declined. More supra-local districts were also delineated. Compared to the previous periods, internal demographic centralization was less strong and regional interaction was not clear, possibly reflecting competition between districts. In the Longshan period (2400-1900 BCE), population surged to its highest levels. Zhoujiazhuang, the largest community, grew to 15,000-25,000 inhabitants and a possible defensive trench enclosing some 200 ha was dug. The supra-local community centered on Zhoujiazhuang included the entire Yuncheng basin survey area and more. Some 40,000 inhabitants can be estimated for the portion of its territory within the survey area. In the Erlitou period (1900-1600 BCE), the Zhoujiazhuang regional polity disintegrated into two or more parts, and regional population declined sharply. Even the former central community of Zhoujiazhuang split into several separate local communities. The same trends continued in Erligang times (1600-1300 BCE); the largest settlement had about 2000 inhabitants and the Yuncheng basin might have been incorporated into the Shang dynasty state (Drennan and Dai 2010).

5.4.3 Walled towns in Eastern China

In eastern China, a full-coverage systematic survey of the Rizhao region in Shandong Province (Underhill et al. 1998, 2002, 2008) can be compared to the Jianghan Plain. In Rizhao sedentary settlements appeared from Beixin times (5300-4100 BCE) and increased in size and number during the late Dawenkou period (3000-2600 BCE). In the Longshan period, regional population reached some 60,000. From early Longshan, two very large settlements (Liangchengzhen and Yaowangcheng) developed and began competing for resources. The largest, Liangchengzhen, had a population of 7200-14,400 inhabitants, and enclosing walls were built. The second largest, Yaowangcheng initially had only about one-fourth the population of Liangchengzhen (Underhill et al. 1998, 2002 and 2008; Zhongmei 1997), but in late Longshan, Yaowangcheng grew past Liangchengzhen to become the largest community in the Rizhao region. Both Liangchengzhen and Yaowangcheng are identified as heading supra-local communities with four tiered settlement hierarchies, which is used to suggest that state level societies emerged in the late Longshan period. Some have suggested that the emergence of state-like societies in eastern Shandong was response to neighboring states to the west in the Central Plain. During the Bronze Age, the settlement hierarchy and population size decreased, but the Rizhao region probably remained politically independent until the end of the Eastern Zhou period. In the Han period, the Rizhao region seems under the control of powerful government from the Central Plain.

5.4.4 Walled towns in Northeastern China

In northeastern China, full-coverage regional survey in the Chifeng region can be compared systematically to the Taojiahu-Xiaocheng region. In the Xinglongwa period (6000-5250 BCE), scattered local communities were found in the Chifeng region. In the Zhaobaogou period (5250-4500 BCE), population density stayed low with only a few local communities. Supra-local communities appeared in the Hongshan period (4500-3000 BCE), attributed largely to the centripetal forces of religious and ritual interaction centered in some larger villages. These villages, however, were still quite small, numbering only in the low hundreds of inhabitants. Lower Xiajiadian (2000-1200 BCE) population showed a sharp increase to a level nearly 20 times higher than in any previous period. The largest settlements had fewer than 5000 inhabitants. A stalemate of hostile competition between districts is seen in multiple very compact heavily fortified hilltop settlements.

5.4.5 Comparative conclusions

A systematic comparative study on a large scale would contribute to a greater understanding of social trajectories in different parts of China. Making such comparisons requires considerable attention to the comparability of the methods of collecting data in the field and then analyzing the data as well. A comparative study of the Chifeng region and the Yuncheng Basin (Drennan and Dai 2010) provides an example of a comparative study of settlement change through time, with detailed attention to demography and social dynamics based on a careful consideration of how different field and analytical methods could affect the comparison. Estimation of population and its spatial distribution is fundamental for understanding human social organization, particularly for large scale comparative study of social trajectories. Number of sites, area of sites, and density of surface materials are all field observations that contribute to making local and regional scale population estimates as accurate as possible.

Comparison of systematic full-coverage settlement survey results from different regions leads to several conclusions about the varied nature in different regions of walled towns, the assumed defensive functions of their walls, the societies and polities they existed in, and the developmental trajectories of those societies.

The fortified Lower Xiajiadian settlements in Chifeng were very different from the early walled towns of the Yellow and Yangtze River Basins. With populations of a few thousand inhabitants, packed tightly into areas usually much less than 10 ha, their fortifications would have been much more practical to defend than the expansive walled towns of the Yellow and Yangtze rivers. The Yellow and Yangtze River town walls often enclosed huge areas ranging into the hundreds of hectares. Even considering the larger populations of the Yellow and Yangtze River towns, the expansiveness of their walls would seem to undermine the practicality of their defense (Drennan and Dai 2010). In many cases, substantial areas within the walls were not even occupied by their residents, as indicated by large gaps in sherd distributions. It is these large unoccupied areas that seem impractical from the point of view of defense. These areas not only increase the labor required for construction of longer stretches of wall, but also they spread defenders out much more thinly along thousands of meters of wall that must be defended.

Whatever the nature of the defensive function of the walls of Yellow and Yangtze River walled towns, it suggests that the nature of military conflict was not the same as that in the Chifeng region in Lower Xiajiadian times. It also raises the question of how important were straightforward practical defensive considerations in the construction of walls around very early towns in the Yellow and Yangtze River basins. Arriving at such observations is only possible when field observations of early walled towns include not just mapping out the walls but also rigorous and systematic attention to sherd distributions both within and around them and how these distributions change through time.

Compared to walled towns of other regions, Taojiahu and Xiaocheng are striking because they had almost no hinterland population at all. Unlike the settlement pattern shifts seen in other Yellow and Yangtze Valley regions, these two very early walled towns grew *in situ*, not by drawing in rural farmers who had previously lived in a periphery. Instead, they started as small concentrated settlements predating the construction of walls. These very early small communities then expanded in both population size and settlement size. Even after they had become large walled towns, Taojiahu and Xiaocheng are not associated with the kinds of regional settlement hierarchies described around early walled towns from the Central Plain and eastern China. The Taojiahu-Xiaocheng survey area does not show any sign of the settlement hierarchy of three or four levels that has occupied much attention in the study of early complex society settlement patterns. The ring-like character of Shijiahe sherd distribution around Taojiahu might be taken for such a hierarchy, but a careful examination of population estimates shows that the hinterland communities were so tiny compared to Taojiahu itself that no meaningful settlement hierarchy is indicated.

The highly concentrated populations of the Taojiahu and Xiaocheng towns, then, were practically the entire regional populations of the northern and southern survey zones. The town populations clearly included even the vast majority of the farmers who raised the food to sustain the region. These two especially early concentrated walled towns would have provided an excellent environment to encourage rapidly increasing economic interdependence among households because the large number of people living very close together would greatly facilitate the intensive interaction that real economic interdependence requires. The conspicuous indications of the economic functions of Taojiahu and Xiaocheng in the regional survey analysis are consistent with this idea. It may have been only in later walled towns farther north in the Yellow River Valley that such economic interdependence, combined with strong political administration, expanded spatially around places like Erlitou, Zhoujiazhuang, Liangchengzhen, and Yaowangcheng to become truly regional in scope with settlement hierarchies reflecting regional political administrative hierarchies.

In addition to the very early development of walled towns in the Jianghan Plain, their abandonment after the Shijiahe period raises equally interesting anthropological questions. For example, what did cause the sharp decrease of site numbers and population during Erlitou and Erligang times in the Jianghan Plain? If it was the result of flooding or warfare, then where did people moved to from the Taojiahu-Xiaocheng survey area? It has been suggested that the Jianghan Plain was governed by the Xia and Shang centered in the Central Plain (Li 1997), but Erlitou (Xia) and Erligang (Shang) remains are extremely scarce in the Jianghan Plain, except at a few locations such as Panlongcheng and Jingnansi, which have been interpreted specifically as colonies. More important, a considerable portion of excavated artifacts demonstrate unique local styles (Zhang 2006). Who do these local artifact styles represent? Too much attention to interaction with the Central Plain in comparative studies of artifact styles has distracted attention away from settlement and demographic research on the people who lived in the Jianghan Plain. Such research is essential for understanding social dynamics and answering anthropological questions. For example, in the Taojiahu-Xiaocheng area, little was known about population distribution during these historical periods before the survey. For Zhou, Han and Wei-Jin periods, even most archaeological research has mainly focused on capitals, elite tombs, or especially finely-worked artifacts, thereby emphasizing the same things dealt with by the documents rather than complementing the documents by answering anthropological questions about local social dynamics and settlement patterns. The Taojiahu-Xiaocheng regional survey and population analysis has begun to provide kinds of information about settlement changes and social dynamics which is not thoroughly recorded in historical documents. Still more micro-scale investigation of household interaction within communities would also be helpful.

APPENDIX. ELECTRONIC ACCESS TO DATASETS AND IMAGES

The data collected by this research is available online in the University of Pittsburgh Comparative Archaeology Database. The intent is that this data can be used for comparative purposes. To give the public greatest ease of access, simple file formats and small files are used. The database of collection lots and sherd collections is available as tabular data. The settlement maps are organized by period and are available as AutoCAD DXF files.

The University of Pittsburgh Comparative Archaeology Database is available online at:

http://www**.cadb.pitt.edu/**

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