Provisioning a Pilgrimage Center:
Land Use and Settlement Patterns in Niuheliang, Liaoning, China

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Hsi-Wen Chen

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This dissertation was presented

by

Hsi-Wen Chen

It was defended on

February 17, 2023

and approved by

Marc Bermann, Associate Professor, Department of Anthropology, University of Pittsburgh

Elizabeth Arkush, Professor, Department of Anthropology, University of Pittsburgh

Christian E. Peterson, Professor, Department of Anthropology, University of Hawaiʻi at Mānoa

Ruth Mostern, Professor, Department of History, University of Pittsburgh

Dissertation Director: Robert D. Drennan, Distinguished Professor Emeritus, Department of Anthropology, University of Pittsburgh

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Hsi-Wen Chen, PhD

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The remarkable concentration of ceremonial facilities combined with evidence of a decent occupation at Niuheliang, a Hongshan-period ceremonial complex, indicates its special role as a pilgrimage center in the macro-regional integration that had characterized ancient societies in northeastern China from around 4500 to 3000 BCE. Even if this conceptualization of Niuheliang is consistent with the widely acknowledged notion that Hongshan socio-political organization at all scales was based on religion and ritual, this system had to be supported by a subsistence economy working to feed a growing population. The mountainous landscape surrounding Niuheliang would have posed a problem for its residents, a decent portion of whom were non-farming ritual specialists, to sustain themselves on the unpromising lands around the pilgrimage center.

This study investigates patterns of settlement distribution through time in relation to agricultural strategies in Chifeng, the Upper Daling Valley, and Niuheliang, three systematically surveyed areas in the Western Liao Valley, with special attention given to Hongshan times. Results of settlement analysis show that the normal Hongshan human-land relationship was seriously altered at and nearby the pilgrimage center as a result of the need to provision the residents and visitors there. In Chifeng and the Upper Daling Valley, Hongshan people took risk management into serious consideration when choosing where to live. In Niuheliang, on the other hand, proximity to the pilgrimage center was an important factor in deciding settlement location as the

transportation of food on a regular basis depended heavily on distance. An attempt to estimate Hongshan absolute agricultural production also strongly suggests a provisioning relationship between the pilgrimage center and the main provisioning community located to the southwest, but not far from it.

In addition to providing empirical support to the model of Hongshan macro-regional integration, this study also explores how settlement patterns in relation to agricultural strategies changed through time along with fluctuating population levels and climatic conditions. Systematic settlement analyses reveal an incredible degree of inter-regional variability in how social dynamics developed in idiosyncratic yet sensible ways and produced unique patterns of settlement distribution, which encourages a comparative approach for those pondering questions of social change.

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1.0 Interests, Aims, and Strategies

1.1 Early Social Complexity in Northeastern China

Hongshan societies (4500 to 3000 BCE) were the first to witness a dramatic increase in population since food production and a sedentary way of living were embraced some 9,000 years ago in the northeastern part of modern China (Figure 1.1) (Guo 1995). The earliest evidence of political integration at a regional level, leadership with some degree of authority, and institutionalized social inequality immediately put Hongshan societies among early complex societies that were often inclusively labelled chiefdoms (Chifeng International Collaborative Archaeological Research Project 2011a; Linduff, Drennan, and Shelach 2004; Peterson et al. 2014a). Such chiefdom societies have been documented emerging repeatedly and independently in many parts of the world, and scholars are increasingly aware that they are highly variable in terms of the societal form they took, the developmental trajectory they underwent, and the socio-ecological conditions under which they rose, prospered, and receded (Clark and Blake 1994; Drennan, Peterson, and Fox 2010; Earle 1997; Feinman and Neitzel 1984; Spencer 1993). This formational variation under the broad category of chiefdom has attracted attention of many archaeologists concerned with social change, and a comparative approach is required in search of more generalized explanations for why and how these early complex societies emerged when and where they did, and for why and how some developmental trajectories resemble each other quite strongly while others are significantly different from that (Drennan and Peterson 2005; Peterson, Drennan, and Bartel 2016). The comparative approach emphasizes the search for what social forces were at work shaping early complex societies and giving them the characteristics that they had, and what others were not. This study shares the same ambition and investigates which combination of some forces, but clearly not others, was at work facilitating the development of Hongshan societies along the lines in which it unfolded.

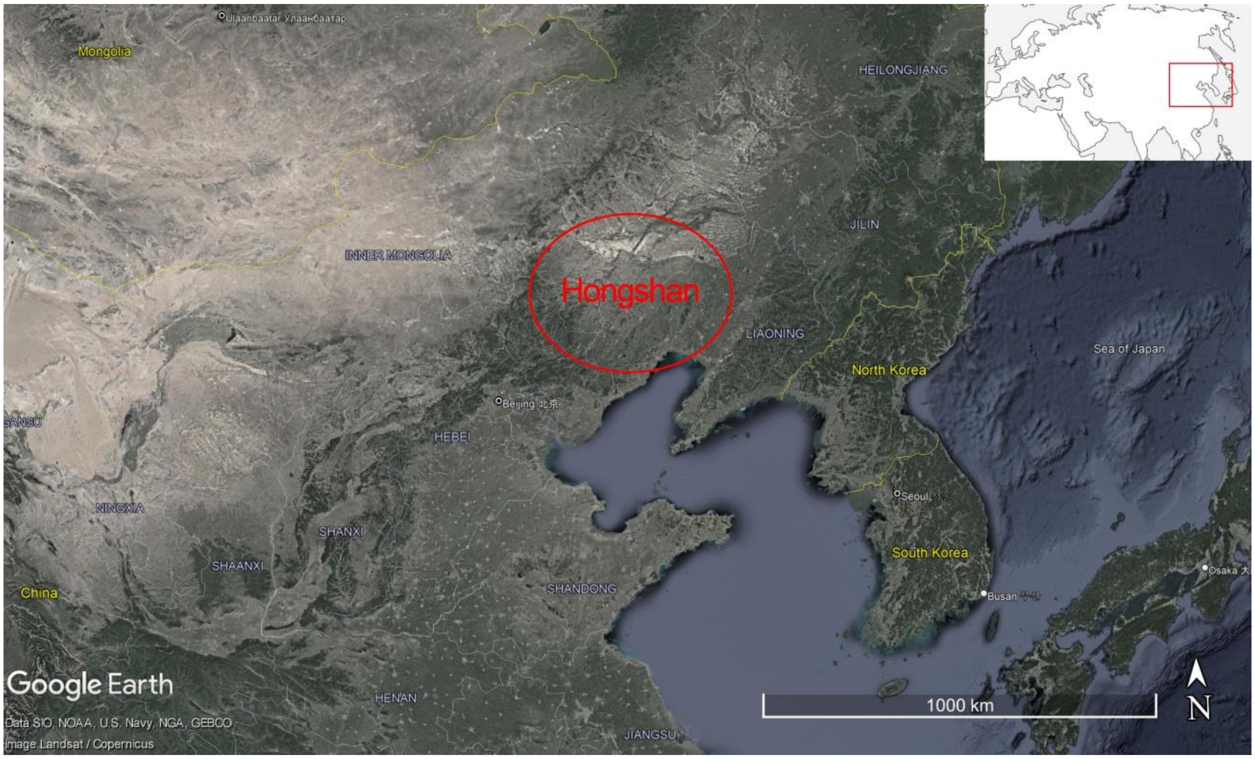

Figure 1.1 Area of the Hongshan archaeological culture (Google Earth).

1.2 Hongshan Socio-political Organization

Local Communities

The scale and nature of Hongshan local communities are known from the excavated site of Baiyinchanghan in the city of Chifeng (Neimenggu Zizhiqu Institute of Cultural Relics and Archaeology 2004). Composed of seventeen visible structures with associated storage pits, rectangular graves, and other features scattered across 4.5 ha, Baiyinchanghan represents a typical Hongshan village that was relatively small and dispersed by global comparative standards. On a larger scale, systematic regional surveys have been carried out in Chifeng and the Upper Daling Valley to document human occupation during Hongshan times based on the distribution of ceramic sherds visible on the ground surface (Figure 1.2) (Chifeng International Collaborative Archaeological Research Project 2011a; Peterson et al. 2014a). Demographic reconstruction in the Upper Daling survey area that covers about 200 sq km reveals that about 87% of Hongshan local communities had a population estimated at fewer than 5-10 inhabitants and would thus be thought of as scattered hamlets and farmsteads, instead of villages like Baiyinchanghan that harbored around 50-100 inhabitants. In addition, eight villages were identified within the survey area, and each had an estimated population similar to or larger than that of Baiyinchanghan, ranging from more than 30-60 to up to 250-500 inhabitants. While villages were few in number, about 75% of the population in the Upper Daling Valley was living in them. A village way of life was therefore the most common pattern for Hongshan people despite the presence of many hamlets and farmsteads, which consisted of perhaps only one or two households. Results from the Chifeng survey, which covers an area of about 1,234 sq km, have shown similar patterns. Most of other known Hongshan settlements generally fit this description except for a few unusual sites, such as Weijiawopu, which are somewhat larger and have higher residential densities than regular Hongshan villages (Cheng et al. 2014).

Figure 1.2 Locations of the three surveys mentioned in the texts (Google Earth).

Supra-local Communities

Spatial clustering of multiple local villages into regional supra-local communities is widely used to infer the presence of a form of political integration among them in the archaeological literature (Alden 1979; Stoner 2012; Wilson 1988). These entities of a higher order are frequently referred to as regional polities, or districts, for their formation requires a social transformation that allows the new social units to functionally incorporate a larger number of people across a wider area. Systematic settlement studies carried out in the Hongshan archaeological culture area around Chifeng and in the Upper Daling Valley have discovered that Hongshan societies were composed of numerous such polities that were spread through a macro-region stretching across several hundred kilometers (Peterson et al. 2010). The concentration of occupation within a Hongshan regional polity separated by more sparsely settled areas between them implies a pattern of human interaction that was more intense and focused within each polity than between them, which, combined with the observation that these polities were all about the same spatial and demographic size, has led scholars to refer to Hongshan regional polities as autonomous, without any obviously dominating others (Peterson and Drennan 2005).

Typical Hongshan regional polities consisted of a few hundred to up to around a thousand people in an area usually less than 5-10 km across. Within each regional polity, there was a tendency for residential distribution to be centralized around constructions of ceremonial function, though to varying degrees. Meanwhile, in Hongshan residential zones of Dongshanzui, Sanjia, and Erbuchi, individual households possessing more prestige items were found located generally closer to constructions of ritual significance (Drennan et al. 2017). These patterns of residential distribution have been taken to indicate that each of numerous autonomous Hongshan regional polities of more or less similar size was integrated primarily through religious belief and ceremonial activities, with which social prestige and a form of leadership were likely associated. Moreover, social inequality in Hongshan societies was most notable in differential mortuary treatment in which people of high prestige were buried in association with centrally located ritual constructions and interred with carved jades of supernatural themes, while those of lower rank were accompanied by a few utilitarian artifacts at best. On the other hand, analysis of household artifact assemblages from Hongshan residential zones detected very little to no differentiation between households in terms of wealth and only modest differentiation in terms of prestige and production (Drennan et al. 2017). Although prestige and productive differentiation were recognizably stronger in the "core zone" of the Hongshan world, where remains of substantial Hongshan public construction occurred more frequently, than in the "periphery," they were not nearly as conspicuous as the ritual differentiation shown in mortuary treatment. Ritual, in this regard, was arguably the single most important centripetal force that drew Hongshan people together into regional polities. At the same time, religious belief and ceremonial activities were not only principal organizing elements but also the axis of social ranking for households within Hongshan polities.

1.3 Niuheliang and Hongshan Macro-regional Integration

At a much larger scale, a set of Hongshan traits was unmistakably shared among the Hongshan archaeological culture area, including similar artifact and architectural characteristics, burial practices, community organization, and religious beliefs. Ceramic vessels were made and decorated in the same way. Human figurines of the same theme and distinctive bottomless painted pottery cylinders (tongxingqi) were found incorporated into ceremonial architecture in many Hongshan sites. Each of numerous regional polities of similar size and scale was internally integrated primarily through religious belief and ritual activities, on which social prestige and leadership were based. People all across the Hongshan world were clearly in close interaction so as to share such pronounced similarities in material culture and socio-political organization. A certain degree of communication and connection must also have existed among autonomous Hongshan regional polities that were often only a few kilometers away from one another yet spread across hundreds of thousands of square kilometers. Many scholars have been inspired and attempted to characterize the interaction and communication among Hongshan people and polities. Also, many of these accounts implicitly or explicitly proposed explanations for how the interaction and communication could have facilitated the sharing of similar material culture and socio-political organization.

Figure 1.3 Examples of top-tier Hongshan monuments at Niuheliang (Liaoning Province Institute of Cultural Relics and Archaeology 2012).

Niuheliang Ceremonial Complex

This brings our attention to Niuheliang, a site complex known for its extraordinary concentration of Hongshan constructions of ceremonial significance within a hilly area of a few tens of sq km between the cities of Lingyuan and Jianping in the Province of Liaoning (Figure 1.3) (Liaoning Province Institute of Cultural Relics and Archaeology 2012). Hongshan monuments here either took unique forms or were better constructed than those elsewhere, and at least twenty-four localities with top-tier ceremonial facilities have been found, including the "Goddess Temple" at Locality 1, named after a life-sized, seated female figure made of clay and with inlaid jade eyes found within the semi-subterranean structure along with abundant burned clay, animal bones, and fragments of clay figures of winged animals. Built exclusively of daub and wood, but no stone, the Goddess Temple contains two separate rooms and a pathway leading to a large artificially levelled open area around which the slopes were transformed into tiered platforms running up the hill. This open area could have accommodated a few hundred people and presumably served as a locus for public ceremonies. Also unique is a conical mound of earth and stone, 7-m-tall, built on a three-tiered foundation measuring some 100 m on each side at Locality 13. This mound was unusual not only for its scale and the large amount of labor investment it represented, but also for its uncommon isolation from any evidence of residential occupation. Many of the platforms at Niuheliang contain one or more well-built tiered-stone burial chambers in which a few carved jades or shell ornaments were found with the interred. The platform at Locality 16, for example, was situated on the top of a small hill and measured 80 by 100 m. Associated with this platform were some fifteen burial chambers in which carved jades of natural and supernatural themes were recovered in abundance, including a human figurine measuring 18.5 cm in height, three dragon figurines, many cloud-shaped pieces, and several jade animals, including bird, tortoise, and bear. At some locations there is evidence of continuous use and investment of time and effort into the maintenance and preservation of platforms (Liaoning Province Institute of Cultural Relics and Archaeology and Renmin University of China School of History 2015; Lu and Zhu 2002). In addition to burial chambers, numerous tongxingqi, often large, and highly decorated, were also frequently present around monuments and thought to have ritual significance. They were more abundant in the Niuheliang area than elsewhere.

Overall, these monuments are generally believed to be the loci of substantial ceremonial activities. The interment of important people might have been a focus of such ceremonies and ancestor worship has frequently been envisioned as the main theme of Hongshan religious belief (Lee and Zhu 2002). While some of the basic forms of ritual constructions in Niuheliang were similar to those built in typical Hongshan regional polities, these structures in Niuheliang were notably larger and more elaborate, and some of them were even unique as described above. Based on the unusual concentration of monuments in Niuheliang and the general agreement that ritual was the major centripetal social force bringing Hongshan people together, Niuheliang has long been the focus of research looking to understand what special roles it might have played in promoting Hongshan macro-regional integration (Nelson 1991).

Vacant Ceremonial Center?

The unusual scale and concentration of monuments of ritual and mortuary functions, with seemingly little sign of residential use and associated occupation, have led some authors to view Niuheliang as a vacant ceremonial center built and used by people who did not live nearby (Lee and Zhu 2002; Liaoning Province Institute of Cultural Relics and Archaeology 1997). It was suggested, for example, that the ceremonial structures in Niuheliang were carefully set apart from residential sites, perhaps to emphasize the sacredness of the local landscape (Barnes and Guo 1996). Such a separation of ritual and residential areas has even been proposed as a general characteristic of Hongshan settlement patterns, with ritual structures isolated in the low hills, while residential settlements mostly appeared in river valleys and other agriculturally favorable locations (Li 2004; Zhang, Bevan, and Guo 2013). Recent systematic regional surveys, however, have shown not only that the numerous Hongshan platforms in places like Chifeng and the Upper Daling Valley were often built right in the largest village of a small regional polity, but also that there was residential occupation all around and between the ceremonial structures at Niuheliang (Chifeng International Collaborative Archaeological Research Project 2011a; Drennan, Lu, and Peterson 2017; Liaoning Province Institute of Cultural Relics and Archaeology and Renmin University of China School of History 2015; Peterson et al. 2014a). The population around the Niuheliang ceremonial center, based on the area and density of visible scattering of surface ceramic sherds, is estimated at 350-700 people. Around 75% of Niuheliang population lived in ten small, dispersed villages, while the others were widely scattered in tiny hamlets and farmsteads, a pattern resembling that in both Chifeng and the Upper Daling Valley. Although not particularly large in scale, there were unmistakably local, probably permanent, residents present in Niuheliang, forcing us to reject the notion of Niuheliang as a vacant ceremonial center.

Capital of a State?

The peculiar combination of abundant top-tier ritual constructions and associated population has also led to another suggestion that Niuheliang could have been the administrative capital of a "Hongshan State" transcending numerous ordinary regional polities (Liu 2010; Xu, Zhao, and Xie 2015). Elaborate burials and a large quantity of tongxingqi associated with them suggested for some a highly stratified social hierarchy of at least three tiers and the presence of a full-time craftsmen class, two often cited characteristics of early state-level societies. Carved jades of supernatural themes represented symbols of great power and authority, and female figurines signified a matriarchal clan structure, which was also perceived as a unique signature of incipient civilization. The scale of the ritual constructions in Niuheliang was taken to be too large to be built by and serve only one or two clan-based tribes, and the sophisticated layout of them was argued to have been carefully planned by specialized architects, who were also responsible for the unprecedented combination of altars, temples, and cairns built into religious facilities (Guo 1995). It was argued that the series of unparalleled architecture and artifacts could only be achieved through a state-level socio-political integration founded on centralized ancestor worship (Nelson 1996; 1997). Niuheliang thus seemed to represent a political capital of the highest level and testified to the emergence of a sophisticated administration underlying the communications and interactions among numerous Hongshan regional subsidiary districts.

The settlement evidence, however, has shown that Niuheliang was clearly not a political capital that politically dominated all the other Hongshan small regional polities (Drennan, Lu, and Peterson 2017; Liaoning Province Institute of Cultural Relics and Archaeology and Renmin University of China School of History 2015). The largest local village at Niuheliang, with a population estimated at no more than 100 inhabitants, was far smaller than villages of 500 or more in the Chifeng and Upper Daling survey areas. If the entire Niuheliang survey area to this point was viewed as one single regional polity, it would have an estimated population of 350-700 people in an area of 42.5 sq km, a normal size for a Hongshan regional polity, which ranged from a few hundred to very few thousands of people in between 20 and 60 sq km. Niuheliang's demographic profile contrasts sharply with what one might envision for an administrative capital of a large territory. In addition to the critical demographic evidence against the political capital idea, public facilities in Niuheliang, while more densely distributed and more elaborately built, were not large enough to accommodate more people than those found in other regional polities, and none of them have the characteristics usually seen in buildings of political administrative function. The Goddess Temple at Locality 1, for example, had a rather restricted entrance and limited interior space, suggesting it was for a ritual experience restricted to a small number of people. The conical mound at Locality 13, while unique, was set apart from any residential area. It is thus difficult to imagine Niuheliang to be a state capital in which major political administrative activities took place. Moreover, the internal distribution of Niuheliang's population was also inconsistent with that of a political capital. In comparison with other Hongshan regional polities, the smaller population in Niuheliang was spread across an area more than twice as large as the largest documented Hongshan regional polity, District 2 in the Upper Daling Valley, indicating weaker internal centripetal forces working in Niuheliang than those that had created other Hongshan regional polities, a scenario, again, contrasting sharply with the idea of a state capital.

Pilgrimage Center?

The scale and distribution of residential occupation revealed by the systematic regional survey in Niuheliang, combined with its concentration of unusually large, elaborate, and well-constructed ceremonial monuments, has led to yet another suggestion. Niuheliang could have been a pilgrimage center toward which visitors, perhaps ritual elites in other regional polities, traveled from afar to participate in special ritual activities that only occurred here (Drennan, Lu, and Peterson 2017). Indeed, the similarities in material culture, religious beliefs, and local patterns of social, political, and economic organization could have been achieved by the degree of communication and steady interaction facilitated by the pilgrimage phenomenon in the absence of evidence for inter-regional political integration, military conquest, or any vigorous, well-developed economic exchange network.

Evidence found in Niuheliang did bear some resemblance to other places also viewed as pilgrimage destinations in other parts of the world. Take Cahuachi near the south coast Peru for example. A series of adobe pyramids, accompanied by plazas and numerous burial grounds, was built by modifying natural hills in order to inspire awe and admiration, and is thought to be different from how a residential tell grew (Silverman 1993; 1994). Material remains associated with these temple mounds show a predominance of artifacts of ritual significance, including caches of trophy heads, musical instruments, and non-utilitarian fine wares, indicating the ceremonial function of these structures with only a modest number of residents living in them. Furthermore, the excavation at Unit 19, presumably a temple mound, found storage vessels in which ritual paraphernalia were stored. Faunal and botanical remains also suggested that food was being brought to the site to be immediately consumed at communal feasts. Based on all this evidence, Cahuachi is frequently cited as a pilgrimage destination in the prehistoric Nazca world. Some characteristics of the prehistoric Pueblo groups who lived in Chaco Canyon during the 9th through 12th centuries also have implied a pilgrimage destination to some. Based on the contrast between a tentative population estimate of Chaco Canyon and the possible maximum occupation allowed by the residential facilities there, Chacoan great houses were suggested to have had the function of providing accommodation for periodic influxes of visitors, turquoise traders, or pilgrims in substantial numbers (Judge 1989; Windes 1984). Located in an agriculturally unfavorable environment, the biggest and oldest Chacoan great house, Pueblo Bonito, with its special layout, artifact assemblages, and associated road systems of a degree of ritual significance, was argued to have served as a ceremonial center throughout most of its use history (Neitzel 2003). Moreover, in a recent examination of early excavation reports of Pueblo Bonito, it was suggested that if strong social hierarchy had ever existed in Pueblo societies, it was one that was centered on religious authority, based on the extraordinary abundance of offerings in only a few burials (Cordell 1994; Plog and Heitman 2010). Niuheliang shared characteristics that have been recognized in these two and other pilgrimage centers (Kahn 2015). For many authors, the ceremonial constructions in Niuheliang, impressive in themselves, were built into a sacred landscape in a way that was intentionally designed to provoke transcendental senses when seen from afar (Barnes and Guo 1996; Li 2008; Zhang, Bevan, and Guo 2013). Carved jades of supernatural themes and tongxingqi that were abundant in Niuheliang were also religious in nature. Although direct evidence for non-local visitors is lacking, the monuments in Niuheliang were suggested to be too large in scale and too elaborate to have been built and used by only a few nearby communities (Guo 1995; Lee and Zhu 2002).

In addition to the physical material remains, their spatial distribution also provides support for the pilgrimage center idea (Drennan, Lu, and Peterson 2017). While being similar to other Hongshan regional polities in terms of demography and territory, Niuheliang harbored some twenty-four localities of ceremonial function. They represent about one for every 15-30 persons in Niuheliang, a figure that is twice larger than that in the Upper Daling Valley survey area and some 30 times larger than that in the Chifeng survey area. Tongxingqi comprised 12% of the Hongshan sherds collected in Niuheliang, 10% of those in the Upper Daling Valley and only 1% of those in Chifeng. Furthermore, the modest population of Niuheliang did not cluster around a central ritual area as was common in typical Hongshan regional polities, but was broadly scattered in very small local communities, some in direct association with Niuheliang's unusual ceremonial architecture, while others not. Moreover, despite being located in a zone of very low agricultural productivity, Niuheliang had a higher regional population density at 8-16 persons per sq km than the Upper Daling Valley at 4-8 persons per sq km or Chifeng at 2-4 persons per sq km (Drennan, Lu, and Peterson 2017).

These characteristics just mentioned above make it seem likely that Niuheliang functioned as a pilgrimage center which not only represented the earthly center of gravity of Hongshan cosmology, but also distributed rituality among Hongshan societies at a macro-regional scale. Ritual leaders of typical Hongshan regional polities may have enhanced their local status and authority by demonstrating their associations with the Niuheliang ceremonial complex, and only those few privileged local leaders had the opportunity to access the ritual experiences afforded by highest-tier facilities at Niuheliang. Through pilgrimages to Niuheliang, Hongshan cosmology, loaded with remarkable social significance, was shared and distributed to distant polities as far as a few hundred kilometers away. Not only was a form of political leadership maintained within Hongshan regional polities through an expressed connection to the common Hongshan cosmology, but the macro-regional relationships and functional interactions between them were made conceivable.

1.4 Subsistence Economy and Agricultural Strategies in Hongshan Times

Even if this model of Hongshan macro-regional integration is consistent with the observation that Hongshan socio-political organization at all scales was based on religion and ritual, this system had to be supported by a subsistence economy working to feed a fast-growing population, especially at the Niuheliang ceremonial complex. For its abundance in ceremonial facilities, a decent portion of the residents must have been non-farming ritual specialists and visitors whose broken pottery was also included in the demographic reconstruction. Moreover, it is even possible that not many residents there had been engaged in food production in any serious sense at all, because it was really a terrible place to farm. The significance of the Niuheliang ceremonial complex depended on the services it offered, and those real Hongshan people who provided and participated in these services had to consider the issue of food, too.

Information about Hongshan diet is available from studies of botanical remains, several of which indicated that domesticated plants, especially millet, had increased considerably in importance by Hongshan times, while wild resources were still being utilized as a supplementary source of food. For example, a residue analysis of starch grains discovered on the inner surfaces of pottery from the Weijiawopu site suggests intentional storage of plant seeds in a Hongshan residential settlement, and millet comprised almost half of recognizable botanical remains (Wang et al. 2017). A diachronic morphological analysis of millet starch grains further indicates that the process of millet domestication in the Western Liao Valley began as early as in the early Neolithic Xinglongwa period and likely continued up to Hongshan times (Ma et al. 2016). Moreover, an isotopic analysis on human bones proposed that millet consumption constituted a significant part of human diet by the early Neolithic in the Chifeng region (Liu et al. 2012). All this and other evidence indicate that, even though a fully sedentary settlement dependent to a large extent on domesticated species was probably still coming into being in very early Hongshan times, millet-focused agriculture has fairly soon become more important than ever before among the subsistence resources Hongshan people used.

The geographical and climatic contexts in which millet-focused agriculture was practiced by Hongshan people afford certain possibilities of subsistence economic organization. In the Western Liao Valley, the impression of lower productive potential and higher level of agricultural risk than those in the Central Plains was among the first observations that inspired the interest in conducting comparative studies in this area (Linduff and Ta 2011). In the Central Plains, the agricultural abundance and stable production has been associated by many scholars, including Liu (1996), with the emergence of complex chiefdoms that ended up developing into state-level societies. Inhabitants of the Western Liao Valley, on the other hand, were faced with cooler and drier environments and the possibility of marginal agricultural production with fluctuations in climatic conditions as well as unpredictable inter-annual variation in precipitation, which encouraged very different farming dynamics than those in the Central Plains as well as elsewhere (Drennan, Peterson, and Berrey 2020). For Hongshan as well as modern farmers in the Western Liao Valley, flat alluvial stream floodplains are fertile, well-watered, and will therefore make ideal places for millet cultivation (Figure 1.4). However, crops grown on lower valley floors are at risk of flooding because these lands lie only slightly above the small streams. The narrow linear floodplains of the small streams quickly meet the rolling uplands with a sharp elevation change of 5-10 m. These elevated lands are naturally protected from flooding and also quite fertile, but crops grown there are at risk of droughts because precipitation is the only source of water for millet cultivation. Further away from the valley floor, patches of steep, stony hills and mountains replace the uplands and would be the least desirable farmlands because of their little agricultural utility.

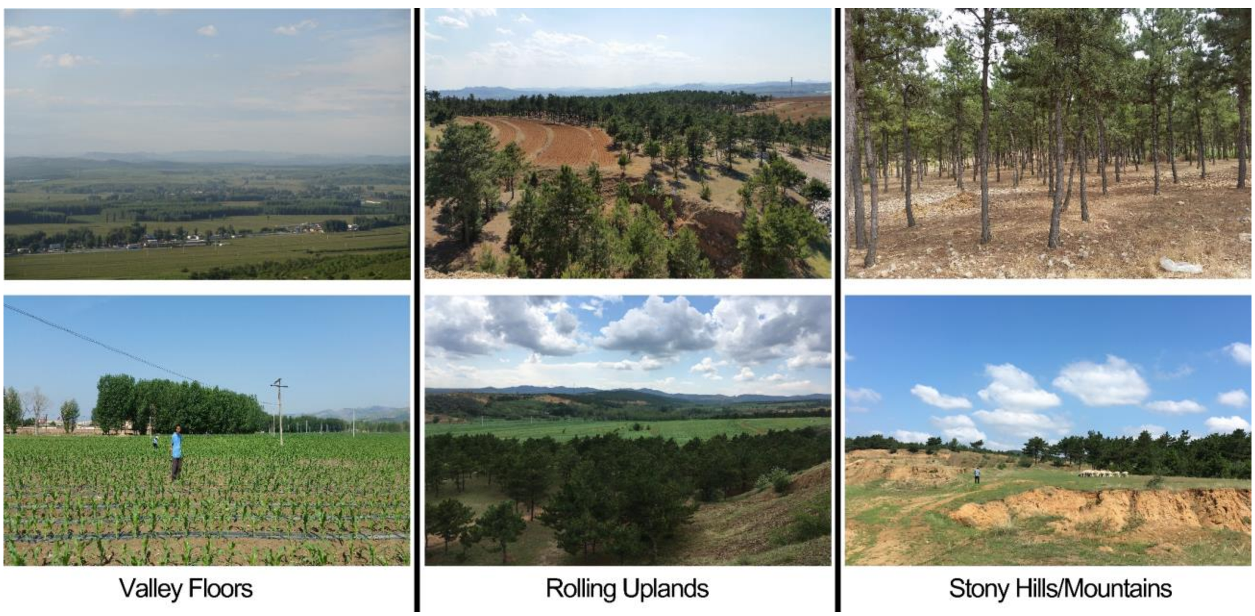

Figure 1.4 Three zones for agriculture in the Western Liao Valley.

This pattern of risk to agricultural production in the Western Liao Valley is largely associated with unpredictable inter-annual variation in precipitation. Generally shorter frost-free periods than those in the Central Plains highlight the necessity to prepare for the possibilities of flooding and droughts. Failure to do so could lead to catastrophic consequences, particularly in the winters of northeastern China. Today levees have been built along streams and reservoirs constructed as flood protection, and there are some efforts at irrigation of the uplands to mitigate the impact of droughts, but Hongshan farmers had to make do without modern technology. One possible strategy to mitigate the dual risk of floods and drought as a result of unpredictable inter-annual variation in precipitation was for each household to simply cultivate crops in both the floodplains and the uplands (Drennan, Peterson, and Berrey 2020). In most years the yields in the valley floors are the best. But in some years with high precipitation, abundant crops there are destroyed by floods. These are precisely the years in which the upland plots are especially well supplied with rainfall and yield better to fill in the gap created by the lost valley floor crops. In a dry year, on the other hand, crops in the uplands would fail, but crops in the valley floor would have sufficient water and yield well without flooding to destroy them.

Inhabitants of the Western Liao Valley following this risk-buffering strategy would choose to live near the margins of the uplands where they would have easy access to both the valley floors and the uplands, both of which they farmed, and they would have little motive to form any cooperative relationship with others, as this strategy involves little interaction between households (Berrey, Drennan, and Peterson 2021; Drennan, Peterson, and Berrey 2020). As a comparison, the Central Plains offer an example of agricultural strategies that place more importance on cooperation between households. There, river valleys are much wider and form vast, gently rising floodplains that cover several tens of thousands sq km. They are extremely productive for rice and millet cultivation, but agricultural production is also subject to crop-destroying floods and drought as a result of unpredictable inter-annual variation in precipitation. However, the gradual changes in elevation do not provide a well-defined zone of transition between lower and higher lands to be utilized as a settlement location to hedge against the risk. The effort to manage the risk and ensure reliable agricultural production in the Central Plains is therefore not an individual household activity and requires cooperation between households. Probable cooperative efforts for Neolithic farmers to mitigate the risk include cultivating cooperatively on a larger scale to increase production for storage in preparation for bad years or for exchange with farmers living in zones with contrasting agricultural risks. Inhabitants of the Central Plans following this strategy would choose to live close to their neighbors, because, whatever cooperative subsistence economy organization they adopted, it would require much more interaction between households.

The environmental contrast between the Western Liao Valley and the Central Plains has led Drennan, Peterson, and Berrey (2020) to hypothesize distinct patterns of settlement distribution as a consequence of different risk-buffering strategies for Neolithic societies. Narrower river floodplains in the Western Liao Valley offer a well-defined ecotone between the valley floors and the uplands. Hongshan households concerned with buffering the risk would live on the bluffs at the edge of the flat valley floor so as to have easy access to farm plots in both zones. Since this ecotone along the edge of narrow river floors is linear rather than centralized, and Hongshan households would have little incentive to live near each other so as to facilitate cooperative relationships, the risk-buffering rationale in the Western Liao Valley would encourage dispersed local communities. On the other hand, wider, vast river floodplains in the Central Plains create a broad, ambiguous ecotone that was unable to be taken advantage of by Yangshao households concerned with buffering the risk. The alternative solution to form cooperative relationships with others entailed higher frequencies of inter-household interaction and would thus encourage larger and more densely packed local communities in the Central Plains. This discussion of Hongshan agriculture and risk-buffering rationale is based to a large extent on contemporary observation and plausibility, but there is some archaeological evidence in favor of it. It was found, for example, that Hongshan settlement in a portion of the Chifeng region shows the characteristics that would result from such a risk-buffering strategy: small hamlets and farmsteads scattered along the margin of the valley floor showed little tendency toward clustering (Chifeng International Collaborative Archaeological Research Project 2011a; 2011b). The reconstructed Hongshan settlement elsewhere generally fits this patten (Peterson et al. 2014a; 2014b).

1.5 Provisioning a Pilgrimage Center: Land Use and Settlement Patterns

Derived from the anthropological archaeology interest in early social complexity, the primary aim of this study is to explore how the Hongshan macro-regional integrative system, one that was mainly based on ritual, was supported and sustained by a subsistence economy working to feed a fast-growing population, especially in the Niuheliang pilgrimage center, where a decent portion of the residents were non-farming ritual specialists and visitors. The farming dynamics and the risk-buffering strategy in the Western Liao Valley as discussed in previous subsections express unambiguous settlement preferences for some zones over the others, which makes it possible for this study to pursue these ideas about how Hongshan subsistence systems were typically organized by systematically relating Hongshan settlement distribution to patterns of agricultural zones in Chifeng and the Upper Daling Valley. The presence and strength of settlement preferences in terms of agricultural productivity and the risk-buffering strategy will be examined comprehensively for Hongshan societies as well as for societies of other periods so as to allow diachronic comparisons to highlight the characteristics of typical Hongshan patterns of subsistence economy organization. If our understanding of Hongshan patterns of land use was accurate, a good correspondence should be observed between Hongshan settlement distribution and patterns of agricultural zones at the scale of individual farmsteads and hamlets, where decisions about settlement locations took place.

This study also utilizes a quadrat grid approach to explore patterns of settlement distribution without assumptions about farming dynamics and agricultural strategies in order to evaluate the presence and strength of other potential centrifugal and centripetal forces at work encouraging or discouraging settlement concentration, and whether settlement concentration, if present, had any recognizable zonal basis, in Hongshan as well as other times.

Then, the reconstruction of typical Hongshan subsistence economy organization will be brought to the special circumstances of Niuheliang where regional surveys over the past several years have found evidence of modest and likely permanent occupation. The knowledge obtained from Chifeng and the Upper Daling Valley about "normal" Hongshan patterns of land use will then be used to compare with that in the Niuheliang area in order to investigate how residents and potential pilgrims there were sustained on the unpromising agricultural lands at and around the Niuheliang ceremonial complex, and whether there were provisioning communities nearby, but in more agriculturally favorable locations.

The provisioning-a-pilgrimage-center idea (Drennan, Lu, and Peterson 2017) has gained some empirical support from studies of household artifact assemblages carried out in the Chifeng, Upper Daling, and Niuheliang regions. Data on 40 Hongshan households at Shangchaoyanggou, a site located a few kilometers from the Niuheliang ceremonial complex and in a zone that is more productive agriculturally, have suggested these households in potential provisioning zones were more involved in food producing as well as food processing activities than those at Dongshanzui, Sanjia, and Erbuchi (Ran 2022). Although Hongshan households at Fushanzhuang showed a similar level of involvement in food production, they were slightly more involved in food processing activities than those at Shangchaoyanggou, which would make good sense if a portion of foods produced at Shangchaoyanggou were processed elsewhere as the transportation of food between local communities was more frequent here. More importantly, Hongshan households at Shangchaoyanggou showed much less involvement in ritual activities than those at Dongshanzui, Sanjia, Erbuchi, and Fushanzhuang, likely because the Niuheliang ceremonial complex nearby served as the main provider of religious activities and offered social recognition and prestige for the residents of its provisioning communities. Households that were particularly engaged in food producing activities at Shangchaoyanggou were spatially clustered and used more decorated ceramics, a pattern not seen elsewhere that indicated a special group of households that differentiated themselves by their management of subsistence activities. Data on household artifact assemblages have also been collected in other parts of the Niuheliang area, such as Yaogouxiliang and Nushenmiao, to investigate the consequences of the interactions between local communities that were happening here. Results of the ongoing analyses at these sites will elucidate what roles local communities in different agricultural zones might have played in the provisioning phenomenon.

Studies like this and many others (Berrey, Drennan, and Peterson 2021; Drennan and Peterson 2005; Drennan, Peterson, and Berrey 2020; Peterson, Drennan, and Bartel 2016) have successfully shown that playing different areas belonging to the same archaeological culture off against each other can reveal sometimes nuanced, yet very important differences in social dynamics and the degree of diversity in human behaviors, and is thus more useful in identifying key elements or drivers of social change than finding similarities across multiple areas or even treating them as an entirely homogeneous entity. This study follows the same comparative approach and compares Hongshan subsistence economy organization at a regional scale between the Chifeng, Upper Daling, and Niuheliang survey areas. Specific questions are derived from the provisioning-a-pilgrimage-center idea and relate to the impact of the Niuheliang pilgrimage center on typical Hongshan subsistence economy organization. To what extent does Hongshan settlement distribution in the Niuheliang area deviate from what may be expected if agricultural considerations were the major determinant of settlement location? Could the residents and potential pilgrims at the pilgrimage center, a decent portion of whom were non-farming ritual specialists, feed themselves on the agriculturally unfavorable lands near where they lived? If not, to what extent did they need to rely on food production in provisioning communities like Shangchaoyanggou in surrounding areas? Were there more provisioning communities near the pilgrimage center, but in more agriculturally favorable locations? If so, does their settlement distribution suggest a more serious engagement in producing agricultural surplus?

The diachronic comparisons to highlight the characteristics of Hongshan patterns of subsistence economy organization will cover the duration of some 7300 years from the earliest evidence of millet cultivation in Xinglongwa times (6000 to 5250 BCE) through Zhaobaogou (5250 to 4500 BCE), Hongshan (4500 to 3000 BCE), Lower Xiajiadian (2000 to 1200 BCE), Upper Xiajiadian (1200 to 600 BCE), Zhanguo-Han (600 BCE to 200 CE), and Liao times (200 to 1300 CE), with the exception of Xiaoheyan times (3000 to 2000 BCE), which are excluded in this study because incomplete knowledge of the chronology pertaining to this period has not been able to amount to a definite, undisputed account of patterns of economic and socio-political organization (Chifeng International Collaborative Archaeological Research Project 2011a; Peterson et al. 2014a).

The next chapter of this dissertation establishes the formal models that are used in the analyses throughout this study. Then, previous archaeological work in Chifeng and the Upper Daling Valley is summarized so as to justify the quality and appropriateness of the data for comparisons. Methodologies for estimating population sizes and for reconstructing community organization are explained as well. The rest of chapter two is dedicated to introducing the Niuheliang survey including the newly surveyed areas.

Chapter three investigates the normal patterns of Hongshan settlement distribution in Chifeng and the Upper Daling Valley and shows how they can be used to infer typical Hongshan subsistence economy organization. The characteristics of typical Hongshan subsistence economy organization in the two survey areas are further highlighted in diachronic comparisons, in which discussions about social developmental dynamics in other periods are provided, too.

Chapter four utilizes a quadrat grid approach to explore the nature of centrifugal and centripetal forces that were at work shaping settlement concentration, in part by looking for potential environmental basis for settlement concentration and the connection between supra-local communities and the risk-buffering strategy.

Chapter five brings the same set of analyses to the special circumstances in Niuheliang and demonstrates how the normal patterns of Hongshan settlement distribution were seriously bent out of shape because of the special activities carried out by Hongshan people living at and nearby the Niuheliang pilgrimage center. The unusualness of the altered Hongshan pattern of land use is highlighted in diachronic comparisons, too. Chapter five concludes with an attempt to estimate Hongshan absolute agricultural production, which reveals interesting potential dependent relationships among social units.

Chapter six summarizes the findings of this study and explains how they lend strong support to the provisioning-a-pilgrimage-center idea. In addition, diachronic comparisons reveal a great deal of inter-regional variability in how social dynamics have developed in idiosyncratic yet sensible ways in the regional context of each, which encourages a comparative approach for those pondering questions of social change. The chapter concludes with proposals for future studies.

2.0 Models, Previous Archaeological Work, and Field Methods

2.1 Models for Explaining Settlement Distribution

Farming dynamics and the risk-buffering strategy in the Western Liao Valley outlined in chapter one produce concrete patterns of settlement distribution and can serve as a model to evaluate to what extent these were accurate descriptions of subsistence economy organization in ancient societies, by systematically relating environments to patterns of human occupation actually documented in archaeological settlement studies (Drennan, Peterson, and Berrey 2020). In Chifeng, the area within 500 m of the edges of the valley floors, or of the rivers themselves if no flat valley floor existed, formed numerous bands in the valley floors and turned out to be strongly favored locations for occupation throughout most of the sequence, as living in this ecotone provided access to both the productive valley floors and the rolling uplands with natural protection from crop-destroying floods (Shelach and Teng 2011). In the Upper Daling Valley, more than 70% of the Hongshan population lived within the same 500 m of the margins of the valley floors or of the rivers, an area that represents only 12% of the survey area (Drennan, Peterson, and Berrey 2020). The two studies have shown the utility of the model focused on the risk-buffering rationale and demonstrated the great potential for a better understanding of social changes in comparing the ways Neolithic farmers took into consideration the more immediate physical requirements associated with practicing agriculture when choosing where to locate their habitations.

This study follows the same line of reasoning and seeks to base the model of settlement distribution more rigidly on agricultural productivity and the risk-buffering strategy as they have been observed in current agricultural practices in the Western Liao Valley, to be applied to the vast

Hongshan world, including the newly surveyed Niuheliang area. The first of the two models that are used in this study deals simply with agricultural productivity. The assumption is that, all things being equal, Hongshan farmers would prefer to live close to the most productive lands where they could farm. If agricultural productivity were a major concern for Hongshan farmers, valley floors would be the most preferable settlement locations, followed by similarly productive rolling uplands, while stony hills would show little sign of occupation. Analyses in the following chapters use GIS layers that delineate the three zones for practicing agriculture based on topology on satellite images and modern land use. If agricultural productivity were an important consideration in the way Hongshan farmers organized subsistence activities, results of spatial analyses should reflect the preferences for some zones over the others by showing higher population densities in these zones.

The second model, on the other hand, evaluates the importance of the risk-buffering strategy. Facing largely similar climatic conditions as farmers today do, but without modern technologies, Hongshan farmers could mitigate the dual risk of floods and drought by strategically cultivating both the valley floors and the uplands (Drennan, Peterson, and Berrey 2020). If the risk-buffering rationale were a major concern for Hongshan farmers, they would choose to live near the margins of the uplands where they would have easy access to farm plots both in the valley floors and the uplands. Analyses in the following chapters use GIS layers that experiment with different shapes and widths of the ecotone between valley floors and rolling uplands so as to avoid making unwanted assumptions about what this buffer band would really look like. Double-sided buffer bands are areas along the boundary between the valley floor and upland zones that extend to both the valley floor and upland sides of the boundary. Double-sided buffer bands of 200, 300, 400, 500, and 600 m in width are explored in this study. Single-sided buffer bands are areas along the boundary that extended only to the upland side of the the boundary. Although both the valley floors and rolling uplands were necessary farm plots in the scheme, the uplands would make better locations for habitation because, although valley floors were level for house construction, they were also poorly drained. Hongshan semi-subterranean, wattle-and-daub houses built on the flat floors would be vulnerable to water damage as quickly rising ground water would soak up through the daub and destroy the structure. If Hongshan farmers following the risk-buffering strategy and cultivating crops in both zones were to build their house on only one side of the the boundary, they would most likely build it and live on the upland side. Single-sided buffer bands of 100, 150, 200, 250, and 300 m in width are explored in this study. If the upland-lowland farming strategy were an important consideration in the way Hongshan farmers organized subsistence activities, results of spatial analyses should reflect the preferences for some bands over elsewhere by showing higher population densities in these bands.

With the two models, this study is at an advantageous position to systematically investigate Hongshan subsistence economy organizations that are key to the provisioning-a-pilgrimage-center idea. This investigation involves two stages of analyses. The first is to reconstruct the normal Hongshan patterns of land-use by characterizing the relationship between agricultural practices and settlement distribution in Chifeng and the Upper Daling Valley. This study seeks to establish how Hongshan farmers organized the subsistence economy that sustained the small regional polities that have been reconstructed for Hongshan times, which lays the groundwork for a comparison of subsistence economy organization with the Niuheliang area. In the second stage, this study investigates whether and to what extent the residents of the probable pilgrimage center in Niuheliang, a good portion of whom were non-farming ritual specialists, depended on neighboring communities for food provisioning. How that might bend the normal behavioral patterns out of shape for the neighboring provisioning communities will add to our understanding of the social processes associated with the Niuheliang ceremonial complex (Drennan, Lu, and Peterson 2017).

2.2 Surveys in Chifeng and the Upper Daling Valley

Chifeng

Information about Hongshan settlement distribution, key to the analyses in this study, is the fruit of many explorations, surveys, and pioneering studies. The Chifeng International Collaborative Archaeological Research Project, which started in the nineties, was the earliest effort in systematically obtaining regional-scale data of prehistoric populations in northeastern China (Chifeng International Collaborative Archaeological Research Project 2011a; 2011b; Linduff, Drennan, and Shelach 2004). Results of this fieldwork give a detailed picture of settlement from Xinglongwa through Liao times and reconstruct socio-political organization at a macro-regional scale that was barely understood at that time. The Chifeng survey covers an area of 1,234 sq km roughly surrounding Chifeng and encompassing multiple river valleys to the west of the urban zone (Teng and Shelach 2011a). The mountains in the west range from 1,000 to 1,300 m in elevation, and the terrain gradually slopes downward to low hills and sedimentary valley floors in the east, as low as 550 m above sea level. Yin River, Banzhijian River, and several other rivers run across the survey area from south and west to north and east, forming flat valley floors that are sharply set apart from mountains and hills by cliffs or bluffs. The Chifeng survey area, part of a semi-arid, continental monsoon climate regime, is cold and dry in the winter and very hot during the summer. Annual rainfall averages 450-500 mm in the western mountains and is reduced to only 330-350 mm farther east because of the topography and monsoons. Most of the annual precipitation occurs in June through August, and the frost-free period lasts 60-115 days in the west and 135-148 days in the east. Within the survey area, there is a substantial variation in precipitation in terms of both space and time. Current land use clearly relates to these topographical and climatic characteristics. Intensive irrigation agriculture focused on maize, millet, and other crops occurs on the level river floors, protected from flooding by dikes built along the rivers. Meanwhile, more extensive cultivation, often without irrigation, is practiced on the rolling uplands a few kilometers away from the rivers. Further away from the rivers and up on the hills, lands with a thinner layer of soil are used for the cultivation of fruit trees, reforestation, and seasonal herding.

To systematically document patterns of prehistoric populations on this landscape, the Chifeng project utilized a strategy of full-coverage pedestrian survey, which involves a team of four archaeologists, spaced about 50 m apart, walking back and forth across the entire survey area. Survey was carried out between late spring and late fall in multiple years for mobility and good surface visibility (Drennan 2011). The essence of the data was the areal extent and density of the surface scatters of ceramic artifacts, which were recorded with a map of "collection units." When the team encountered a concentration of at least three artifacts within an area of about 1 ha, team members made an initial estimation of the boundary and density of the surface artifact distribution. A collection unit, 1 ha or less in size, was then drawn on a satellite image to delineate the areal limit of the artifact distribution. If the artifact scatter was more extensive, multiple contiguous collection units were used to allow a consistent, desired resolution. The team made the collection unit in one of the two ways. If the density appeared to exceed 0.5 pieces per sq m, a "systematic collection" was made by marking out a circle 3 m in diameter in a randomly selected location within the collection unit and collecting all artifacts found within. Additional adjacent circles were made until the minimum sample size of 20 ceramic sherds were found. Alternatively, a "general collection" was made when the density of the artifact distribution was less than 0.5 pieces per sq m. Team members collected the first artifacts they saw until the minimum sample size was reached. The field procedures were designed in this way to eliminate on-site subjective judgements, reduce the sampling bias, and thus enable standardized and comparable results.

Several geomorphological studies have been carried out in the Chifeng survey area to assess the effects of post-depositional processes on the surface visibility and spatial distribution of artifacts (Shelach and Avni 2011). The primary geomorphological process concerned here as well as in the wider Western Liao Valley was narrow gully formation that transported alluvium directly from the uplands and mountains to the valley floors. In the uplands, gullies can be 10-20 m deep, but are usually quite narrow, only a few meters wide, meaning the spatial extent of their damage to a site is quite limited. There is also evidence for the incorporation of gullies into the design of prehistoric structures, suggesting sites have not been extensively affected by more recent gully erosion. In the lowlands, a total of 11 trenches were dug in several locations on the flat floor floors of small and middle-sized rivers as well as in the broad Chifeng floodplain to document the accumulation of alluvial deposits in different subzones of the survey area. The fast rates of alluvial accumulation in the small and middle-sized drainages range from about 1.0 to 3.2 m per thousand year and indicate substantial flooding at frequent intervals and lateral migration of the river channel, which would discourage prehistoric populations from constructing wattle-and-daub houses there. More trenches were dug in the broad Chifeng floodplain to represent its different and more complicated micro zones. Overall, the rates of sediment accumulation range from 0.5 to 1.5 m, also suggesting frequent flooding and lateral migration of the river system. These and the periodic development of swamp conditions in some parts of the Chifeng floodplain would have made this an even more unattractive zone for prehistoric settlement. In conclusion, it is extremely unlikely that any substantial prehistoric occupation ever existed in the lowlands, and geomorphological processes during the several thousands of years do not appear to have altered settlement evidence in any significant way.

The Upper Daling Valley

The Upper Daling survey adopted the same methodological principles, but was carried out in an area around the Hongshan monumental site of Dongshanzui to document the size, nature, and sequences of development of human communities that lived in the Hongshan core zone, the comparison of which, along with results from the Chifeng survey, added to our knowledge of Hongshan ceremonial structures and the developmental trajectory of Hongshan societies (Peterson et al. 2014a). The survey area of 200 sq km included both the agriculturally productive level lands and less attractive hills along the course of the Daling River. Elevation ranges from 250 m in the valley floors to about 500 m in the higher hills. Annual precipitation is a bit higher at 500 mm on average, with most of it concentrated in June through August as well. The Upper Daling Valley is cold and dry in the winter and very hot during the summer, with an average of 141 days without frost each year. Overall, the Upper Daling survey focused on a smaller area with greater annual precipitation, shorter frost period, and a broader river valley farther downstream that has been known to be favorable locations for Hongshan settlement. Despite a somewhat higher agricultural productivity, current land use in the Upper Daling Valley is similar to that in Chifeng and the effort to manage the substantial variation in precipitation is visible in different land use patterns on valley floors, rolling uplands, and stony hills.

The way survey was carried out in the Upper Daling Valley was very similar to how it was done in Chifeng, except that the criteria for making a collection unit became two or more ceramic artifacts found within 50 m of one another. This would result in more collection units being made in areas with very low density of surface artifact scatter. Analysis of the Chifeng dataset, however, showed that locations that were identified with less than five ceramic sherds were very few and had little impact on the overall conclusions. The maximum size of a collection unit became smaller at 0.25 ha. The higher resolution would encourage the survey team to detect gaps in occupation that might have been glossed over by larger units used in Chifeng, resulting to an average of 33% smaller area measured for the same occupation zone in the Upper Daling Valley. This would have an effect on population estimates as discussed below. The minimum sample size increased from 20 to 25 ceramic sherds in order to more confidently characterize differences in the proportions of artifacts of different periods. The threshold between making a systematic or general collection remained an estimated density of 0.5 sherds per sq m. When systematic collections were made, the size of a circle was enlarged to 3.6 m in diameter, but this had no effect on the documentation of the areal extent and density of the surface scatter of ceramic artifacts.

Population Estimation

Actual numbers of premodern inhabitants were estimated based on the area and surface artifact density of collection units in the Chifeng and Upper Daling survey areas (Drennan and Peterson 2011; Peterson 2006; Peterson et al. 2014a). For a systematic collection unit, an accurate calculation of surface artifact density for each period is made possible by documenting the exact number of circles drawn and the exact count of surface artifacts collected, corrected for unidentified but definitely ancient sherds. For a general collection, the task begins with an initial examination of the frequency distribution of the total artifact count in all general collection units in the region, so as to achieve standardized and comparable results between survey areas. Different surface artifact density values, ranging from 0.1 to 2 sherds per sq m in Chifeng and from 0.05 to 0.5 sherds per sq m in the Upper Daling Valley, were then assigned to individual general collection units based on the number of artifacts recovered in the field. The range of these density values was determined by the minimal surface artifact density to be detected by the survey team in the first place and the maximal surface artifact density that would not require a systematic collection unit. After the surface artifact density for each period was determined in all collection units, the value was multiplied by the area of that unit to obtain an "area-density index," which was then divided by the number of centuries in that period to obtain the population proxy for population estimates. The basis for the conversion between area-density index and the actual number of inhabitants is the alignment of the range of occupational densities seen in several fully or partially excavated Neolithic and Early Bronze Age sites, including Jiangzhai, Laohushan, and a few documented right in the Chifeng survey area, with the range of surface artifact densities observed for the same periods in Chifeng. Stratigraphic testing at Site 342 and 674, as well as intensive surface collection at Fushanzhuang, showed broadly consistent results in such alignment. Chifeng population estimates were produced by multiplying the population proxy by 500 for a minimum estimate and by 1,000 for a maximum estimate, while Upper Daling population estimates were calculated by multiplying the population proxy by 750 and by 1,500 for minimum and maximum estimates, respectively, to compensate for the unexpected, systematic effect of smaller areal measurement as a result of smaller collection units in the Upper Daling Valley. Population estimates derived in this way were used in the analyses in both survey reports as well as in this study.

Community Organization

Information on community organization was made available based on population estimates and the spatial patterning of the collection units in both survey areas (Peterson and Drennan 2011; Peterson et al. 2014a). The delineation of local communities and supra-local communities, or often referred to as districts or polities, is centered around the idea of patterned interactions between households (Peterson and Drennan 2005). Meaningful social units for analyses have to recognize and be based on meaningful social interactions. For households of a preindustrial agrarian society, the need to interact with other households on a daily face-to-face basis pulled them physically closer to each other because the costs and inconvenience of interaction increased substantially with distance. Moreover, the more inhabitants were engaged in the interactions, the stronger the strength of this pull would be. A local community in archaeology can therefore be defined as a group of households that interacted more intensely with each other within the group than with households outside the group, and they are recognizable as a cluster of material remains of habitation that is spatially distanced from other clusters. The field data collection strategies utilized in the Chifeng and Upper Daling surveys were designed to systematically document prehistoric populations in a way that makes the identification of meaningful social units possible. Collection units, the essence of the data in both surveys, by recording both the intensity and the areal extent of occupation, enable an analytical approach that takes not only separation distance between clusters, but also the population size of them, into consideration. The analytical approach involves a regularly-spaced grid of cells whose values are proportional to surface artifact densities averaged for that cell. When visualized as a density surface, the grid reflects regional occupational distribution and can be represented as a contour map with many contour lines. A cutoff contour line, when selected in a sensible way, reveals clusters of collection units that constituted local communities. For example, a cutoff contour line that defines clusters covering distances too great for daily face-to-face interaction is probably not a good selection.

More inclusive groupings of collection units emerge when the density surface is mathematically “smoothed” with inverse distance weighted interpolation. That is, each cell in the grid is assigned a new value equal to the average of all the values of all the cells, each weighted according to some inverse power of its distance. The new grids are then visualized as density surfaces smoothed to varying extents (to varying powers), and can be represented as multiple contour maps. Again, when a contour map is appropriately chosen, and a cutoff contour line is sensibly selected, clusters of smaller settlements may appear and form a community structure above local communities, or supra-local communities, for there are more intensive interactions among the local communities within the cluster than with those outside of it.

2.3 Survey in Niuheliang

Regional-scale survey including the ceremonial structures at Niuheliang and a substantial area surrounding them provided the data upon which the analysis of Niuheliang settlement patterns in this dissertation was based. The field survey was carried out in three stages. First, survey of a zone including most of the ceremonial structures and some surrounding territory was carried out in 2014 by the Liaoning Province Institute of Archaeology. Results, analysis, and interpretation of this survey zone have provided the basis for two publications (Liaoning Province Institute of Cultural Relics and Archaeology and Renmin University of China School of History 2015; Drennan, Lu, and Peterson 2017). In 2016 and 2017 this zone was expanded substantially toward the west and southwest in a second stage of survey carried out as part of the Liaoning Hongshan

Period Community Project, a collaboration between the Liaoning Province Institute of Archaeology, Renmin University of China, the University of Pittsburgh, and the University of Hawai'i at Mānoa. This dissertation represents the first public presentation of analysis of results from this part of the survey. In 2019, as part of the research carried out for this dissertation, I directed a third stage of field survey toward the north and east of the territory covered in the first stage. The third stage of survey was also carried out as part of the Liaoning Hongshan Period Community Project. This dissertation represents the first public presentation of analysis of results from this part of the survey. The Niuheliang analyses presented here are all based on the complete combined results of the three stages of survey described above. The complete dataset from all three stages will, in due course, be made available online in the University of Pittsburgh Comparative Archaeology Database.

The Niuheliang survey area is part of a region belonging to the southern extension of the Nuluerhu mountains and is characterized by series of lower hills and mountains, running in a general direction from southwest to northeast. These lands at higher elevations are somewhat less stony than those in Chifeng and the Upper Daling Valley, and are therefore referred to in this study as mountains instead of stony hills. Nonetheless, they represent the least productive one of the three agricultural zones in the Niuheliang region in the same way stony hills do in Chifeng and the Upper Daling Valley. Below the mountains, seasonal streams flow to branches of the Daling River in three directions, meeting the lower flat lands where Lingyuan is located toward southwest. Located just 25 km northwest of the Upper Daling survey area, the Niuheliang survey area has a set of climatic conditions for agriculture that is somewhat similar to the Upper Daling Valley (Liaoning Province Institute of Cultural Relics and Archaeology 2012; Lingyuan County Annals Production Committee 1995). Annual precipitation ranges between 450 and 480 mm on average, with most of it concentrated in June through August, and the frost-free period can last up to 166 days. Various crops are cultivated on the flat river floor and slightly elevated uplands, while lower hills and mountains are used for the cultivation of fruit trees, reforestation, and seasonal herding. The Niuheliang survey adopted identical field methods and approaches to demographic analysis and community delineation as used in Chifeng and the Upper Daling survey, thus producing comparable results across the three survey areas.

3.0 Chifeng and the Upper Daling Valley

To establish typical Hongshan subsistence economy organization, this chapter analyzes patterns of Hongshan settlement distribution in relation to agricultural considerations and strategies in Chifeng and the Upper Daling Valley. The basis of the following analyses is the population estimates published for Chifeng and the Upper Daling Valley (Chifeng International Collaborative Archaeological Research Project 2011a; 2011b; Peterson et al. 2014a; 2014b). Systematic pedestrian surveys have been conducted in the two survey areas at a sensible scale that allows us to observe and discuss settlement pattern in a meaningful way. The delineation of the three zones for practicing agriculture in Chifeng and the Upper Daling Valley is based on topology on satellite images and modern land use as described in chapter two (Figure 3.1). Overall, the two regions have similar zonal proportions. The Chifeng survey has a bit less stony hills because it includes the urban area of Chifeng, which is founded on a large flat valley.

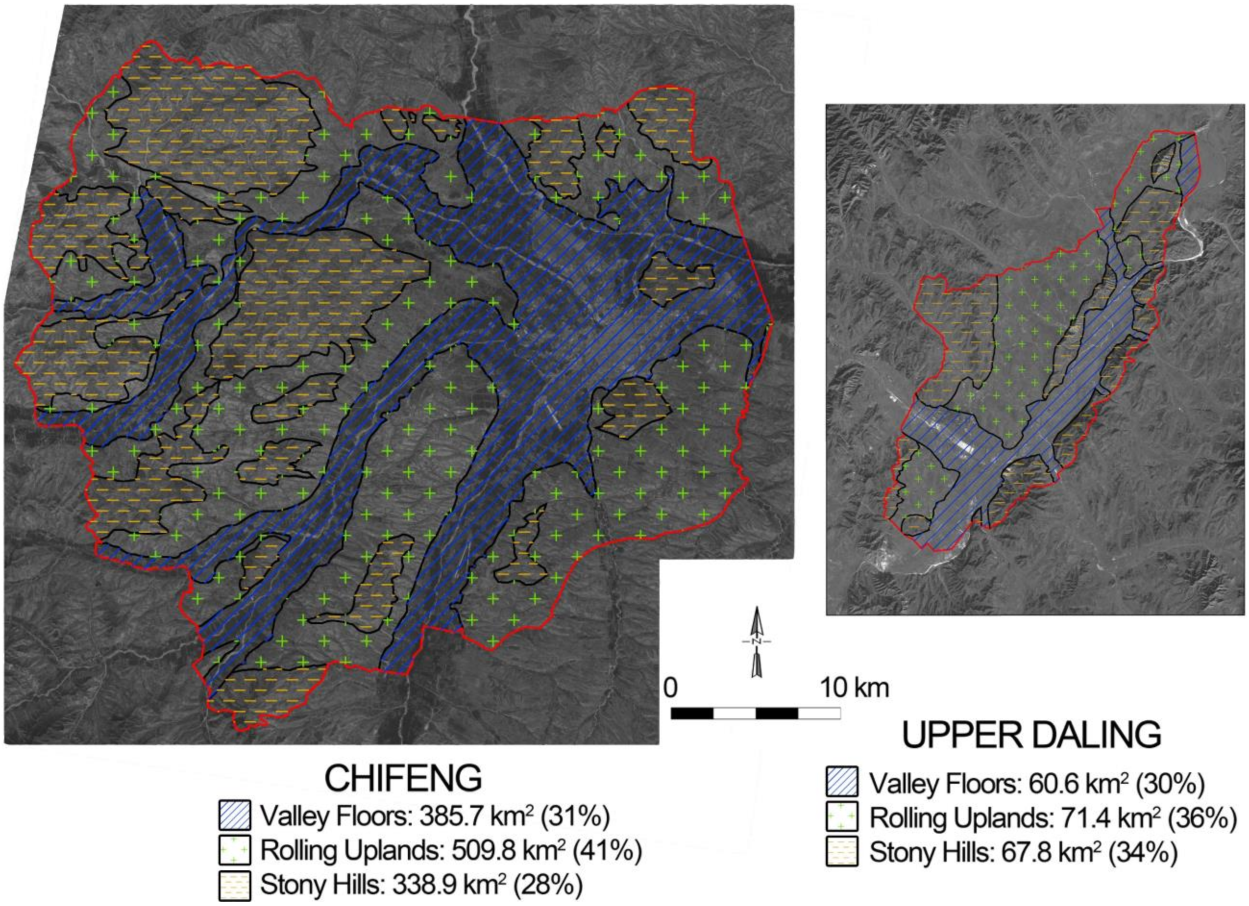

Figure 3.1 Three zones for agriculture in Chifeng and the Upper Daling Valley. Red lines are survey boundaries. Black lines are boundaries between zones. Blue diagonal lines are valley floors. Green crosses are rolling uplands. Brown dashed lines are stony hills.

3.1 Patterns of Settlement Distribution in Chifeng and the Upper Daling Valley

Agricultural Productivity

To explore Hongshan patterns of settlement distribution in relation to agricultural productivity, population densities were calculated in each of the three zones based on average population estimates in Chifeng and the Upper Daling Valley (Figure 3.2). In both regions, rolling uplands were the most densely occupied zone, thus the most preferred settlement location during

Hongshan times, followed by stony hills, and then by valley floors. In addition, the relative population densities of the three zones behave somewhat similarly in the two survey areas, suggesting some degree of consistency. Population density is the highest on rolling uplands, decreases to about a half on stony hills, and further drops to very low on valley floors. This pattern suggests two Hongshan settlement preferences. First, agriculturally productive lands were unmistakably preferred over agriculturally unproductive stony hills. Given the choice, Hongshan farmers would not prefer to live there, as the generally low population densities throughout Hongshan times indicated little competition over lands. Second, valley floors were clearly avoided as settlement location despite their high productivity. This agrees with the observation that exposure to water damage would make valley floors a terrible location to build Hongshan semi-subterranean, wattle-and-daub houses (Drennan, Peterson, and Berrey 2020). The population density of these fertile, flat lands was barely one seventh of the overall regional population density in Chifeng at 2.8 persons per sq km, and less than a quarter of regional population density in the Upper Daling Valley at 5.6 persons per sq km. The preference for rolling uplands, on the other hand, was slightly stronger in the Upper Daling Valley, as the upland density at 10.1 persons per sq km (all numbers rounded off to one decimal place) was more than two times higher than the stony hill density at 4.7 persons per sq km and the valley floor density at 1.3 persons per sq km, while rolling uplands in Chifeng had a population density of 4.4 persons per sq km, still higher but to a lesser extent than the stony hill density at 3.0 persons per sq km and the valley floor density at 0.4 persons per sq km.

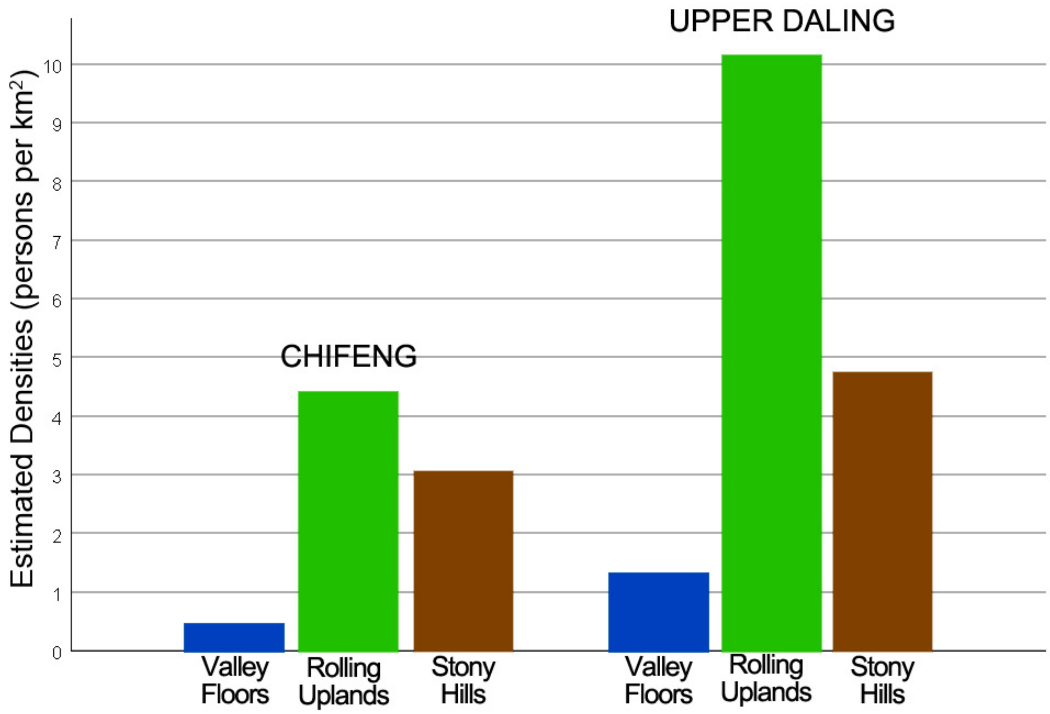

Figure 3.2 Estimated Hongshan population densities of the three zones in Chifeng and the Upper Daling Valley.

Risk-buffering Strategies

Hongshan farmers who sought to mitigate the risks associated with unpredictable inter-annual variation in precipitation would choose to build a house near the boundary between the uplands and the lowlands with easy access to farm plots in both zones (Drennan, Peterson, and Berrey 2020). These elevated areas were also safe, ideal locations for building semi-subterranean houses. To explore Hongshan patterns of settlement distribution in relation to this risk-buffering strategy without making assumptions about what this buffer band would really look like, different variations of buffer bands were experimented, including single-sided buffer bands of various widths, which extend to the rolling upland side of the line, and double-sided buffer bands of various widths, which extend to both the upland and lowland sides (Figure 3.3). Single-sided buffer bands on the valley floor side of the line were excluded because, if Hongshan farmers had preferred to settle on only one side of the boundary, it would have been the rolling upland side, as shown in the previous subsections.

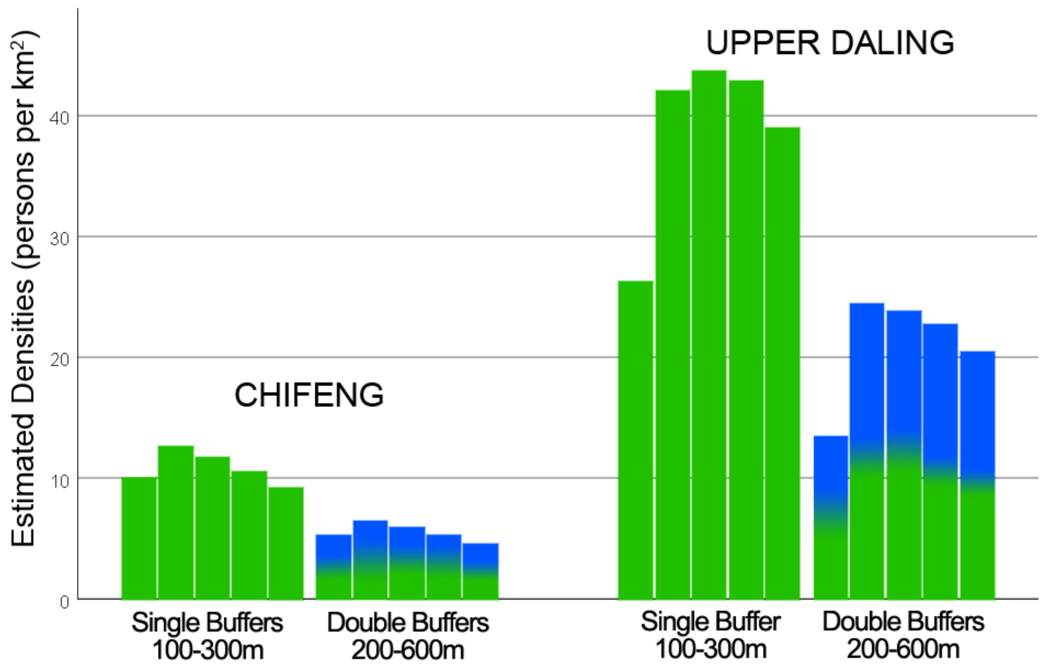

Figure 3.3 Estimated Hongshan population densities of several variations of buffer bands in Chifeng and the Upper Daling Valley.

The relative population densities of the various buffer bands behave, again, quite similarly in Chifeng and the Upper Daling Valley, suggesting some degree of consistency in these settlement preferences. Population density is moderately high in the widest buffer band, higher in the next smaller, still higher in the next two smaller, and then lower in the smallest. This is true of both single-sided and double-sided buffer bands in both regions, except for the 150m single-sided buffer band in the Upper Daling Valley that shows a minor decrease against the trend. In both regions, population density is about two times higher on single-sided buffer bands than on double-sided ones. This pattern confirms that, in addition to easy access to productive farmlands, risk management was also a vital factor in Hongshan farmers' residential decision. They settled on the rolling upland side of the ecotone much more densely than anywhere else, likely because this area provided the best conditions for building and maintaining a house, and for simultaneously cultivating both zones. Their highest density was within 150-200 m of it, at 11.7 persons per sq km in Chifeng and 43.6 persons per sq km in the Upper Daling Valley, higher than any estimated population density of the three zones in their respective regions. Here and onward, this study uses the 200m single-sided buffer band to represent the ecotone for the convenience of comparison. As it turned out, this buffer band consistently showed the highest or second highest population density in Hongshan times in the three survey areas. The documented population density of this buffer band thus serves as a good indicator of the settlement preference for living on the bluffs at the edge of the flat valley floor in the Western Liao Valley. For example, the preference for living in the ecotone, and therefore the emphasis on the risk-buffering strategy, was stronger in the Upper Daling Valley than in Chifeng in Hongshan times, as the density of the 200m single-sided buffer band were about 7.8 times higher than the overall regional population density. Meanwhile, the same buffer density in Chifeng was only about 4.2 times higher than the overall regional population density there.

These findings also support the postulation that the maximization of agricultural productivity consistent with minimization of risk was an individual household decision and did not involve much cooperation at all between households. (Drennan, Peterson, and Berrey 2020). Hongshan farmers could have maximized productivity by specializing in subsistence production with some families living in and farming the uplands and others living right at the edge of valley floors and farming them. These cooperative behaviors would produce a wider dispersal of farmsteads across the uplands farther away from the valley, and the heaviest concentration of occupation would occur in the first single-sided buffer band nearest to the floodplains. That this is not seen in the patterns of population densities across the variations of buffer bands argues against the cooperative scenario of Hongshan subsistence economy organization. That Hongshan subsistence strategies involved little more than an individual household decision also argues for a relatively loosely integrated local economy and thus fewer opportunities for aspiring aggrandizers to mobilize the flow of economic resources to their advantage in pursuit of social power (Berrey, Drennan, and Peterson 2021; Earle 1997; Mann 1986). As a result, ritual and religion were sought after as a base of power, and Hongshan subsistence strategies and developmental dynamics make an accurate account of this relationship.

Viewed together, results of the two analyses revealed that not only was the Upper Daling Valley more densely occupied than Chifeng during Hongshan times, but farmers there were also choosing settlement location in better accordance with agricultural considerations, especially in terms of risk management. Despite general similarities in demographic patterns, socio-political organization, and levels of differentiation among households between the two regions (Drennan et al. 2014; Drennan et al. 2017; Peterson et al. 2014a), the two times higher regional population density and nearly four times higher buffer densities in the Upper Daling Valley fall well outside the error ranges possibly imagined for population estimates and are thus quite real. The greater level of regional population in the Upper Daling Valley might have benefited from better agricultural environments, including broader valley floors, greater precipitation levels, and shorter frost-free-period in a survey area 100 km or so to the southeast of Chifeng (Teng and Shelach 2011a). Alternatively, the higher density of Hongshan population could also be a direct result of the archaeological decision to focus the survey on a river valley that has been known in the Chifeng survey to be preferable settlement locations for Hongshan farmers. Or higher population densities in the Upper Daling Valley might have something to do with the generally higher density of occupation across the Hongshan core zone, where remains of monumental construction were more concentrated and well-built, which in turn may go back to higher precipitation levels and a bigger valley farther downstream than the smaller streams and valleys in Chifeng.

One way or the other, higher population levels in the Upper Daling Valley did relate to a further concentration of regional population in the ecotone. It could be that higher regional population in the Upper Daling Valley during Hongshan times had consequently helped make it important to have effective risk management in place. Or, conversely, effective management of agricultural risk might have enabled these populations to grow more strongly than those in Chifeng in the Hongshan peripheral zone. The two contrasting causal relationships could have different implications about the nature of Hongshan human-land relationships and social developmental dynamics. One possibility is that Hongshan farmers living in the Upper Daling Valley had to plan more carefully than those in Chifeng to ensure stable agricultural production by living near the ecotone so as to better cope with the dual risk of floods and drought in order to provision non-farming ritual specialists that must have comprised a larger portion of regional population there than in Chifeng. To determine which of the two was a more accurate account for the contrasting patterns between the two regions, this study proceeds with an investigation of how other known or widely accepted social factors of other periods of time might have been shaping patterns of settlement distribution by extending the comparisons and applying the same models to other ancient societies in the same geographical settings. The diachronic comparisons can potentially bring insights into the complicated interactions between humans and the environments in Hongshan as well as other premodern societies.

3.2 Patterns of Settlement Distribution through Time in Chifeng and the Upper Daling Valley

This characterization of human-land relationships in Chifeng and the Upper Daling Valley adds to our understanding of the subsistence economy organization underlying Hongshan social development. When the same set of analyses is carried out for other periods, it presents an opportunity to examine whether and to what extent some of the most important socio-economic elements, known to have accompanied the developmental trajectory of societies in northeastern China (Drennan et al. 2014), caused settlement distribution to look in one way or another. With the analyses of settlement preference on a level pertaining to individual decision-making process, this study investigates the varying extents to which agricultural productivity and the risk-buffering strategy served as an important factor in the decision of settlement location throughout the premodern sequence, and whether the results support or contradict the recent synthetic discussion of internal social dynamics underlying trajectories of social change in this part of the world, with the exception of the Xiaoheyan period for the reasons stated in chapter one. For the convenience of comparison, the following diachronic analyses continue to use the 200m single-sided buffer band to represent the ecotone in general. The overall regional population densities (Figure 3.4) and estimated densities of the three zones and the 200m single-sided buffer band (Figures 3.5 and 3.6) in Chifeng and the Upper Daling Valley were based on average population estimates in the survey reports (Chifeng International Collaborative Archaeological Research Project 2011a; Peterson et al. 2014a). The observed proportions of regional population in each of the three zones and the 200m single-sided buffer band (Figures 3.7 and 3.8) were calculated from the population estimates for each zone divided by the total estimated population of the survey area, all based on the area-density index. The "expected" proportion for each zone was the proportion of the total survey area that the zone occupied. That is, if the area of a zone represented 30% of a survey area, then its "expected" population would be 30% of that survey area's estimated population. If there was no strong preference for or against a particular zone in a period, the observed proportion of regional population distributed on that zones would be relatively close to the proportion of lands in the survey area that belonged to that zone. Conversely, conspicuous deviations from the expected proportion would mean people either strongly preferred to live on that zone, or felt averse to it, equally strongly. The proportions are rounded off to the nearest whole number and do not necessarily add up to 100% because there are small rounding errors and because the area of the 200m single-sided buffer band is not excluded from the upland category for the purpose of this analysis.

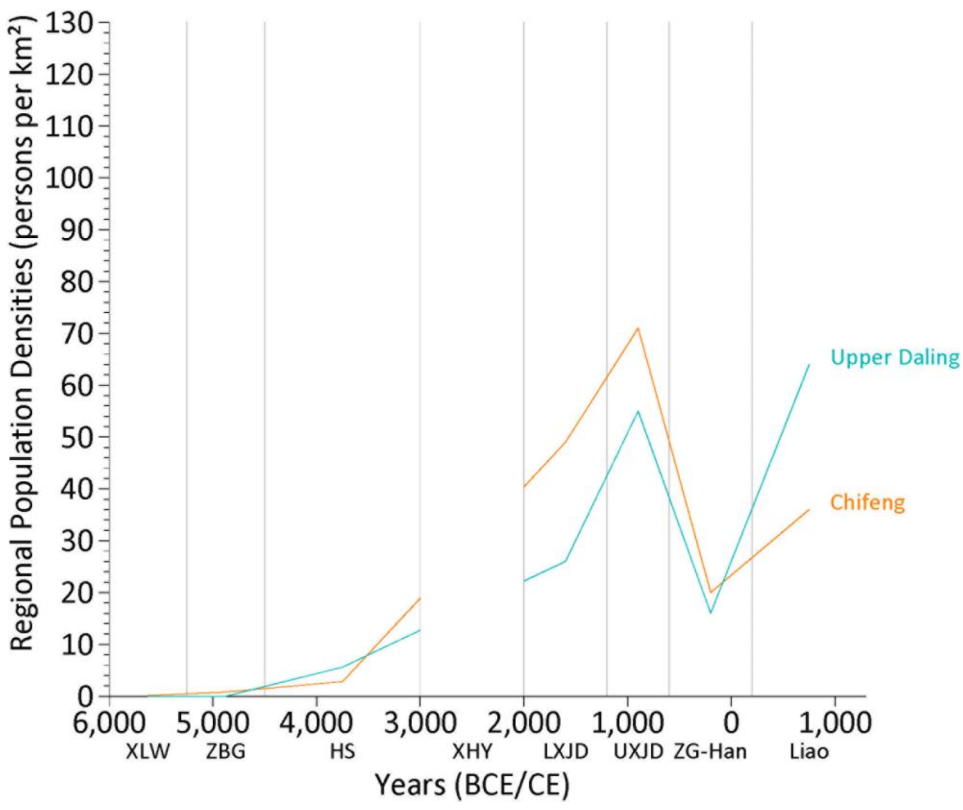

Figure 3.4 Regional population densities through time in Chifeng and the Upper Daling Valley.

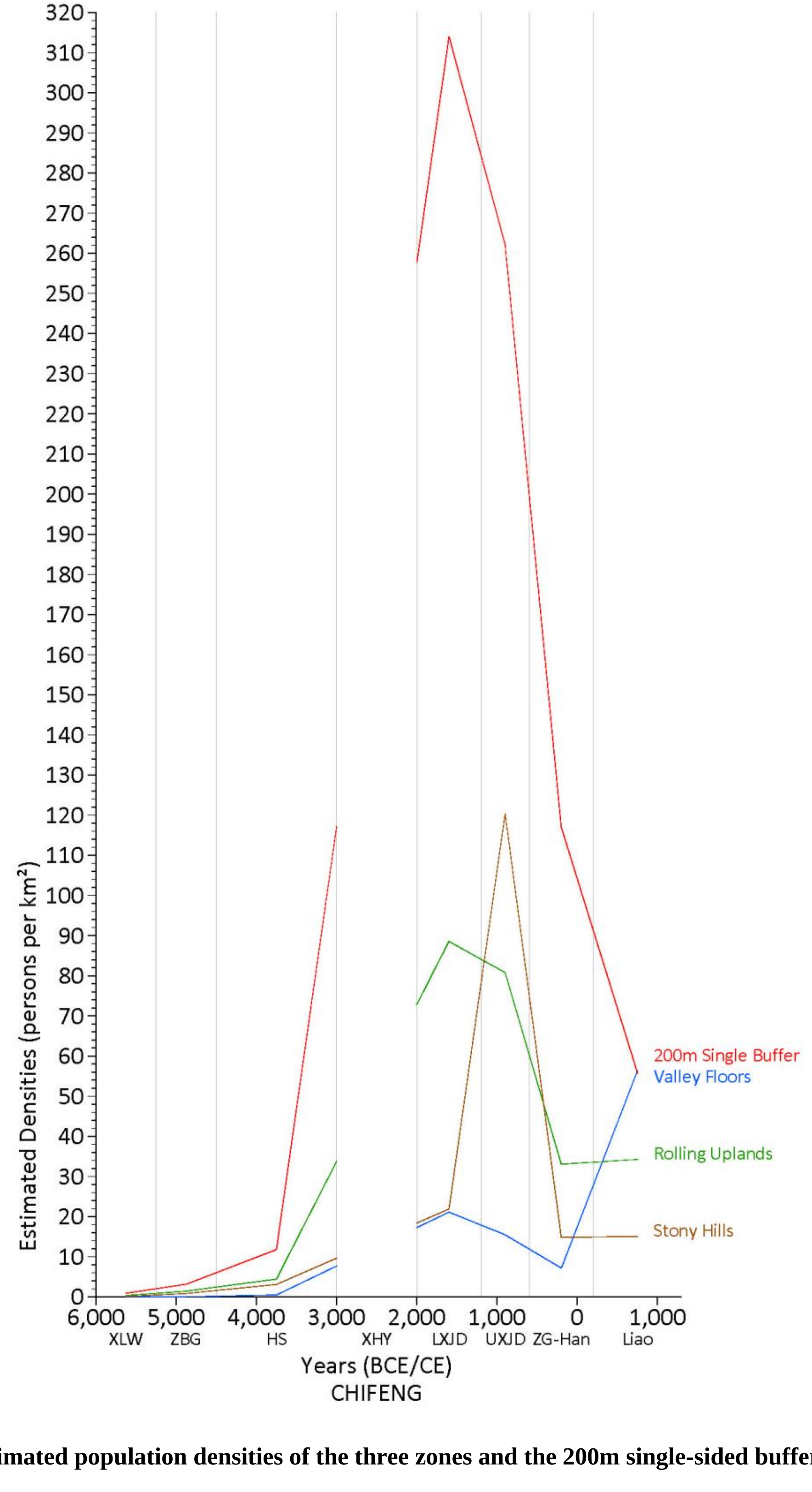

Figure 3.5 Estimated population densities of the three zones and the 200m single-sided buffer band through time in Chifeng.

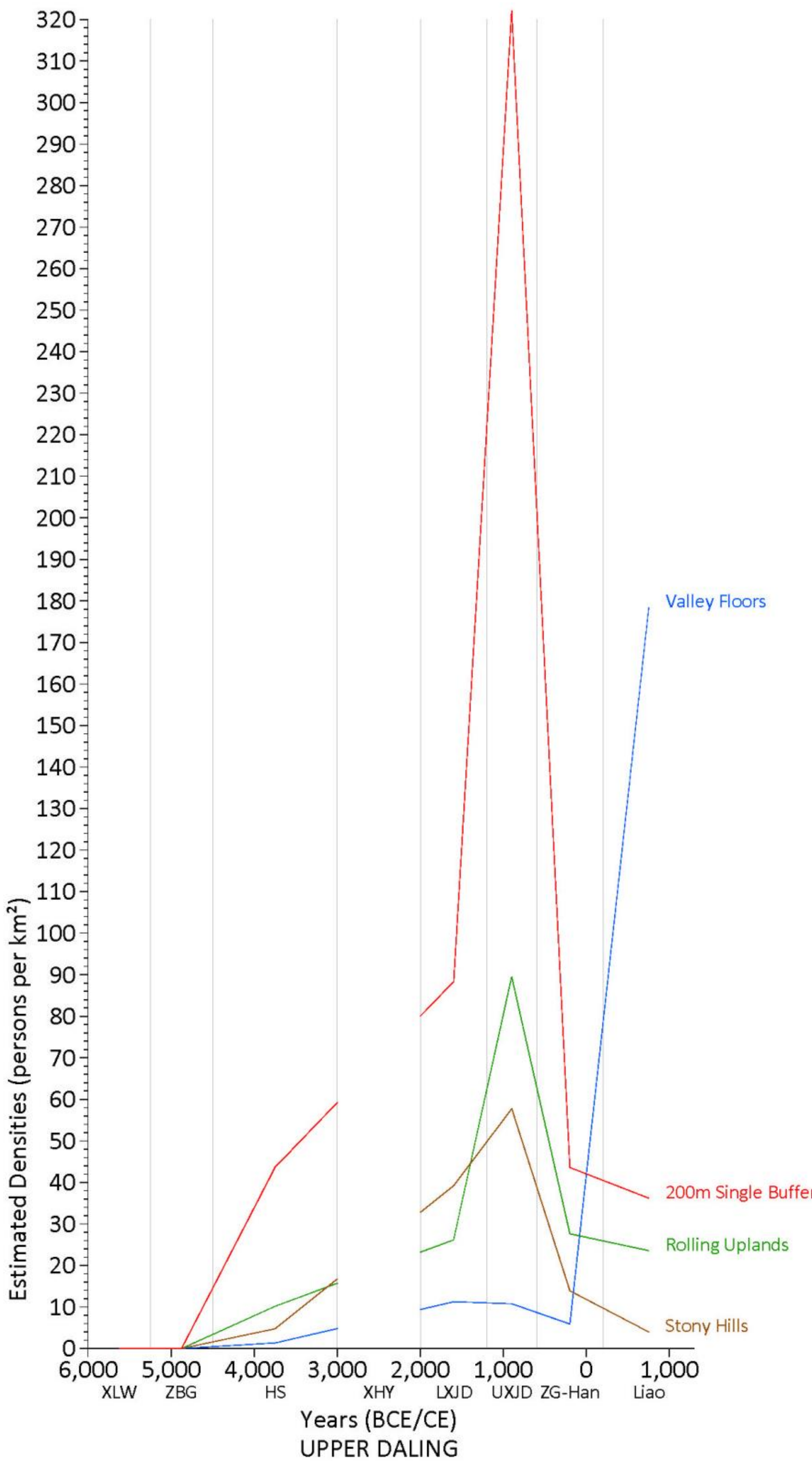

Figure 3.6 Estimated population densities of the three zones and the 200m single-sided buffer band through time in the Upper Daling Valley.

Figure 3.7 Proportions of regional population distributed on valley floors, rolling uplands, stony hills, and the 200m single-sided buffer band through time in Chifeng. The straight level line in each graph indicates the expected proportion based on the amount of lands of that zone in the survey area.

Figure 3.8 Proportions of regional population distributed on valley floors, rolling uplands, stony hills, and the 200m single-sided buffer band through time in the Upper Daling Valley. The straight level line in each graph indicates the expected proportion based on the amount of lands of that zone in the survey area.

Early Neolithic Patterns of Settlement Distribution (6000 to 4500 BCE)

The Xinglongwa and Zhaobaogou periods represent the earliest well-known sedentary societies in northeastern China. Hunting and gathering comprised a large part of subsistence strategies, complemented by domesticated plants and animals (Fuller, Harvey, and Qin 2007; Shelach 2000; 2006; Tao et al. 2011). A very small sedentary population spread through the vast landscape led to sparse settlements in Chifeng and left no surface artifacts to be found at all in pedestrian survey in the Upper Daling Valley (Chifeng International Collaborative Archaeological Research Project 2011a; Drennan et al. 2014; Peterson et al. 2014a). Analysis of community organization revealed that most of the early Neolithic population had lived in local communities consisting of a few families, and some larger ones that could be labeled small villages. Beyond local communities, on the other hand, no clustering at the regional scale indicated the presence of socio-political integration. Little sign of productive differentiation among households and the lack of evidence for status markers suggested an egalitarian social organization in the beginning of the Neolithic (Shelach 2000; 2006).

Results of our analyses are consistent with the observation in the Chifeng report of Xinglongwa and Zhaobaogou settlement patterns that were predominantly focused on bluff edge locations just above flat floodplains (Chifeng International Collaborative Archaeological Research Project 2011a). Warmer and wetter climatic conditions would make flooding on the valley floor a more severe concern yet at the same time mitigate the risk of drought on the uplands to some extent, which were forested and provided rich wild resources. Having a wide range of options for settlement location as a result of an extremely low population level and the absence of strong socio-economic integration, Xinglongwa and Zhaobaogou people in Chifeng both strongly preferred valley-margin locations for practicing agriculture and hunter-gathering. Our analyses showed that the early Neolithic population in Chifeng, totaling in 800-1,500 people, had a clear preference for rolling uplands, with about 75% of them choosing to live on these elevated areas that accounted for only 41% of the total land. The resulting upland densities at 0.3 persons per sq km during Xinglongwa times and at 1.4 persons per sq km during Zhaobaogou times were all noticeably higher than their respective regional population densities at 0.1 and 0.8 persons per sq km. As higher precipitation levels would have made valley floors much less habitable and the uplands better watered, it should come as no surprise that the 200m single-sided buffer band in Chifeng showed the highest population density at 0.9 persons per sq km during Xinglongwa times and at 3.1 persons per sq km during Zhaobaogou times. This represented 35% of the early Neolithic population concentrated in this ecotone which only took up 8% of the total land in the Chifeng survey area. Although this pattern may not be interpreted in the strict sense as reflecting the effort to manage the dual risk of floods and drought as described for later societies with much higher populations that relied heavily on food production, it nonetheless shows the powerful impact subsistence economy organization could have on settlement pattern as early as the times when a sedentary way of life was first established in Chifeng.

Hongshan Patterns of Settlement Distribution (4500 to 3000 BCE)

Evidence for a subsistence system that relied more heavily on food production is abundant for Hongshan societies. The increased importance of agriculture was indicated by remains of domesticated grains, numerous storage pits associated with Hongshan houses, and functional analysis of stone tools (Li 2008; Ma et al. 2016; Neimenggu Zizhiqu Institute of Cultural Relics and Archaeology 1997; 2004; Wang et al. 2017; Zhang 1994), although wild resources continued to complement Hongshan diets. Regional population increased significantly in Chifeng from early

Neolithic to Hongshan times, reaching 2,300-4,600 people in total, while Hongshan sherds were the earliest evidence of human occupation that was recorded in the Upper Daling survey area, with the regional population estimated at 750-1,500 people (Chifeng International Collaborative Archaeological Research Project 2011a; Drennan et al. 2014; Peterson et al. 2014a). As noted above, no meaningful difference could be detected in community structure between the two regions. The village way of life had become a common community pattern in both regions, as local communities of more than 50-100 inhabitants in demographic size, ones that were truly villages, now harbored as much as 59% of the Chifeng regional population and 48% of the Upper Daling regional population. The somewhat weaker centripetal forces forming Hongshan local communities, as inferred from their dispersed nature, contrasted with the stronger centripetal forces working at the regional scale drawing local communities closer in space to form supra-local communities. These emerged for the first time during the Hongshan period in northeastern China and represented new social units that were able to integrate a larger number of people at a higher spatial scale. This social consolidation involved many people. More than 80% of the Chifeng regional population and 98% of the Upper Daling regional population were now part of these new units. Analyses of rank-size patterns and the evaluation of degrees of population centralization indicated a high level of integration within each of these entities both in Chifeng and the Upper Daling Valley, while no sign of hierarchy or evidence for further integration at a level above these supra-local communities was recognized. On the other hand, the difference in socio-political organization between the two regions was most noticeably marked by the intensity of ritual activities. Remains of ceremonial constructions in Chifeng were less than one tenth as abundant as in the Upper Daling Valley, yet the stronger expression of Hongshan cosmology did not seem to connect to other aspects of social inequality. In both regions, differentiation among Hongshan households in terms of prestige was only modest; somewhat weaker was productive differentiation; and almost no wealth differentiation was detected at all (Drennan et al. 2017).

Results of our analyses, as shown earlier, are consistent with the observation in both survey reports that Hongshan settlements were concentrated on bluff-top locations at the edge of river valleys as well as slightly rolling terrain farther back from the rivers (Chifeng International Collaborative Archaeological Research Project 2011a; Peterson et al. 2014a). These locations provided protection from flooding and access to farmlands in both zones, which were becoming more important than before as cultivation had come to comprise a larger part of Hongshan subsistence strategies. About 65% of regional population, both in Chifeng and the Upper Daling Valley, resided on the uplands, a proportion that was just a bit lower than that in the early Neolithic. With that in mind, the same 35% of the Chifeng regional population distributed in the 200m single-sided buffer band indicated a genuinely stronger preference for settling in the ecotone, which makes good sense because agriculture was taking a more important role in subsistence strategies into Hongshan times along with a three-fold growth of regional population. Moreover, that as much as 41% of Upper Daling regional population was concentrated in the ecotone which took up an even smaller portion (5%) of the total land was just another way to show that the risk-buffering strategy was really a more important factor in the decision of settlement location in the Upper Daling Valley, an observation already made in previous subsections. Compared with the early Neolithic patterns, Hongshan settlements were more focused on the ecotone, especially in the more densely occupied Upper Daling Valley, where ritual expression, but nothing else, appeared stronger than in Chifeng.

Lower Xiajiadian Patterns of Settlement Distribution (2000 to 1200 BCE)

The Lower Xiajiadian period marks the beginning of Bronze Age in northeastern China. Results from stratigraphic excavation in the Chifeng survey area were consistent with numerous other studies arguing for a Lower Xiajiadian subsistence that was centered on millet production combined with animal husbandry (Li and Gao 1984; Peterson 2011; Sun 2013; Zhao 2011). Population growth was substantial in both Chifeng and the Upper Daling Valley, potentially as a result of wetter climatic conditions during early Lower Xiajiadian times (Teng and Shelach 2011b). Regional population in Chifeng was estimated at 40,000-80,000 people, representing a 20-fold increase in population (Chifeng International Collaborative Archaeological Research Project 2011a). The Upper Daling population, estimated at 3,500-7,000 people, also showed a remarkable five-fold growth (Peterson et al. 2014a). With that disparity in population level, community organization started to show some quantitative differences between the two regions, too (Drennan et al. 2014). Larger local communities of 500-1,000 or more inhabitants, ones that could be called "towns," emerged in Chifeng. These larger settlements were newly popular residential locations as about 60% of Chifeng regional population lived in these towns. The largest local communities in the Upper Daling Valley, on the other hand, only ranged between 300-600 inhabitants. Still, the trend toward more populous settlements was visible in the Upper Daling survey area, too, albeit to a lesser extent. The proportion of Upper Daling regional population living in local communities of more than 50-100 inhabitants increased to 72% during Lower Xiajiadian times. As for supra-local communities, they grew sharply in demographic size in Chifeng, with several now having as many as 4,000-7,000 people. Supra-local communities in the Upper Daling Valley also showed an increase in demographic size of two to three times, incorporating up to 1,200-2,500 people. Their spatial size, however, did not change much from Hongshan times in both regions. Supra-local communities delineated for the Upper Daling Valley in fact even shrank a bit. Their independent, autonomous nature, indicated by the lack of size hierarchy, also continued from Hongshan times. Internally, they were all well integrated and often centered on a large local community. Lower Xiajiadian societies were characterized by a more pronounced level of wealth differentiation (Drennan et al. 2014). Considerable variation in burial goods as well as the disparity in residential structure argued strongly for some families being economically much better-off than others (Chinese Academy of Social Sciences Institute of Archaeology 1996; Liu 2006). High quality of artifacts of several materials suggested the likely presence of specialist producers. More importantly, conflict and a constant state of hostilities between Lower Xiajiadian districts were indicated by the presence of fortification facilities, that often included stone enclosures on hilltops, ditches, and gated entries (Neimenggu Zizhiqu Institute of Cultural Relics and Archaeology 2007; 2010; Shelach, Raphael, and Jaffe 2011; Su 1986).

Results of our analyses relate to these descriptions of Lower Xiajiadian societies in more nuanced ways. The preference for rolling uplands continued in Chifeng, agreeing with the observation in the survey report that bluff edge locations, especially near the boundary of the two zones, were strongly favored (Chifeng International Collaborative Archaeological Research Project 2011a). About 74% of the Chifeng regional population lived there, leading to a remarkable upland density at 88.5 persons per sq km. In addition, the concentration of Chifeng population in the ecotone was astonishing. As much as 53% of regional population was found on the 200m single-sided buffer band that comprised only 8% of the total land. The resulting buffer density at 314.0 persons per sq km reflected a serious concern over the risk-buffering strategy when choosing settlement location, potentially as a result of an enormous population facing a general climatic instability during the later part of the Lower Xiajiadian period (Teng and Shelach 2011b).

Moreover, much of the Lower Xiajiadian population living on the hills was in fortified hilltop settlements (Drennan et al. 2014). These patterns in Chifeng showed a high level of consistency with the characteristics of Lower Xiajiadian social dynamics that were focused on scarcity, risk, and competition over resources. In the Upper Daling Valley, on the other hand, rolling uplands were not the most densely occupied zone. Although the survey report indicated that higher ground adjacent to the flat valley floors remained the most favored settlement location (Peterson et al. 2014a), the densest occupation occurred on steep, rocky, and agriculturally unproductive hills, with 51% of regional population concentrated on 34% of total land. Moreover, the buffer density at 88.3 persons per sq km in the Upper Daling Valley was still higher than that of any zone, but the proportion of regional population residing there decreased to only 18%. It seemed that, with a relatively smaller, yet still considerable demographic growth, the Lower Xiajiadian patterns of settlement distribution in the Upper Daling Valley could not be explained by considerations of simple agricultural productivity. The importance of the risk-buffering strategy in the decision of settlement location also did not stand out as extraordinary as it was in Chifeng, or as it had been during Hongshan times. The model based on resource scarcity and conflict seemingly applicable to Chifeng does not produce entirely the same set of changes in the Upper Daling settlement patterns. The relatively lower regional population density in the Upper Daling Valley might have meant less agricultural risk in the face of climatic instability, and people there tended to just live in or near defensible settlements and farm more extensively on the less productive lands that were relatively near them, whereas the much more dramatic population growth in Chifeng with lower precipitation levels and narrower valley floors might have meant more intensive cultivation with substantial numbers of people living in good agricultural lands, more intense competition as a result of which was very likely at the core of the more vigorous Chifeng supra-local community consolidation.

Upper Xiajiadian Patterns of Settlement Distribution (1200 to 600 BCE)

The lack of fortified sites indicated a reduction in conflict and warfare in Upper Xiajiadian times. With decreasing precipitation and a continued growth of population in both Chifeng and the Upper Daling Valley, the radical decline in resource stress was more likely a result of advances in productive technologies, a more specialized economic organization associated with the emergence of a socio-economic integration at a larger scale--stretching as far as to the Central Plains--or a combination of both (Drennan et al. 2014; Teng and Shelach 2011a). More substantial inequalities of wealth were indicated in mortuary remains, while the presence of specialized producers is even more strongly attested to than for previous periods based on the quality of bronze, stone, and other objects (Shelach 1999; 2001). Population grew about a half of the previous period in Chifeng and reached the highest in the regional sequence at 60,000-120,000 people (Chifeng International Collaborative Archaeological Research Project 2011a). The Upper Daling population, estimated now at 7,500-15,000 people, represented a stronger, two-fold increase that narrowed the population-density gap between the two regions (Peterson et al. 2014a). The pattern of town dwelling that was established in Chifeng during Lower Xiajiadian times now characterized community organization in both regions. In Chifeng, 80% of the regional population lived in local communities of over 500-1,000 inhabitants, the largest of which had as many as 6,000-12,000. In the Upper Daling Valley, over half of regional population lived in larger settlements of more than 500 inhabitants. Supra-local communities in both regions were best interpreted as separate, internally centralized polities without integration at a higher scale. All of them were centered on unfortified Upper Xiajiadian towns. Clearly, the social dynamics that had characterized the development of Upper Xiajiadian societies were closely related to a series of town-living experiences, including intensified interaction among inhabitants of compact communities, increasing economic interdependence, and a level of productive specialization higher than ever seen before.

Results of our analyses support many observations in the two survey reports (Chifeng International Collaborative Archaeological Research Project 2011a; Peterson et al. 2014a). In both Chifeng and the Upper Daling Valley, bluff edges and uplands continued to be favorable settlement locations in the face of a growing population and drier climatic conditions during Upper Xiajiadian times. The concentration of regional population in the ecotone in both regions unambiguously indicated the effort to assure food production while managing the risks. However, the locations of some of the densely occupied towns, likely determined by political and economic patterns on a scale beyond the scope of archaeological survey, altered patterns of settlement distribution in quite different ways between the two regions. In Chifeng, the upland density at 80.8 persons per sq km appeared lower than the hill density at 120.4 persons per sq km, yet, still, 31% of the Chifeng population was concentrated on 8% of the total land contained within the 200m single-sided buffer band, making a much higher buffer density at 262.1 persons per sq km. The dense occupation on the hills when Chifeng population reached the highest in the regional sequence was not likely a forced expansion of occupation due to resource pressure, as there were still a lot of lands left unoccupied in the survey area. Instead, this is more consistent with the observation in the Chifeng report that most of the population on stony hills was inhabitants of Upper Xiajiadian towns that were concentrated in the western half of the survey area, where mountains and high hills were more abundant. The decision to locate these towns at larger distance from valley floors could be to separate occupation and agricultural zones. Maximal utilization of most productive lands could therefore help support an enormous amount of population living in these towns. A high buffer density combined with an only modest upland density would fit this description of economic organization. In the Upper Daling Valley, lessened conflict and generally better environments for agriculture had led to a sharper increase in population and a stronger community consolidation. Unlike in Chifeng, larger Upper Xiajiadian settlements and towns here were more spread out across the entire survey area. If these large settlements were like their Chifeng counterparts, and if the economic organization were to a large extent similar, they would be located somewhat away from the river valley and relied on heavy utilization of most productive lands. Consequently, a modestly high upland density, a modest hill density, and a very high buffer density were expected to characterize Upper Xiajiadian patterns of settlement distribution in the Upper Daling Valley. This does turn out to be the case. The upland density at 89.5 persons per sq km was higher than the modest hill density at 57.7 persons per sq km, but they were both significantly lower than the buffer density at 322.1 persons per sq km. About 31% of Upper Daling population was concentrated on 5% of the total land contained within the 200m single-sided buffer band. Viewed together, these results suggest that even though the exact locations of Upper Xiajiadian towns might be subject to other factors of a socio-political integration at a scale beyond the survey area, the economic organization supporting these towns showed a more or less consistent effect on regional settlement pattern in Chifeng and the Upper Daling Valley.

Zhanguo-Han Patterns of Settlement Distribution (600 BCE to 200 CE)

Zhanguo-Han societies in northeastern China represent small patches of distant hinterland of powerful states with capitals far away in the Central Plains (Drennan et al. 2014). Iron tools would have greatly improved agricultural production. Horse-drawn transportation enabled the exchange network to expand at an unprecedented scale. With social and economic development centered elsewhere, Zhanguo-Han settlements in Chifeng and the Upper Daling Valley were in a very different context than in earlier periods. In Chifeng, regional population declined to 15,000-30,000 people who were distributed in considerably smaller local communities, the largest of which had only 1,500-3,000 inhabitants (Chifeng International Collaborative Archaeological Research Project 2011a). As much as 20% of regional population lived in settlements with 100 or fewer inhabitants. The pattern of independent, internally highly centralized supra-local communities continued in Chifeng, despite their smaller size in both spatial and demographic terms. The Upper Daling population estimated at 2,000-4,000 people represented a demographic decline of a similar degree, but the disappearance of larger settlements, or the trend toward "ruralization", was even more severe here (Peterson et al. 2014a). The largest Upper Daling local community only had 200-400 inhabitants, and about 18% of regional population lived in small settlements that were not larger than farmsteads of one or two families. Moreover, supra-local communities could no longer be easily delineated because there was not any local community in the entire survey area that was demographically large enough to serve as a central place or exert any strong centripetal forces.

The contribution of archaeological settlement study during Zhanguo-Han times is to focus on the impact of a truly large scale political integration on imperial hinterlands (Peterson et al. 2014a). Results of our analyses are primarily meant to complement some of the observations made in the two survey reports (Chifeng International Collaborative Archaeological Research Project 2011a; Peterson et al. 2014a). In Chifeng, the edge of the valley floor and the valley floor itself were popular settlement locations. With a lower population level than during previous Lower or

Upper Xiajiadian times, the focus on these very productive lands was probably due to a demand of tribute from administrative centers outside the survey area. The Zhanguo-Han city of Heicheng, some 100 km south of Chifeng, was suggested in the survey report to be one of such centers. The socio-political importance of Heicheng during Zhanguo-Han times was indicated by the uninterrupted occupation from Zhanguo through Ming (1368 to 1644 CE) of this strategic location, massive wall structures at its peak during Han, and the rare presence of coin molds dating specifically to Xin (9 to 23 CE) along with many other elaborate Han artifacts (Feng and Jiang 1982; Zhaowudameng Cultural Relics Workstation and Ningcheng Cultural Center 1977). Our analyses confirmed the preference for rolling uplands in Chifeng. About 68% of the regional population was located on 41% of the total land that belonged to this zone. However, the upland density at 33.0 persons per sq km was dwarfed by the impressive buffer density at 117.0 persons per sq km. The emphasis on the risk-buffering strategy could be a consequence of population level in Chifeng, which, despite being much lower than during Upper Xiajiadian times, still numbered in the tens of thousands of people. It could also result from the generally unstable climatic conditions that had continued since Upper Xiajiadian times. Or, it might have a lot to do with heavy imperial taxation demand from Heicheng and other Zhanguo-Han cities. The scope of this phenomenon would be out of reach of archaeological survey. In the Upper Daling Valley, there was a similar, modestly strong preference for the uplands (Peterson et al. 2014a). About 60% of the regional population was found on 36% of the total land that belonged to this zone. However, inhabitants of the Upper Daling Valley were not attracted to settle in the ecotone as much as they were in Chifeng. The buffer density at 43.6 persons per sq km was not significantly higher than the upland density at 27.6 persons per sq km, definitely not as much as it was in Chifeng. Once again, the reasons behind the only modest degree of emphasis on the risk-buffering strategy cannot be accurately pinpointed with current evidence. But it was not counterintuitive to see a lessened concern over risks in the Upper Daling Valley with somewhat better environments for agriculture and a much lower population level. In addition, no trace of Zhanguo-Han administrative centers as important as Heicheng was found near the survey area. Although Heicheng was located closer to the Upper Daling survey area than it was to the Chifeng survey area, it would have less access to this region due to a more complicated topography in between. The Upper Daling patterns of settlement distribution would be consistent with the scenario of several small, broadly scattered communities that maintained a general preference for the uplands and were not subject to imperial tribute demand to a similar extent as those in Chifeng were.

Liao Patterns of Settlement Distribution (200 to 1300 CE)

An intensification of the large-scale, highly diverse, and specialized economic interdependence characterized the social dynamics of Liao societies (Drennan et al. 2014). The Liao capital of Zhongjing was located between the Chifeng and Upper Daling survey areas, about 75 km from either one, making the two survey areas not distant hinterlands of an empire, but parts of the very important heartlands close to the major capital. Chifeng population grew back to 30,000-60,000 people, about half of which lived in the historically known town of Songshanzhou, a lower-level Liao administrative center (Chifeng International Collaborative Archaeological Research Project 2011a). Apart from those living in Songshanzhou, the rest of the Liao occupation was more broadly scattered throughout the survey area in numerous small local communities that rarely exceeded 1,000 inhabitants in size. A sharp distinction was thus recognized in the Chifeng report between town-dwelling and living in rural hinterland. The same community organization also characterized the Upper Daling Valley, except that the mid-level Liao administrative center of Lizhou encompassed as much as 84% of the regional population within the survey area (Peterson et al. 2014a). On the contrary, the largest local community second to Lizhou only had 150-300 inhabitants. At the regional scale, strong integration was indicated for the first time in both Chifeng and the Upper Daling Valley. The high level of correspondence between boundaries of neighboring historically known Liao county seats and the limits of the Lizhou district delineated using smoothed surfaces as described in chapter two attested to the validity of the analytical approaches used in the two survey reports.

In Liao times, living on the valley floors was newly possible because houses constructed of fired brick better resisted the ground water, and dikes were built to help contain flood waters and reduce flooding risks (Chifeng International Collaborative Archaeological Research Project 2011a). For inhabitants of the two administrative centers, living on the valley floors was probably particularly desirable because substantial quantities or grain and other bulk goods were being produced and transported to sustain urban populations, including that of Zhongjing, not far from either region. This form of exchange must have encouraged Liao farmers to substantially increase labor investment in cultivation and to live on or very close to the fields they farmed. The agriculturally most productive valley floors without flooding risks made ideal farmlands. The transportation was by animal-drawn cart and required better roads than had ever existed before. These roads could best be built along the level valley floors, too. That both Songshanzhou and Lizhou were located predominantly on valley floors agreed well with these descriptions of Liao social dynamics. Overall, valley floors were the most densely occupied zone in both survey areas, with the valley floor density estimated at 56.3 persons per sq km in Chifeng and at 178.4 persons per sq km in the Upper Daling Valley, both higher than the buffer density of 55.6 and 36.2 persons per sq km in their respective region.

Outside of the two towns, on the other hand, patterns of settlement distribution in the countryside looked somewhat different. There was a modestly strong preference for the uplands in Chifeng outside Songshanzhou. With Songshanzhou removed from the analysis, 69% of the rest of regional population lived on rolling uplands that only took up 41% of the total land. The buffer density in the rest of the survey area at 36.2 persons per sq km, while still somewhat higher than the upland density at 30.3 persons per sq km, represented only 17% of the rest of Chifeng regional population on 8% of the total land, marking the lowest proportion in the entire sequence. The concern over the risk-buffering strategy was visible, but did not seem as important as it used to be. On the other hand, in the Upper Daling countryside, the preference for settling on the uplands was stronger than in the Chifeng countryside. With Lizhou removed from the analysis, fully 83% of the remaining Upper Daling population was concentrated on 36% of the total land that were rolling uplands. In addition, that 19% of the Upper Daling countryside population resided on 5% of the total land contained within the 200m single-sided buffer band also represented a heavier focus of occupation on the ecotone than in Chifeng. As in Zhanguo-Han times, the factors shaping the differences in patterns of settlement distribution between Chifeng and Upper Daling countryside, especially the unequal levels of concern over the risk-buffering strategy, could not be precisely pinpointed. It could simply be that Lizhou, being a higher-level administrative center, imposed a heavier demand of tribute in the form of staple food on Upper Daling villages and farmsteads. Supporting this possibility was the contrast in population density not only between Lizhou and Songshanzhou, but also between the Upper Daling countryside and the Chifeng countryside. The much more densely occupied Lizhou might have to extract more tribute from the rest of the survey area that was only about half as densely occupied as the Chifeng survey area outside Songshanzhou. Or the seemingly heavier utilization of the ecotone in the Upper Daling countryside could be at least partly attributable to the smaller survey area which could only include this many villages and farmsteads subject to the demand of tribute around Lizhou, while a lot more potential taxation subjects located further away from Songshanzhou could be included in the larger Chifeng survey area were. The modest focus of Chifeng countryside population on the ecotone could just result from the intensity of tribute demand and the feasibility of enforcing it decreasing with distance.

3.3 Summary: The "Normal" Patterns of Hongshan Settlement Distribution

Some of the observations derived from the diachronic comparisons between the two regions in the previous subsection may help us make better sense of Hongshan settlement preferences. Specifically, how to understand the higher regional population in Upper Daling Valley during Hongshan times? And what did higher buffer densities, also occurring in the Upper Daling Valley, have to do with that? As was revealed earlier, regional population density in the Upper Daling Valley had consistently been lower than that in Chifeng throughout thousands of years before and after Hongshan times, until Liao. Were it not for the urban population in Lizhou, Hongshan would have been the only period of time the Upper Daling Valley was more densely occupied than Chifeng. The generally better environments for practicing agriculture in the Upper Daling Valley seldom led to a denser occupation. The denser occupation in either one of the two regions seems better explained in reference to the working of socio-political factors. The spatial extent of Xinglongwa and Zhaobaogou societies without a doubt included the Upper Daling survey area, yet it was in Chifeng that stronger signs of early Neolithic occupation were recorded. This might be due to better climatic conditions in Chifeng, a smaller role of agriculture in subsistence strategies, or just the vagaries of occurrence associated with their sparse occupation. During Lower Xiajiadian times, more vigorous social development, accompanied by a higher regional population, was observed in Chifeng. During Upper Xiajiadian times, when conflict and resource scarcity that had so profoundly characterized the social dynamics of Lower Xiajiadian societies in Chifeng were lessened and resolved, Chifeng settlements continued to grow larger and harbored a larger portion of regional population. The demographic size of Upper Daling local communities also grew with a sharp increase in regional population, too, but its overall population level was still notably lower than in Chifeng. Chifeng continued to be occupied some 1.2 times more densely than the Upper Daling Valley during the subsequent Zhanguo-Han, likely as a result of its more accessible location from the city of Heicheng. It was not until Liao times that the Upper Daling Valley once again showed a higher regional population density, likely due to the presence of the mid-level Liao administrative center of Lizhou within the survey area. During Liao times, regional density in the Upper Daling survey area was about 1.8 times higher than that in Chifeng. From this perspective, the twice higher Upper Daling regional density during Hongshan times seemed to invite socio-political interpretations rather than simply reflecting better environments for practicing agriculture.

Another observation in the diachronic comparisons above is that, while the ecotone has consistently been preferred settlement locations in both Chifeng and the Upper Daling Valley (the observed proportion of regional population on the 200m single-sided buffer band was seldom below the topologically expected proportion), buffer densities corresponded to population levels to varying degrees. Changes in the degree of correspondence between disparity in ecotone density and disparity in regional population density through time may inform of the relationship between buffer densities and population levels (Table 3.1). During Hongshan times when agriculture became an important part of subsistence strategies, the buffer density at 43.6 persons per sq km in the Upper Daling Valley was about 3.7 times higher than the buffer density in Chifeng at 11.7 persons per sq km. Meanwhile, regional population density in the Upper Daling Valley was around two times higher than that in Chifeng.

Table 3.1 Region with a heavier population concentration in the ecotone through time. Note the varying levels of correspondence between buffer densities and regional population densities.

	HS	LXJD	UXJD	ZG-Han	Liao
Region with a Heavier Population Concentration in the Ecotone	Upper Daling	Chifeng	Upper Daling	Chifeng	Chifeng
Disparity in Ecotone Density	3.7	3.6	1.2	2.7	1.5
Disparity in Regional Population Density	2.0	1.9	0.8	1.2	0.6
Correspondence	Good	Good	Neutral	Bad	Bad

During Upper Xiajiadian times, the positive relationship between buffer densities and regional population densities showed a reversal. However, this should not be seen as a major violation of the correlation because occupation in both regions was heavily focused on the ecotone to some extent, and the fast-growing population in the Upper Daling Valley made the population-density gap between the two regions narrower than ever. The first real deviation from the trend seemed to happen during Zhanguo-Han times when buffer densities in Chifeng appeared much higher than in the Upper Daling Valley despite roughly similar regional population densities between the two survey areas. Inhabitants of the Chifeng region were much more concerned with effective risk management than they should probably have been with this level of regional population density, which was lower in an absolute sense since Upper Xiajiadian times as well as in a relative sense compared with the similar density in the Upper Daling Valley. The numbers for the Liao period apparently resulted from a substantial proportion of Upper Daling population living in Lizhou that was located on the river floor. If the two Liao cities, Songshanzhou in Chifeng and Lizhou in the Upper Daling Valley, were removed from the calculation, buffer densities were exactly the same at 36.2 persons per sq km in both regions. However, the Chifeng countryside was about 1.8 times more densely occupied than the Upper Daling countryside, making population concentration in the ecotone in the Upper Daling Valley relatively more unusual. There seems to be a general trend. The positive relationship between buffer densities and regional population densities earlier in the sequence appeared to be altered by other powerful social processes during later periods. The growth of an extensive socio-political integration since Upper Xiajiadian times, the intensification of long-distance exchange network, and the provisioning of state-level administrative centers, could all be among the important factors shaping risk-buffering behaviors of premodern farmers. From this perspective, the intensity of population concentration in the ecotone in the Upper Daling Valley during Hongshan times seemed to be better explained in terms of higher population densities there (which was a result of socio-political forces). With these tentative statements, a productive next step would be to try to disentangle the relationships between population level, socio-political factors, and their often contradictive forces shaping settlement distribution. To do this, the following chapter switches the bases of the analyses and focus on these forces themselves and their observed impact on settlement pattern.

4.0 The Quadrat Grid Approach

The analyses to this point of settlement distribution in accordance with zones rely on assumptions about agricultural productivity and farming strategies. Derived from observations on modern agricultural practices, these assumptions have gained empirical support from this and other settlement studies (Drennan, Peterson, and Berrey 2020), but the applicability of these assumptions to premodern agricultural systems ultimately remains difficult to assess. In addition, despite some propositions that have been put forward along the way, it remains a difficult task to assess to what extent the patten of settlement distribution observed in archaeological records is a result of environment conditions and to what extent it is a product of socio-political factors. To that goal, it would be helpful to compare the pattern of settlement distribution in relation to environments (what was done in chapter three) with the locations of settlement concentration as a result of socio-political factors in relation to environments. In the following analyses, this study seeks to identify if there is any zonal basis for the formation of settlement concentration by making the starting point not assumptions about agricultural productivity or farming strategies, but instead a society in which social centripetal forces exist to create concentrations of human occupation (Drennan, Quattrin, and Peterson 2006; Nicholas 1989). This study is searching in Chifeng and the Upper Daling Valley for the locations where strong deviations from expected population occurred in each period, based on what is known about the distribution of population across the zones. The results are an environmental profiling of settlement concentration for each period that will help assess the accuracy of the zonal model and provide a sounder base for the discussion of internal social dynamics underlying trajectories of social change in northeastern China.

4.1 Centrifugal Forces, Centripetal Forces, and Settlement Concentration

Observed Population and Expected Population

This set of analyses uses a grid of quadrats, each 500 by 500 m, covering the entire survey area in both regions. The size of the quadrats used here was chosen with a view to sensibly apprehending patterns of settlement distribution that were a result of both centripetal and centrifugal forces simultaneously operating in a region. A scale between a typical Neolithic local community and a typical Neolithic supra-local community would be appropriate for observing the working of both kinds of forces and avoid giving undue explaining power to either of them. Once the grid of 500m quadrats was in place, the total observed population for each period was measured in each of the 4,940 quadrats that cover the Chifeng survey area (Figure 4.1) and 794 quadrats that cover the Upper Daling survey area (Figure 4.2). Fully saturated red quadrats show relatively higher observed population, while lighter and less saturated red quadrats indicate gradually lower observed population. The clustering of high value, saturated red quadrats in the map is where settlement concentration occurred in the survey area.

The level of settlement concentration can be evaluated in several ways. Relative standard deviation ($RSD = 100 \times \frac{s}{|\bar{x}|}$), for example, is an analytical tool for measuring how spread out a set of data is from the mean value in a relative sense. If each of the 4,940 quadrats in Chifeng is treated as a case whose value represents the number of persons living in that quadrat, the 4,940 cases will form a set of data that is more spread out if some quadrats are more densely occupied than others. The level of settlement concentration in Chifeng can therefore be mathematically evaluated with RSD and be compared with that in other regions or during different periods of time. RSD is calculated by dividing the standard deviation by the absolute mean value and multiplying by 100 to express it as a percentage of the mean value. Standard deviation ($s = \sqrt{\frac{1}{(n-1)} \sum_{i=1}^{n} (x_i - \bar{x})^2}$) is the square root of the data set's variance, which is obtained by adding together the squared deviation of each variable from the sample mean, and then dividing the sum by sample size minus one (degrees of freedom). If some quadrats were much more densely occupied than others, the variance (the sum of each variable's deviation from the sample mean) will be larger, resulting in a higher RSD for observed population in all quadrats. If, on the other hand, these quadrats were more or less equally densely occupied, the variance will be smaller, resulting in a lower RSD. Changes in RSD values through time indicate changes in the level of settlement concentration (Table 4.1)

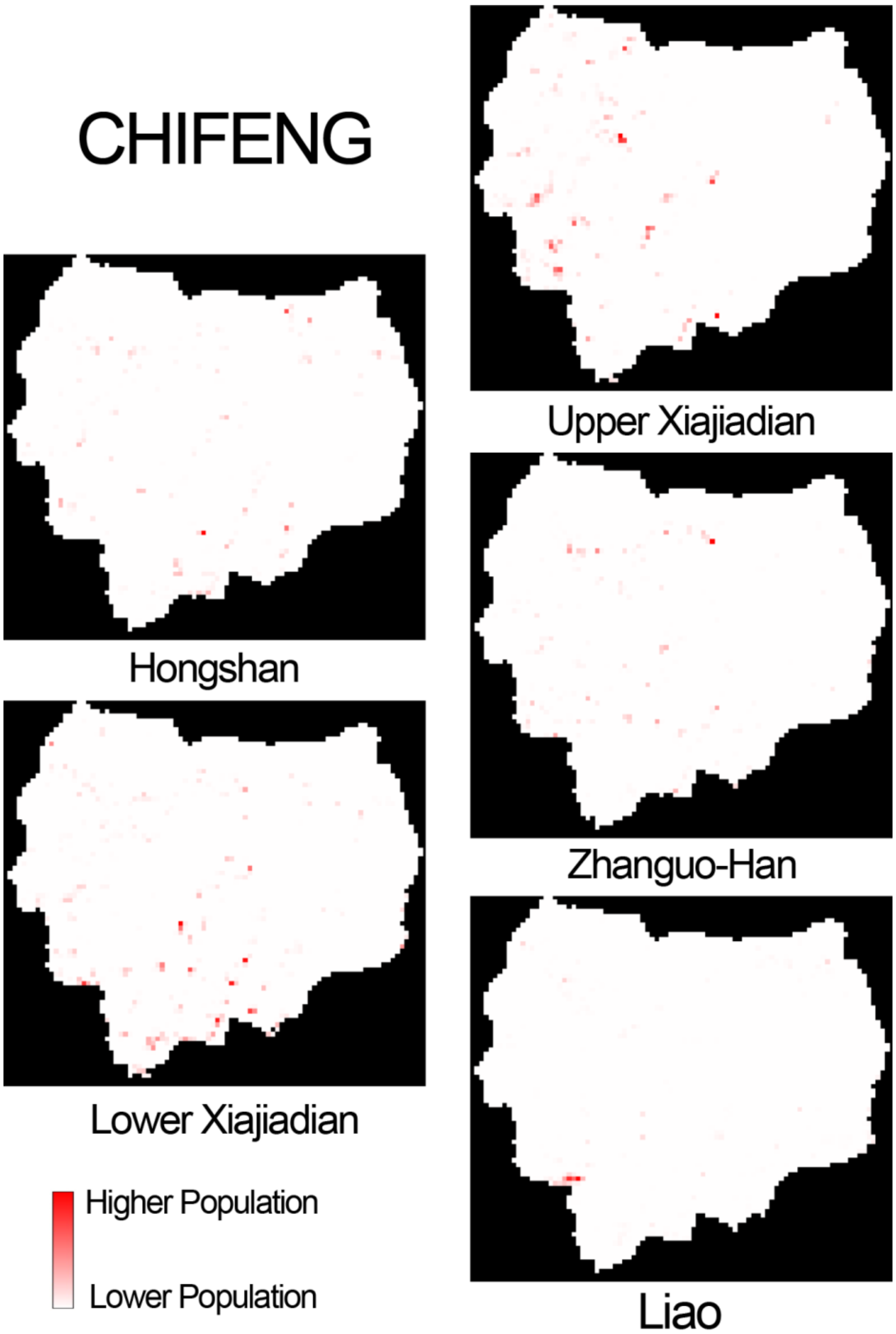

Figure 4.1 Observed population by 500m quadrat in Chifeng. Fully saturated red indicates quadrats with a relatively higher observed population for the period. Lighter and less saturated red indicates quadrats with a gradually lower observed population.

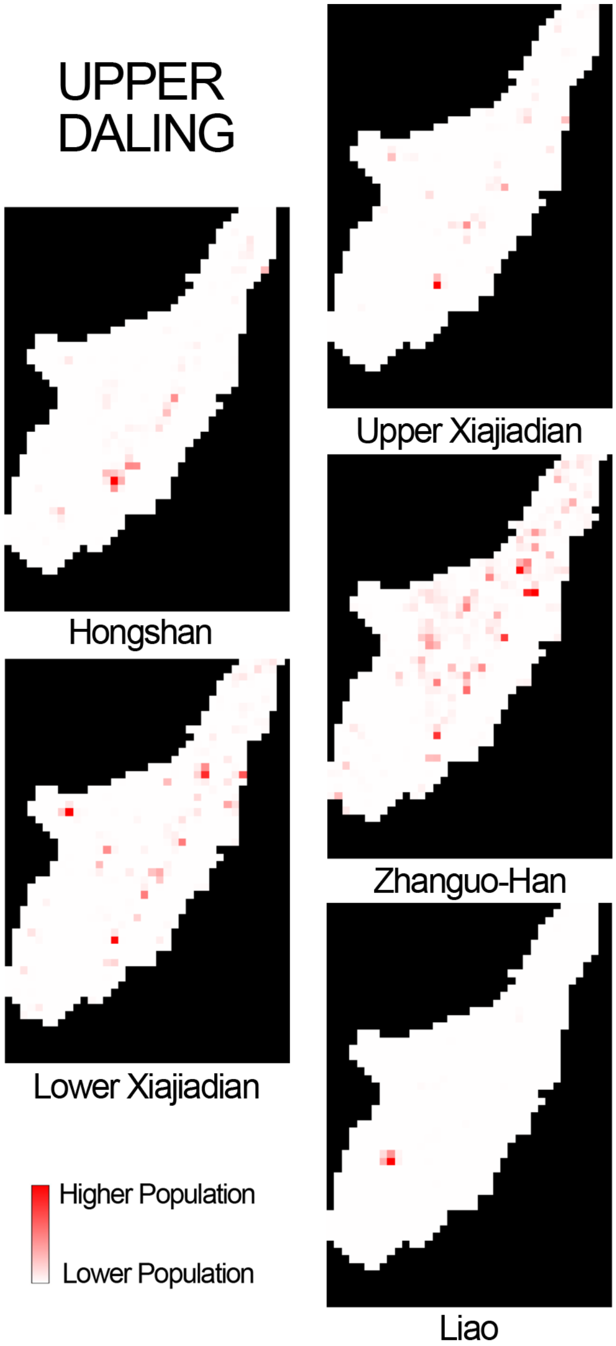

Figure 4.2 Observed population by 500m quadrat in the Upper Daling Valley. Fully saturated red indicates quadrats with a relatively higher observed population for the period. Lighter and less saturated red indicates quadrats with a gradually lower observed population.

Table 4.1 Observed and expected population by 500m quadrat in Chifeng and the Upper Daling Valley. Bold numbers are noticeably larger numbers.

CHIFENG	HS	LXJD	UXJD	ZG-Han	Liao
RSD of Observed Population (%)	906	741	785	993	1465
RSD of Observed minus Expected Population (%)	79K	**26K**	**182K**	**405K**	18K
Correlation between Observed and Expected Population (r^2)	0.008	0.034	0.012	0.014	0.001
UPPER DALING	HS	LXJD	UXJD	ZG-Han	Liao
RSD of Observed Population (%)	579	508	593	350	1386
RSD of Observed minus Expected Population (%)	**145K**	10K	20K	14K	30K
Correlation between Observed and Expected Population (r^2)	0.08	0.01	0.008	0.024	0.01

Next, for each period, the overall actual population densities estimated in chapter three for each of the four zones, including the 200m single-sided buffer band, were treated as the expected population density for each 500m quadrat in that zone. The total expected population for a quadrat was based on the area of each of the four zones contained in that 500m quadrat. Take a random quadrat of 25 ha in Chifeng during Lower Xiajiadian times as an example. Its territory includes 10 ha of valley floors. For the Lower Xiajiadian period, the population density of valley floors was estimated at 0.211 persons per ha. Therefore, a total of 2.11 persons would be expected to live in the 10 ha of valley floor in this quadrat. The total expected population for a quadrat is thus determined by adding together the expected populations for all zones occurring in that quadrat. The correspondence between the observed and expected populations for all quadrats in each region can then be evaluated with the square of the correlation coefficient (r^2) (Table 4.1). It will be relatively close to 1 if the observed population matches the expected well across the quadrats, and close to 0 if the observed population differs substantially from the expected in many of the quadrats. The correlation coefficients thus indicate how well environmental conditions for practicing agriculture predict the density of occupation through time.

Finally, the total expected population for each period in each quadrat was subtracted from the actually observed population for that period in that quadrat. The resulting numbers are positive if more people were actually observed than expected, and negative if fewer people were actually observed than expected. If environments perfectly predict settlement distribution, the observed minus expected value for a quadrat will be zero. Red and orange quadrats in Figures 4.3 and 4.4 indicate where in the survey area substantially more occupation than expected occurred and formed settlement concentrations, enabling us to determine just where some factor drew people to reside where they did despite environmental conditions. In addition, the RSD of observed minus expected population for all quadrats indicates the strength of the centripetal forces that drew people to reside in locations that do not match our environmentally-based expectations (Table 4.1). They are expressed as a percentage of the mean value, which enables comparisons with the RSD of simple observed population and between the two regions. Take the first column in Table 4.1 as an example, the standard deviation of observed population for all quadrats in Chifeng during Hongshan times is about 9 times (906%) larger than the mean value, suggesting some quadrats were indeed quite more densely occupied than others. However, the standard deviation of observed minus expected population for all quadrats in the same region is about 790 times (79,000%, abbreviated as 79K%) larger than the mean value, showing that the quadrat values are a lot more spread out with environmentally-based expected population deducted from them. The contrast is sharper in the Upper Daling Valley. The standard deviation of observed population for all Upper

Daling quadrats during Hongshan times is about 5.8 times (579%) larger than the mean value. Some quadrats in the Upper Daling Valley were similarly more densely occupied than others, but to a lesser degree than those in Chifeng were. However, the standard deviation of observed minus expected population in the Upper Daling Valley is as much as 1450 times (145K%) larger than the mean value. With environmentally-based expected population deducted from the quadrat values, they are considerably much more spread out. The implication of the contrast between the two kinds of RSD values will be discussed shortly.

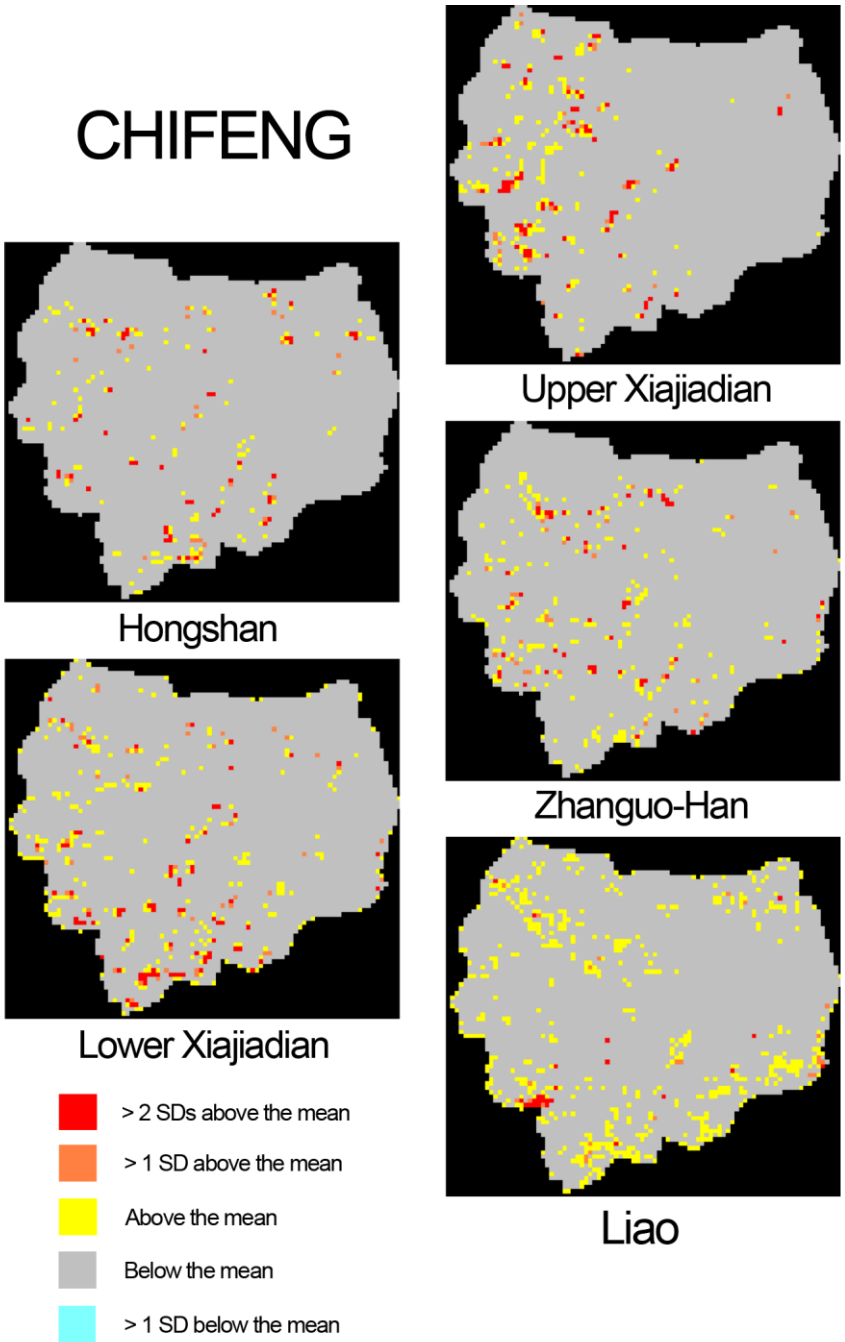

Figure 4.3 Observed minus expected population by 500m quadrat in Chifeng. Red quadrats represent a value more than 2 standard deviations above the mean value for all quadrats; orange quadrats represent a value 1 to 2 standard deviations above the mean; yellow quadrats represent a value less than 1 standard deviation above the mean; grey quadrats represent a value less than 1 standard deviation below the mean; and light blue quadrats represent a value 1 to 2 standard deviations below the mean.

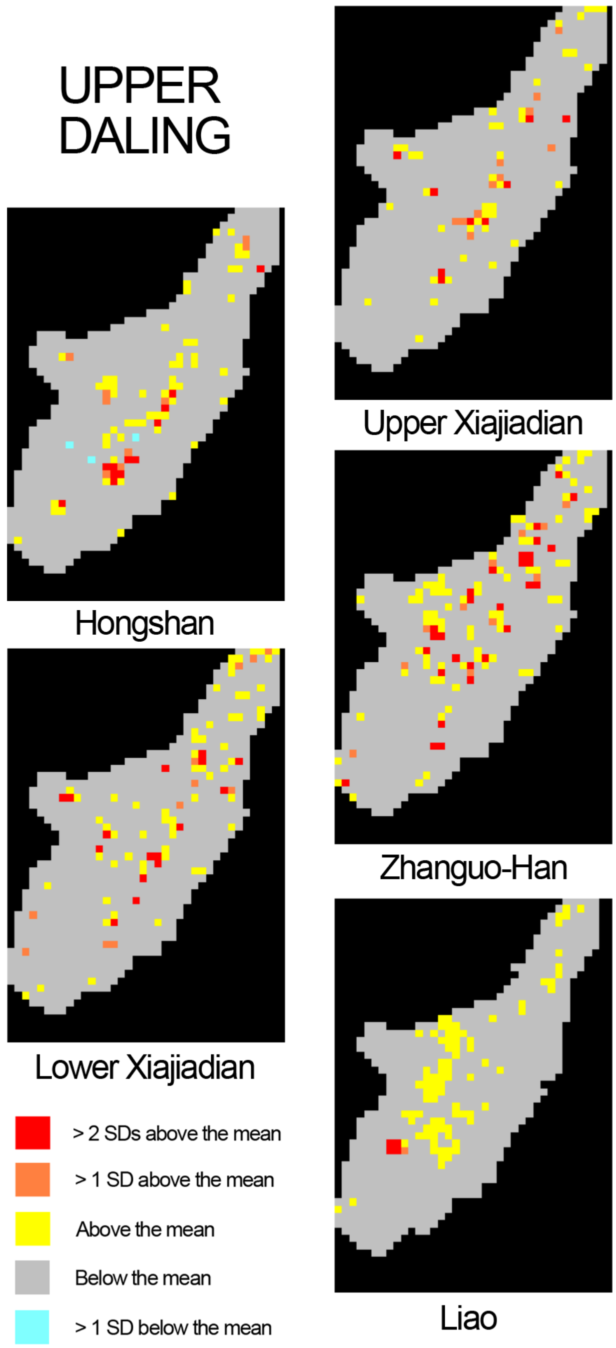

Figure 4.4 Observed minus expected population by 500m quadrat in the Upper Daling Valley. Red quadrats represent a value more than 2 standard deviations above the mean value for all quadrats; orange quadrats represent a value 1 to 2 standard deviations above the mean; yellow quadrats represent a value less than 1 standard deviation above the mean; grey quadrats represent a value less than 1 standard deviation below the mean; and light blue quadrats represent a value 1 to 2 standard deviations below the mean.

Centrifugal Forces, Centripetal Forces, and Settlement Concentration

The quadrat grid approach thus enables us to determine the extent to which the observed population matches the expected population calculated on the basis of environmental zones. At this scale, environments have accounted quite little for the actual amount of population recorded in a quadrat throughout the entire sequence, despite varying zonal preferences from one period to another. The immediate impression is that the correlations between observed and expected population are all extremely weak in both Chifeng and the Upper Daling Valley. The absolutely optimal population distribution was bent seriously out of shape by large numbers of quadrats showing a lot more population than expected in both Chifeng and the Upper Daling Valley. This may be a direct result of population pressure never being high enough to force people to use resources maximally. Premodern inhabitants of northeastern China might have never felt any urgent need to set off and look for unoccupied, better lands in other parts of the survey area, even though people did show unmistakable preferences to live in certain zones rather than others. Another possibility, though, is that there were supra-local communities creating centripetal forces in all periods, and encouraging people to live in impractical locations from the single point of view of agricultural productivity. Or, both factors could have been operating together to create the same effect.

A direct visual inspection of the two sets of maps argues for the effect of centripetal forces on the discrepancy between observed and expected population. With environmentally-based expected population deducted from the quadrat values, the resulting higher-than-expected quadrats, instead of occurring randomly, form visible clusters in both survey areas (Figure 4.3 and 4.4). Their patterns of grouping remained largely unchanged when compared with the maps of 500m quadrats with observed population (Figure 4.1 and 4.2). While more obvious in some periods than in others, the overall high degree of locational correspondence indicates these settlement concentrations were produced by centripetal forces that operated beyond the quadrat scale rather than a simple reflection of environmental conditions. Also in support of this proposition are the constantly substantially higher RSD values of observed minus expected population than RSD values of observed population in both regions and throughout the entire sequence. It shows that some quadrats were more densely occupied than others to a much greater extent when environmentally-based expected population was deducted from the quadrat values. Factors other than environmental conditions have contributed to much more spread out quadrat values than the zonal factors have done.

We are therefore presented with two major contrasting forces shaping settlement distribution. One one hand, unambiguous zonal preferences attested to farmers' considerable zonal sensitivity in choosing settlement location (Figure 3.5 to 3.8). As agriculturally productive lands and the ecotone are not geographically concentrated in Chifeng or the Upper Daling Valley (Figure 3.1), subsistence considerations that encourage population to disperse and distribute in closer correspondence to these preferable lands would create a sort of centrifugal force, producing lower numbers of both RSD of observed population and RSD of observed minus expected population. The correlation between observed and expected population would also be relatively stronger. On the other hand, when social integration at the regional scale is vigorous and supra-local communities are well developed, socio-political factors would exert stronger centripetal forces of some sort that draw people closer together than the optimal distribution with regard to resources, and produce higher numbers of both RSD of observed population and RSD of observed minus expected population. The correlation between observed and expected population would be relatively weaker. To observe how the two interplayed differently in different times and places has great potential for further elucidating internal social dynamics in our early discussion. For their impact on settlement pattern, centrifugal and centripetal forces are relative to each other, and they are more often than not operating simultaneously, with varying degrees of strength. Even though it may be assumed that *practical* subsistence considerations would create stronger *local* centrifugal forces opposing the centripetal forces exerted by *distant* centers of supra-local communities, the settlement patterns are still a product of mixed, and often contrasting forces, and interpretation remains a challenging task.

We may proceed with the following inter-regional comparison, assuming firstly that the region with overall higher population levels (in terms of regional population density) is expected to show a stronger correlation between observed and expected population than in the other region during the same period, and secondly that the region with more strongly developed supra-local communities is expected to show a higher RSD of observed minus expected population. Inter-regional comparison of RSD values of observed population may be less informative because population pressure was likely never high enough to force people to overflow to unoccupied quadrats elsewhere in either of the two survey areas. Even when regional population densities were the highest and zonal preferences for settlement location were strongly expressed during Lower and Upper Xiajiadian times in Chifeng and Upper Xiajiadian and Liao times in the Upper Daling Valley, a lot of quadrats remained underoccupied in both regions.

Hongshan Patterns of Settlement Concentration (4500 to 3000 BCE)

The characteristics of Hongshan patterns of settlement concentration indicate powerful social centripetal forces shaping settlement distribution, especially in the Upper Daling Valley. The slightly higher RSD of observed population in Chifeng was incomparable to the substantially higher RSD of observed minus expected population in the Upper Daling Valley. Settlement concentration as a result of strong centripetal forces was more vigorous there than it was in Chifeng, despite the general similarity in community organization between the two regions (Peterson et al. 2014a). The quadrats with more population than expected coincide with Dongshanzui and the centers of other Hongshan supra-local communities. And correspondingly the quadrats with less occupation than expected are fairly far from those centers. On the other hand, Hongshan settlement concentration in the Upper Daling Valley was less likely a consequence of weak centrifugal forces. The proportion of population concentrated in the ecotone was high, and the correlation between observed and expected population was relatively stronger than in Chifeng or during other periods. These numbers suggested Hongshan farmers in the Upper Daling Valley were indeed more sensitive to environments in choosing settlement location and thus subject to the centrifugal forces to a relatively larger extent, as one would expect for a region with higher Hongshan population density. But the effect of centrifugal forces derived from subsistence considerations on settlement distribution must have been overshadowed by the impact of much stronger social centripetal forces that had accompanied more pronounced Hongshan social development in the Upper Daling Valley.

Lower Xiajiadian Patterns of Settlement Concentration (2000 to 1200 BCE)

The characteristics of Lower Xiajiadian patterns of settlement concentration indicate powerful social centripetal forces as well as influential centrifugal forces shaping settlement distribution in Chifeng. A noticeable decline in both RSD of observed population and RSD of observed minus expected population in both Chifeng and the Upper Daling Valley must have resulted from a spatial expansion of occupation in both regions (Chifeng International

Collaborative Archaeological Research Project 2011a; Peterson et al. 2014a). The implication that resource scarcity associated with a fast-growing population would force people to look for and settle on previously unoccupied lands also finds support in the stronger correlation between observed and expected population in Chifeng. Settlement distribution there was subject to stronger centrifugal forces, which could reasonably be related to a higher population level. However, the higher RSD of observed minus expected population, also in Chifeng, indicated stronger centripetal forces operating to shape settlement concentration, too. Horizonal comparisons revealed that Chifeng during Lower Xiajiadian times was just like the Upper Daling Valley during Hongshan times. Two kinds of forces, working in opposite directions, were relatively stronger in the same region. What seemed to be unique for Chifeng during Lower Xiajiadian times, though, was that the severity of resource pressure might have made the impact of centripetal forces on patterns of settlement distribution appear less pronounced than they really were. The locations of quadrats with more population than expected match well with that of larger settlements and centers of Lower Xiajiadian supra-local communities, except for a few high value quadrats scattered in the eastern part of the Chifeng survey area, where no supra-local community was present. The fast-growing population in Chifeng made sensible choice of settlement location more necessary than ever, yet the Chifeng supra-local communities that were more strongly developed also exercised stronger social centripetal forces, leading to a higher RSD of observed minus expected population.

Upper Xiajiadian Patterns of Settlement Concentration (1200 to 600 BCE)

The characteristics of Upper Xiajiadian patterns of settlement concentration indicate powerful social centripetal forces shaping settlement distribution in Chifeng. With population continuing to grow in both Chifeng and the Upper Daling Valley, the RSD of observed population increased slightly, suggesting inhabitants of the two regions were not forced to look for and settle on unoccupied lands. Instead, Upper Xiajiadian occupation in Chifeng even seemed to concentrate further in the western part of the survey area, leaving the most productive valley floors toward the east underused (Chifeng International Collaborative Archaeological Research Project 2011a). The correlation between observed and expected population appeared equally very weak in both Chifeng and the Upper Daling Valley. Changes in technology and economic organization must have successfully helped mitigate the resource pressure that had loomed large in Lower Xiajiadian social dynamics. Another implication is that, unlike resource scarcity and conflict, the engagement in agricultural production to support Upper Xiajiadian towns did not lead to spatially extensive settlements. As for the much higher RSD of observed minus expected population in Chifeng, it was most likely a reflection of the unusual locations of Upper Xiajiadian larger settlement and towns away from valley floors in the mountainous western survey area. These hills and uplands of higher elevation were not preferred environments for practicing agriculture, yet settlement concentration occurred almost exclusively in these areas, showing strong social centripetal forces at work. Although changes in community organization toward larger settlement were more pronounced in the Upper Daling Valley, population density remained higher in Chifeng, and Upper Xiajiadian towns that were often the center of supra-local communities were also demographically larger in Chifeng (Drennan et al. 2014). These towns must have exerted powerful centripetal forces, attracting larger amounts of population to reside near them. The decent level of locational correspondence between quadrats with more population than expected and centers of Upper Xiajiadian supra-local communities provided yet another line of evidence indicative of influential centripetal forces shaping settlement concentrations despite environments.

Zhanguo-Han Patterns of Settlement Concentration (600 BCE to 200 CE)

The characteristics of Zhanguo-Han patterns of settlement concentration support our previous conclusions about the potential impact of Heicheng on settlement distribution in Chifeng as well as the more severe ruralization of community organization in the Upper Daling Valley. With a decline in regional population by a third to a quarter from the previous period in both Chifeng and the Upper Daling Valley, a weak correlation is expected between observed and expected population as much lower population levels in both regions were unlikely to pose a greater pressure driving people to distribute in closer correspondence with agriculturally productive lands. In Chifeng, patterns of settlement distribution across various zones for practicing agriculture and the continued presence of highly internally centralized supra-local communities indicated a stronger socio-political influence, potentially from Heicheng, prevailing in this region, from which a higher RSD of observed minus expected population would be expected as a result of stronger social centripetal forces. Without any Zhanguo-Han city similar in administrative level, the Upper Daling Valley, on the other hand, should show a lower RSD of observed population as a result of much more scattered settlements, along with a lower RSD of observed minus expected population. All of these are exactly what have been seen in our results. The high RSD of observed population in Chifeng could be more of a reflection of the significantly high RSD of observed minus expected population. That Zhanguo-Han settlement in Chifeng continued to concentrate in the western part of the survey area was likely a result of more vigorous large-scale political integration in Chifeng. On a higher scale, locations of settlement concentrations also matched well with the centers of Zhanguo-Han supra-local communities in Chifeng, while this was not the case in the Upper Daling Valley.

Liao Patterns of Settlement Concentration (200 to 1300 CE)

Since Zhanguo-Han times, premodern societies in northeastern China had been subject to socio-political integration of a scale larger than the scope of archaeological survey (Drennan et al. 2014), especially during Liao times, when the center of a state-level integration, the Liao capital of Zhongjing, was just located between the Chifeng and Upper Daling survey areas, making them imperial heartlands. That supra-local communities could no longer be easily delineated in both regions implied that their scale might far exceed the areal extent of both survey areas. In this context, quadrats of 500 m might not be as adequate for observing social centripetal forces working at this scale as they were in other periods. Nevertheless, there are still a few interesting observations. Just as in other periods, settlement distribution during Liao times was still largely shaped by strong social centripetal forces in both Chifeng and the Upper Daling Valley, but the numeric gap between the two calculations, as indicated by much larger RSD values of observed minus expected population than RSD values of observed population, was narrower than ever before. The RSD of observed minus expected population was not particularly high in either region. The clustering of only a few quadrats with more population than expected around the two cities shows their unmistakable impact on the formation of settlement concentration, but it also makes this impact seem rather local. The contribution of social centripetal forces to the formation of settlement concentration was very conspicuous near the two urban centers, but their influence did not prevail across the entire region as strongly as in some other periods. The localized impact of centripetal forces is also manifested in the distribution of quadrat values. In Chifeng, among a total of 4940 quadrats, there were only 11 that had a value larger than the 10^{th} percentile of observed minus expected population during Liao times, in comparison with 31 and 77 such quadrats during Zhanguo-Han and Upper Xiajiadian times when the high RSD of observed minus expected population indicated strong social centripetal forces prevailing across the entire region. In the Upper Daling Valley, among a total of 794 quadrats, there were only 4 that had a value larger than the 10^{th} percentile of observed minus expected population during Liao times, whereas there were 17 such quadrats during Hongshan times. The RSD of observed population of all time in both Chifeng and the Upper Daling Valley was relatively higher than in previous periods, probably as a result of two contrasting forces. On one hand, the need to provision the two administrative centers, Songshanzhou in Chifeng and Lizhou in the Upper Daling Valley, encouraged a broad dispersal of farmsteads and small hamlets in search of ideal farmlands. On the other hand, the two cities at the same time also attracted a large number of people to live in or near them. All in all, the strength of Liao social centripetal forces was unquestionable, but the relatively small survey area might just not have been sufficient to capture the entire scope of the provisioning phenomenon.

4.2 Environmental Basis for Settlement Concentration

By now, we have seen settlement concentration throughout the sequence was to a large extent a result of strong social centripetal forces, and we have also assessed the relative strength of these centripetal forces operating in each period and each region. The next step in the search for a potential environmental basis for settlement concentration is to establish a set of environmental conditions, or an environmental profile, which characterized where settlement concentration did occur as a result of social centripetal forces. The 200m single-sided buffer band was separated from the general upland category in this analysis, as the preference for uplands does not necessarily equal the preference for living on the bluffs at the edge of the flat valley floor, especially with regard to socio-political factors. That settlement concentration as a result of social centripetal forces occurred more in the ecotone, for example, could have very different implications than if settlement concentration occurred equally frequently on the uplands in general. Quadrats with at least 1 standard deviation higher than the mean value of observed over expected population were selected to represent the locations of our interest. That is, where significantly more population than expected was observed. The numbers of 10 by 10 m cells in each of the four zones were then calculated for every high value quadrat to obtain an environmental profile for settlement concentration in each period, which was then compared with the "default" environmental profile for the region, consisting of the total numbers of 10m cells in each of the four zones in the survey area. If the formation of settlement concentration as a result of social centripetal forces had its environmental basis and tended to occur more in some zones than in others, high value quadrats should be found more frequently in the preferred zones and include more 10m cells on these zones, which would result in an environmental profile quite different from the default environmental profile for the region. If, on the other hand, the formation of settlement concentration as a result of social centripetal forces had no or very little environmental basis, high value quadrats should be expected to tend to occur randomly, and the environmental profile would appear more similar to the default environmental profile for the region. The default regional environmental profile was determined as follows. In Chifeng, valley floors take up 31% of the total land in the entire survey area; general rolling uplands, with the 200m single-sided buffer band excluded, 33%; stony hills, slightly above 27%; and the 200m single-sided buffer band comprises only 8% of the total land (Figure 4.5). In the Upper Daling Valley, valley floors take up 30% of the total land; general rolling uplands, also 30%; stony hills, 34%; and the 200m single-sided buffer band comprises a little more than 5% of the total land (Figure 4.6). These numbers were rounded off to the nearest whole number and represented the set of proportions used as the "background" to be compared with potentially deviating patterns that were actually observed in the field. The results will indicate the presence of an environmental basis for the formation of settlement concentration as a result of social centripetal forces, and their implications will add to our understanding of the developmental dynamics in these premodern societies.

Figure 4.5 Environmental profile for settlement concentration through time in Chifeng. Proportions of the total 10m cells included in high value quadrats where more population than expected was observed for valley floors, general rolling uplands, stony hills, and the 200m single-sided buffer band. The numbers were rounded off to the nearest whole number and added up to 100%.

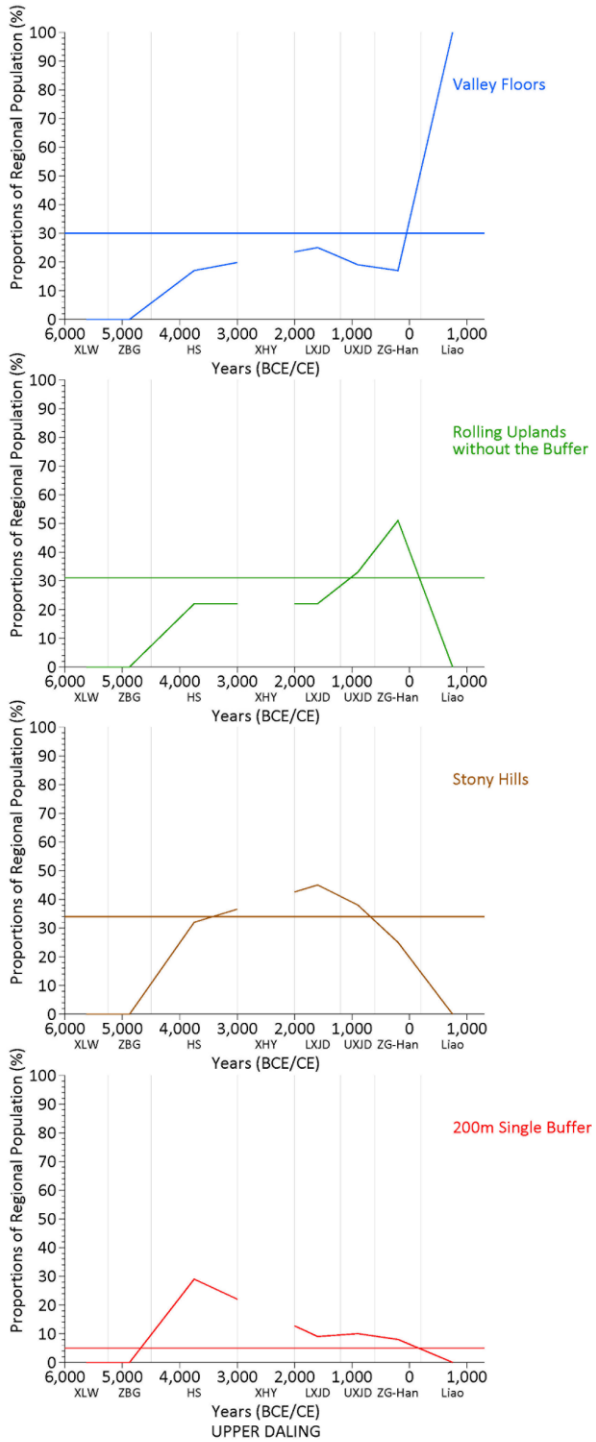

Figure 4.6 Environmental profile for settlement concentration through time in the Upper Daling Valley. Proportions of the total 10m cells included in high value quadrats where more population than expected was observed for valley floors, general rolling uplands, stony hills, and the 200m single-sided buffer band. The numbers were rounded off to the nearest whole number and added up to 100%.

Hongshan Environmental Profile (4500 to 3000 BCE)

During Hongshan times, settlement concentration tended to form in the ecotone more than anywhere else in both Chifeng and the Upper Daling Valley. When the numbers of 10m cells comprising high value quadrats were counted across the four zones in Chifeng, about 23% of them was found on the 200m single-sided buffer band, which only took up 8% of the total land. The tendency was somewhat stronger in the Upper Daling Valley. There, 29% of the cells were found on 5% of the total land contained within the 200m single-sided buffer band. Overall, the formation of Hongshan settlement concentration had a clear, consistent environmental basis, and that the same tendency of settlement concentration to form in the ecotone was stronger in the Upper Daling Valley was unlikely just a simple reflection of the higher population density there. During the subsequent Lower Xiajiadian and Upper Xiajiadian times, when population density in Chifeng became higher than in Upper Daling Valley, and living on the bluffs at the edge of the flat valley floor remained a preferable farming strategy for individual households, the same environmental basis was not observed. The Upper Daling Valley, with stronger ritual expression and a denser Hongshan occupation, not only showed more powerful social centripetal forces, but also had a more pronounced focus of occupation on the ecotone. Our results from this subsection further suggest a functional relation between the two observations. That is, inhabitants of the Upper Daling Valley were paying closer attention to strategically practicing agriculture, presumably to provision non-farming ritual specialists, who must have comprised a larger portion of regional population there.

Lower Xiajiadian Environmental Profile (2000 to 1200 BCE)

Settlement concentration in Chifeng continued the tendency to form in the ecotone during Lower Xiajiadian times, as 25% of the total 10m cells were found in the 200m single-sided buffer band. In the Upper Daling Valley, settlement concentration occurred on stony hills more than anywhere else. There, 45% of the cells were found on 34% of the total land that belonged to that zone, making a somewhat weaker, yet unmistakable preference. On the other hand, the ecotone that was a crucial part of the zonal basis for settlement concentration in Chifeng did not seem particularly important at all in the Upper Daling Valley. A total of 9% of the cells were found on the 200m single-sided buffer band which took up 5% of the total land. The diminished importance of the ecotone in the environmental basis for settlement concentration seemed to have characterized premodern societies in the Upper Daling Valley ever since the end of Hongshan. For Lower Xiajiadian societies in Chifeng, our results make good sense in that social groups competing for resources would prioritize the occupation of best farmlands, which were rolling uplands and bluff edge locations. And the large amount of people drawn together by strong social forces would also require careful selection of lands to settle and farm. The Upper Daling environmental profile is also consistent with our observation in chapter three that less agricultural risk as a result of a lower population level could have allowed people there to just live in or near defensible settlements and farm more extensively on the less productive lands. The contrast in the environmental basis for settlement concentration between the two regions relates to different levels of importance of the risk-buffering strategy felt by Lower Xiajiadian farmers facing different pace of demographic changes in different environments.

Upper Xiajiadian Environmental Profile (1200 to 600 BCE)

The Upper Xiajiadian environmental profile in Chifeng is highly consistent with the observation that towns were concentrated in the mountainous, western half of the survey area. Quadrats with higher observed over expected population in Chifeng included more 10m cells on stony hills and the 200m single-sided buffer band, with 44% and 21% of them found on 27% and 8% of the total land, respectively. The locations of these Upper Xiajiadian towns away from valley floors in an area where hills are much steeper, combined with heavy utilization of productive lands immediately nearby, would have reasonably generated an environmental profile like this. Upper Xiajiadian towns in the Upper Daling Valley, also located away from the river valley, yet more spread out across the entire survey area, produced a near random environmental profile except for a modest avoidance of valley floors. Only 19% of the cells were found on 30% of the total land that were valley floors. The dense occupation in the ecotone in the Upper Daling Valley did not translate into part of the environmental basis for settlement concentration. One possibility is that the sustaining population surrounding demographically smaller Upper Xiajiadian towns in the Upper Daling Valley was not subject to social centripetal forces as strong as those exerted by demographically larger and denser towns in Chifeng, and could be more spread out due to its wider valley floor, which would be consistent with the relatively lower RSD of observed population there. In addition, the declining contribution of the risk-buffering strategy to the environmental basis for settlement concentration since Upper Xiajiadian times, especially in the Upper Daling Valley, might also have resulted from an emerging large-scale socio-economic integration (Drennan et al. 2014). The increasing diversification, specialized subsistence production, and deepening regional interdependence could have helped sustain the population living in large communities without requiring more farmers to produce more.

Zhanguo-Han Environmental Profile (600 BCE to 200 CE)

That 21% of the total 10m cells were found on 8% of the total land contained within the 200m single-sided buffer band in Chifeng implied that risk management continued to be an important part of the environmental basis for settlement concentration during Zhanguo-Han times despite a much lower population level and improved agricultural productivity with iron tools. This is consistent with relatively stronger social centripetal forces observed in Chifeng and the potential need to meet taxation demand from the city of Heicheng. The Upper Daling Valley, on the other hand, experienced much more severe ruralization processes without administrative centers as important as Heicheng found near the survey area. Population distribution was scattered; supra-local communities disappeared, and the distribution of quadrats with more population than expected did not have a clear pattern of recognizable clustering or show alignment with anything. This leads us to interpret the Upper Daling environmental profile as a simple reflection of the general preference to settle on the uplands with a lessened concern over risks, which in turn was likely a result of a much lower population level and somewhat better environments for agriculture in the Upper Daling Valley. Our results present a very interesting contrast between the two regions. If the heavier utilization of the ecotone at a lower population level was indeed a response to the obligation to meet tribute demand in Chifeng, it was experienced across the Chifeng survey area, not only in where settlement concentration occurred, presumably local level administrative centers, but also in smaller local communities, too. On the contrary, inhabitants of the Upper Daling Valley just did not feel the need to live close to the ecotone as much as those in Chifeng did, and settlement concentration was probably very local at scale, instead of showing any easily recognizable regional pattern of clustering. This shows the internal social dynamics of the two regions could be very different even when they were all just part of distant hinterlands of an empire.

Liao Environmental Profile (200 to 1300 CE)

Advances in architectural technologies during Liao times to a large extent prevented the flooding damage on the valley floors and made living on them newly possible. The environmental profile in the Upper Daling Valley showed a heavy focus on this category of lower, flat lands where more than 99% of the total 10m cells that comprised high value quadrats were found. It was apparently a direct reflection of the location of Lizhou on the valley floor, which was not only supreme farmlands for intensive production, but also ideal level ground to build roads that were necessary for animal-drawn carts. Both of them were especially important features of a Liao city. The preference for valley floors in Chifeng, however, was not as predominant as it was in the Upper Daling Valley. For one thing, Songshanzhou did not appear as demographically dominant in the Chifeng survey area as Lizhou did in the Upper Daling survey area. In addition to those in and around Songshanzhou, there were still a few high value quadrats with more population than expected occurring in other parts of the survey area. These additional high value quadrats did not cluster as the ones representing Songshanzhou did, yet they included more cells in different zones. Moreover, the location of Songshanzhou in a narrow river valley toward the southwest of the survey area also meant the quadrats representing it would include cells in zones other than valley floors, too. The end product was a rather random environmental profile that slightly deemphasized the ecotone and agriculturally unproductive stony hills. Around 15% and 14% of the cells were found on 8% and 27% of the total land contained within the 200m single-sided buffer band and the hills, respectively. Both numbers were among the lowest proportions ever observed for that category in any environmental profile in Chifeng. These results generally agree with our expectations for the two regions as imperial heartlands where the need to sustain Liao administrative centers and the involvement in a well-developed exchange network, among other things, would contribute greatly to the environmental basis for settlement concentration.

4.3 Supra-local Communities and the Risk-buffering Strategy

The last part of the analyses considers supra-local communities, which are the spatial clustering at a regional scale of distant local communities, or villages, which may not interact with each other on a daily basis, but do tend to interact with each other more often than with local communities outside the cluster, according to distance-interaction principles (Peterson and Drennan 2005). The formation of supra-local communities was often taken to imply a sort of functional relationship existing among participant local communities and exercising social centripetal forces pulling them closer to each other than to the other non-participant local communities. This human-to-human interaction, whatever the content may be, is the essence of social centripetal forces that draw people closer to one another. The nature and intensity of this functional relationship may vary from one society to another, and the purpose of this subsection is to examine the extent to which the model based on the risk-buffering strategy was relevant to the kind of functional relationship that helped form supra-local communities in premodern societies of northeastern China. As previously noted, risk management has consistently been an important factor in the decision of settlement location, making the bluffs at the edge of the flat valley floor the most densely occupied zone throughout most of the sequence, but how that contributes to the formation of supra-local communities is something worth further examination. In characterizing a supra-local community, although total population, territory, and population density are all listed, it is probably more meaningful to focus only on population density (Table 4.2 and 4.3). The Upper Daling survey area was focused on a river valley and could be too small to confidently determine the exact areal extent of some supra-local communities in certain periods, and, throughout the sequence there has not been a polity demographically particularly larger than others, seemingly dominating the rest. This analysis only includes those time periods with more than two identified supra-local communities, which include Hongshan, Lower Xiajiadian, Upper Xiajiadian, and Zhanguo-Han societies in Chifeng, and Hongshan, Lower Xiajiadian, and Upper Xiajiadian societies in the Upper Daling Valley.

If the formation of supra-local communities in either region during any of these periods had a lot to do with strategically practicing agriculture by mitigating risk, people living in better-developed supra-local communities, ones that were more densely occupied, would be expected to distribute themselves across the zones in better accordance with the risk-buffering rationale, leading to a stronger correlation between population density and the proportion of population living on the 200m single-sided buffer band. On the other hand, if the formation of supra-local communities had relatively little to do with the risk-buffering rationale, either because the risk-buffering strategy was not an important factor in particular, or its significance was overshadowed by other factors, a weaker correlation or none would be expected between population density and the proportion of population living in the ecotone. A conceptual difference was made between the absolute and relative proportions of population living in the ecotone to recognize the complexity of causal relationship between the two. The former simply calculates the observed population living on the 200m single-sided buffer band in a supra-local community, without regard to how much or how little area the 200m single-sided buffer band occupies in that supra-local community;

while the latter is arrived at by subtracting the proportion of the total area of the supra-local community that the 200m single-sided buffer band represents from the proportion of the total population of the supra-local community that the population of the 200m single-sided buffer band represents. The resulting numbers for the relative proportion are positive if people in that supra-local community are more concentrated in the ecotone than the expectation based on the area of the ecotone, and negative if people in that supra-local community are less concentrated in the ecotone than the same expectation based on its area. The implications derived from the results will complement our understanding of the formation of supra-local communities and its relation to the risk-buffering model that has been used to this point.

Table 4.2 Societies with more than two identified supra-local communities in Chifeng. Bold numbers are noticeably larger numbers.

CHIFENG	HS (n=20)	LXJD (n=16)	UXJD (n=13)	ZG-Han (n=18)
RSD of Total Population (%)	57.36	59.35	64.63	96.68
RSD of Territory (%)	65.12	81.94	88.14	92.16
RSD of Population Density (%)	41.35	76.73	47.29	25.79
Correlation between Total Population and Absolute Proportion of Population on the Buffer Band (r^2)	0.001 (p=0.874)	0.058 (p=0.368)	0.079 (p=0.354)	0.021 (p=0.568)
Correlation between Total Population and Relative Proportion of Population on the Buffer Band (r^2)	<0.001 (p=0.947)	0.09 (p=0.26)	0.074 (p=0.367)	0.043 (p=0.41)
Correlation between Territory and Absolute Proportion of Population on the Buffer Band (r^2)	0.015 (p=0.155)	0.011 (p=0.699)	0.202 (p=0.123)	0.007 (p=0.75)
Correlation between Territory and Relative Proportion of Population on the Buffer Band (r^2)	0.025 (p=0.504)	0.022 (p=0.587)	0.193 (p=0.133)	0.021 (p=0.566)
Correlation between Population Density and Absolute Proportion of Population on the Buffer Band (r^2)	0.168 (p=0.073)	0.07 (p=0.323)	**0.648 (p<0.001)**	0.097 (p=0.207)
Correlation between Population Density and Relative Proportion of Population on the Buffer Band (r^2)	0.109 (p=0.155)	0.051 (p=0.401)	**0.581 (p=0.002)**	0.075 (p=0.27)

Table 4.3 Societies with more than two identified supra-local communities in the Upper Daling Valley. Bold numbers are noticeably larger numbers.

UPPER DALING	HS (n=4)	LXJD (n=6)	UXJD (n=6)	-
RSD of Total Population (%)	101.97	66.59	59.33	-
RSD of Territory (%)	50.21	51.35	64.54	-
RSD of Population Density (%)	57.09	35.61	22.5	-
Correlation between Total Population and Absolute Proportion of Population on the Buffer Band (r^2)	**0.786 (*p*=0.114)**	0.027 (p=0.758)	0.286 (p=0.275)	-
Correlation between Total Population and Relative Proportion of Population on the Buffer Band (r^2)	**0.837 (*p*=0.085)**	0.003 (p=0.912)	0.312 (p=0.249)	-
Correlation between Territory and Absolute Proportion of Population on the Buffer Band (r^2)	0.473 (p=0.312)	0.407 (p=0.173)	0.464 (p=0.136)	-
Correlation between Territory and Relative Proportion of Population on the Buffer Band (r^2)	0.551 (p=0.258)	0.308 (p=0.253)	0.492 (p=0.12)	-
Correlation between Population Density and Absolute Proportion of Population on the Buffer Band (r^2)	**0.738 (*p*=0.141)**	0.209 (p=0.363)	0.206 (p=0.366)	-
Correlation between Population Density and Relative Proportion of Population on the Buffer Band (r^2)	**0.773 (*p*=0.121)**	0.244 (p=0.32)	0.167 (p=0.422)	-

RSD values of total population, territory, and population density for all supra-local communities help evaluate the level of differentiation among them in the same way of treating each supra-local community as a case whose value represents its population, the area of its territory, and its internal population density. (Table 4.2 and 4.3). They are expressed as a percentage of the mean value so as to make inter-regional comparison possible. Take the first column in the two tables as an example, the standard deviation of total population for all twenty Hongshan supra-local communities in Chifeng is about 57% of the mean value. Population varied more cross the four Hongshan supra-local communities in the Upper Daling Valley, as the standard deviation of total population for them is about the same (102%) as the mean value. Territory, on the other hand, seemed to vary more cross Chifeng supra-local communities than it did across the small number of Upper Daling supra-local communities, albeit to a lesser extent. The standard deviation of territory for the twenty supra-local communities in Chifeng is about 65% of the mean value, while it is only about 50% of the mean value for the four supra-local communities in the Upper Daling Valley. Last but probably most importantly, population density varied more across the four supra-local communities in the Upper Daling Valley than it did across the twenty Chifeng supra-local communities. The standard deviation of population density for the twenty supra-local communities in Chifeng is about 41% of the mean value, while the standard deviation of population density for the four supra-local communities in the Upper Daling Valley is about 57% of the mean value.

When comparing the three characteristics of supra-local communities with the proportions of population living on the bluffs at the edge of the flat valley floor, the four Hongshan supra-local communities in the Upper Daling Valley show relatively strong correlations between total population and the absolute proportion of population found in the 200m single-sided buffer band (r^2=0.786, p=0.114, n=4), and between total population and the relative proportion of population found in the 200m single-sided buffer band (r^2=0.837, p=0.085, n=4). In addition, the correlations between population density and the absolute proportion of population found in the 200m single-sided buffer band (r^2=0.738, p=0.141, n=4) and between population density and the relative proportion of population found in the 200m single-sided buffer band (r^2=0.773, p=0.121, n=4) are also relatively strong for the four Upper Daling supra-local communities during Hongshan times. The two characteristics, most importantly population density, not only varied more across the four Hongshan supra-local communities in the Upper Daling Valley than it did across Chifeng supra-local communities, but they also seemed to vary across the four supra-local communities in accordance with how many people in the supra-local community were found in the ecotone in the Upper Daling Valley. This is primarily a result of District 2. District 2 includes the Dongshanzui and Sanjia areas and is the largest Upper Daling supra-local community in terms of population (Peterson et al. 2014a). Its population estimated at 450-900 people not only stands out as extraordinary in the Upper Daling Valley but also has no parallel in Chifeng, where Hongshan supra-local communities seldom have populations exceeding about 400 people (Chifeng International Collaborative Archaeological Research Project 2011a). At the same time, District 2 also has 64.3% of its population concentrated on 4.8% of its total land that is the 200m single-sided buffer band, which makes both its absolute and relative proportions of population in the ecotone equally high. On the contrary, this combination of an extraordinary level of population and a heavy concentration of population in the ecotone is not seen among the twenty Hongshan supra-local communities in Chifeng. District 10 in the upper middle of the Chifeng survey area has a decent population estimated at 170-340 people, and 82.6% of its population is concentrated on 5.6% of the total land that is the 200m single-sided buffer band. However, the demographic size of District 10 in Chifeng is not as special as District 2 in the Upper Daling Valley, and the population density of District 10 is even below the average density for the twenty supra-local communities in Chifeng. Districts 18, 19, and 20 are the three other Hongshan supra-local communities in Chifeng that have a bit more population than District 10, but only District 19 shows some degree of population concentration in the ecotone. Some 40% of its population, estimated at 180-360 people, is found on 9.8% of its total land that is the 200m single-sided buffer band. Moreover, just like District 10, the three are all less densely occupied than average. In sum, the results indicate a connection between variations among Hongshan supra-local communities in the Upper Daling Valley and the risk-buffering strategy, and this is primarily a consequence of the unique presence of District 2. District 2 not only caused the four Hongshan supra-local communities in the Upper Daling Valley to appear more differentiated in terms of total population and population density than their Chifeng counterparts, but also displayed an uncommonly strong connection between these demographic characteristics and the risk-buffering rationale.

For premodern societies during other periods, the correlation seldom appears as strong or significant. During Lower Xiajiadian times, although higher RSD numbers indicate territory and population density varied more across the sixteen supra-local communities in Chifeng than they did across the six Upper Daling supra-local communities, no characteristic of Chifeng or Upper Daling supra-local communities showed a connection to the proportion of population distributed in the ecotone. The higher level of differentiation among Chifeng supra-local communities could not be related solely to the risk-buffering strategy. Similarly, no link between any characteristic of Zhanguo-Han supra-local communities in Chifeng and the risk-buffering strategy is indicated. The only exception is Upper Xiajiadian societies in Chifeng. Population density varied more across the thirteen Upper Xiajiadian supra-local communities in Chifeng than it did across the six supra-local communities in the Upper Daling Valley, and population density of Chifeng supra-local communities also showed a connection to the absolute as well as relative proportions of population distributed in the 200m single-sided buffer band (r^2=0.648, p<0.001, n=13 and r^2=0.581, p=0.002, n=13, respectively). The five most densely occupied supra-local communities, District 5, 13, 4, 12, and 6, are at the same time the top five ones with highest proportions of population concentrated in the ecotone, even though their populations estimated at about 2,600-6,600 people are rather average for Upper Xiajiadian supra-local communities. The differentiation of Chifeng supra-local communities in terms of population density might be linked to the risk-buffering rationale.

4.4 Summary of the Quadrat Grid Approach

The quadrat grid approach complements our understanding of human-land relationships in premodern societies in northeastern China by assessing the strength of the impact social centripetal forces had on settlement pattern through time, without making assumptions about agricultural productivity and farming strategies. This subsection summarizes the results of this approach and discusses how they, viewed together with previous observations on patterns of settlement distribution, relate to the descriptions of internal social dynamics outlined in previous comprehensive settlement studies (Drennan et al. 2014).

For Hongshan societies, these results present a coherent account supporting what has been described about the internal dynamics underlying ritual-based Hongshan social development. The buffer density was very high in both regions. Yet, the concern over risk management was unmistakably stronger in the socially more developed Upper Daling Valley, as Hongshan occupation there was more conspicuously concentrated in the ecotone. Also, regional population was distributed in better accordance with environments, as indicated by the stronger correlation between observed and expected population there. On top of that, the quadrat grid approach reveals that settlement distribution in the Upper Daling Valley was also subject to more powerful social centripetal forces, and settlement concentration as a result of these forces showed a clear environmental basis that was focused on the ecotone. Meanwhile, these same characteristics of settlement concentration were also present in Chifeng, even though they appeared to be somewhat weaker. Matching locations of settlement concentration between the two maps also argue for the contribution of social centripetal forces in shaping concentrations of Hongshan occupation, and the environmental profile similarly indicated a focus on the ecotone. These results suggest some level of consistency in the nature of the prevailing centripetal forces during Hongshan times in the same way the similar patterns of settlement distribution across the four zones between the two regions suggest some degree of consistency in the settlement preferences for uplands and the ecotone. A high level of consistency in almost every settlement characteristic also agrees well with the similarities in various aspects of Hongshan societies, such as community organization and levels of differentiation among households (Drennan et al. 2014; Drennan et al. 2017; Peterson et al. 2014a). What Hongshan people were doing might not be very different between the two regions, yet inhabitants of the Upper Daling Valley did engage themselves in the upland-lowland farming strategy by living on the bluffs at the edge of the flat valley floor to a greater extent. The more serious concern over risk management there was potentially also linked to the differentiation among supra-local communities.

Compared with the high level of consistency in various Hongshan settlement characteristics between Chifeng and the Upper Daling Valley, the lack of it during Lower Xiajiadian times hints at different responses by inhabitants of the two regions, and consequently different outcomes. Settlement distribution was heavily focused on the ecotone in Chifeng. In comparison, the extent to which Lower Xiajiadian occupation in the Upper Daling Valley was concentrated in the ecotone can only be labeled moderate. Stony hills were the most preferred settlement locations in the Upper Daling Valley, while rolling uplands were the most densely occupied of the three zones in Chifeng. Unsurprisingly, the correlation between observed and expected population was stronger in Chifeng, implying a population distribution in better accordance with environments. Other results of the quadrat grid approach continue to show differences in settlement characteristics between the two regions. In Chifeng, settlement distribution was subject to more powerful social centripetal forces in Lower Xiajiadian times than was the case in the Upper Daling Valley, and settlement concentration as a result of these forces showed a clear environmental basis that was focused on the ecotone. The relatively weaker social centripetal forces in the Upper Daling Valley were shaping settlement concentration on stony hills more than anywhere else. The disparity in population level between the two regions, as well as slightly higher temperature and better precipitation in the Upper Daling Valley, had provided unequal opportunity for elite advancement and political centralization (Drennan et al. 2014). Supporting this description, our results show very different dynamics could have characterized the processes of social consolidation between the two regions. The differentiation among supra-local communities did not show any potential connection to the risk-buffering strategy in either region. Risk management in agricultural production must not have been the only important factor for the formation of Lower Xiajiadian political entities.

The contrast in settlement characteristics between the two regions grew sharper during Upper Xiajiadian times. Stony hills were the most densely occupied of the three zones in Chifeng, but the concentration of population in the ecotone was also remarkable. Inhabitants of the Upper Daling Valley favored rolling uplands and showed an even heavier focus on the ecotone. Despite the heavy concentration of occupation in the ecotone in both survey areas, neither region showed a strong correlation between observed and expected population. It was hypothesized that, in addition to agricultural considerations, the locations of Upper Xiajiadian towns and the economic organization associated with these new social units that could harbor a few thousand inhabitants within, had also greatly contributed to the pattern of population distribution. Consistent with the description of Upper Xiajiadian internal social dynamics that were largely based on the emergence of a more spatially extensive, diverse, and increasingly interdependent economic system along with a reduction in conflict and warfare (Drennan et al. 2014), results from our analyses suggest Upper Xiajiadian towns in the two regions might have indeed taken advantage of regionally varying environments and developed in quite different ways. In Chifeng, powerful social centripetal forces were drawing people to reside in and near these towns, forming settlement concentration on stony hills and in the ecotone. In addition, the differentiation among Upper Xiajiadian supra-local communities there also showed a potential connection to the level of concern with risk management. In the Upper Daling Valley, on the other hand, neither social centripetal forces nor an environmental basis for settlement concentration were as recognizable, even though Upper Daling population grew more sharply; settlement distribution was more heavily focused on the ecotone; and changes of community organization toward town dwelling were also stronger. The seemingly more vigorous social development in the Upper Daling Valley led to settlement characteristics very different from that in Chifeng, indicating contrasting regional dynamics that could very likely be a result of an increasingly interdependent macro-regional economic system encouraging some sort of specialization.

During Zhanguo-Han times, results from the quadrat grid approach can be taken to support the hypothesis that it was mainly Heicheng and its socio-political influence that had greatly contributed to the much heavier concentration of occupation in the ecotone in Chifeng than in the Upper Daling Valley. The correlation between observed and expected population was not strong in either region, suggesting environmental conditions were not the only powerful factor shaping population distribution. This is not surprising for a much lower Zhanguo-Han population level in both survey areas. However, in contrast with the severely ruralized settlement in the Upper Daling Valley, social centripetal forces remained powerful in Chifeng, forming supra-local communities visible in the smoothed surfaces, and there was an unmistakable environmental basis for settlement concentration that emphasized the ecotone, too. With a much lower population level than in Lower or Upper Xiajiadian times, if the emphasis on the risk-buffering strategy in Chifeng had resulted from a regional population still numbering in some tens of thousands of people during climatically unstable Zhanguo-Han times, the results would show a population distribution in better accordance with environments indicated by a stronger correlation between observed and expected population, and a more extensive pattern of occupation. However, these were not observed in Chifeng, and many inhabitants of the Chifeng survey area still lived in settlements that were part of highly internally centralized supra-local communities, instead of much smaller and dispersed local communities (Chifeng International Collaborative Archaeological Research Project 2011a). Their decision to live on the bluffs at the edge of the flat valley floor was likely a result of something other than population pressure. Probably taking a role not so much of a food provider, Zhanguo-Han societies in the Upper Daling showed an extensive and dispersed settlement. Without powerful social centripetal forces visibly forming settlement concentration beyond the local scale, inhabitants of the Upper Daling Valley preferred to live on rolling uplands but did not concentrate in the ecotone as much as their Chifeng counterparts did.

Settlement characteristics during Liao times reflected the impact of the two cities on patterns of settlement distribution in both Chifeng and the Upper Daling Valley. Valley floors were the most densely occupied zone as both Songshanzhou and Lizhou were predominantly located on these flat, level lands. The provisioning phenomenon associated with the two cities could have stretched beyond the scope of archaeological studies, but the results did show powerful social centripetal forces visibly shaping settlement concentration within the two survey areas. Suggesting the same was the very weak correspondence between actually observed population distribution and what was environmentally expected in both regions. In Chifeng, both valley floors and general rolling uplands were important parts of the environmental basis for settlement concentration, because Songshanzhou did not demographically dominate the entire survey area as Lizhou did in the Upper Daling Valley, where the environmental basis for settlement concentration was strongly focused on valley floors. Urban inhabitants were taking advantage of the agricultural potential of valley floors as well as the scale of an exchange network afforded by better roads that were built on the level lands. People outside the two cities continued to show enduring preferences for rolling uplands and the ecotone in both regions. These preferences were stronger in the more urbanized Upper Daling survey area, supporting the view of Lizhou as exerting more powerful socio-political impact upon nearby villages and farmsteads.

5.0 Niuheliang

Niuheliang stands out as a very unique place in the Hongshan world not just in the sense of having more and better constructed ceremonial facilities. Relative to Chifeng and the Upper Daling Valley, Niuheliang is located in a mountainous area with very low agricultural productivity that has been known to be an unfavorable location for Hongshan settlement (Figure 5.1). Mountains take up more than half of the total land in the entire survey area. Yet, preliminary systematic regional surveys revealed a population density at about 8-16 persons per sq km in and around the Niuheliang ceremonial complex during Hongshan times, which was higher than the regional population density in either of the other two survey areas (Drennan, Lu, and Peterson 2017). The impressive concentration of high-level ceremonial facilities and the unusual presence of a somewhat dense occupation in the high hills and mountains imply that, in contrast to the normal patterns of Hongshan settlement distribution that have been established in Chifeng and the Upper Daling Valley, the patterns in Niuheliang should be recognized as extraordinary. Therefore, if Hongshan settlement patterns in Niuheliang turn out to be strikingly different, they should be deemed as informing of how the normal behavioral patterns of the Hongshan period were bent out of shape there by the special social processes associated with the ceremonial complex.

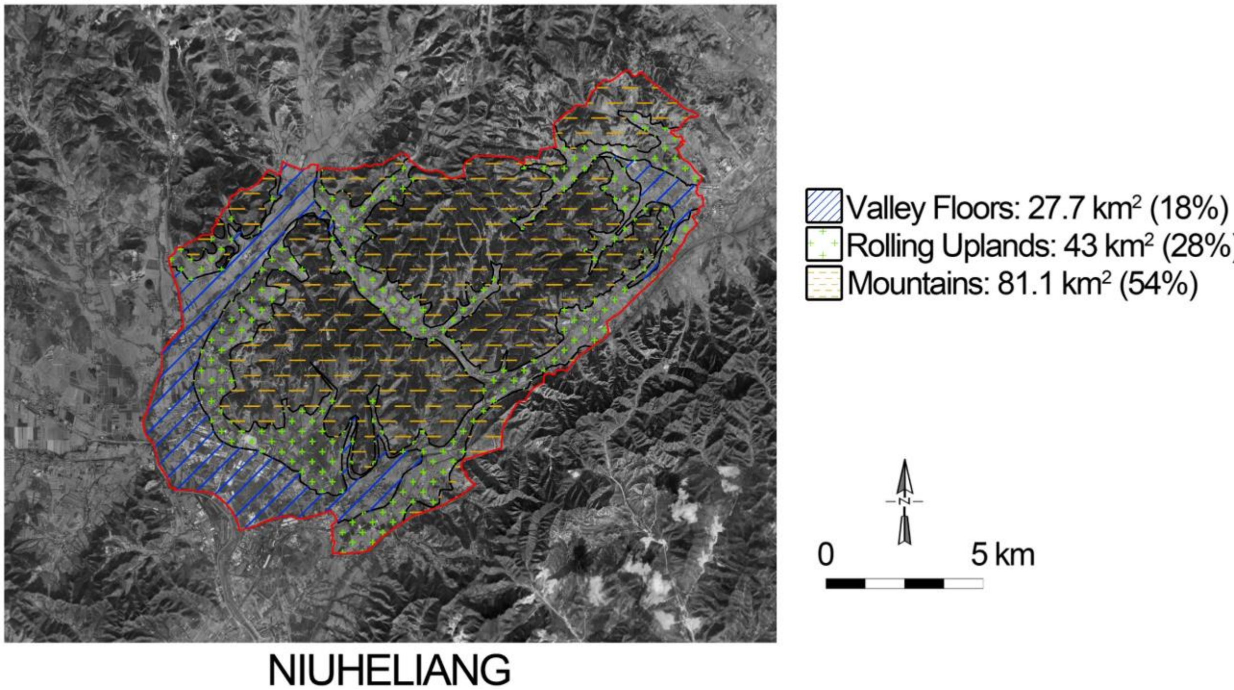

Figure 5.1 Three zones for agriculture in Niuheliang. Red lines are survey boundaries. Black lines are boundaries between zones. Blue diagonal lines are valley floors. Green crosses are rolling uplands. Brown dashed lines are mountains.

The Niuheliang survey has been expanded to include lower lands to the northeast and to the southwest with the aim of exploring settlement patterns in the wider geographical context around the Niuheliang ceremonial complex. Particularly, if provisioning communities do exist near the ceremonial center but at agriculturally more favorable locations, the limits of the expanded survey are designed to make sure they will be identified. Demographic reconstruction in the complete Niuheliang survey area, now of about 152 sq km, was done in a way comparable to that in Chifeng and the Upper Daling Valley. The distribution of Hongshan settlement around localities of important monuments immediately agreed with some of our expectations related to the provisioning-a-pilgrimage-center idea (Figure 5.2).

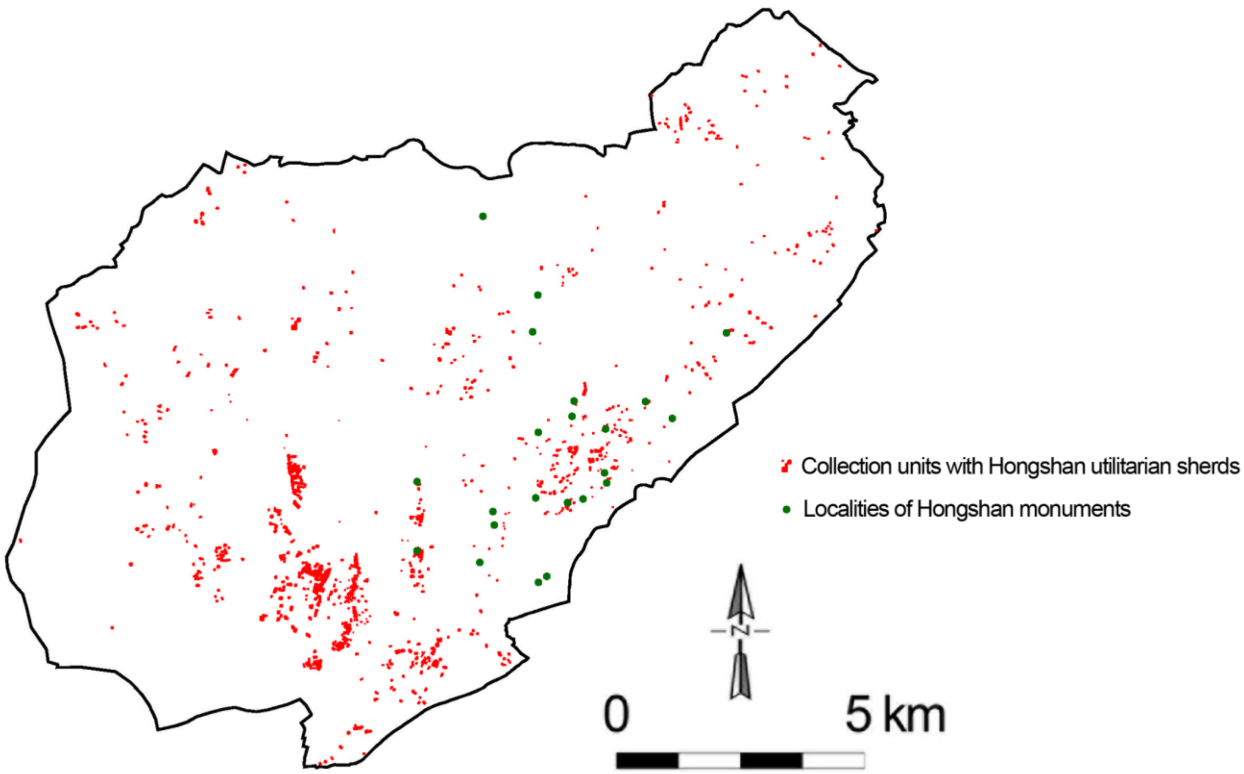

Figure 5.2 Hongshan settlement in the Niuheliang survey area in relation to localities of Hongshan ceremonial constructions (redrawn from Drennan, Lu, and Peterson 2017).

The Niuheliang ceremonial complex produced a concentration of occupation in the mountains, as evidenced by a cluster of collection units with Hongshan utilitarian sherds forming around Hongshan monuments; the need to grow food for the residents living there produced another bigger concentration in the mountains and uplands to the southwest; and there was no other concentration of population visible elsewhere in the entire survey area. There may not be a matching one on the northeast side toward Jianping because it is farther away and across still higher mountain crests, making food transport more difficult.

Overall, the Hongshan population in the Niuheliang survey area was estimated at 1,600-3,200 people in total that represented a regional density at 15.5 persons per sq km. It was about 2.8 times higher than the Upper Daling regional density of the same period, and 5.5 times higher than the Chifeng regional density. If seen as a regional polity, the total Hongshan population in Niuheliang would make it the largest one ever systematically identified in northeastern China. If the two concentrations of occupation represent the center of gravity for two separate Hongshan regional polities, which is likely the case since the distribution of Hongshan population in Niuheliang was not focused centrally around one or a few platforms, but formed a bicentric pattern around the ceremonial complex and the main provisioning area, the two polities still will rank very high in terms of demographic characteristics among all known Hongshan regional polities.

Preliminary results of demographic reconstruction have made it clear that Niuheliang is unusual for its profusion of Hongshan monuments, for its much larger population than customary for either one or two Hongshan regional polities, for its location without ready access to good farmlands, and for the bicentric pattern of the internal distribution of its population. Although the reason why the Hongshan pilgrimage phenomenon had to focus its development on this area in the first place remains to be explored, this study argues that, in this particularly mountainous environment, Hongshan people might have chosen settlement locations not just for farming to feed themselves, but also to support ritual specialists and visitors at the pilgrimage center at Niuheliang. Without other means of transportation, carrying food staples to the pilgrimage center in the mountains would be an important consideration for inhabitants in Niuheliang, a factor that was not relevant in Chifeng or the Upper Daling Valley because most Hongshan families were self sufficient and provided most of their own food, mostly from the areas relatively near their own houses. Below, results of the same set of analyses will provide quantitative and empirical support for this interpretation.

5.1 Patterns of Settlement Distribution in Niuheliang

Agricultural Productivity

Estimated population densities were calculated in each of the three zones in Niuheliang in the same way they were calculated in Chifeng and the Upper Daling Valley (Figure 5.3). Mountains were the most densely occupied zone and had a population density of 20.5 persons per sq km; rolling uplands had 15.0 persons per sq km; and valley floors were the least favored zone, with an estimated population density of only 1.6 persons per sq km. The somewhat consistent ratio of the valley floor density to the upland density across the three survey areas really highlights the unusualness of the mountain settlement in Niuheliang. Substantial population in and around the Niuheliang ceremonial center in the mountains and uplands led to a much higher population level in the Niuheliang survey area. That high hills and mountains known to be unfavorable locations for Hongshan settlement turned out to be quite densely occupied in the Niuheliang region is consistent with the provisioning behaviors outlined earlier. In addition, the need to provide food to the pilgrimage center would make settlement on valley floors even less attractive because some of them were disadvantageously far from helping to provide food to the pilgrimage center. Valley floors in Niuheliang attracted only 2% of regional population to settle on 18% of the total land, a relative proportion that was lower than that in Chifeng or the Upper Daling Valley. Moreover, the populations calculated in the Niuheliang survey area included the ritual specialists and pilgrims whose broken pottery was part of our data. These non-farmers must have comprised a larger portion of regional population in Niuheliang and would have little motive to live at agriculturally preferable locations.

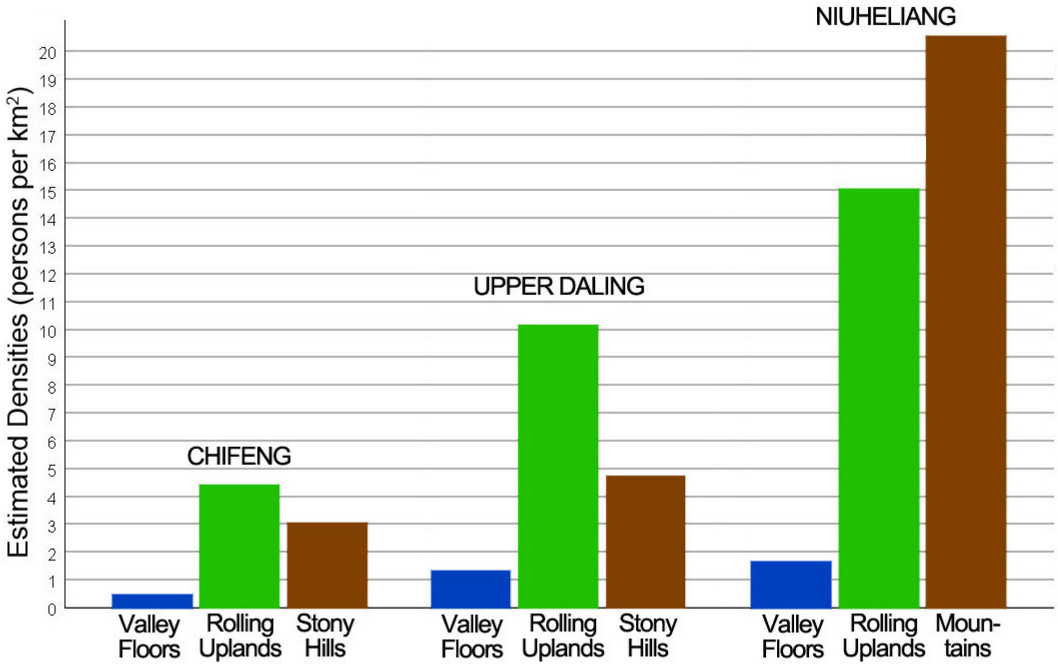

Figure 5.3 Estimated Hongshan population densities of the three zones in Niuheliang, compared with that in Chifeng and the Upper Daling Valley.

Risk-buffering Strategies

Estimated population densities were calculated for the same set of single-sided and double-sided buffer bands of various widths in Niuheliang, too, in order to evaluate the importance of the risk-buffering strategy in the decision of settlement location here (Figure 5.4). The relative population densities of the various buffer bands behave very similarly in all three regions, suggesting the level of consistency in these settlement preferences. Population density is moderately high in the widest buffer band, higher in the next smaller, still higher in the next two smaller, and then lower in the smallest. This is true of both single-sided and double-sided buffer bands in all three regions, except for the 150m single-sided buffer band in the Upper Daling Valley and Niuheliang that shows a minor decrease against the trend. In all three regions, population density is two times higher on single-sided buffer bands than on double-sided ones. Their highest density in Niuheliang was also within 150-200 m of the rolling upland side of the ecotone, the estimated density of which at 29.5 persons per sq km was higher than any estimated population density of the three zones.

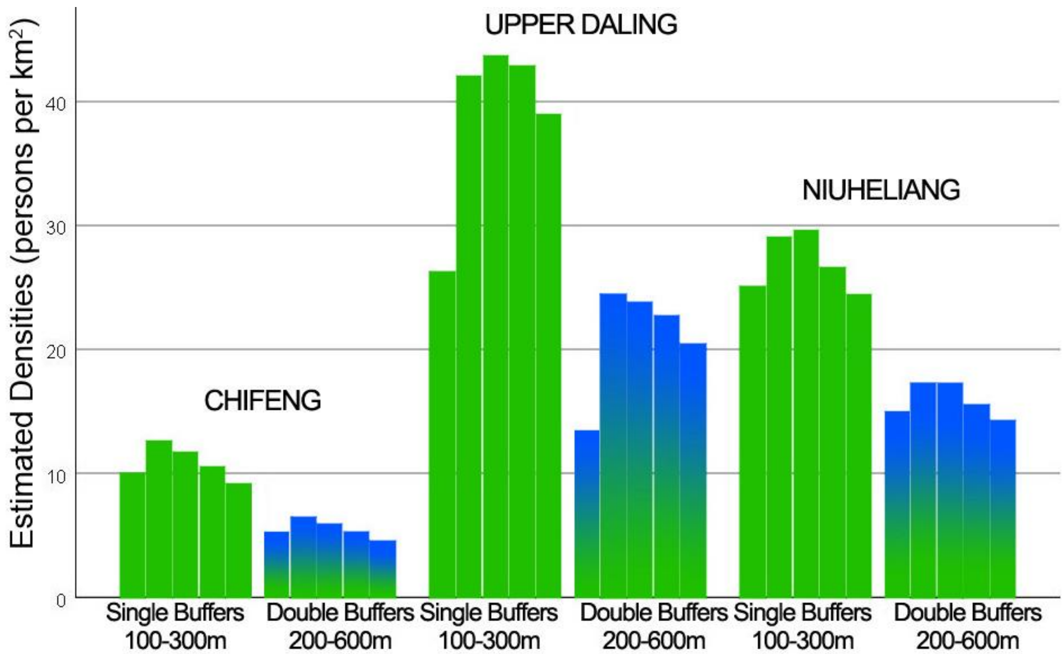

Figure 5.4 Estimated Hongshan population densities of different variations of buffer bands in Niuheliang, compared that with in Chifeng and the Upper Daling Valley.

The bluffs at the edge of the flat valley floor remained the most densely occupied zone in Niuheliang despite the unusual occupation in the mountains, and the relative population densities of the various buffer bands behave in a similar way to those in Chifeng and the Upper Daling Valley. The two observations suggest the risk-buffering strategy continued to be a crucial factor in the decision of settlement location despite the two concentrations of occupation visible in the uplands and in the mountains. The same behavioral logic for practicing agriculture still held true, but the need to live at and near the pilgrimage center makes population concentration in the ecotone in Niuheliang appear much weaker than it is in the other two survey areas in two important ways.

Not only were a large number of Hongshan people living in the mountains, those living in the uplands also tended to spread themselves across wider terrains, rather than concentrating toward the ecotone. Among those who lived in the uplands in Niuheliang, about 43% were concentrated specifically in the 200m single-sided buffer band. This proportion of population in the 200m single-sided buffer band to that on the uplands was 54% in Chifeng and 64% in the Upper Daling Valley. In addition to forming settlement concentration in the mountains, the need to provision the Niuheliang ceremonial complex was also pulling upland population toward higher elevations, overshadowing the impact of the risk-buffering strategy on settlement pattern to a certain extent.

Settlement patterns in Niuheliang also respond to our tentative statements in the summary of chapter three about the likely causal relationship between population density and effective risk management during Hongshan times. Results of the diachronic comparison suggest that the denser Hongshan occupation in the Upper Daling Valley invited socio-political interpretations rather than environmental ones. The mountainous environment of the Niuheliang survey area was unattractive for Hongshan farmers. Yet, the Hongshan occupation here was even much denser than that in Chifeng or the Upper Daling Valley, which, too, was more than a simple reflection of environments. On the other hand, higher population densities in Niuheliang did not lead to further concentration of population in the ecotone, even though the basic behavioral logic of Hongshan farming strategies did not change and the bluffs at the edge of the flat valley floor continued to be the most densely occupied zone. Effective risk management, while remaining an important consideration for settlement location, was not necessarily a reaction to higher population densities in Niuheliang. Despite its mountainous environments, the Niuheliang survey area often was more densely occupied than in Chifeng or the Upper Daling Valley (Figure 5.5). To put Hongshan patterns of settlement distribution in a better context, this study proceeds to investigate how people distributed themselves on this particularly mountainous landscape during other periods.

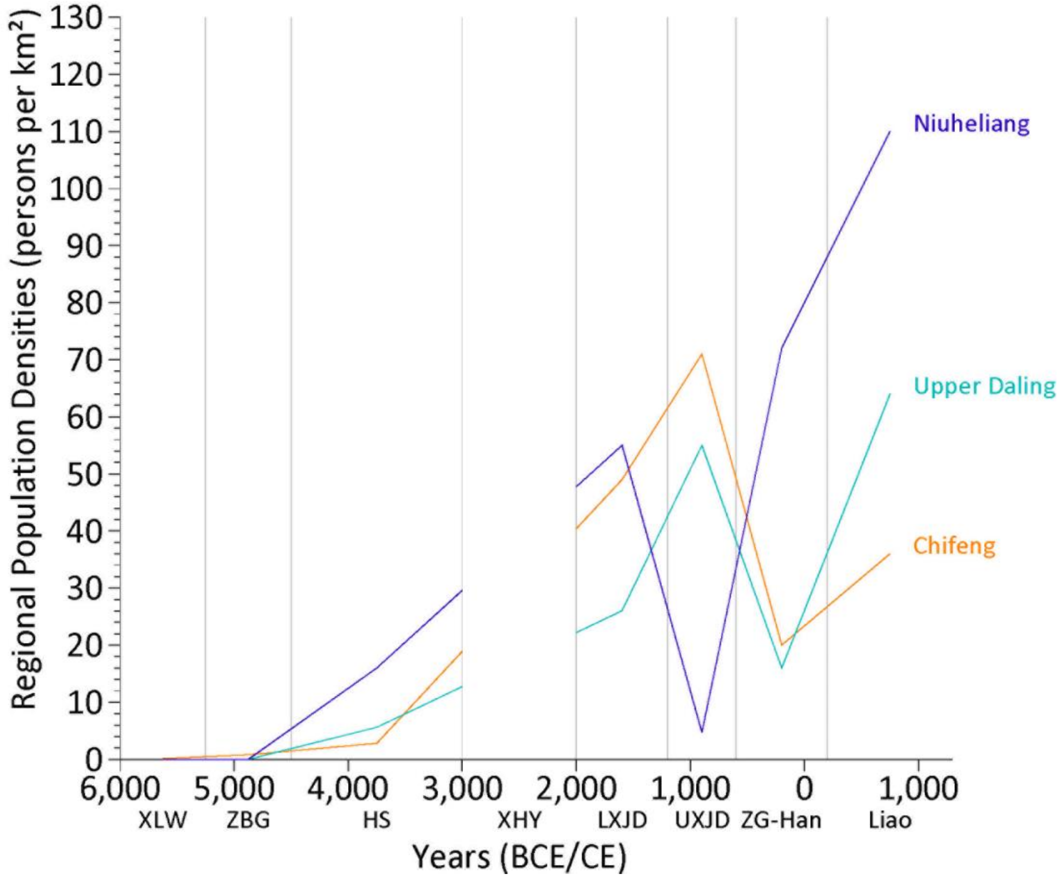

Figure 5.5 Regional population densities through time in Niuheliang, compared with that in Chifeng and the Upper Daling Valley.

5.2 Patterns of Settlement Distribution through Time in Niuheliang

We begin with an assessment of how important agricultural productivity and the risk-buffering strategy were in the decision of settlement location through time, and how these settlement preferences might be related to socio-economic organizations and trajectories of social change in Niuheliang. Estimated population densities of the three zone and the 200m single-sided buffer band were calculated for each of the five periods in Niuheliang (Figure 5.6) in the same way they were in Chifeng and the Upper Daling Valley. Also presented were the proportions of regional population distributed on these zones through time (Figure 5.7). Results from this smaller, more mountainous, yet often more densely occupied survey area and their behavioral implications will further add to our understanding of internal social dynamics underlying the developmental trajectory for societies in northeastern China.

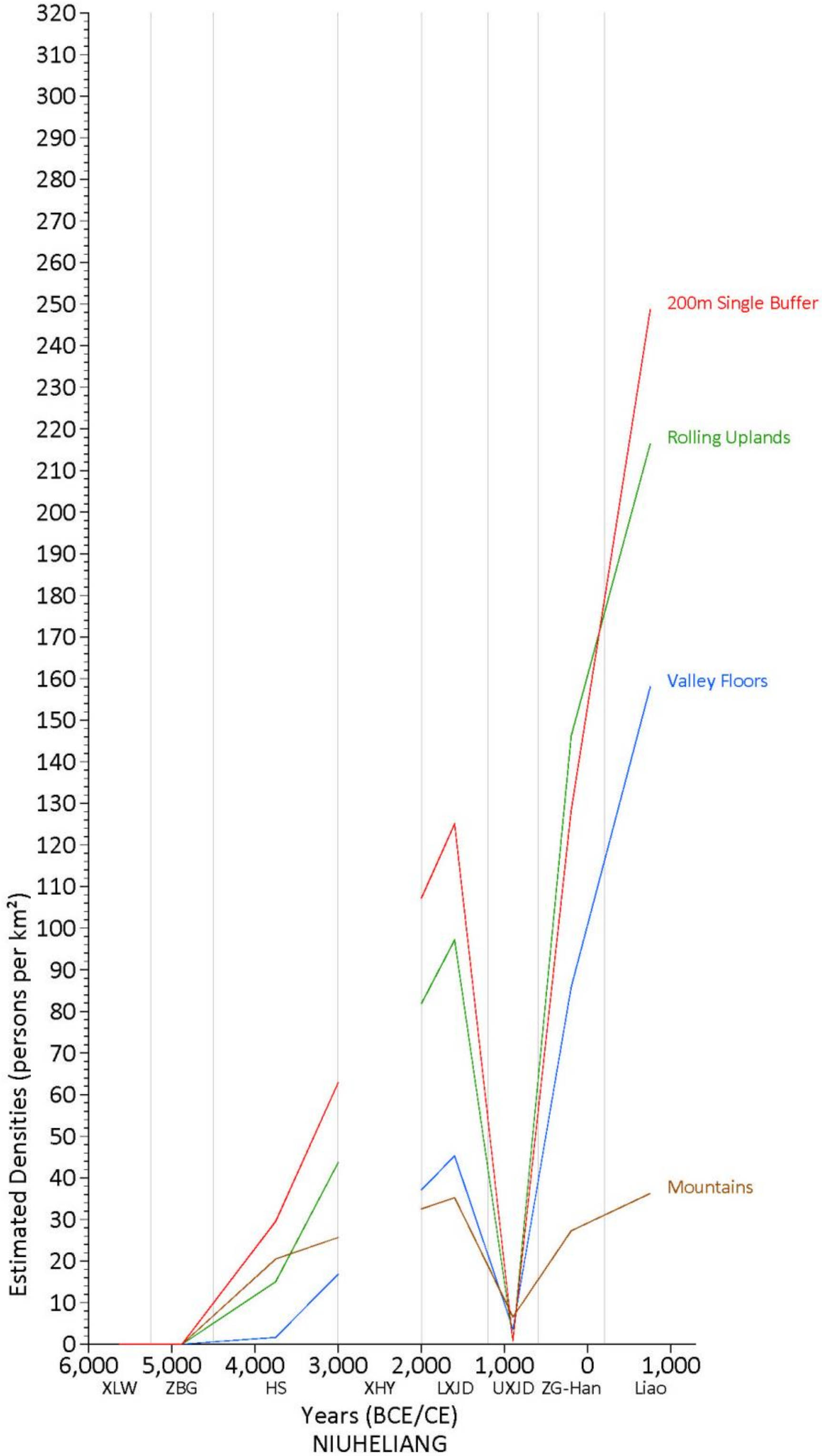

Figure 5.6 Estimated population densities of the three zones and the 200m single-sided buffer band through time in Niuheliang.

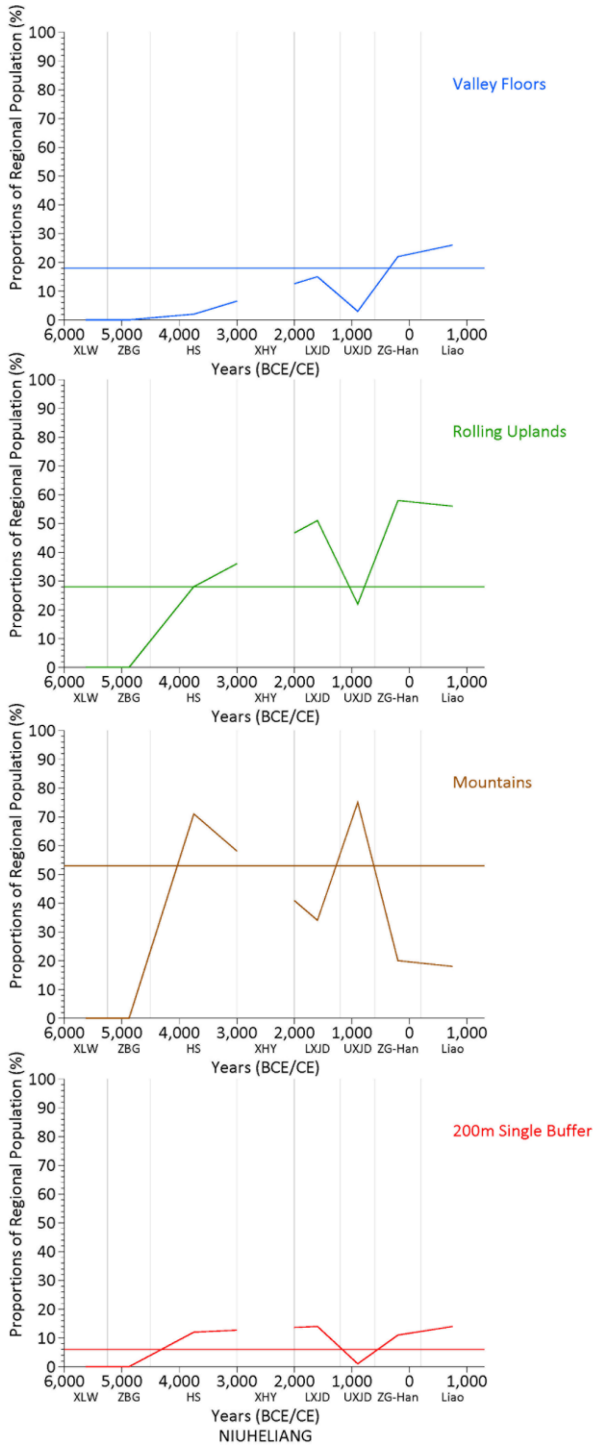

Figure 5.7 Proportions of regional population distributed on valley floors, rolling uplands, mountains, and the 200m single-sided buffer band through time in Niuheliang. The straight level line in each graph indicates the expected proportion based on the amount of lands of that zone in the survey area.

Hongshan Patterns of Settlement Distribution (4500 to 3000 BCE)

As in the Upper Daling Valley, the scattering of surface artifacts dating to before Hongshan times in Niuheliang was too sparse for settlement reconstruction. That Hongshan occupation was quite dense in the survey area was not surprising because the survey was meant to explore settlement patterns around the apex of Hongshan cosmological expression in the first place. Hongshan patterns of settlement distribution in Niuheliang were seriously altered by the presence of the Niuheliang ceremonial center and the need to provision it. Although the investigation of patterns of community organization is still ongoing, two clusters of concentration of collection units with Hongshan artifacts are already visibly corresponding to the pilgrimage center and the main provisioning community to the southwest. The first cluster, or supra-local community, would measure about 5.1 sq km in size, rather small compared with Hongshan supra-local communities identified elsewhere. Its moderately large demographic size of 260-520 people, however, would make it the most densely occupied Hongshan supra-local community ever seen in the three regions that have been systematically surveyed. The other supra-local community in Niuheliang was located southwest of the pilgrimage center and would cover an area of about 27.1 sq km, appearing medium in size. However, its unusually large population estimated at about 1,000-2,000 people would make it the second most densely occupied Hongshan supra-local community, just secondary to the one right at the Niuheliang ceremonial center. Their population densities estimated at 76.8 and 55.1 persons per sq km were much higher than that of the most densely occupied supra-local community in Chifeng at 25.1 persons per sq km and that of the most densely occupied supra-local community in the Upper Daling Valley at 9.0 persons per sq km. This level of disparity was unlikely to have resulted from nuanced differences in field procedures. It was also unlikely just an effect of the special activities that were only happening in the Niuheliang ceremonial center that could have caused a high discard rate of Hongshan artifacts, because both supra-local communities were very densely occupied, and residential behaviors were quite different between the two, too.

The first supra-local community had 28% of its population distributed on the uplands excluding the 200m single-sided buffer band that took up 29.2% of the total land within it. The other 72% of its population was found in the mountains that took up the remaining 70.8% of its territory. Once living in this supra-local community, the inhabitants displayed almost no zonal preference at all within it. The second supra-local community, on the other hand, had 66.5% of its population distributed in the mountains that only took up 51.6% of the total land. Another 17.8% of its population was concentrated on 9.1% of its total land contained within the 200m single-sided buffer band. In other words, more people than expected were living in the mountains and in the ecotone, a pattern of settlement distribution consistent with what might be expected for a provisioning community concerned with agricultural strategies and logistics at the same time. Outside these two unusual concentrations of substantial population at special locations, the rest of the Hongshan occupation in Niuheliang represented a much lower population density of about 4.0 persons per sq km, roughly halfway between the Chifeng regional density at 2.8 persons per sq km and the Upper Daling regional density at 5.6 persons per sq km. Mountains, and nowhere else, were the preferred settlement location for people not living in the two supra-local communities. As much as 82.9% of them were found on 53.1% of the total land that was mountains in the rest of the survey area. These numbers make it clear that the incredibly high density of Hongshan occupation in Niuheliang was mostly a consequence of the two concentrations of population, and their demographic characteristics indicated their special roles and the different behaviors of those who lived in them.

Lower Xiajiadian Patterns of Settlement Distribution (2000 to 1200 BCE)

Estimated at about 5,500-11,000 people, the Lower Xiajiadian population in Niuheliang grew at a rate that was similar to that in the Upper Daling Valley, even though the resulting regional population density at 54.6 persons per sq km was more comparable to that in Chifeng. Geographically, Niuheliang was quite different from the other two regions, and Lower Xiajiadian patterns of settlement distribution here were unlike those in either survey area, too. The preference for rolling uplands was unambiguous. Around 51% of the regional population was located on 28% of the total land that was the uplands, making the upland density at 97.2 persons per sq km higher than the valley floor and mountain density at 45.2 and 35.2 persons per sq km, respectively. The consistently low mountain densities during Lower Xiajiadian and all subsequent periods except for Upper Xiajiadian attested to the unusualness of mountain occupation during Hongshan times. Lower Xiajiadian patterns of settlement distribution in Niuheliang seemed to resemble those in Chifeng at first glance, but were lacking a heavy concentration of population in the ecotone. About 14% of the Niuheliang regional population was found on the 200m single-sided buffer band that took up 6% of the total land. The buffer density at 125.0 persons per sq km was far less than the buffer density in Chifeng at 314.0 persons per sq km. To some extent, it matched the buffer density in the Upper Daling Valley at 88.3 persons per sq km, though, but the concentration of Lower Xiajiadian population on stony hills in the Upper Daling Valley did not happen in Niuheliang, where mountains and higher hills were more abundant. Patterns of community organization in Niuheliang would show some characteristics of the Chifeng patterns and some of the Upper Daling ones. All in all, the conclusion in chapter three that the considerable demographic growth during Lower Xiajiadian times did not result in entirely the same set of changes between Chifeng and the

Upper Daling Valley seems to apply to Niuheliang as well. The patterns in Niuheliang suggested that neither population pressure nor conflict was as severe as it was in the other two regions.

Upper Xiajiadian Patterns of Settlement Distribution (1200 to 600 BCE)

Population declined sharply during Upper Xiajiadian times in Niuheliang, contrasting with the continued demographic growth in both Chifeng and the Upper Daling Valley. The estimated population of 500-1,000 people represented a population density at only 4.7 persons per sq km, less than a tenth of the Upper Daling regional density and only a fifteenth of the Chifeng density. That larger local communities, or towns, so prevalent in both Chifeng and the Upper Daling Valley, were absent in Niuheliang is not a surprise because the mountainous environments would not allow for the utilization of the amount of productive land needed to support the very large population living in a town, nor was the topography ideal for participating in any emerging socio-economic integration. Some 75% of this sparse occupation was located in the mountains that took up 53% of the total land. The 200m single-sided buffer band that took up about 6% of the total land in Niuheliang, on the other hand, harbored only 1% of the regional population.

Zhanguo-Han Patterns of Settlement Distribution (600 BCE to 200 CE)

The soaring Zhanguo-Han population in Niuheliang was also in sharp contrast with the demographic trend in Chifeng and the Upper Daling Valley. The estimated population of 7,300-14,600 people meant Niuheliang was 3.6 times more densely occupied than Chifeng and 4.4 times more densely occupied than the Upper Daling Valley. Although rolling uplands were the most densely occupied zone across all three survey areas, patterns of settlement distribution in Niuheliang showed nuanced differences from those in Chifeng and the Upper Daling Valley.

Slightly more Zhanguo-Han population than expected was distributed on valley floors in Niuheliang, while in both Chifeng and the Upper Daling Valley, only 11% of regional population was found on 31% of the total land that belonged to that zone. On the other hand, 20% of the Niuheliang regional population lived on 53% of the total land that was the mountains, representing a much smaller proportion of the population than expected to be found in this zone. On the contrary, stony hills were only slightly underoccupied in both Chifeng and the Upper Daling Valley. The concentration of Zhanguo-Han settlements on productive lands is consistent with the high population densities in Niuheliang, but, at the same time, the ecotone was not as heavily utilized as it was in the two other regions. In Chifeng, the buffer density at 117.0 persons per sq km was 5.9 times higher than the overall Chifeng regional density. That figure was only 2.7 in the Upper Daling Valley. A few factors that could have potentially contributed to the relatively lessened concern over risk management were listed in chapter three, such as generally better environments, a much lower population level, and the lack of heavy imperial taxation from important Zhanguo-Han administrative centers such as Heicheng. None of these factors applied to Niuheliang, where the buffer density at 128.3 persons per sq km was only 1.8 times higher than the regional density. The unusually dense occupation in Niuheliang might be associated with the fortified site of Anzhangzi, which was located 7 km southwest of the survey area, on elevated lands in Lingyuan. Anzhangzi showed the earliest sign of occupation in Upper Xiajiadian times, developed into an administrative center with the establishment of the Zhanguo county of Youbeiping, and later took on military significance during the Han dynasty, when the site was arguably where the Han county of Shicheng was located (Liaoning Province Institute of Cultural Relics and Archaeology 1996; Xu 2017). Niuheliang's location was strategically important throughout Zhanguo-Han times. Considering the socio-political importance of Anzhangzi, people in the Niuheliang area immediately beside it might have had more opportunities to engage in different kinds of work and provide other services to the city, rather than invariably producing staples. The need to focus settlement on the ecotone was thus diminished. The alternative hypothesis that the ecotone had reached its maximal density at around 115.0-130.0 persons per sq km in the Zhanguo-Han context and could not accommodate more people arises from the fact that the buffer densities in both Chifeng and Niuheliang appear to be capped at that range. This interpretation is unconvincing, however, because, first, the ecotone toward the northwest part of the Niuheliang survey area was clearly less occupied than it used to be, and, second, general rolling uplands excluding the 200m single-sided buffer band in Niuheliang showed a population density higher than that range. All in all, Zhanguo-Han patterns of settlement distribution across the three survey areas implied still very different internal dynamics even in the distant hinterlands away from the state capital.

Liao Patterns of Settlement Distribution (200 to 1300 CE)

The Niuheliang survey area remained very densely occupied during Liao times. The estimated population of 11,000-22,000 people in Niuheliang represented a population density at 110.0 persons per sq km, 3.1 and 1.7 times higher than the Chifeng and Upper Daling regional densities, respectively, which is not surprising for the survey area that was located even closer to the Liao capital of Zhongjing. Liao settlement in Niuheliang was more focused on lower lands than ever before. Valley floors attracted 26% of the regional population, the highest proportion in the regional sequence. Rolling uplands, which took up 28% of the total land, harbored 56% of regional population, just secondary to the figure of 58% during Zhanguo-Han times. That Liao settlement was predominantly concentrated on valley floors and lower rolling uplands even in this particularly mountainous region highlighted the desirability of living on lower lands that was made possible by advances in architectural technologies. On the other hand, the extent to which population was concentrated in the ecotone in Niuheliang, indicated by the buffer density 2.3 times higher than the regional population density, was slightly stronger than that in rural Chifeng with Songshanzhou removed, and slightly weaker than that in rural Upper Daling Valley with Lizhou removed. There was no Liao city equivalent to Songshanzhou or Lizhou within the Niuheliang survey area, but located about 10 km to the southwest was the Liao administrative center of Yuzhou, which is believed to have been built in the process of the Liao dynasty's southward expansion (Xu 2017; Xu and Zhang 2017). The size of its enclosing wall, measuring 535 by 500 m, was similar to that of Lizhou and Songshanzhou, suggesting a comparable administrative level. If living on the bluffs at the edge of the flat valley floor in Liao times could be seen as an effort to ensure reliable agricultural production in order to support nearby Liao administrative centers, the intensity of population concentration in the ecotone in Niuheliang, measuring between that of rural Chifeng and rural Upper Daling Valley, would suggest an urban population in Yuzhou slightly larger than that in Lizhou. The last observation on patterns of settlement distribution in Niuheliang is that, from Hongshan all the way to Liao times, proportions of regional population across the three zones in Niuheliang had changed with population levels in a somewhat consistent way. The proportions of population on valley floors and rolling uplands varied closely with the ups and downs of regional population densities. The proportions of population in the ecotone, on the other hand, never exceeded 14%.

5.3 The Quadrat Grid Approach in Niuheliang

To assess the strength of centrifugal and centripetal forces, and examine the patterns of settlement concentration, the quadrat grid approach was applied to Niuheliang using the same set of analyses as in Chifeng and the Upper Daling Valley. A potential environmental basis for settlement concentration as a result of powerful social centripetal forces is identified and hints at the economic aspect of these forces. The total observed and expected population for each period was measured in each of the 607 quadrats covering the Niuheliang survey area (Figures 5.8 and 5.9). Changes in RSD values through time for observed population in all quadrats indicate changes in the level of settlement concentration (Table 5.1), and changes in RSD values through time for observed minus expected population in all quadrats indicate changes in the level of settlement concentration as a result of social centripetal forces and thus the strength of the centripetal forces that drew people to reside in locations that are not ideal for practicing agriculture.

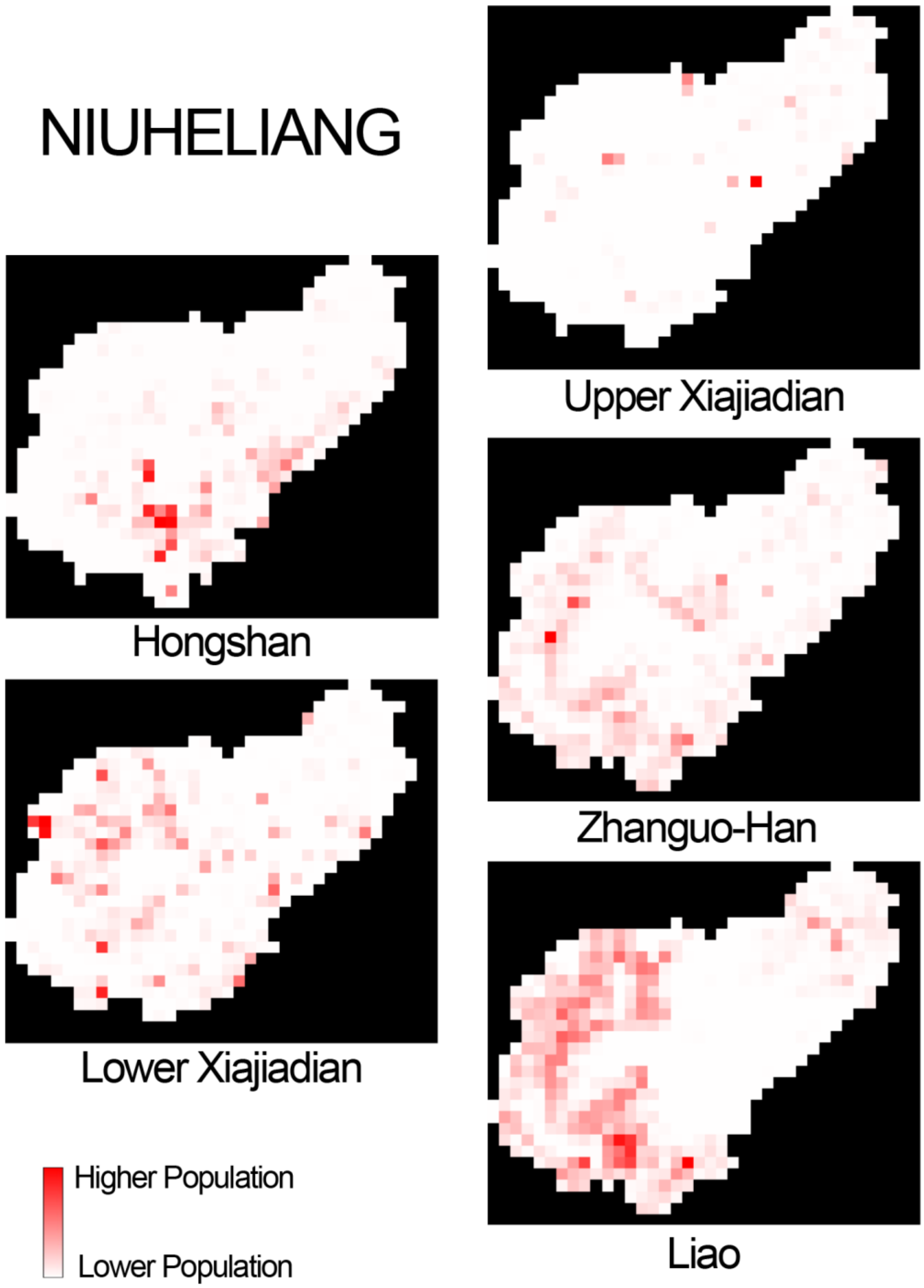

Figure 5.8 Observed population by 500m quadrat in Niuheliang. Fully saturated red indicates quadrats with a relatively higher observed population for the period. Lighter and less saturated red indicates quadrats with a gradually lower observed population.

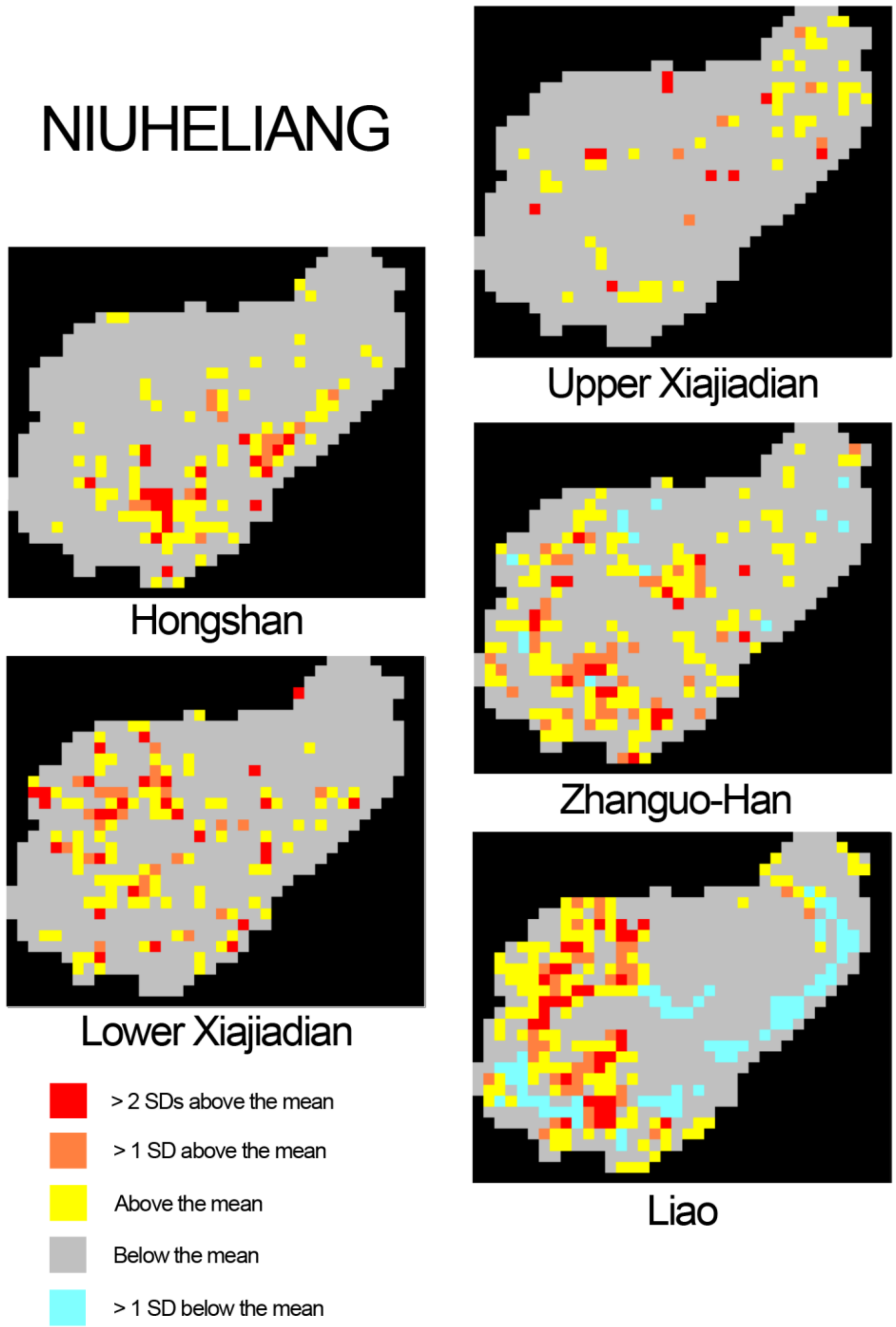

Figure 5.9 Observed minus expected population by 500m quadrat in Niuheliang. Red quadrats represent a value more than 2 standard deviations above the mean value for all quadrats; orange quadrats represent a value 1 to 2 standard deviations above the mean; yellow quadrats represent a value less than 1 standard deviation above the mean; grey quadrats represent a value less than 1 standard deviation below the mean; and light blue quadrats represent a value 1 to 2 standard deviations below the mean.

Table 5.1 Observed and expected population by 500m quadrat in Niuheliang.

NIUHELIANG	HS	LXJD	UXJD	ZG-Han	Liao
RSD of Observed Population (%)	328	264	655	176	163
RSD of Observed minus Expected Population (%)	9K	14K	17K	6K	3K
Correlation between Observed and Expected Population (r^2)	0.021	0.041	0.004	0.202	0.261

The observation in Chifeng and the Upper Daling Valley that the correlations between observed and expected population are all extremely weak throughout the entire sequence holds true in Niuheliang, too, even though the r^2 numbers are somewhat higher here, which is expected for a more densely occupied region. The level of correlation varies in close accordance with the ups and downs of regional population densities, but population pressure was probably never really a serious issue forcing people to use resources maximally in Niuheliang, just like population pressure was probably never really a serious issue in Chifeng and the Upper Daling Valley during any period of time. Or well-developed supra-local communities could create powerful centripetal forces to encourage people to live in impractical locations from the single point of view of agricultural productivity. This possibility was supported by constantly higher RSDs of observed minus expected population than RSDs of observed population in Niuheliang. As in Chifeng and the Upper Daling Valley, environments alone account relatively little for the amount of population actually recorded in a quadrat. The contrast between the two numbers, however, was generally less sharp in Niuheliang than in the two other regions, and the two indexes were frequently lower here than in Chifeng and the Upper Daling Valley. For one thing, constantly higher regional population densities in Niuheliang would encourage more people to use resources maximally and create stronger centrifugal forces than in other two survey areas. For the other, the effect of centrifugal forces created by practical subsistence considerations would probably loom even larger in this smaller and more mountainous region, where there were just not many agriculturally productive lands to be left unoccupied in the first place. A direct visual inspection of the two sets of maps gives the same impression that the locations of observed settlement concentration frequently matched well with where clusters of quadrats with more population than expected formed. In other words, the formation of settlement concentration through much of the sequence was something more than a simple reflection of environmental conditions. Below, changes in both RSD values for observed population and RSD values for observed minus expected population are interpreted in conjunction with an environmental profile for each of the five periods (Figure 5.10). The environmental profiles in Niuheliang were obtained in the same way as in Chifeng and the Upper Daling Valley, by first selecting all 500m quadrats with at least 1 standard deviation higher than the mean value of observed over expected population to represent locations of rigorous settlement concentration, and then calculating for each of the four zones the numbers of 10 by 10 m cells that make up these high value quadrats. The resulting proportions were compared with the default environmental profile, the proportions of the total land belonging to each of the four zones, so as to determine whether and to what extent the formation of settlement concentration as a result of social centripetal forces had any recognizable environmental basis.

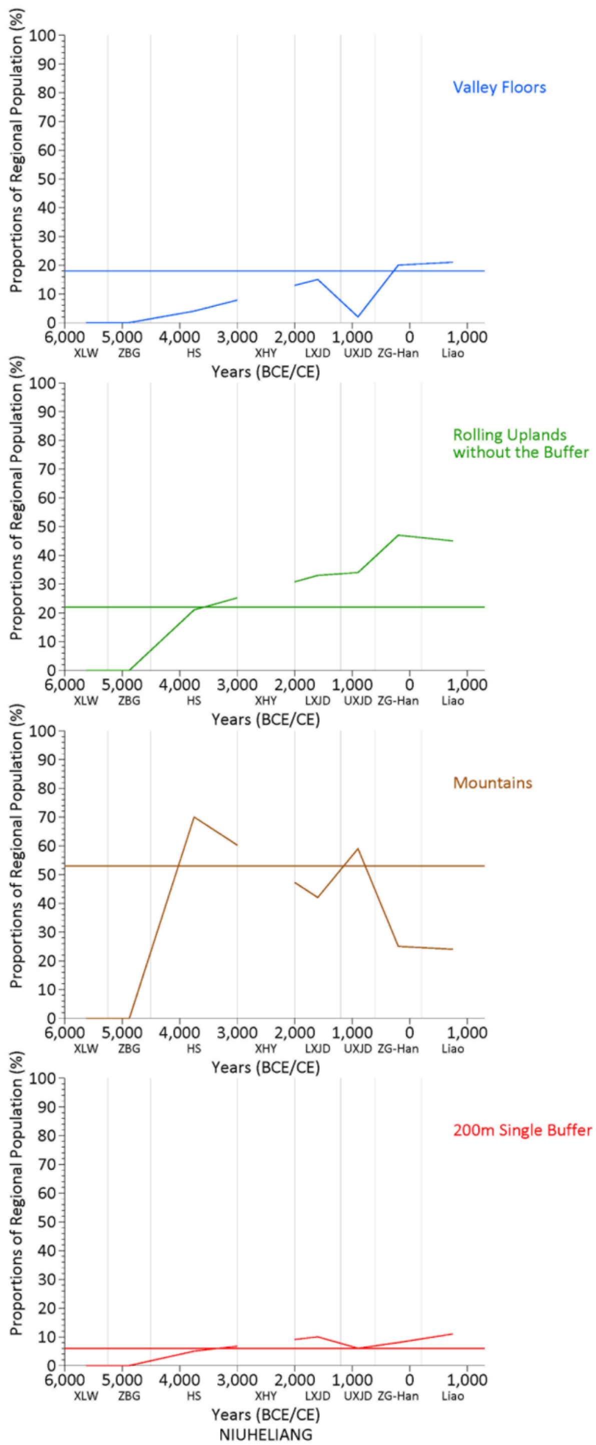

Figure 5.10 Environmental profile for settlement concentration through time in Niuheliang. Proportions of the total 10m cells included in high value quadrats where more population than expected was observed for valley floors, general rolling uplands, mountains, and the 200m single-sided buffer band. The numbers were rounded off to the nearest whole number and add up to 100%.

Hongshan Environmental Profile (4500 to 3000 BCE)

Powerful social centripetal forces were expected in Niuheliang during Hongshan times. That the RSD of observed population at 328% in Niuheliang was somewhat lower than in Chifeng and the Upper Daling Valley was probably a result of a smaller, focused survey area more intensively inhabited by a remarkable amount of people. On the other hand, the RSD of observed minus expected population, at 9K%, was considerably lower than in either of the two regions because it was not valley floors or the ecotone that were the most densely occupied in Niuheliang. Some people lived in the mountains near the Niuheliang ceremonial complex. Others lived in the mountains and on higher uplands at convenient locations to provision the pilgrimage center. And others preferred to live on rolling uplands and in the ecotone just like Hongshan people normally did elsewhere. With fundamentally two groups of people making decisions of settlement location based on different logics, Niuheliang ended up showing relatively similar densities for the three zones just mentioned, which undermines the consistency of environments as a reference for comparison. The correlation between observed and expected population was less telling for the same reason. In support of this description was the clear spatial correspondence between the two clusters of quadrats with more population than expected and the two visible concentrations of observed population, one right around the pilgrimage center and the other to the southwest where the main pilgrimage center provisioning zone might be. The former was located in the mountains, and the latter might be stretched up into the uplands more than in Chifeng and the Upper Daling Valley to be closer to the ceremonial localities and consequently make more use of upland cultivation. Hongshan environmental profile for Niuheliang confirms the focus on the mountains as the environmental basis for settlement concentration. Settlement in Niuheliang tended to concentrate in the mountains rather than anywhere else. As much as 70% of the 10m cells comprising the high value quadrats was found on 53% of the total land that were the mountains. Neither Chifeng nor the Upper Daling Valley had this skewed pattern of distribution for the cells. Meanwhile, the ecotone that was featured so strongly in the environmental basis for settlement concentration in Chifeng and the Upper Daling Valley only includes just 1% more cells than expected. These results indicate a very different logic with which the social centripetal forces in Niuheliang work to encourage settlement concentration, and they are consistent with what may be expected for a place like Niuheliang.

Lower Xiajiadian Environmental Profile (2000 to 1200 BCE)

With a decreasing RSD of observed population, an increasing RSD of observed minus expected population, and a stronger correlation between observed and expected population, Lower Xiajiadian settlement in Niuheliang indicates influential social centripetal forces at work. The RSD of observed population at 264% remained lower than that in Chifeng and the Upper Daling Valley as the Niuheliang survey area continued to be occupied more densely and more extensively during Lower Xiajiadian times. Without many communities located unusually in the mountains, the RSD of observed minus expected population at 14K% during Lower Xiajiadian times was similar to that in the other two regions. The two indexes for settlement concentration were more similar to the Upper Daling ones, but the correlation at 0.041 was closer to that in Chifeng. The latter is understandable as higher population levels in an area with lower agricultural potential would reasonably lead to people making decisions of settlement location in better accordance with environments. The spatial correspondence between clusters of high value quadrats and observed concentrations of population was definitely visible, and the most densely occupied areas seemed to have shifted from around the Niuheliang pilgrimage center and its potential provisioning zone to the river valley to the northwest. Accordingly, Lower Xiajiadian settlement concentration in Niuheliang showed a tendency to form on general rolling uplands excluding the 200m single-sided buffer band. Around 33% of the cells were found on 22% of the total land. The difference of 11% indicated a weak yet unmistakable preference as it was in the Upper Daling Valley. The Lower Xiajiadian environmental profiles in Chifeng, the Upper Daling Valley, and Niuheliang were different from one another. Settlement concentration in Chifeng showed a clear environmental basis for the ecotone, in which population was also concentrated. In the Upper Daling Valley and Niuheliang, where population concentration in the ecotone was not as strong, the environmental basis for settlement concentration was loosely based on stony hills and general rolling uplands. Even though the regional population density was slightly higher in Niuheliang than in Chifeng, and more than half of the lands in the Niuheliang survey area were the agriculturally unproductive mountains, the formation of settlement concentration did not rely on the risk-buffering strategy as it did in Chifeng. Moreover, the differentiation among sixteen Lower Xiajiadian supra-local communities in Niuheliang does not show potential connection to the consideration of the risk-buffering strategy (Table 5.2), unlike what have been observed in Chifeng, too.

Table 5.2 Societies with more than two identified supra-local communities in Niuheliang.

NIUHELIANG	LXJD (n=16)
RSD of Total Population (%)	59.69
RSD of Territory (%)	66.56
RSD of Population Density (%)	91.93
Correlation of Total Population with Absolute Proportion of Population on the Buffer Band (r^2)	0.035 (p=0.488)
Correlation of Total Population with Relative Proportion of Population on the Buffer Band (r^2)	0.148 (p=0.14)
Correlation of Territory with Absolute Proportion of Population on the Buffer Band (r^2)	0.005 (p=0.803)
Correlation of Territory with Relative Proportion of Population on the Buffer Band (r^2)	0.001 (p=0.925)
Correlation of Population Density with Absolute Proportion of Population on the Buffer Band (r^2)	0.023 (p=0.575)
Correlation of Population Density with Relative Proportion of Population on the Buffer Band (r^2)	0.034 (p=0.494)

Upper Xiajiadian Environmental Profile (1200 to 600 BCE)

The very sparse Upper Xiajiadian population in Niuheliang meant population pressure and strong centrifugal forces must have been minimal. As a result, the RSD of observed population reached the regional highest at 655%, and the correlation between observed and expected population was also the weakest. At the same time, that the RSD of observed minus expected population did not increase proportionally likely indicates a relatively weak social centripetal force. In addition, the spatial correspondence between clusters of quadrats with more population than expected and concentrations of population was rather ambiguous compared with other periods in the regional sequence. Settlement concentration was not strong at all during Upper Xiajiadian times, and population was very small. That 12% more cells than expected were found on general rolling uplands, the strongest deviation in the environmental profile, should not be taken too seriously as showing a meaningful environmental preference.

Zhanguo-Han Environmental Profile (600 BCE to 200 CE)

When population levels soared in Niuheliang during Zhanguo-Han times, the RSD of observed population dropped to a point lower than ever before at 176%. Meanwhile, the RSD of observed minus expected population at 6K% remained low and close to the number in the Upper Daling Valley survey area, where Zhanguo-Han settlement was severely ruralized. These results could indicate weak social centripetal forces. Or powerful centripetal forces were offset by similarly powerful centrifugal forces as a result of the enormous amount of regional population. The latter interpretation is supported by the very strong correlation between observed and expected population coexisting with a good spatial correspondence between clusters of high value quadrats and concentrations of observed population which also indicates that important factors other than environments were shaping settlement concentration. More population than expected was observed across the entire western survey area along the broad valley floor, which was definitely a result of zonal sensibility in choosing settlement locations. But, at the same time, the other valley floor to the northwest of the survey area, which had some occupation in Hongshan and Lower Xiajiadian times, remained little occupied, likely because of its proximity to Anzhangzi. Zhanguo-Han settlement concentration in Niuheliang showed a clear tendency to form on general rolling uplands, as 47% of the 10m cells comprising the high value quadrats were found on 22% of the total land that belong to this category. The unusually densely occupied Niuheliang showed signs of both strong centrifugal forces and strong centripetal forces at the same time. Yet, the ecotone was not particularly favored for settlement location as is expected when population densities are high, nor was it a particularly important part of the environmental basis for settlement concentration as they were in Chifeng, where strong centripetal forces were also indicated.

Liao Environmental Profile (200 to 1300 CE)

The RSD of observed population remained similarly low in Niuheliang during Liao times despite a continuously growing population. The RSD of observed minus expected population dropped to 3K%. Social centripetal forces were indicated by the good correspondence between clusters of high value quadrats and concentrations of observed population, but they might not be as powerful as they were in Chifeng or the Upper Daling Valley. This makes sense for there is no Liao administrative center as important as Songshanzhou or Lizhou immediately in the Niuheliang survey area. On the other hand, the correlation between observed and expected population was even stronger than during Zhanguo-Han times, indicating even more powerful centrifugal forces as a result of high population levels. That more population than expected was observed across the entire western survey area along the broad valley floor remained true in Liao times. The tendency of settlement concentration in Niuheliang to form on general rolling uplands excluding the 200m single-sided buffer band also continued. About 45% of the cells were found on 22% of the total land that belongs to this category. The environmental basis for settlement concentration in Liao times was once again different across the three regions. In the most densely occupied Niuheliang, settlement concentration could most likely be found on general rolling uplands, while in the moderately densely occupied Upper Daling Valley, settlement concentration almost exclusively occurred on valley floors. The least densely occupied Chifeng did not show clear preference for any zone for the formation of settlement concentration.

The shifting locations with more population than expected through time in the Niuheliang survey area support the provisioning-a-pilgrimage-center idea. The western survey area along the broad valley floor is very good for agricultural production and had more population than expected during Zhanguo-Han and Liao times right from northwest to southwest. With the highest population density and the possibility of taxation drawing off at least some agricultural production out of the survey area, this makes environmental sense for both periods, especially Liao. In Lower Xiajiadian times, it is the northwest part of the river valley, rather than the entire western survey area, that had more population than expected. And finally, during Hongshan times and only during Hongshan times, it is the southwest where clusters of high value quadrats showed concentration of more population than expected. This makes excellent sense if the main reason for this population buildup was to provide food to the Niuheliang ceremonial complex up in the mountains, because this makes for the shortest transport distance between producers and consumers. Since the population sustained was not nearly as large as it was in Lower Xiajiadian, Zhanguo-Han, or Liao times, the northwest part was not needed to raise food production to higher levels, and it was undesirably far from the ceremonial complex in the mountains and thus did not have the especially high population that it had in the three later periods.

5.4 An Attempt to Estimate Hongshan Absolute Agricultural Production

The calculation of absolute estimates of agricultural production is frequently attempted in archaeological settlement studies of complex societies. The analyses of this study to this point have been focused on *relative* differences in patterns of settlement distribution between survey areas for a few reasons. For one thing, the evidence so far does not indicate a catastrophic scenario of maximized carrying capacity in any serious sense for the three survey areas throughout the entire sequence. Even when population levels increased sharply and competition over resources was the most acute during Lower Xiajiadian times, many lands were left unoccupied. As a result, rather than being seen as a single event happening during a short period of time, the perceived risk of regional population outgrowing food production was a process of which members of ancient societies were constantly aware and to which they reacted. How they perceived and reacted to this pressure is more important, and more traceable, than an absolute estimate of this pressure. In this study, the utilization of the ecotone was shown to be an important way by which inhabitants of the three survey areas coped with the perceived risks to agricultural production, and they did so more often than not regardless of *actual* levels of resource pressure. Finally, a precise estimate of production levels at this scale is, after all, very difficult. The population estimates were not meant for analyses concerned with absolute estimates in the first place. Population levels could potentially fluctuate from one decade to another throughout several centuries within a period. Millet-focused agriculture only comprised a part of the total subsistence strategies, even when people had come to rely more heavily on food production since Hongshan times, and agricultural productivity was also highly variable in accordance with unpredictable inter-annual variation in precipitation. There remain many assumptions to make and justify before an estimation of absolute agricultural production in ancient times can be made with any accuracy.

That being said, insofar as this study is concerned with provisioning, the production and consumption of foods are not irrelevant aspects of the social activities that interest us. With an acknowledgement of its inherent difficulty and inaccuracy, the following analyses are an attempt to measure absolute agricultural production and consumption during Hongshan times. Drawing from the approximation of agricultural production on the basis of land qualities and population levels in the Valley of Oaxaca (Nicholas 1989), this analysis explores the possibility of surplus or deficit at regional as well as local scales by calculating the annual production required and production potential for three analytical units: the entire Niuheliang survey area, the two supra-local communities, and a grid of 2 by 2 km squares, the size of which is determined based on the assumption that Hongshan farmers would be willing to walk up to 2 km to their farmlands (Figure 5.11). Locations of Shangchaoyanggou, Yaogouxiliang, and Nushenmiao, where data on household artifact assemblages have been collected to investigate patterns of inter-household differentiation, are shown in the map, too.

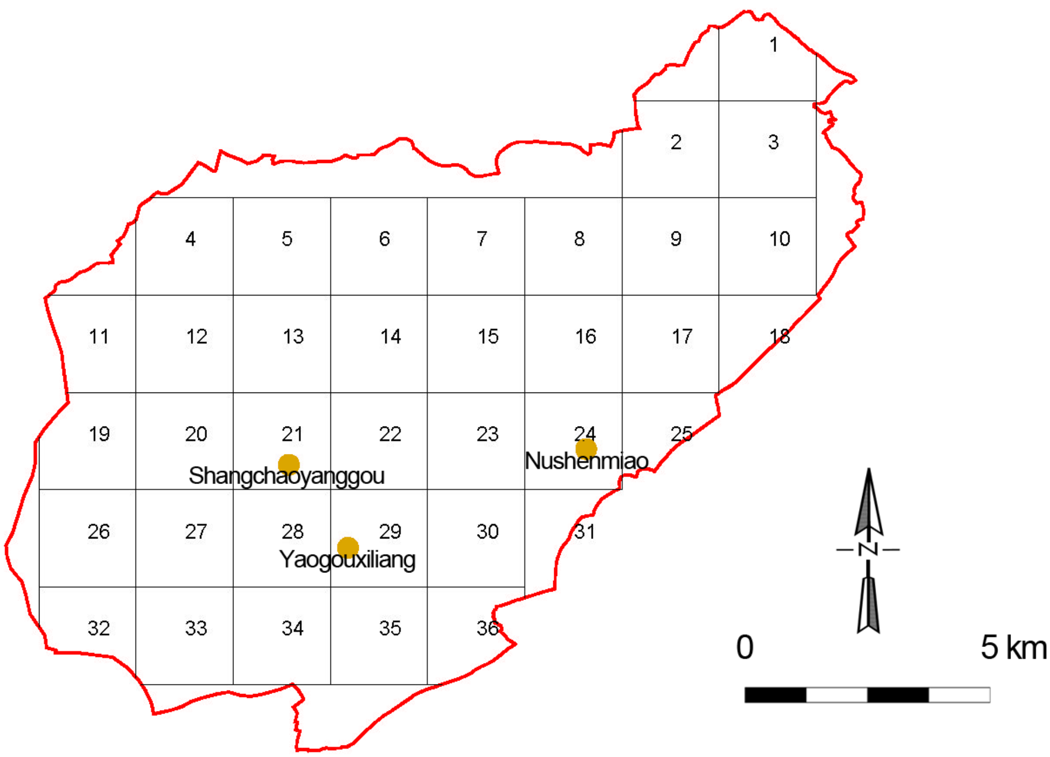

Figure 5.11 The grid of 2 by 2 km squares in Niuheliang. Brown dots are locations where studies of inter-household differentiation have been carried out.

Annual production required is the total weight of millet required to support the population in the target analytical unit, and it is calculated based on the unit's estimated population. It is assumed in this study that 50% of Hongshan population at any given time was adults, who consumed 3,050 calories a day for a male and 2,375 calories a day for a female (Food and Agriculture Organization of the United Nations 2004), and another 50% of the population would be non-adults, who consumed half the amount of foods that adults did. Therefore, a Hongshan person would require an average of 2,035 calories per day to survive. Foxtail millet can provide about 3,530 calories per kg (Kajuna 2001). Half of this number, 1,765 calories per kg, is assumed in this study to be closer to the Neolithic food processing level. Thus, the total production required for the target unit can be arrived by:

$$\frac{Population\ Range \times 2035 \times 365}{1765}$$

Annual production potential is the total weight of millet that can reasonably be produced in the target analytical unit, and it is calculated also based on the unit's estimated population. It is assumed that 50% of the Hongshan population were adults and all potential food producers, who could cultivate 0.02 sq km a year. Local millet productivity is indicated by the county annals of Lingyuan (Lingyuan County Annals Production Committee 1995) to be averaged 128,649 kg per sq km during 1949 to 1969, about half to a third of the modern-day standard. Half of this number, 64,325 kg per sq km, is assumed to be closer to the food production level during Hongshan times. It is also assumed that this production level remained 100% only on alluvial valley floors, decreased to 85% (54,676 kg per sq km) on rolling uplands, and further decreased to 15% (9,649 kg per sq km) on stony hills and in the mountains. Within the areal extent of the unit, lands of higher agricultural productivity are assumed to be farmed first before lands of other kinds are utilized for cultivation. This assumption is made for a best case scenario, ignoring the impact of risk. Whether Hongshan farmers were living on the bluffs at the edge of the flat valley or in the mountains, if they felt the need, they could all have traveled to floodplains and cultivated crops there until they had to turn to other zones because there were not enough farm plots for everyone. This was entirely plausible for farmers in a 2 by 2 km square. Hongshan farmers in the two supra-local communities and in the entire survey area are assumed not to have access to lands of best agricultural productivity more than 2 km away and therefore might not have been able to produce as much as calculated in the grid square analysis. This will only be an issue for the second supra-local community in the main provisioning zone because the first supra-local community at the Niuheliang pilgrimage center is barely larger than 2 km across, and the entire survey area, with a low land use rate around 10-20%, will not appear to have suffered from food deficit either way. Moreover, treating the estimated production potential as a best case scenario can focus our attention to the contrasting results between the three scales. The unusualness of the concentration of Hongshan population in the two clusters, for example, is highlighted by inhabitants of some very densely packed squares not choosing dispersal to mitigate the resource tension, despite clearly having the option. Therefore, with this assumption for a best case scenario, if a square of 4 sq km has 2 sq km of valley floors, 1 sq km of rolling uplands, and 1 sq km of mountains, and if the square has 125 persons that could potentially farm a total of 2.5 sq km, its total land farmed would consist of 2 sq km of valley floors and 0.5 sq km of rolling uplands. No land in the mountains would be utilized in this square. Thus, the total production potential of the square can be arrived by:

$$aVF \times 64325 + aRU \times 54676 + aMT \times 9649$$

Where

$$aVF = area\ of\ valley\ floors\ farmed$$

$$aRU = area\ of\ rolling\ uplands\ farmed$$

$$aMT = area\ of\ mountains\ farmed$$

Annual production potential is then divided by annual production required to obtain a ratio for the unit to indicate how likely the unit would be experiencing population pressure. The ratio will be 1 if production potential is just enough to support the population and equal exactly to production required. The proportion of lands that are farmed is calculated, too, to indicate how much land had to be utilized in the unit.

$$The\ Ratio = \frac{Annual\ Production\ Potential}{Annual\ Production\ Required}$$

If the ratio of production potential over production required is larger than 120%, the analytical unit is considered potentially producing food surplus. If, on the other hand, the ratio is smaller than 80%, the unit is considered potentially suffering from food deficit. Any ratio in between is labeled neutral. The land use rate is calculated, too, based on the maximum amount of land that can potentially be utilized by the labor available in the unit. For example, for a square measuring 4 sq km in area that has 100-200 persons, 50-100 persons are available for farming. Therefore, the total land utilized can range from 100 to 200 ha depending on whether the population is estimated at the maximum or at the minimum. The land use rate for that square will be 25-50%. Any analytical unit showing less than a 20% land use rate is labeled neutral, too (Table 5.3), because such a low land use rate is not in tune with the scenario of either surplus production or deficit.

Table 5.3 Hongshan agricultural consumption and production potential in Niuheliang by the survey area, supra-local community, and 2km square.

	Population Range	Production Required (kg/year)	Production Potential (kg/year)	Land Used (%)	Minimum Population	Median Population	Maximum Population
Region	1,570-3,140	660,232-1,320,463	1,009,470-1,983,056	10.4-20.7	-	-	Surplus
SLC 1	259-518	108,935-217,870	91,620-115,429	51.3-100	-	Deficit	Deficit
SLC 2	994-1,988	418,180-836,360	582,359-821,099	36.8-73.5	Surplus	Surplus	-
Square 1	2-4	632-1,263	821-1,641	0.5-1	-	-	-
Square 2	10-20	4,198-8,396	5,774-11,230	2.7-5.3	-	-	-
Square 3	2-3	608-1,216	930-1,859	0.4-0.8	-	-	-
Square 4	3-6	1,233-2,465	1,885-3,769	0.8-1.5	-	-	-
Square 5	4-7	1,314-2,628	2,010-4,019	0.8-1.6	-	-	-
Square 6	1-1	118-235	153-305	0.1-0.2	-	-	-
Square 7	10-20	3,998-7,995	917-1,834	2.4-4.8	-	-	-
Square 8	11-21	4,271-8,541	5,550-11,100	2.6-5.1	-	-	-
Square 9	9-18	3,759-7,517	4,885-9,769	2.3-4.5	-	-	-
Square 10	19-37	7,607-15,214	11,631-23,262	4.6-9.1	-	-	-
Square 11	4-8	1,620-3,239	2,476-4,952	1.2-2.4	-	-	-
Square 12	8-15	3,016-6,031	4,610-9,220	1.8-3.6	-	-	-
Square 13	23-46	9,499-18,997	12,345-24,689	5.7-11.3	-	-	-
Square 14	9-18	3,687-7,374	4,792-9,583	2.2-4.4	-	-	-
Square 15	68-135	28,271-56,542	36,742-44,266	16.8-33.6	-	-	Deficit

Square 16	4-8	1,594-3,188	2,072-4,143	1-1.9	-	-	-
Square 17	47-94	19,731-39,461	25,642-49,035	11.8-23.5	-	-	Surplus
Square 18	9-18	3,737-7,474	5,714-11,427	4-7.9	-	-	-
Square 19	2-3	549-1,098	840-1,679	0.4-0.8	-	-	-
Square 20	18-35	7,249-14,498	9,421-18,842	4.4-8.7	-	-	-
Square 21	134-267	55,982-111,963	14,767-27,606	33.3-66.6	Deficit	Deficit	Deficit
Square 22	10-20	4,053-8,106	5,268-10,535	2.5-4.9	-	-	-
Square 23	42-83	17,455-34,910	22,685-45,370	10.4-20.8	-	-	Surplus
Square 24	197-393	82,579-165,158	65,236-84,175	49.3-98.5	Deficit	Deficit	Deficit
Square 25	16-31	6,511-13,022	8,462-16,924	6.5-13	-	-	-
Square 26	5-9	1,736-3,471	2,654-5,307	1.1-2.1	-	-	-
Square 27	71-142	29,686-59,372	38,653-77,233	17.7-35.3	-	Surplus	Surplus
Square 28	229-457	95,930-191,860	111,538-128,131	57.1-100	-	-	Deficit
Square 29	253-505	106,176-212,352	52,190-66,434	63.1-100	Deficit	Deficit	Deficit
Square 30	13-26	5,435-10,869	7,063-14,125	3.3-6.5	-	-	-
Square 31	54-108	22,697-45,394	29,498-39,782	26.9-53.7	Surplus	-	-
Square 32	1-2	400-800	612-1,223	0.4-0.7	-	-	-
Square 33	1-1	62-123	94-187	0.1-0.1	-	-	-
Square 34	103-205	43,089-86,178	65,882-128,450	25.7-51.3	Surplus	Surplus	Surplus
Square 35	130-260	54,645-109,289	83,549-163,588	32.5-65	Surplus	Surplus	Surplus
Square 36	16-32	6,689-13,378	9,137-17,830	5.6-11.1	-	-	-

The numbers at the regional level are consistent with our impression that little resource stress was ever felt during Hongshan times. The Niuheliang survey area as a whole has a ratio of 153% when its population is estimated at the minimum, and of 151% when its population is estimated at the maximum, which means that production potential could be as much as 1.5 times higher than production required at the scale of the entire region, and the proportion of lands utilized would range merely between 10.4% and 20.7%. Even when settlement was dense and concentrated in the mountains, Hongshan societies in Niuheliang did not seem to be experiencing resource pressure in any serious sense. Hongshan farmers in Niuheliang looking to increase food production could have easily moved to lands elsewhere in the survey area that were less occupied.

Another implication of high ratio numbers and low land use rates at the regional level is that all the food needed to sustain the Niuheliang pilgrimage center could very easily have been raised quite nearby, without large-scale economic arrangements bringing food tribute from more distant Hongshan settlements. The estimated number of people within the survey area, which might include ritual specialists living permanently at Niuheliang, some component of visitors from afar, and farmers growing the food that everyone ate, had no need at all of food brought from more than a few kilometers away. Despite its macro-regional symbolic, ritual, and cultural importance, economically the pilgrimage center was a very local operation made feasible by the productivity of the soils within such a short distance and the people living nearby providing the labor.

With the numbers at the regional level in mind, the high utilization rate of lands for the two Hongshan supra-local communities shows an interesting contrast. Even when as much as 51% to 100% of the lands within its territory could have been utilized in order to achieve the maximum level of estimated production, the first supra-local community, or District 1, which is centered around the Niuheliang ceremonial complex, shows a ratio ranging from 85%, when its population is estimated at the minimum, to 53%, when its population is estimated at the maximum. Both numbers would indicate potential food deficit, and they might have actually been even lower because it would probably be too generous to assume 50% of its population to be food producers for a place where ritual facilities were the most abundant and well-constructed. The other supra-local community southwest of the Niuheliang ceremonial complex, or District 2, on the other hand, shows a ratio of 140% when its population is estimated at the minimum, and 99% when its population is estimated at the maximum, with a land utilization rate ranging from 36.8% to 73.5% to achieve the estimated level of production. These ratios suggest that District 2 could have been where potential surplus was produced. The remarkable contrast in the resulting ratio between the two supra-local communities would remain consistent even if our production and consumption rates are very tentative and could have varied substantially. Despite the error ranges inherent in absolute estimates of agricultural production, the contrast in the ratio strongly hints at a dependent relationship, which fits in the scenario of the provisioning-a-pilgrimage-center idea.

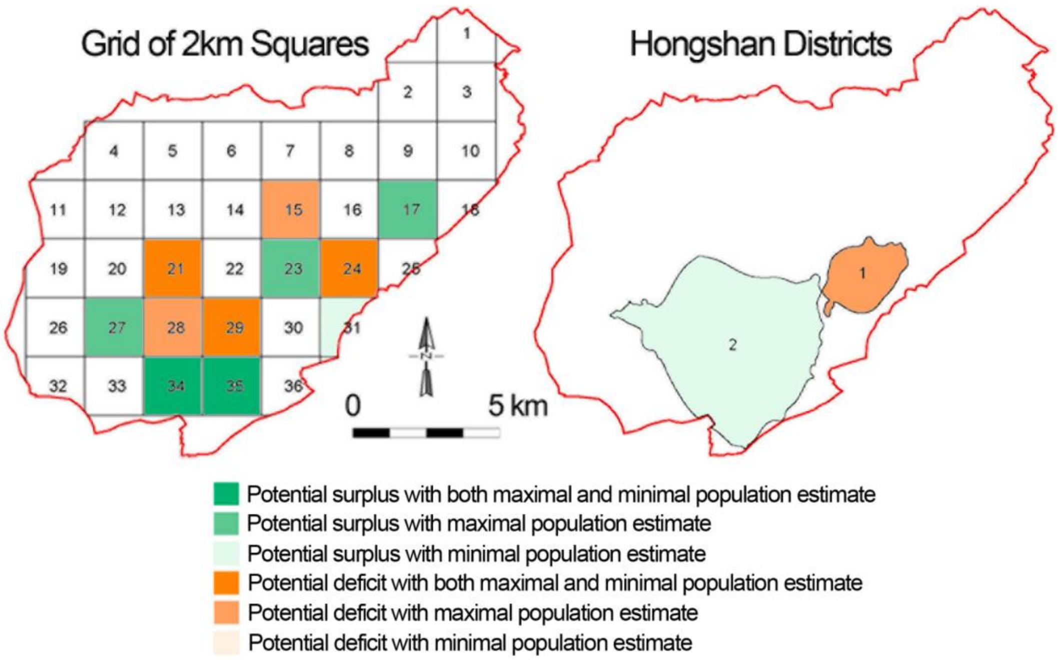

Figure 5.12 Potential surplus producing and deficit suffering areas in Niuheliang during Hongshan times.

The scale of 2km squares is more sensitive to behaviors of individual Hongshan farmers. Among the 36 squares, 3 to 6 of them could potentially produce surplus, depending on whether their population was estimated at the minimum or maximum (Figure 5.12). Squares 31, 34, and 35 are all relatively densely occupied, and they are potentially capable of producing a good amount of surplus even when their population (and thus available labor supply) is estimated at the minimum. They show ratios of 130%, 153%, and 153%, respectively, with very modest land utilization rates at 26.9%, 25.7%, and 32.5%. When population is estimated at the maximum, square 31 is omitted from the list of potential surplus producers. Square 31 involves two ridges across a river valley. Most of its population lived on the northern ridge, where most of the Hongshan ceremonial constructions in Niuheliang are concentrated. On the southern ridge were Localities 14 and 15 where no sign of considerable occupation was found. Therefore, land outside the survey boundary to the south are unlikely to have been utilized by inhabitants of Square 31, and its role of a potential surplus producer should be taken with a grain of salt. When population is estimated at the maximum, Squares 17, 23, and 27 join in as potential surplus producers. The three additional squares are also moderately densely occupied, but not as densely occupied as the first three squares. The five now show a ratio of 125%, 130%, 131%, 150%, and 150%, respectively, with land utilization rates at 23.5%, 20.8%, 35.3%, 51.3%, and 65%. At any rate, the five squares can be seen as potentially producing surplus for nearby squares.

On the other hand, 3 to 5 of the same 36 squares could have potentially suffered from food deficit, depending on whether their population was estimated at the minimum or maximum. Squares 21, 24, and 29 are all very densely occupied, and they show signs of food shortage no matter whether their population is estimated at the minimum or maximum. When their population is estimated at the minimum, they have ratios of 27%, 79%, and 50%, respectively, with moderately high land utilization rates at 33.3%, 49.3%, and 63.1%. Square 21 includes Shangchaoyanggou, where data on household artifact assemblages and the spatial distribution of households suggest a heavier involvement in food producing activities and an only slightly less heavy involvement in food processing activities for households here than those in Hongshan local communities in Chifeng and the Upper Daling Valley, and these activities were more focused on a spatially clustered group of households and were closely associated with some form of prestige (Ran 2022). On the other hand, Hongshan households at Shangchaoyanggou were less involved in ritual activities.

The findings at Shangchaoyanggou are consistent with a provisioning community. Inhabitants of Square 21, including of those living at Shangchaoyanggou, chose to stay here despite potential food deficit. They were not the one of the two groups of people in the main provisioning area that intensively utilized the ecotone to ensure reliable agricultural production by living on the bluffs at the edge of the flat valley floor. Instead, they represented the other group of people that lived on higher locations for proximity to the pilgrimage center. If this association between food deficit squares and a special group of households engaged in food provisioning activities is accurate, ongoing analyses at Yaogouxiliang, located in Square 29 as well as in the main provisioning area, should show similar patterns of inter-household differentiation, as Square 29 is also a potential food deficit square, and it is even more densely occupied than Square 21. Square 29 also includes Locality 16, which, although situated on top of a separate, individual ridge some distance away from other localities, has a village community beside it and stands out as impressive for carved jades of natural and supernatural themes that were recovered in abundance in multiple burial chambers. If the population next to Locality 16 was more focused on ritual activities rather than farming, households at Yaogouxiliang might have been engaged more intensely in food producing and processing activities than those at Shangchaoyanggou.

Square 24 is where Hongshan ceremonial constructions are concentrated the most, although it is hard to draw a clear line between ceremonial construction that should be considered part of the Niuheliang pilgrimage center and structures that are just "normal" platforms associated with residential communities in the sustaining zone. Localities 1 to 10 are all found within this 2km square. Data on household artifact assemblages at Nushenmiao here in Square 24 should reveal a higher level of participation in ritual activities, if a decent portion of the residents here was indeed non-farming ritual specialists and visitors. It will be rather surprising if results of the complete analysis indicate considerable involvement in food producing activities (Ran 2022), even though Square 24 does include about 1 sq km of rolling uplands to the southeast. Patterns of inter-household differentiation will inform on what the households here were doing and how their focused activities were different from those elsewhere.

In addition, when population is estimated at the maximum, Squares 15 and 28 also show sign of food shortage. Square 28 is as densely occupied as the other three food deficit squares, while Square 15 is only moderately densely occupied and is almost classified in the neutral category. The five now show ratios of 79%, 25%, 51%, 67%, and 32%, with some of the highest land utilization rates at 33.6%, 66.6%, 98.5%, 100%, and 100%. Squares 24, 28, and 29 are so densely occupied and their labor supply is so abundant that every bit of land within the square is reconstructed as farmed, and the total production still cannot sustain the population.

Inhabitants of the surplus-producing squares would find themselves facing fewer options in choosing where to farm, as the land utilization rate of these squares is often much higher. They could have lived in other less densely occupied squares to enjoy more flexibility. Inhabitants of the deficit squares could also have simply moved to other squares to cope with the risk, as many squares still had much underutilized land. Instead, they chose to live in the more-densely populated squares despite the inconveniences. The spatial patterning of the squares showing either surplus or deficit is not random and may hint at some of the reasons behind the decision to live in them. The immediate impression is that all of them are located near the two Hongshan supra-local communities. A closer look reveals that the first, smaller supra-local community, which is focused on the Niuheliang pilgrimage center, roughly overlaps with deficit Square 24 and is surrounded by three surplus-producing squares and another deficit square. The second, larger supra-local community, on the other hand, which represents the main provisioning zone, consists of three deficit squares that are located closer to the pilgrimage center and three surplus squares that are closer to the river valley.

The analyses in this subsection are based on a model that highlights labor availability and agricultural productivity of different land types. Since estimated population determines both how much food must be produced and how much food can be produced (since it determines the labor available for farming), the accuracy of absolute population estimates does not matter as long as all farmers can find good lands to farm. Higher population estimates produce both higher requirements and higher production in similar amounts. However, not all farmers can find good land to farm. For Hongshan farmers who lived too close to each other, there might not be enough land for each of them to have 2 ha of farm plots within 2 km walking distance. Or, there might not be enough productive land to make possible the food production required. This is what happened between Squares 21 and 35. Both squares have about 130-260 persons, thus similar labor availability and numbers of mouths to feed. Yet, Square 21 is mostly located in the mountains, while Square 35 includes much valley floor and upland land. The production potential estimated for Square 35 is about six times higher than the production potential estimated for Square 21, making the former a surplus producing square and the latter a deficit one.

Viewed together, there were about 260-520 persons at the Niuheliang pilgrimage center that could have been dependent on food production elsewhere. Considering that many of them were non-farming ritual specialist or visitors, and that these numbers are average momentary populations across some 15 centuries and that frequent visitors would have made fluctuations in local population more unpredictable here than anywhere else, it is safe to assume a level of demand corresponding to the maximum estimate of 520 persons, that is, an annual total of 217,870 kg of crops. Although production potential would be 115,429 kg of crops for this population size, let us assume a worst case scenario in which the population of the pilgrimage center produced no food at all, and see if the provisioning-a-pilgrimage-center idea could work in this extreme situation. There were about 994-1,988 persons in the main provisioning area whose annual production potential minus production required, or the possible amount of surplus, ranged from 164,179 kg of crops when population was estimated at the minimum, to 145,875 kg of crops when population was estimated at the median, and to -15261 kg of crops when population was estimated at the maximum. The relationship between population estimates and the possible amount of surplus is not linear but forms a frown curve because the 13 sq km of agriculturally productive lands in the main provisioning area could accommodate a total of 655 farmers out of a population of about 1,311 persons. At this threshold, the possible amount of surplus is at the highest at 204,252 kg of crops. One less farmer would mean a decrease in production that was larger than the amount of food the farmer had to consume, and one more farmer would mean the farmer had to cultivate crops on unproductive lands for an increase in production that was smaller than the amount of food the farmer had to consume. In either case, the possible amount of surplus decreases.

This resonates with our earlier conclusion that the Niuheliang pilgrimage center was economically a very local operation. The population in the main provisioning area could have provided the food needed for the residents and visitors at the Niuheliang pilgrimage center, even if the pilgrimage center population was not involved in agricultural production at all. The maximum requirement of 217,870 kg of crops could be reasonably met by those living in the main provisioning area, according to the most accurate absolute population estimates that can be made. If special groups of households more involved in food producing and processing activities like those at Shangchaoyanggou are found at Yaogouxiliang as well as at other local communities in the main provisioning area, the combined possible amount of surplus would be even higher.

Overall, these results are not only consistent with the provisioning-a-pilgrimage-center idea, but also reveal more details on how this system worked. The Niuheliang pilgrimage center concentrated a large amount of population in the unproductive mountains, requiring at least partial support from communities immediately nearby. While the main provisioning zone took advantage of the broader river valley to the southwest for better agricultural productivity, its population concentration also continued to extend into the uplands and mountains in the direction of the pilgrimage center, so as to minimize the labor required for regular food transport. It may not be irrelevant that Shangchaoyanggou and Yaogouxiliang are located toward the west and south of the squares they are in. There is land in surplus squares well within 2 km of both local communities. These two possible provisioning communities might well have lived closer to the pilgrimage center, in deficit Squares 21, 28, and 29, and walked south and west from their residences to farm land in surplus Squares 27, 34, and 25, to take advantage of productive land still within the 2 km acceptable walking distance or not much beyond it.

The model used in this analysis could be improved by research aimed at reconstructing Hongshan subsistence strategies in greater detail. Yet, the general conclusions for the region about the ratio of production required to production potential during Hongshan times are unlikely to change substantially if absolute population estimates are modified in the future.

6.0 Conclusions

This study reconstructed patterns of settlement distribution in relation to agricultural considerations through time in Chifeng, the Upper Daling Valley, and Niuheliang in northeastern China, with a focus to exploring how the regular Hongshan economic organization was different in Niuheliang, for which the amount and quality of ceremonial facilities there indicate a special role in Hongshan macro-regional integration, than in Chifeng and the Upper Daling Valley. Demographic reconstruction in the Niuheliang region shows two unusual concentrations of population on uplands and in the mountains effectively make patterns of settlement distribution here deviate from the established Hongshan norm in the other two regions. One of the two population concentrations is centered on the ceremonial complex. Inhabitants of this mountainous location presumably consisted of more ritual specialists, pilgrims, and visitors than anywhere else, who did not farm as much and paid little attention to agricultural considerations when choosing where to live. The second concentration is found to the southwest of the first, but not far from it, and toward the broader river valley near Lingyuan. In this main provisioning area, inhabitants not only took advantage of both the productive lands near the river valley, but they also settled on the uplands and in the mountains to ensure the proximity to the Niuheliang pilgrimage center. Results of several additional analyses provide empirical support for this impression and help answer the set of questions outlined in chapter one about the social dynamics associated with this provisioning-a-pilgrimage-center idea. Below is a summary of our findings with regard to these questions.

6.1 Niuheliang as a Pilgrimage Center: An "Altered" Pattern of Hongshan Settlement Distribution

The need to provision the ritual specialists at the Niuheliang pilgrimage center made settlement distribution in the Niuheliang region deviate from normal Hongshan patterns. Based on demographic reconstruction in Chifeng and the Upper Daling Valley, Hongshan people took risk management into serious consideration when choosing where to live and farm. The relative densities of the various zones and the ecotone behave similarly in both survey areas, suggesting some degree of consistency in settlement preferences. In Niuheliang, on the other hand, locational proximity to the pilgrimage center was an important factor in deciding settlement location. A large number of people were concentrated at the pilgrimage center in the mountains. Another larger concentration of population was located not far away to the southwest in order to take advantage of the wider river valley and adjacent uplands and mountains in the direction of the pilgrimage center. These two concentrations of population result in lower population densities on valley floors, rolling uplands, and in the ecotone than in Chifeng and the Upper Daling Valley, despite higher population levels in Niuheliang. In contrast to Chifeng and the Upper Daling Valley, agricultural conditions for local production were overshadowed by proximity to the pilgrimage center not only as the major determinant of settlement location, but also as an important part of the environmental basis for settlement concentration. Quadrats with more population than (environmentally) expected tend to cluster in the mountains, suggesting a very different logic of social centripetal forces working in Niuheliang than in Chifeng or the Upper Daling Valley, where the ecotone was unambiguously a highly favored environmental basis for settlement concentration.

The settlement distribution within the second supra-local community to the southwest of the Niuheliang pilgrimage center did show a more serious engagement in producing agricultural surplus, as expected in a major provisioning area. This provisioning community included only about 25.9% of the total area of the ecotone in the entire Niuheliang survey area, but as much as 94.7% of the inhabitants of the ecotone were found here, making the density of the 200m single-sided buffer band, at 107.7 persons per sq km, some 50 times higher than the density in this buffer outside of the provisioning community. The ecotone was much more intensively utilized here within the provisioning community than elsewhere. Moreover, results of our attempt at an absolute estimate of Hongshan agricultural production suggest a potentially dependent relationship between the supra-local community centered around the pilgrimage center and the one representing the major provisioning area. Compared with other Hongshan supra-local communities in Chifeng and the Upper Daling Valley that are more distant from one another and appear to be independent entities, the two supra-local communities in Niuheliang are both very densely occupied yet show contrasting deficit-to-surplus ratios. Although a few squares very close to the Niuheliang pilgrimage center show the potential of producing surplus and being suppliers of food, the supra-local community to the southwest was the main provisioning community. People there would have little other reason to distribute themselves across the landscape in the way they did if they did not have a major involvement in provisioning the Niuheliang pilgrimage center. Within the main provisioning area, some local communities lived on the bluffs at the edge of the flat valley floor and utilized the ecotone for the upland-lowland farming strategy more intensively than anywhere else in the Niuheliang survey area, while some others lived on higher locations to gain proximity to the pilgrimage center. Nonetheless, together these local communities formed an internally centralized concentration of population at some distance away from the pilgrimage center, suggesting more frequent interactions among themselves than with those at the pilgrimage center.

6.2 Settlement Patterns and Internal Social Dynamics in the Three Survey Areas

Social dynamics, or the ways individuals and human groups interact with each other under changing circumstances, even of the same archaeological culture, have played out very differently in different regions in northeastern China since as early as Hongshan times (Drennan et al. 2014). The Niuheliang survey provides further evidence for the degree of inter-regional variability in the settlement pattern of ancient societies. While some of our observations point unambiguously to factors of a specific kind, others are the result of mixed and often competing forces simultaneously at work. This diversity of early social complexity encourages comparison and dialogue, rather than single monolithic answers. Below, this study will conclude with a summary of the sequence of change in terms of population level, geographical composition, and characteristics of settlement patterns across the three survey areas. A tentative discussion of how internal social dynamics might have developed in idiosyncratic yet sensible ways in the regional context of each will be provided, too.

Hongshan Societies (4500 to 3000 BCE)

The fast-growing population in Hongshan times relied more heavily on food production than ever before. Millet, in particular, had increased considerably in importance. Since water availability was the main determinant of millet productivity, for Hongshan farmers who had to deal with unpredictable inter-annual variation in precipitation in the Western Liao Valley, margins of the river valley were favorable settlement locations because easy access to both valley floors and rolling uplands hedged against the risks of flooding and drought. Moreover, water damage to the Hongshan wattle-and-daub houses was minimal on these elevated areas, and rainfall could be better retained than on stony hills or in the mountains. In light of this, the Upper Daling survey area that has better geographical settings and climatic conditions for practicing agriculture than Chifeng was indeed more densely occupied by Hongshan people. Hongshan population density in the Upper Daling Valley at 5.6 persons per sq km was twice as high as it was in Chifeng at 2.8 persons per sq km.

The higher Upper Daling density is a direct result of the existence of District 2, which includes the monumental site of Dongshanzui and has more population than any of the Hongshan supra-local communities in Chifeng. Consequently, Upper Daling population was more concentrated in the ecotone, and by a similar degree. The 200m single-sided buffer band was 7.8 times more densely occupied than the regional average in the Upper Daling Valley. In Chifeng, it was only 4.2 times. It was less likely that effective risk management in the Upper Daling Valley allowed higher population levels there, because Hongshan occupation was also intense in the Niuheliang survey area without better risk management in place. Estimated at 15.5 persons per sq km in regional population density, Hongshan people in Niuheliang also practiced the risk-buffering strategy, as demonstrated by similar behaviors of the relative population densities of the various buffer bands across the three survey areas. However, the unusual population level in the Niuheliang survey area had to do with two unusual concentrations of people, one immediately surrounding the Niuheliang pilgrimage center in the mountains, and the other in the uplands and mountains to the southwest. They made two supra-local communities that would rank first and second in population density among all Hongshan districts identified so far. Their locations single-handedly altered the normal patterns of Hongshan settlement distribution as mountains became the most densely occupied of the three zones, and the 200m single-sided buffer band was barely twice more densely occupied than the regional average.

The uniqueness of the two concentrations of Hongshan occupation as a result of strong centripetal forces associated with the Niuheliang pilgrimage center was especially well demonstrated by the quadrat grid approach, in which 70% of the 10m cells comprising quadrats with more population than expected were found on the 53% of the total land classified as mountains. Neither Chifeng nor the Upper Daling Valley had such a skewed pattern of distribution for the cells. Instead, these two regions not only had similar patterns of community organization, but also showed similarly moderate focus on the ecotone as the environmental basis for settlement concentration. About 23% of the cells with more population than expected in Chifeng and 29% in the Upper Daling Valley were found in the 200m single-sided buffer band.

From a diachronic perspective, the river valley in the southwest sector of the survey area was only one of the two most agriculturally productive areas in Niuheliang. The river valley in the northwest had just as much excess population (above expected) as the river valley in the southwest did in Zhanguo-Han and Liao times. The river valley in the northwest had visibly even more excess population than did the river valley in the southwest in Lower Xiajiadian times. Yet, in Hongshan times, it was the river valley in the southwest, rather than in the northwest, that showed a dense occupation. The river valley in the southwest made an ideal location for provisioning communities not only for its access to the broader valley floor, but also because its proximity to the Niuheliang pilgrimage center was important for the transportation of food, the feasibility of which was very sensitive to distance during the Neolithic. The smaller floodplain northeast of the pilgrimage center toward Jianping at least showed some occupation in Lower Xiajiadian and Liao times. Yet, there was not a concentration of population like the one toward the southwest in Hongshan times because it is farther away from the pilgrimage center and across still higher mountain crests, making food transport to the pilgrimage center more difficult.

The attempt to estimate Hongshan absolute agricultural production provided the final line of support for the provisioning-the-pilgrimage-center idea by exploring the distribution of potential surplus-producing and surplus-consuming areas in the Niuheliang survey area. Results of this analysis strongly hint at a potential unidirectional provisioning relationship between the two supra-local communities that generally corresponded to the two unusual concentrations of Hongshan occupation.

Lower Xiajiadian Societies (2000 to 1200 BCE)

Population grew sharply into Lower Xiajiadian times. Conflict that was evidenced by remains of fortifications might have accompanied intensified competition over resources. Hostility between communities would encourage expansion and demographic growth for competitive advantage, which not only provided opportunities for aspiring individuals to control resources and consolidate political power, but also in turn exacerbated resource scarcity. This developmental spiral, if accurate, should play out more intensely in the Chifeng and Niuheliang survey areas where geographical and climatic conditions were inferior to those in the Upper Daling Valley. Lower Xiajiadian population density was indeed about twice as high in Chifeng and Niuheliang, estimated at 49.2 and 54.6 persons per sq km, respectively, as it was in the Upper Daling Valley at 26.0 persons per sq km. Despite a similar settlement preference for the uplands in both the Chifeng and Niuheliang survey areas, substantial population concentration in the ecotone only occurred in Chifeng, where the buffer density was 6.4 times higher than the regional average. While the buffer densities in the Upper Daling Valley and Niuheliang, at 3.4 and 2.3 times higher than their respective regional averages, were also considerable in comparison with what they were in later periods, the inter-regional contrast speaks volumes for the tension felt by Lower Xiajiadian farmers in Chifeng. Settlement concentration as a result of social centripetal forces showed a consistent environmental preference for the ecotone in Chifeng. In the quadrat grid approach, 25% of of the 10m cells comprising quadrats with more population than expected were found on 8% of the total land within the 200m single-sided buffer band. The environmental basis for settlement concentration in the Upper Daling Valley and Niuheliang, on the other hand, was rather ambiguous, if not random. Changes in patterns of community organization were also more conspicuous in Chifeng than they were in either the Upper Daling Valley or Niuheliang. Results of ongoing settlement analyses indicate that several small, autonomous supra-local communities consistent with Lower Xiajiadian dynamics characterized the pattern in Niuheliang. Local and supra-local communities in Niuheliang likely grew demographically at a similar rate to that of the Upper Daling Valley, a rather unimpressive rate compared with the aggressive transformation of communities in Chifeng.

Upper Xiajiadian Societies (1200 to 600 BCE)

The very sparse Upper Xiajiadian occupation in Niuheliang does not really add anything to what have been observed in Chifeng and the Upper Daling Valley, except probably for supporting the idea that participation in the emerging socio-economic integration was likely an important, foundational part of Upper Xiajiadian towns. The mountainous environment of the Niuheliang survey area might have not allowed the level of production needed to support the larger populations of towns, or at least made it quite difficult. It could also have made intensified interaction among inhabitants of nearby communities, which was the basis of economic interdependence and productive specialization, relatively inconvenient. These new dynamics, on the other hand, accompanied social development in the other two survey areas. Upper Xiajiadian population density was similarly high in both Chifeng and the Upper Daling Valley, estimated at 71.2 and 54.8 persons per sq km, respectively. Maximal utilization of the most productive lands to support urban population was evidenced in both survey areas in high buffer densities. In the Upper Daling Valley, the 200m single-sided buffer band was 5.9 times more densely occupied than the regional average. In Chifeng, it was also more densely occupied, although by a smaller factor of 3.7 because, for some reason, Upper Xiajiadian towns were concentrated in the western, hilly part of the survey area. The unusual locations of these towns in Chifeng corresponded to an environmental basis for settlement concentration that was focused on stony hills and the 200m single-sided buffer band. Some 44% and 21% of the 10m cells comprising quadrats with more population than expected were found on only 27% and 8% of the total land that was classified in these two zones. Moreover, the thirteen Upper Xiajiadian supra-local communities in Chifeng seemed to differ in population density in good accordance with the proportion of population located in the ecotone. The environmental basis for settlement concentration in the Upper Daling Valley, on the other hand, was essentially random, despite the heavy concentration of population in the ecotone. The level of diversity with which similar socio-economic organizations could result in distinctive patterns of settlement distribution was evidenced again. One potentially relevant factor might simply be the difference in demographic size of the Upper Xiajiadian towns between the two survey areas. Since Upper Xiajiadian times, patterns of settlement distribution in northeastern China have been subject to an increasingly wider range of socio-economic activities, some of which might operate at a scale beyond the scope of archaeological surveys, casting an impact on patterns of settlement distribution in very different ways across the three survey areas. The basic behavioral logic of the risk-buffering strategy, however, remained largely unchanged, as the ecotone continued to be a desirable settlement location until Liao times.

Zhanguo-Han Societies (600 BCE to 200 CE)

Zhanguo-Han settlements are an excellent example of how large-scale socio-economic organizations could make patterns of settlement distribution very different across the three survey areas. Without any major Zhanguo-Han city immediately nearby, Chifeng and the Upper Daling Valley underwent similar processes of ruralization of regional population. Population density dropped to 19.9 and 16.4 persons per sq km, respectively. The diminishing of community organization was severe in both regions. Local communities shrank in size. Supra-local communities even disappeared altogether in the Upper Daling Valley. Zhanguo-Han settlement in Chifeng, though, displayed an unusually high level of concentration of population in the 200m single-sided buffer band, which was 5.9 times more densely occupied than the regional average. The buffer density was also 2.7 times higher than the regional average in the Upper Daling Valley. With population levels this low, the emphasis on the risk-buffering strategy might be best explained by imperial taxation demand from major Zhanguo-Han cities, such as Heicheng, outside the survey boundary. Niuheliang presents an exactly opposite case. With Anzhangzi just several kilometers outside the survey area, Zhanguo-Han population in the Niuheliang survey area might instead have been a consumer of taxation in the form of staples. Even when regional population density reached 71.6 persons per sq km, the 200m single-sided buffer band was barely 1.8 times more densely occupied than the regional average. Results of the quadrat grid approach are consistent with this description. Zhanguo-Han settlement concentration in Chifeng had an environmental basis focused on the ecotone, which makes good sense if organizing agricultural production to meet taxation demand was a priority mission for the larger communities there. For inhabitants of the two other survey areas who might not have been subject to imperial taxation demand as intensive as that in Chifeng, no environmental basis could be very meaningfully interpreted in the severely ruralized Upper Daling Valley, and 47% of the 10m cells comprising quadrats with more population than expected in the Niuheliang survey area were found on the 22% of total land that was general rolling uplands excluding the 200m single-sided buffer band. By this time, though, the entire western Niuheliang survey area along the broad valley floor had been occupied very intensively. Still zonally sensitive, Zhanguo-Han people in Niuheliang took advantage of agriculturally productive lands, but they did not feel the same strong urge to live on the bluffs at the edge of the flat valley floor and concentrate in this ecotone.

Liao Societies (200 to 1300 CE)

The proximity to the Liao capital of Zhongjing makes the three survey areas imperial heartlands with substantial populations. Liao population density was estimated at 35.9 persons per sq km in Chifeng, 63.9 persons per sq km in the Upper Daling Valley, and 110.0 persons per sq km in Niuheliang, seemingly corresponding to the administrative level of the Liao cities of Songshanzhou, Lizhou, and Yuzhou within or near each one's respective survey area. Living on the valley floors was newly possible in Liao times and was also desirable for inhabitants of administrative centers for participation in the intensified exchange network was greatly facilitated by transportation by animal-drawn cart that required roads best built along the level lower lands. As a consequence, Songshanzhou and Lizhou made valley floors the most densely occupied zone in Chifeng and the Upper Daling Valley. On the other hand, for the Chifeng and Upper Daling countryside outside the two cities, as well as for the Niuheliang survey area to which Yuzhou was 10 km away, rolling uplands were consistently the most preferred settlement location. The extent by which regional population was concentrated in the ecotone was similar across the three survey areas, ranging between 0.6-2.3 times more densely occupied than the average for the 200m single-sided buffer band, if Songshanzhou and Lizhou were involved in the calculation, or between 2.0-3.6 times more densely occupied than the average for the 200m single-sided buffer band, if the two cities were removed from the calculation. The risk-buffering strategy seemed to have decreased in importance along with the advances in architectural technology and the expansion of exchange networks. The environmental basis for settlement concentration in Liao times differed across the three survey areas also in accordance with how predominantly the three Liao cities contributed to the regional population. In the Upper Daling Valley, as much as 84% of regional population lived in Lizhou. It was therefore not surprising that all quadrats with more population than expected in the Upper Daling Valley occurred around Lizhou, and that all the 10m cells comprising these quadrats were found on valley floors. In Chifeng, only about half of regional population lived in Songshanzhou. There were high value quadrats with more population than expected occurring in other parts of the survey area, resulting in a rather random environmental basis for settlement concentration. Last but not least, in Niuheliang, where no Liao city was immediately in the survey area, settlement concentration tended to occur on general rolling uplands excluding the 200m single-sided buffer band more than anywhere else, a scenario probably typical of the Liao countryside.

6.3 Directions for Future Studies

This study demonstrates how the normal Hongshan relationship between agricultural practices and settlement distribution was seriously bent out of shape in the Niuheliang survey area by the presence of two groupings of multiple local communities visible in the smoothed surfaces.

Our results strongly suggest that the Niuheliang ceremonial complex that functioned as a pilgrimage center had a high proportion of residents who were non-farming ritual specialists and were dependent on food produced elsewhere. Building on these results, more information could be gathered that would help us to understand better just how the Niuheliang pilgrimage center worked to facilitate Hongshan integration at varying scales.

More rigorous analysis of community organization in the Niuheliang survey area is ongoing and will inform us on how human groups were integrated within the two supra-local communities. Both show remarkably higher population density, and the estimated population of the provisioning supra-local community, at about 1,000-2,000 people, is as much as twice as large as a typical Hongshan regional polity. Given the special activities that were practiced by Hongshan people here, one would wonder whether the participant local communities were glued together in some unique ways. Are the two supra-local communities internally more centralized? Within the supra-local community corresponding to the pilgrimage center, how are patterns of occupation related to the distribution of ceremonial localities? Inside the provisioning supra-local community, will the tendency to centralize toward a large village be negatively affected by some communities focusing more on growing foods and living closer to the river valley to the southwest, while others were more concerned about organizing the transportation of the food and were located closer to the ceremonial localities?

Studies of inter-household differentiation can be expanded to include more local communities in addition to those at Shangchaoyanggou, Yaogouxiliang, and Nushenmiao, especially in different environmental settings. More provisioning local communities than just Shangchaoyanggou and Yaogouxiliang have been found in the main provisioning area southwest of the Niuheliang pilgrimage center to take advantage of productive lands near the broader river valley as well as of proximity to the pilgrimage center. Do local communities near the river valley, for example, display different patterns of differentiation among households than those located closer to the pilgrimage center? Similarly, surface collections of artifacts made in local communities in the residential zones at the pilgrimage center will tell us more about who the people living among the ceremonial facilities were and what they did. The variation in patterns of inter-household differentiation will have important implications on how Hongshan people might have arranged economic activities, communicated prestige, and negotiated social power within and across distant villages.

Some interpretations in this study rely on bolder assumptions than others do. Research targeted to refine these assumptions will also be very beneficial. For example, estimates of agricultural production and agricultural productivity on different land types can be improved by a more accurate reconstruction of Hongshan diet and environments. Useful information can come from botanical and faunal data recovered through excavation and paleoenvironmental studies, as well as isotopic studies of human remains. Use-wear analysis will also address the issue of subsistence activities.

Last but not least, the systematic regional survey in Niuheliang once again showed the vast range of diversity in how human groups interacted with environments as well as in the ways social developmental trajectories played out. Recognizing individual households as the agent of settlement decision, future studies of settlement patterns at a truly regional scale will continue to elucidate human-land relationships underlying social change and help contextualize studies carried out at other scales. The comparative investigation into how these social forces play out in different environmental settings can greatly benefit research on social changes and improve our understanding of ancient ways of life.

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