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Environmental risk buffering in Chinese Neolithic villages: Impacts on community structure in the Central Plains and the Western Liao Valley[☆]

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ABSTRACT

Much of the literature on the role played by environment in complex society development focuses on temporal correspondence between climate change and human social change. Many such studies fall into a series of traps: the unwarranted assumption that correlation equals causation; failure to evaluate the statistical significance of the association; simplistic characterization of climate change's human impact or of the nature of human social change itself; and focusing on a spatial scale too large to intersect with the human decision-making processes where social change begins. Here we compare decisions made about buffering agricultural risk by Neolithic farmers in two regions of northern China. Hongshan farmers in the Western Liao Valley chose to cope with agricultural risk at the individual household level and lived in scattered farmsteads and dispersed villages, while Yangshao farmers in the Central Plains chose cooperation and interdependence between households living in large compact villages. These decisions were clearly rooted in the particular environmental conditions of the two regions and had far-reaching and unanticipated consequences for the two long-term trajectories of complex society development. The forces that shaped the trajectories of the Western Liao and the Central Plains differently fit a pattern that is global in scope. Examining the decisions made by Neolithic farmers in response to an essentially static feature of their environments contributes more to our understanding of the dynamics of long-term human social change (and the environment's role in it) than attempting to correlate social changes to particular climate changes.

Through the long, gradual process of complex society emergence and development during the Chinese Neolithic, organizational patterns took on varied forms in different regions. Investigating this variation is a way to move beyond the quest for unitary and/or universal "causes" of complex society emergence toward deeper, anthropological understandings of the dynamics of human social change—of how the structure of human societies is modified as people actively pursue their own agendas in the social, cultural, economic, and environmental circumstances in which they find themselves. For a Neolithic sedentary farming family, the spatial scale of these relevant circumstances is quite small, consisting primarily of neighbors sufficiently nearby to interact with at least from time to time (by walking to where they live), and a natural environment that does not stretch as far as the horizon, from which sustenance must be obtained.

1. Climate change and culture change

When researchers look at environment in relation to the emergence and development of complex societies in China, our minds seem usually to turn to large-scale matching of climate change with culture change. Though widespread in the literature, especially in the geoscience literature, such matching approaches regularly fall into a series of traps. Foremost among these is environmental determinism: the assumption, implicit or explicit, that a climate change occurring at the same time as a change in human society must have caused the human social change. Chronological correlation is thus erroneously taken as a sufficient demonstration of causation. This is not an issue of data quality or precision, but a fundamental logical flaw—one that has been pointed out repeatedly in general (Dincauze, 2000) and with specific reference to China (Madsen et al., 2007; Jia, 2011). But simplistic attribution of direct causality to climate change simply because of chronological

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correlation continues to proliferate in the literature for China and other parts of the world as well (e.g. deMenocal, 2001; Polyak and Asmerom, 2001; Kuper and Kröpelin, 2006; Li et al., 2006; Mercuri et al., 2011; Liu and Feng, 2012; Wang et al., 2014; Li et al., 2015; Büntgen et al., 2016; Weiss, 2017; Guo et al., 2018; Walker et al., 2018; etc.).

A second trap into which studies that correlate climate change with human social change almost always fall is failure to evaluate the statistical significance of the chronological correlation. This is not an arcane statistical point; it is the utterly essential assessment of how likely it is that a chronological correspondence is nothing more than coincidence. If a climate change does not correspond properly in time to a human social change, then it cannot have caused the human social change, but one of several reasons that a chronological correlation between the two does not demonstrate causality is that a chronological correlation might occur by pure random chance. Kintigh and Ingram (2018) point this out, and provide a means of assessing the statistical significance of a chronological correlation between climate change and human social change (more properly called an *association* in statistics). They carry out such an assessment for seven instances in the U.S. Southwest in which climate causality has been asserted, and find such a high probability of random coincidence in all seven instances that no convincing statistical case can be made for any relationship at all between climate and human social change. There is no reason to believe that assertions of climate causality in other parts of the world would fare any better in such an assessment of statistical significance.

A third pitfall in climate-culture correlation research is embedding overgeneralized assumptions about impact on human societies in the very terms used to characterize changes in temperature and precipitation patterns in the first place. As primary descriptors of climate trends, labels like “thermal optimum,” “climate deterioration,” or “climatic amelioration” gloss over the essential details of just how increasing or decreasing temperature or precipitation affect human activities. The hasty application of such terms evades due examination of the ways in which a specific climate change alters the decision-making calculus of real human beings, leading them to change their patterns of activities in particular ways. Taking human response to climate change to be automatic or self-evident ignores the fact that people make choices, and short-circuits precisely the consideration that leads most directly to greater understanding of the dynamics of human behavioral change.

A fourth pitfall parallels the third, but in the cultural realm: naïve and simplistic characterization of human social changes. For example, the long, gradual process of complex society emergence has been unrealistically reduced to a simple event that can be dated and found to be contemporaneous with the emergence of other complex societies or a change in climate (e.g. Wu et al., 2018). The literature is rife with assertions of climate causality for “cultural decline” or “collapse,” overgeneralized terms widely criticized on conceptual and empirical grounds (McAnany and Yoffee, eds., 2009; Faulseit et al., eds., 2015; Middleton, 2018). Vague metaphor for human activities that require clear and concrete specification may reach its ultimate extreme with “persistent cultural derailment” (Liu and Feng, 2012:1189). Even those who find the concept of collapse useful insist that the notion be carefully clarified and defined (cf. Tainter, 1990).

And finally, efforts to correlate climate and human social change usually operate at spatial and temporal scales far too large to intersect meaningfully with human decision-making, where social change has its roots (cf. Contreras et al., 2018). This is in part an understandable consequence of the generally poor resolution of paleoclimatic data, but archaeological data with suitable resolution are abundant and regularly ignored or misinterpreted in climate-culture correlation research. Studies sometimes seem almost perversely determined to enlarge an already oversized spatial scale in the mistaken belief that larger-scale correlations are more persuasive or meaningful. Beyond any other issues, however, climate-culture correlations are enlightening only if they contribute to concrete understandings of how and why human beings chose to modify their adaptive strategies as the returns from specific subsistence pursuits changed with rising or falling temperature and precipitation (cf. d’Alpoim Guedes and Bocinsky, 2018). These understandings are simply not to be found at scales encompassing millions of square kilometers (e.g. Wagner et al., 2013), or even tens of thousands of square kilometers for that matter, because such scales are so wildly incommensurate with that of human observation and decision-making.

Despite its popularity, then—not only in research on ancient China but also in the archaeology of many other parts of the world—the effort to find large-scale correlations between climate change and cultural change cannot, as a matter of principle, contribute to better understandings of human behavior or of how human social change happens. Concentrating on climate change as the essential cause of human social change actually underrates the role of environment in shaping human societies, because it diverts attention away from the specifics of the relationship between the environment and the human populations that inhabit it, a dynamic relationship that itself encompasses powerful forces for change even during periods of climate stability. In what follows, we suggest ways in which aspects of the environment that did not change through time affected the trajectories of complex society development in the Neolithic societies of northern China.

Attention focuses on environmental risk, following a classic definition of risk as “unpredictable variation in an outcome with consequences that matter” (Winterhalder, 2007:433; see also Cashdan, 1990:2–3 and Winterhalder et al., 1999:302). In the instances we consider here, it is unpredictable inter-annual variation in precipitation that creates risk that fall harvests in any given year will not be sufficient to enable Neolithic farmers to survive the winter. We selected two regions in northern China (the Western Liao Valley and the Central Plains, Fig. 1) for which there are good archaeological data and where harvests can be drastically reduced both by drought in years of light rainfall and by flooding in years of heavy rainfall. Although the risks are the same in the two regions, the plausible strategies available to Neolithic farmers to buffer, or ameliorate, the risks are different. We examine these strategies and their impacts on trajectories of development in the Western Liao Valley and the Central Plains, and we consider more briefly similarities to social dynamics in the Alto Magdalena (Colombia) and the Valley of Oaxaca (Mexico), respectively.

Our suggestions about risk-buffering strategies and their implications for social change find clear support in available data, but we offer them as hypotheses for further empirical evaluation. We try to consider the plausibility of subsistence strategies concretely and at a scale that matches the scale at which Neolithic farmers could observe their environment and make decisions about how to make a reliable living in it. We do not argue that such consideration of plausibility directly yields information about what Neolithic farmers did, but rather that it is a fruitful way to formulate hypotheses about what they did and why they did it—hypotheses capable of generating specific expectations about what patterns we should find in archaeological data if the hypotheses are correct.

2. Neolithic farming in the Western Liao Valley

Plant cultivation had begun in the Western Liao Valley of northeastern China (Fig. 1) by 6000 BCE. Some relatively large excavated village settlements date to Xinglongwa and Zhaobaogou times (Neimenggu, 1997, 2004; Zhongguo 1997a, 1997b, 2004; Liaoning 2012a), but regional survey in Chifeng, the Upper Daling Valley, and Fuxin (Chifeng, 2011b; Peterson et al., 2014a; Shelach-Lavi et al., 2016) makes it clear that most settlements were very small and widely scattered. Wild plants and animals were important subsistence resources (Liu et al., 2015; Shelach-Lavi et al., 2019). Wild resources continued to be exploited in Hongshan times (4500–3000 BCE), but domesticated plants, especially millet, had increased considerably in importance (Liu et al., 2012; Ma et al., 2016). There were two principal zones for cultivation: flat alluvial stream floodplains with very fertile soils and good availability of water but frequent crop-destroying floods; and rolling

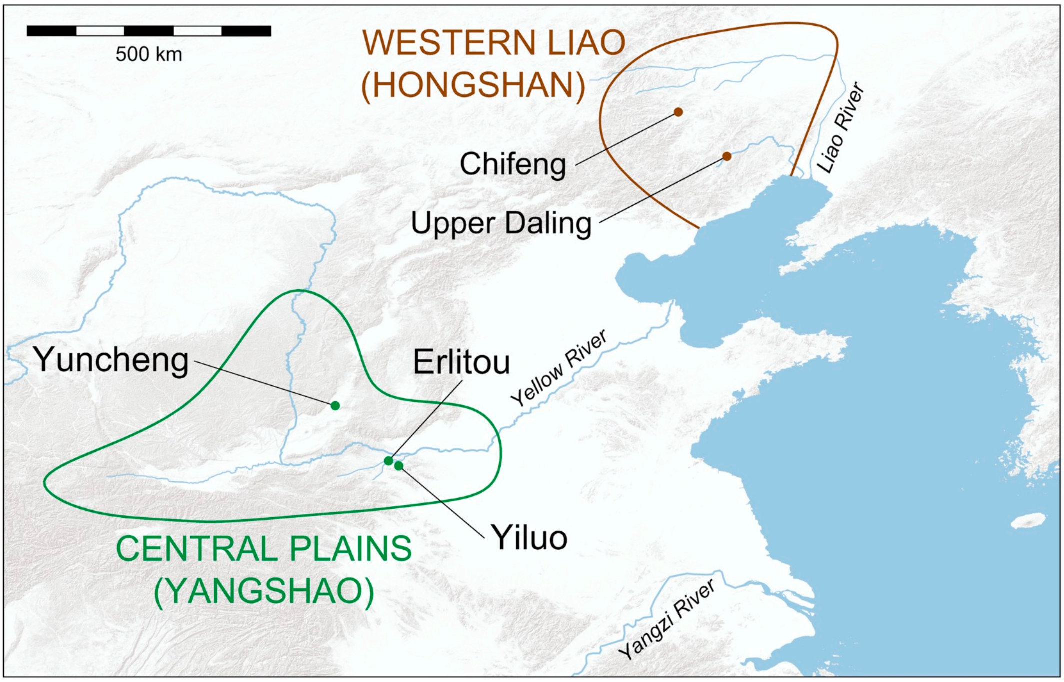

Fig. 1. Northern China with the Western Liao Valley, the Central Plains, and locations of systematically surveyed regions.

Fig. 2. Narrow, flat alluvial valley floor and bluffs where uplands begin in the Western Liao Valley.

loess uplands with very fertile soils and sufficient water from precipitation in most years, but frequent droughts (Fig. 2). This pattern of risk to agricultural production could be mitigated by the very simple strategy of cultivating crops in both the valley floors and the uplands. In an average year, crops in both places would yield well; in a wet year, crops in the uplands would be especially well supplied with water, but valley floor crops would be destroyed by floods; and in a dry year, crops in the uplands would do poorly, but those in the valley floor would have sufficient water, and there would be no flooding to destroy them.

This fundamental dynamic of agricultural production and risk would have persisted through the climate changes of the past 10,000 years. It did not first appear in Hongshan times nor disappear after, so its implications for Hongshan farmers were not a product of climate change but instead a persistent characteristic of farming and risk-buffering dynamics in the Western Liao. Frequency of drought and flooding would vary with overall decreases and increases in precipitation (cf. Wan et al., 2016), but cultivating upland plots as a hedge against flooding and valley floor plots as a hedge against drought would have been a stable strategy. What was new in Hongshan times was the growth of population to substantial levels for the first time. Settlements were broadly distributed throughout the small river valleys that make up the Western Liao, although overall regional population densities were still much lower than those of later periods. A sensible Hongshan household seeking to cultivate in the uplands and the lowlands would position itself near the boundary between the two zones with easy access to both. And, since no cooperation or interaction with other households is involved in the strategy, it would be desirable to choose a location that was not too close to very many other households for

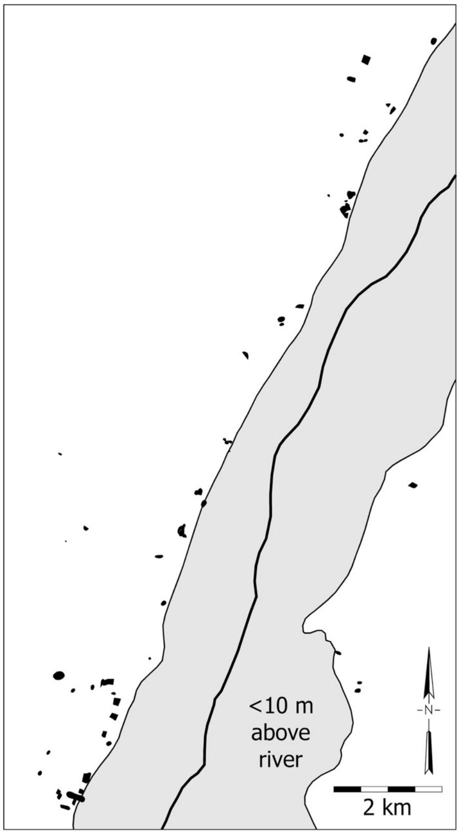

Fig. 3. Dispersed Hongshan settlement along the margin of the alluvial valley floor in a portion of the Chifeng region (Chifeng 2011a, 2011b).

optimal choice of farm plots without much competition. By the same token, there would be nothing about this strategy that would encourage households to draw closely together into compact villages.

The documented Hongshan settlement pattern shows precisely the characteristics that would result from an upland-lowland risk-buffering strategy. Fig. 3 shows Hongshan settlement in a portion of the Chifeng region—very small villages, hamlets, and farmsteads scattered all along the margin of the alluvial valley floor. In the Upper Daling Valley 71% of the Hongshan population lived within 500 m of this ecotone, a band that represents only 12% of the survey area (based on Peterson et al., 2014b). Fig. 4 shows that local communities were small. In the Chifeng and Upper Daling survey zones, villages did not number more than 500 inhabitants, and half the population or more lived in local communities of fewer than 100 people (Chifeng 2011b:111; Peterson et al., 2014a:53). In general, houses were spaced fairly far apart within Hongshan villages (Fig. 5), although this varied considerably. Extensively excavated or intensively surface-collected Hongshan sites where house locations can be counted show a wide range of within-village residential densities, with a median of 71 persons/ha (Table 1). This is certainly an unrealistically high generalization since places selected for excavation usually have especially high densities of materials, reflecting especially high residential densities, and since large-area excavations often end where patches of closely spaced houses do. A median estimate of 15 persons/ha from Upper Daling regional survey data (Table 1) is a lower generalization for Hongshan villages because settlement areas from survey represent surface sherd scatter, which is more extensive than the area that contains house structures, and because it includes many very small settlements. For the moment we will simply observe that these high and low estimates, taken together, turn out to be comparatively low residential densities; we will consider them further below.

3. Neolithic farming in the Central Plains

Plant domestication was well underway in some areas of the Central Plains by 7000 BCE (Lu et al., 2009; Yang et al., 2012), although these cultivars would not become a staple component of Neolithic diet for another 2000 years (Pechenkina, 2018). Wild resources continued to be heavily exploited throughout the Peiligang period (Liu, 2015); settlements were few in number and mostly set well back from the main river along small tributary streams. Established farming settlements became much more numerous during Yangshao times (5000–3000 BCE), although at least in the early part of the period, overall regional population densities remained quite low (Zhongguo, 2005; Qiao, 2007). Agricultural subsistence was subject to the same two risks as in the Western Liao Valley: floods and drought. The spatial distribution of these risks mimicked that of the Western Liao to a certain extent as well. The greatest availability of water for cultivation year in and year out is, of course, near the major rivers, but flooding can be devastating, especially along the Yellow and Wei rivers. Uplands are protected from flooding, but crops planted there are highly susceptible to frequent droughts (Wan et al., 2016). The logical and simple risk-buffering strategy suitable in the Western Liao, however, was available only to a very few fortunately located Yangshao households because of the vast scale of the landforms that make up the Central Plains and adjacent uplands.

In the Western Liao, the numerous river floodplains are seldom more than 2–3 km wide, producing literally thousands of linear kilometers of well-defined ecotone along which the rolling uplands meet the floodplains with a fairly sharp elevation difference of 5–20 m. The Central Plains are very different. Along the Wei River in Shaanxi Province and east of the Yellow River in Shanxi Province is an enormous plain (in the Guanzhong and Yuncheng basins) covering some 25,000 km^2 that rises gently back from the rivers, often gaining no more than 1 m in elevation for each kilometer across distances up to 50 km. The eastern coastal plain through which the lower Yellow River flows is even vaster. The enormous expanses of flat land in these plains could not provide a sharper contrast to the narrow linear floodplains of the small rivers in the Western Liao (Fig. 6). It is, of course, the agricultural productivity of these plains that has sustained the extraordinarily large and dense populations of historic and modern Chinese states, and they were an equally attractive agricultural resource to Early Yangshao farmers who began to settle well out into the plains on patches of slightly higher ground near the major rivers. Here by the end of Yangshao times they were planting rice in the low floodplains while cultivating millet in drier locations (Zhang et al., 2010; Zhuang and Kidder, 2014). The Central Plains were, like all of northern China, subject to devastating droughts (Wan et al., 2016), and the Yellow River is infamous for its tendency to flood in modern and historic times. Protection from the dual risks of flooding and drought was essential, but, as noted above, not so simple in the huge Central Plains as in the small river valleys of the Western Liao. There are low areas with especially good access to water and concomitantly high risk of flooding, and there is higher ground where crops are better protected from flooding but at risk of drought. Out in the plains, the elevation changes are very gradual, making the ecotone between these two sets of characteristics a broad, vaguely defined zone of transition that is much more difficult to delineate and to take advantage of as a key settlement location. The ecotone, moreover, is constantly shifting because the plains are extremely active geologically, with changing river courses and dramatic episodes of sediment deposition and alternate downcutting during the span of substantial human occupation (Zhuang and Kidder, 2014). Conditions with respect to protection from flooding versus protection from drought often change little over distances of tens of kilometers. Living along the ecotone and cultivating both uplands and lowlands was just not a broadly practical option for Neolithic farmers in the Central Plains.

Risk-buffering to provide reliable agricultural subsistence for

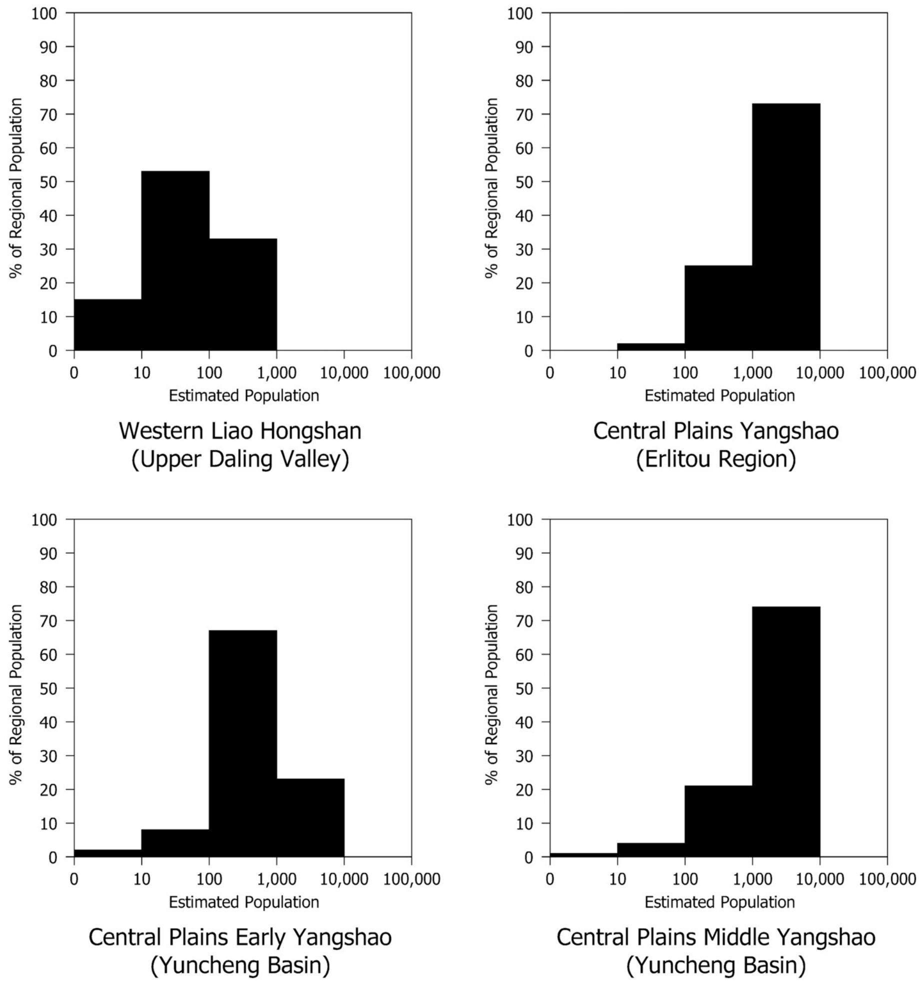

Fig. 4. Population distribution across settlements in different size ranges for Hongshan and Yangshao settlements (Peterson et al., 2014a, 2014b; Zhongguo 2005; Qiao, 2007; Drennan and Dai, 2010).

substantial populations in the Central Plains is not an independent household activity as it is in the Western Liao; it requires cooperation. Ways in which Neolithic farmers might have cooperated to buffer risk are numerous. They might have cultivated cooperatively on a larger scale to increase yields so as to store food for future bad years or for exchange with other farmers who lived in zones with contrasting agricultural risks. In either case, collective local community storage would be advantageous. Networks of such subsistence interdependence involving people living in contrasting zones some distance apart would be more effective and reliable if they were composed of corporate local-community groups rather than individual households. Labor pooling for the creation of water management infrastructure could also help mitigate subsistence risk. Such infrastructure might include drainage ditches to protect crops and homes in low areas, wells or canals for irrigation in higher areas, or terracing of gentle upland slopes for better water retention. These kinds of cooperation and interdependence do not necessarily require management or leadership, but they do require much more interaction between households than do the risk-buffering strategies suitable for the Western Liao Valley. Owing to distance-interaction principles, higher frequencies of inter-household interaction

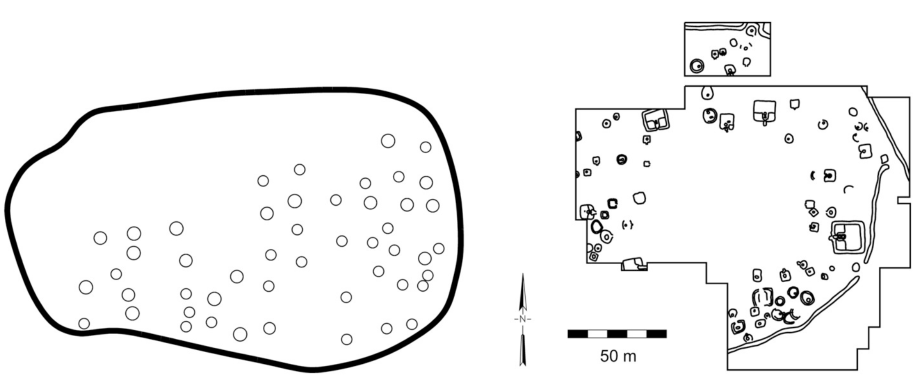

Fig. 5. Plan of houses within the ditch at Duliyingzi (at left) and in the excavated portion of Jiangzhai (at right). These two plans illustrate about the median spacing for Hongshan and Yangshao sites, respectively, where houses can be counted (after Aohan 2009 and Xi'an et al., 1998).

Table 1
Estimates of within-village residential densities for Hongshan and Yangshao settlements.

Hongshan		
Site	Density *persons/ha*	Source
Baiyinchanghan	11–23	Neimenggu 2004
Dongshanzui	18–36	Drennan et al., 2017; Peterson et al., 2017
Duliyingzi	57–113	Aohan 2009
Erbuchi	16–32	Drennan et al., 2017; Peterson et al., 2017
Erdaoliang	140–280	Neimenggu 1994
Fushanzhuang	3–5	Peterson, 2006
Haminmangha	275–549	Neimenggu and Jilin, 2012; Neimenggu 2015
Sanjia	38–75	Drennan et al., 2017; Peterson et al., 2017
Site 6384	300–600	Li, 2008
Weijiawopu	225–451	Duan et al., 2011
	71 *Median from counting houses above*	
	15 *Median from regional survey data* (Peterson et al., 2014b)	
Early Yangshao		
Site	Density *persons/ha*	Source
Banpo	114–228	Kaogu and Shaanxi, 1963
Beishouling (I)	90–180	Kaogu 1983
Dadiwan (II)	318–636	Gansu 2006
Jiangzhai	162–324	Xi'an et al., 1998
Shihushan (Loc. 2)	141–282	Liu et al., 2014
	212 *Median from counting houses above*	
	53 *Median from regional survey data* (Drennan and Dai, 2010)	

serve as centripetal forces drawing households together into larger and more densely packed local communities (Peterson and Drennan, 2005, 2012; Drennan and Peterson, 2006, 2008; Drennan and Haller, 2007; Berrey, 2013, 2015). A sensible Central Plains household seeking stable agricultural subsistence, then, would locate itself in close proximity to a goodly number of neighbors and interact with them in a system of mutual (and mutually beneficial) obligation. The cumulative effect of such decisions would be a pattern of large compact villages that would become especially strong as substantial populations of early farmers appeared in locations out in the broad plains.

The currently available archaeological evidence from the Central Plains is entirely consistent with these notions about risk-buffering strategies. Yangshao villages numbering several thousand inhabitants were common in both the Erlitou/Yiluo and Yuncheng Basin survey areas (Fig. 4), with around 80% of the population living in communities of this size by Middle Yangshao times (Zhongguo, 2005; Qiao, 2007; Drennan and Dai, 2010). Scattered farmsteads or tiny hamlets were quite rare. Houses within Yangshao villages were on average much more closely spaced than in Hongshan villages (Fig. 5). As in the case of Hongshan sites where houses can be counted, estimates for residential density from excavated Yangshao village sites vary considerably, but the median is 212 persons/ha, compared to 71 for Hongshan (Table 1). The estimate from regional settlement data is 53 persons/ha, compared to 15 for Hongshan (Table 1). Yangshao villages were thus both much larger and much more tightly packed than Hongshan ones, exactly as expected where cooperative subsistence strategies requiring much more inter-household interaction would be advantageous. These very large, compact villages emerged as Yangshao farmers moved far out into the major river plains, and the villages nearest the banks of main river channels in the Erlitou survey area are the largest (Fig. 7), with much smaller villages along tributary streams. Spatially distinct groups of house structures at Early Yangshao villages like Banpo, Jiangzhai, Dadiwan, and Beishouling may correspond to collaborative work groups, possibly based on kinship, and could be social-structural antecedents to the “row houses” found at a number of Late Yangshao sites (Fig. 8). Remains of large urns and a set of pottery scoops recovered from an

Fig. 6. Broad flat alluvial plain of the Yellow River.

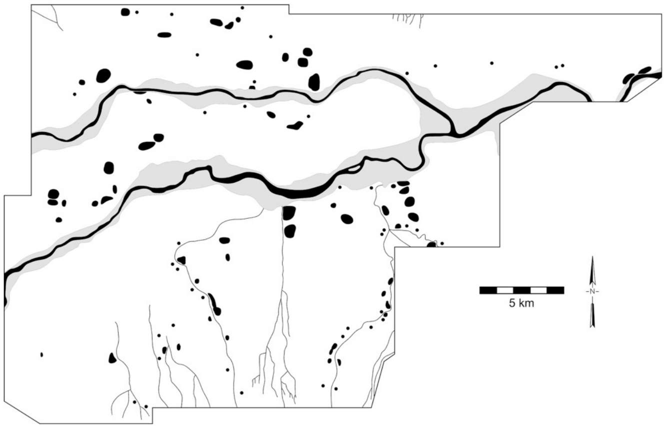

Fig. 7. Yangshao settlement in the Erlitou survey area (after Erlitou 2005).

unusually large and centrally located structure in the Late Yangshao village at Dadiwan might reflect centralized communal storage of grain (Fig. 9).

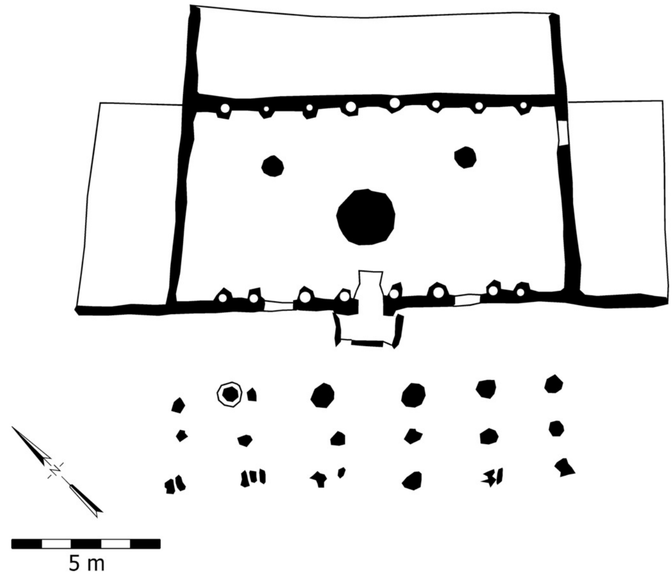

Fig. 9. Large Late Yangshao structure with columned portico at Dadiwan. The room at rear contained very large urns for grain storage (after Gansu 2006).

4. Subsequent trajectories of social change

The patterns of interaction and village formation that we attribute to different dynamics of mitigating agricultural risk in the Western Liao Valley and the Central Plains have further implications as well. There is archaeological evidence from other parts of the world, such as the Valley of Oaxaca (Mexico), the Basin of Mexico, and the Río Parita Valley (Panama), that large compact villages are often a setting that encourages substantial productive differentiation and economic interdependence extending beyond subsistence goods into the arena of craft products (Drennan and Peterson, 2005, 2008; Berrey, 2013, 2015). Indeed this is a central part of the traditional archaeological vision of the Neolithic village as a fertile seedbed for the development of craft specialization along *the* path of complex society development. Actually it turns out that there are not just one but at least several different pathways for the development of complex social organization (cf. Drennan and Peterson, 2006, 2012; Peterson and Drennan, 2012; and many others), and some of these paths do not involve villages at all—more on this later.

With the emergence of large compact Yangshao villages, though, the Central Plains trajectory does seem to trace a path along which subsistence-based cooperation and interdependence between households within villages (and possibly some degree of interdependence between villages in contrasting environmental zones) expands progressively into the arena of non-subsistence goods. Analysis of differences between Yangshao household artifact assemblages is hampered by a lack of large samples from midden deposits, but combined data on artifacts from house floors and trash pits does suggest that by Late Yangshao times some households were more intensively engaged than others in lithic tool production, woodworking, leather working, spinning, weaving, and pottery production (Peterson and Shelach, 2012; Peterson et al., 2016). Emerging inequality through Yangshao times was based on accumulation of material wealth, indicated by villages of small houses with a few distinctively larger ones, sometimes with painted designs on plaster floors, and by burials with occasional ornamental jade items and up to a dozen or more finely made pottery vessels. And an increasing scale of regional political integration and the concentration of power in the hands of a few had its foundations in the control of resources via an increasingly specialized and developed economy of household, local community, and regional interdependence (Peterson and Shelach, 2010). This is the central current in the powerful stream of social changes in the Central Plains from Yangshao through Longshan, Erlitou (Xia), and Shang times (Liu, 2004; Liu and Chen, 2015; Shelach-Lavi, 2015). It would be a gross overstatement to assert that this course of development of large-scale states and empires founded on resource control in large networks of interdependence was nothing more than the inevitable unfolding of social features established in Yangshao times, but Yangshao forms of organization shaped by the nature of strategies for buffering agricultural risk in the Central Plains aimed the development strongly in this direction.

The trajectory of developing social complexity in the Western Liao

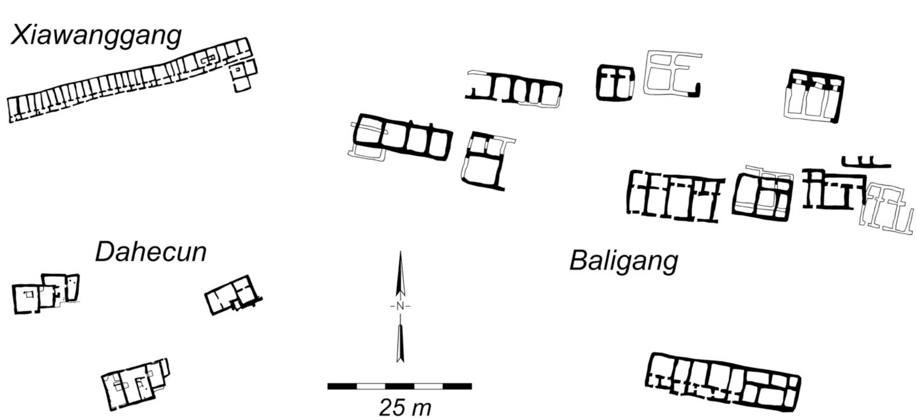

Fig. 8. Examples of the “row houses” that have been found in a number of Late Yangshao villages (after Cao et al. 2013).

Valley is strikingly different. The independent nature of Hongshan household subsistence production and risk mitigation did not plant the seeds of productive differentiation and economic interdependence. The scattered farmsteads and hamlets and dispersed villages provided only very small-scale groups of consumers for specialized craft producers. Pottery was produced in a limited number of locations, but distributed only over fairly short distances (Li, 2016; Drennan et al., 2017). Analysis of large samples of household lithic assemblages from numerous households within several local communities reveals only slight differences in productive activities between households (Drennan et al., 2017). All this would seem to comprise the opposite of the traditional scenario of the Neolithic village as the launching pad for the economic development essential to complex society. And yet Hongshan societies were characterized by regional-scale political integration, well-developed prestige differentiation, widely distributed ceremonial architecture, highly skilled jade carving, and a probable pan-regional pilgrimage center at Niuheliang (Peterson and Lu, 2013; Peterson et al., 2014a; Drennan et al., 2016, 2017). All this shows that a need for cooperative action to cope with subsistence risk is not the essential driving force behind complex society development in general, as has sometimes been at least implicitly suggested (e.g. Peebles and Kus, 1977; Halstead and O'Shea, 1982), since such a need did not exist in the Western Liao Valley. The much weaker patterns of inter-household interaction and the much more dispersed settlement pattern of the Western Liao Valley, deriving ultimately from the unimportance of cooperation to agricultural risk mitigation, are characteristics also seen in early complex societies in other parts of the world where little economic interdependence or wealth accumulation occurred—places such as the Alto Magdalena of Colombia, the Quijos region of Ecuador, and the Río Tonosí Valley of Panama, (Drennan and Peterson, 2005, 2006; Cuéllar, 2009; Berrey, 2013, 2015).

The regional-scale political integration and inequalities that did exist in Hongshan societies were founded, not on wealth accumulation and resource control, but on social prestige connected to ceremonial activities and ritual roles (Drennan and Peterson, 2006; Peterson and Lu, 2013; Drennan et al., 2017). This has made the archaeological record for Hongshan society—with its well-known stone platforms, painted cylinders, carved jades, and elaborate burials (Guo, 2005; Liaoning 2012b)—palpably different from the archaeological record for Yangshao society because the character of Hongshan society and the foundations of its complexity are palpably different from those of Yangshao society.

Unlike the Yangshao social formation, Hongshan organization did not continue to develop into larger and larger scale political integration and stronger and stronger patterns of leadership. The most widespread account of the end of the Hongshan social formation in the literature is that drying climatic conditions caused “persistent cultural derailment” (Liu and Feng, 2012:1189). What vague pronouncements like this usually seem to mean is a catastrophic demographic decline, since the archaeological evidence upon which they are based is that no one finds many sites of the Xiaoheyan archaeological “culture” that succeeds Hongshan in the same area. Another possibility is that a culture historical approach misleads because the definition of Xiaoheyan centers on a restricted range of elaborate ceramics made especially for inclusion in burials, and our knowledge of Xiaoheyan domestic ceramics is scanty (Peterson et al., 2014a:63–67). This would lead to substantial under-counting of Xiaoheyan sites. Be that as it may, it is clear that there was a cessation of the ceremonial activities and belief system that led to the construction of platforms and the burial of important individuals with impressive carved jades. This would be consistent with the notion that belief systems in the absence of substantial wealth accumulation and resource control provide only a limited source of power (e.g. Mann, 1986; Earle, 1997) and that even the small Hongshan regional polities had little further growth potential and disintegrated. Xiaoheyan clearly represents a rupture of some kind in the Western Liao Valley's sequence of social change—one whose nature requires considerably more solid and concrete empirically based delineation before its causes can be seriously considered.

5. Setting northern China's earliest complex societies in a global comparative context

The distinctive developmental trajectories of early complex societies in the Central Plains and the Western Liao Valley are not unique. There are particularly striking parallels to the trajectories seen in the Valley of Oaxaca in Mexico and the Alto Magdalena of Colombia, respectively.

Settlement in the Alto Magdalena persistently took the form of scattered farmsteads from the very beginning of sedentary agricultural life about 1000 BCE (Drennan, 2000; Drennan, ed., 2006; Drennan et al., 2018). There was no evidence in any prehispanic period of even dispersed villages similar to Hongshan ones. As in the Western Liao Valley, this settlement pattern makes very good environmental sense, although not for exactly the same reasons. The Alto Magdalena's very steep but well-watered slopes present far less agricultural risk than either the Central Plains or the Western Liao Valley (Fig. 10). Droughts severe enough to seriously reduce agricultural production are rare; heavy precipitation can cause soil slips, but these have only very small-scale impact; excessive cloudiness can slow plant growth, but at 2° north latitude this is of little concern because there is not a frost season to get the crops in ahead of; and what little agricultural risk there is, is broadly distributed across the region rather than in contrasting and thus complementary zones. Mitigating agricultural risk not only does not call for cooperation and interdependence, it just does not figure importantly in subsistence strategies here. Early farmers lived in scattered farmsteads on the plots that they farmed, and by 500–1000 CE as regional population densities grew to far higher levels than those experienced by either Hongshan or Yangshao farmers, increasing amounts of labor were needed in individual family plots to maximize agricultural yields, and households found living directly on the land that they farmed even more advantageous. As in the Western Liao, regionally integrated complex societies developed with a strong focus on social prestige grounded in ritual and belief systems; ceremonial architecture focused on tombs and, in this case, monumental sculpture; and there was very little productive differentiation, economic interdependence, or wealth accumulation (González Fernández, 2007). Also as in the Western Liao, there came a moment (around 1000 CE in the Alto Magdalena) when belief systems and ritual practices changed and ceremonial construction ceased, although in the Alto Magdalena it is quite clear that this was not precipitated by climate change and did not involve any demographic decrease at all. Population, instead, was growing vigorously at this time. A series of social organizational pieces, then, seem to fit together in the same way in the Alto Magdalena and the Western Liao: dispersed residence patterns, absence of compact villages, lack of much productive differentiation or interdependence, absence of wealth accumulation, and considerable differentiation in terms of social prestige based on ritual and ideology. In both regions the whole package has its roots in the environmental basis for the agricultural strategies chosen by Neolithic farmers—strategies that (for somewhat different reasons) discouraged cooperation, interdependence, compact village formation, and wealth accumulation.

Settlement in the Valley of Oaxaca took the form of compact villages from the very beginning of sedentary agricultural life about 1500 BCE (Blanton et al., 1982; Kowalewski et al., 1989; Drennan and Peterson, 2005, 2006; Peterson and Drennan, 2012). This makes good solid environmental sense in Oaxaca, although the environmental dynamic that may have given rise to it is not identical to that of the Central Plains. There is nonetheless a common denominator: cooperation and interdependence. Of particular importance to early farmers was the very small-scale unpredictability of precipitation in Oaxaca, where much of the summer rainy-season precipitation can come in the the form of intense rainstorms sometimes only 200–300 m across that move erratically across the valley (Fig. 11). Their unpredictable tracks can leave

Fig. 10. Sharply dissected, well-watered landscape in the Alto Magdalena.

one field very dry and another only a few hundred meters away well watered in any given year—a contrast that can be reversed the following year. In contemporary traditional farming communities in Oaxaca, this risk is mitigated by food-sharing via festivals such as the *guelaguetza* (Liverman, 1999:110) and by irrigation. In addition, households each cultivate several small scattered plots, maximizing the chance of at least some well-watered crops each year (Kirkby, 1973). These would have been practical and straightforward possibilities for early farmers as well. The effective scale for spatial averaging of precipitation and for food sharing or irrigation to mitigate this risk is very small—that of the hinterland of a single compact village community like those in which Oaxaca farmers have lived since the beginning, facilitating the necessary subsistence cooperation and interdependence. While cultivation of separate plots does not involve multi-household cooperation, it does further encourage living in a village centrally located among the scattered plots. Within a few hundred years of the establishment of these villages, clear indications of both productive and wealth differentiation are seen, and quite substantial power became concentrated in the hands of leaders (Drennan and Peterson, 2005, 2006; Peterson and Drennan, 2012). And, as in the Central Plains, the trajectory went on in fairly linear fashion to large-scale state integration and empire. Substantial productive differentiation, economic interdependence, and wealth accumulation sustained this political development, but religion and ceremony were a more conspicuous part of it than in the Central Plains.

These parallels in how essential elements fit together in each pair of similar trajectories (Central Plains/Valley of Oaxaca and Western Liao/Alto Magdalena) support the idea that these trajectories are not just unique cultural forms but that there are causal connections linking the elements in each of the two packages of organizational characteristics.

Fig. 11. Intense local rainstorm in the Valley of Oaxaca.

The fact of causality is more important to establish here than the direction of causality, since the causality seems to be mutual, linking each set of features in a spiraling intensification and expansion of the pattern they collectively create. Greater understanding of the developmental dynamics of these trajectories and of the forces that shaped them differently thus comes, not from identifying a prime cause (in climate change or elsewhere), but from seeing how a particular set of characteristics are inter-linked in a web of mutual causality in a way that gave far-reaching and unanticipated consequences to some straightforward decisions made early on by Neolithic farmers.

6. Further empirical research

We return in conclusion to emphasize that the foregoing should be considered a description of a set of hypothetical relationships that help us understand better the differences between trajectories of early complex society development in the Western Liao Valley and the Central Plains, and that seem to have broader applicability as well. These hypothesized relationships are consistent with a goodly amount of existing archaeological data and environmental observation. If true, they are enlightening enough about the dynamics of some (pre)historically important human social changes that they are worth further empirical evaluation against systematic data that at least in principle could be collected in several disciplines to really put them to the test.

Many of our characterizations of environment and agricultural practices are based on an accumulation of informal observations made in the course of archaeological fieldwork in the regions we have discussed. If these characterizations are really accurate, high resolution data from agronomy on agricultural yields and risks should reveal the patterns we have described. Likewise, systematically collected ethnographic data should reveal how contemporary farmers observe risk from flooding or drought and whether they engage in practices like those we have described to mitigate the risks. Data on changing temperature and precipitation at high spatial and temporal resolutions (cf. Contreras et al., 2018) would reveal whether our assertion that the risk dynamics we have described are truly an accurate characterization under the climatic conditions of Hongshan and Yangshao times. Archaeological field research could focus on the recovery of abundant samples of artifact assemblages from the accumulated garbage of numerous distinguishable Yangshao households, and this would put comparisons with Hongshan households on a sounder footing to evaluate our characterizations that Hongshan households show more prestige and ritual differentiation and Yangshao households more productive and wealth differentiation. And further comparative investigation would reveal more regions in which these relationships also hold, and probably additional pathways of developing complexity as well, in which other forces are more strongly at work.

Finally we do not suggest that the differences between the developmental trajectories of the Central Plains and the Western Liao Valley were inevitably “determined” by the risk-buffering strategies appropriate to the different environments in which these societies developed, but the differences do seem to have their roots there. Nor do we suggest that climate change played no role in prehistoric social change. Our point is that attempting to look at environmental opportunities and challenges (whether changing or static) from the perspective of the Neolithic farmers who faced them, and at a scale commensurate with the observations on which Neolithic farmers based their decisions, yields considerably more enlightening hypotheses about the dynamics of human social change than the effort to simply correlate vaguely defined social changes with climate change on a large scale.

Declaration of Competing Interest

None.

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