

Commentary: A Critical Review of Environmental Archaeology in Northeast China



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INTRODUCTION

THIS ARTICLE FOCUSES ON THE FIELD OF ENVIRONMENTAL ARCHAEOLOGY in the northeastern region of China, although a few external examples of archaeological work in other regions will also be considered for comparison (Fig. 1). The term “Northeast China,” as used in the context of this article, comprises mainly the current Chinese administrative divisions of Liaoning, Jilin, and Heilongjiang, and extends to the three city-districts of Chifeng (赤峰), Tongliao (通辽), Hulunbeier (呼伦贝尔), as well as the two Mengs (盟), Xingan (兴安盟) and Xilinguole (锡林郭勒盟), in the eastern part of the Inner Mongolian Autonomous Region¹ (Zi and Gao 2006: 2–3).

Northeast China is a region of diverse natural resources found in different land formations and climate zones, and many different kinds of economies have flourished here throughout history. Hunting and gathering, as evidence has suggested, was the main subsistence method for early human settlers no later than 40 kya (Jinniushan Team 1976). Crop cultivation and animal domestication began in the Chifeng region in the southwestern part of Northeast China as early as 8000 B.P. (Z. Zhao 2008), and continued to develop and spread over the entire region. Nonetheless, hunting, gathering, and fishing also existed alongside farming throughout history (P. Jia 2007). Today, except in areas covered by desert, swamp, forest, and steppe, where herding or other economic activities are favored, agriculture is widely practiced in most of Northeast China. The variation of natural resources caused by climate shift during ancient times provides researchers with the fundamental data for studying environmental changes and human responses to such changes. The relationship between humans and their natural surroundings is of critical interest for scientists engaged in the study of the evolution of human society, the economy, and political institutions.

When the study of the environment began around the 1920s, it was mainly applied to archaeological research in conjunction with geographical studies (Trigger 1971). This type of research continued to develop, and in the 1950s began to adopt an ecological approach to prehistoric economies (Adams 1988; O'Connor and Evans 2005: 1–8), although it was considered in the form of subordinate comments that were passively attached to archaeological data and could only serve as geographical

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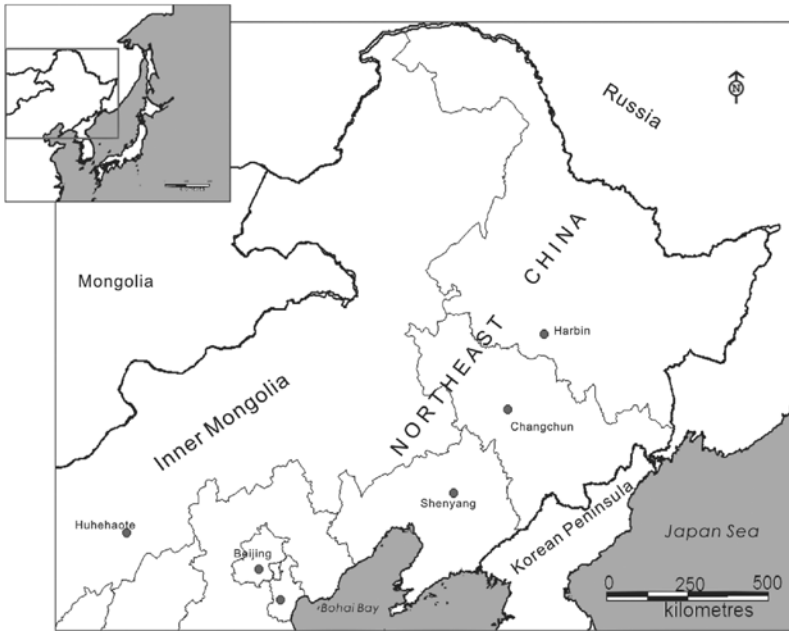


Fig. 1. Map of Northeast China.

background. The specific term “environmental archaeology” did not appear until the late twentieth century (e.g., Bintliff et al. 1988; Boyd 1990; Shackley 1985), when the emergence of this term was associated with great debate on how to properly define its context as a new discipline (e.g., Albrella 2001; Branch et al. 2005: 1–8; Coles 1995). In the last two decades, the term has been used more frequently, and gradually was defined as an ecological study of the interaction between human and environment (Boyd 1990; Shackley 1981). Based on the geoscience principle of uniformitarianism (Cameron 1993), environmental archaeology is defined as a study comprising archaeological and environmental theories and methodologies. Reitz et al. (2008:ix) described the broad contents of environmental archaeology as containing diverse fields and interests that are embraced by both ecological and anthropological studies. Three major themes are extrapolated: “systematic relationships between humans and the physical, chemical, and biological world in which they live; human nutrition and health; and complex human behaviors associated with acquiring resources” (Reitz et al. 2008:ix). Today, the term “environmental archaeology” frequently appears in both verbal communication and written sources, and both the journal *Environmental Archaeology* and the Association of Environmental Archaeology have emerged due to the increasing popularity of archaeological research, teaching, and publication, even if the term itself might not be appropriate for this growing discipline during its early stage (Luff and Rowley-Conwy 1994).

Environmental research applied in the context of archaeology in China, including Northeast China, began around the early twentieth century. There is no doubt that significant developments in this area of research in Northeast China have been made in the past century, especially in the last two decades, as exemplified by a number of

case studies in recent years (e.g., Avni et al. 2009; P. Jia 2007; X. Jiang 2007; B. Shi 2005; Song and Zhang 2001; Z. Tang 2004a, 2004b; Z. Tang et al. 2006), even though there is generally less discussion of theory and methodology than in the West. On the other hand, there are also many problems and shortcomings associated with this approach in China, which require critical reflection and improvement, similar to Western scholarship on this topic (Albrella 2001:4–8). Such critical review is essential to increasing the theoretical and methodological robustness of current research in this vein and to establishing a better trajectory for future work. In this review, I will of course acknowledge the commendable achievements of recent research in environmental archaeology, but the main focus will be on illuminating some of its shortcomings and offering suggestions for improving its contributions to archaeological research in China. Since the discussion of environmental archaeology in Northeast China is not only relevant to Chinese archaeology in general, but also to worldwide trends in the implementation of environmentally focused approaches in archaeology, it is maintained that these criticisms and suggestions may have far-reaching implications.

HISTORY AND RECENT DEVELOPMENTS

Pursuant to international collaborative projects, contemporary Chinese archaeologists have actively accepted Western theories and methodologies in environmental archaeology (see L. Liu 2004:19–32, 2009; Wang and Fang 2008). They appreciate that these methodologies and theories can improve research (X. Yang et al. 2005a, 2005b; Yang and Xia 2001; K. Zhou 2000, 2005, 2006). Environmental studies in archaeology began as early as the 1930s (e.g., Teilhard de Chardin and Young 1936; Yang and Liu 1949) and continued to be integrated with archaeological study into the 1960s (e.g., K. Zhou 1963). During this period, studies were carried out in collaboration with palaeontologists, geologists, and palynologists, but were limited to certain areas with specific projects (Z. Tang 2004a:1–7), an experience similar to the early development of environmental archaeology in the West during the eighteenth and early nineteenth centuries (Branch et al. 2005:4–8).

In China, environmental study has always been associated with palaeolithic archaeology, not only because the study relies on specific scientific disciplines such as palaeontology, geology, and palynology but also because it has been classified as part of the natural sciences while the archaeology of the Neolithic and later periods was traditionally assigned to the social sciences² (K. Zhou K. 2007:10–33). This arrangement is still evident in China today: for example, the Institute of Vertebrate Palaeontology and Palaeoanthropology for palaeolithic study comes under the jurisdiction of the Chinese Academy of Science, whereas the Institute of Archaeology (state level) that carries out the study of the Neolithic and later periods comes under the jurisdiction of the Chinese Academy of Social Science. Although environmental research in archaeology began quite early in China, due to the separation of the natural and social sciences an updated Western approach to environmental archaeology was not adopted until the early 1990s, and the most successful developments have only occurred thereafter (C. Liu et al. 2008; L. Liu et al. 2004; Madsen et al. 2007a, 2007b; Wünnemann et al. 2007; D. Y. Yang et al. 2009; K. Zhou 2005). Evidence of this development can be seen in the published proceedings of four national conferences on environmental archaeology that contain articles based on case studies written by archaeologists as well

as various associated scientists (K. Zhou et al. 2006, 2007; Zhou and Gong 1991; Zhou and Song 2000). Active research on the interaction between humans and the surrounding environment, between social, economic, and spiritual changes and ecological alterations, has become more common in contemporary Chinese archaeology. For instance, the International Symposium: Environmental and Social Change in Ancient China organized by Shandong University in 2009 (Xinhuaawang 2009), clearly indicates a research trend toward sociopolitical reconstructions involving ecological components.

Likewise, early environmental studies for archaeological projects in Northeast China were identified as palaeolithic research because, by nature, they were scientific in the natural science sense, and this remained so until the 1990s (e.g. Heilongjiang wenguanhui et al. 1987; P. Jia 1989; Jin et al. 1984; Jinniushan Team 1976; X. Li et al. 1984; Y. You et al. 1984; B. Zhao 2006). In recent years, international collaborative projects, particularly those in the southwest part of Northeast China, have contributed to substantial developments in this research through their influence on local research methods and theories (e.g., Tarasov et al. 2006). For instance, two separate Chinese monographs titled *Environmental Archaeology* (Z. Tang 2004a; K. Zhou 2007) contain a vast amount of information derived from Western publications,³ much to the delight of Chinese academics. The monograph edited by Z. Tang (2004a) is directly influenced by international collaboration, because the author was a key participant in the project. As a result of Western influence, universities in China began to teach environmental archaeology using these monographs as the only available Chinese textbooks. Subsequently, studies by scholars trained in Western theories and methodologies using such textbooks have emerged (e.g., X. Jiang 2007; B. Shi 2005; Song and Zhang 2001; Z. Tang 2004a, 2004b; Z. Tang et al. 2006). For instance, after comparing studies on stratigraphy in archaeology and earth science, X. Jiang (2007) argued that those two systems must complement each other in order to better suit research needs. He also suggested that terms used to define archaeological deposits had to correspond to stratigraphic sediment layers as defined in geoscience (X. Jiang 2007). In fact, his findings and suggestions were already integral parts of most teaching and research in Western archaeology (Donahue 1985).

Many other studies have also made contributions to the development of research methods. For instance, Z. Tang (2004b), incorporating a large amount of environmental and archaeological data, particularly faunal records, created a model that reflects the relationship between prehistoric economies and the environment. He and his colleagues later used (mainly) zoological data to reconstruct ancient environments and to retrieve information about the human exploitation of animals (Z. Tang et al. 2007). It was found that human resource exploitation, combined with climatic changes, might have been responsible for the decrease in the number of wild animals in local prehistoric environments (Z. Tang et al. 2007). B. Shi (2005) used an assemblage of tools found in ancient sites to deduce the activities of past subsistence economies, which were then compared with the findings of environmental studies. W. Zhou et al. (2002), Song and Zhang (2001), and Ren (2000b) gathered environmental data in the southwest region of Northeast China in an attempt to determine whether human activities had caused deforestation and desertification during prehistoric times. All these studies are indicative of major achievements in the development of environmental archaeology in Northeast China.

PROBLEMS WITH CURRENT ENVIRONMENTAL RESEARCH IN ARCHAEOLOGY

While many archaeologists have been satisfied with these developments in environmental archaeology (K. Zhou 2005, 2006), some environmental experts have raised concerns and identified problems existing with current practices (X. Yang et al. 2005a, 2005b; Yang and Xia 2001). It is likely that because these concerns were raised by environmental experts who were not trained in archaeology or directly collaborating with archaeologists, they failed to gain attention in the Chinese archaeological world. Nonetheless, these problems need clarification, discussion, and emphasis to lead to improvements in the current research practices within environmental archaeology. These problems may be grouped into the following categories: (1) the conservative influence of traditional Chinese archaeology; (2) the lack of a culture of cooperation across disciplines; and (3) the presence of a rigidly deterministic approach, combined with simplistic research methodologies.

Historiographical Influence

As a modern discipline in China, archaeology was established during the early twentieth century mainly to enrich the study of Chinese historiography and antiquity. It was therefore strongly influenced by orthodox approaches in Chinese historical studies (P. Jia 2007: 16–17; L. Liu 2004: 1–18). This type of primacy given to historical analysis over material studies has also been encountered in archaeological work in other parts of the world, but the impact of traditional historiography on archaeological practices is particularly strong in the case of China because historical records have been relatively continuous, complete, and consistent. This is one of the major problems hindering the progress of environmental archaeology in Northeast China.

Within this conservative paradigm, Chinese archaeology is naturally defined within the historiographical context of the social sciences. Therefore, little communication is encouraged between archaeologists and associated natural scientists in fields within the earth and environmental sciences in Northeast China. Of course, environmental scientists and institutions have participated in specific archaeological projects that have been prioritized because of their national importance. For instance, the Searching for the Origins of Chinese Civilization project (文明探源工程) supported by the Administration of Chinese Science and Technology (not social science) involved a large number of natural scientists from various institutions. However, these scientists working collaboratively with archaeologists are not recognized as members of the archaeological community by archaeologists: they are regarded as “service scientists” (Boyd 1989). Donahue (1985) described how his students with limited scientific knowledge had done poorly in their geoarchaeology coursework, highlighting the shortcomings of archaeologists who lack scientific knowledge outside a narrowly defined historiographic archaeology, and noting the limited education in geoarchaeology that characterizes current research in environmental archaeology in Northeast China. There remain a considerable number of archaeologists in China who lack basic knowledge in the natural sciences, most critically geoarchaeology, that together constitute the core knowledge of environmental archaeology. Geoarchaeology, with its emphasis on ecological constraints, human environmental impacts, and dynamic site

formation processes, is still not one of the requirements of a general archaeological education in many universities in China.

As a result of this historiographical influence, environmental archaeology has made varied progress in different regions of Northeast China. For example, because of the strong interest in ecologically focused research in the southwestern part of Northeast China, there have been numerous international collaborative projects over the past decades. Continuous fieldwork since the 1980s has resulted in a relatively complete chronology of material culture revealing significant aspects of resource use and environmental impacts (see Chifeng Team 2003; Linduff et al. 2004). By comparison, other areas have received little attention, and have been studied mainly by archaeologists using traditional fieldwork practices with the result that research is far less developed (X. Yang et al. 2005a, 2005b; Yang and Xia 2001). In addition to inadequate funding and limited excavation time, a conservative influence is the major reason for the uneven regional development of environmental archaeology.

An Uncooperative Attitude

Archaeologists who have this historiographical mind-set are usually skeptical about applying scientific methods to archaeological study, and this limits opportunities to collaborate with environmental experts. Nonetheless, the rapid development of environmental archaeology in China has created pressures on the academic community. It is therefore a common practice for Chinese archaeologists to reach out to relevant scientists outside archaeology to assist with soil sample collection for environmental study when this is needed for archaeological interpretations. Even so, some archaeologists continue to reject the idea of cooperating with environmental scientists; in some cases, funding can be a consideration. As Boyd (1989) noted, the “service scientists” who were called upon by archaeologists to perform specialized scientific analyses were not regarded as a part of mainstream archaeology. This attitude was prevalent in Europe and North America during the 1980s, and is now also a prevalent view in China. The label of “service scientist” has led to reluctance by archaeologists to consider the notion of any collaboration: the “service scientist” merely perform “services” for the “master” scientist—the archaeologist. This uncooperative attitude on the part of archaeologists, in which they marginalized the knowledge of these specialists and did not fully integrate them into their research program, led to a lack of communication between archaeologists and environmental scientists, and caused significant dissonance between the two disciplines (Lu 2007: 325), a pattern that was established in Western archaeological scholarship in the 1990s (Albrella 2001). As a result, environmental research has been sidelined and thought to be insignificant in the research of some archaeological projects in Northeast China.

There are opposing views about how collaborative environmental archaeology involving archaeologists and environmental scientists should be conducted. From the perspective of archaeologists who are reluctant to collaborate, environmental research is merely “service science” that does not go beyond collecting soil samples for pollen analysis in the final stage of the excavation (Boyd 1989). However, environmental scientists maintain that collecting samples at the termination of the excavation does not allow a comprehensive examination of all excavated sediments relevant to the archaeological history of a site. What should also be included is an analysis of how the

deposits were discovered, their formation, and the kinds of cultural contexts to which they belonged, as well as how those cultural contexts relate to environmental data. Unfortunately, soil sample reports are often treated as background data by archaeologists and only included in the appendices of published papers (Yang and Xia 2001). This devalues the scientific input of environmental archaeology as a means to reconstructing ancient ecological systems and understanding human interactions with the environment, which deprives archaeological research of a valuable set of data.

This situation has led to some natural scientists choosing to work alone on issues of human–environmental interactions without any input from archaeologists, due to their belief that the principles of environmental archaeology (Dincauze 2000) dictate that archaeology cannot be properly done without the gathering of detailed scientific evidence on human ecology. They have conducted fieldwork and collected samples from archaeological sites and established a significant environmental database (e.g., C. Jin et al. 1984; X. Li et al. 1984, 2007; H. Lu et al. 2009). However, this important groundwork is usually published in purely natural science journals such as *The Holocene*, *Quaternary Science* (Disiji kexue 第四纪科学), *Advances in Earth Science* (Dixue qianyan 地学前沿), *Geology and Geography* (Dizhi yu dili 地质与地理), and other publications in English-language journals that are much less likely to reach the majority of Chinese archaeological readers, particularly those who question the value of environmental science in archaeology. Environmental studies, therefore, have had less recognition in the archaeological arena than they deserve. However, these “archaeologist-free” excavations for sample collections are equally flawed: because no archaeologically trained excavators are involved in the sample collection, none of the excavated human artifacts have verifiable cultural contexts, and without reliable cultural contexts such research is difficult to compare with any known archaeological data. Some natural scientists even follow the practice of using archaeological data obtained under these poorly documented conditions to reconstruct human–environment interactions, but without consulting archaeologists. Without collaboration from archaeological experts, their use of archaeological data for the reconstruction of human–environment interactions has also caused many problems, such as the deterministic approach (discussed below) adopted by some natural scientists (e.g. M. Han et al. 2007; W. Jiang et al. 2008; Y. Li et al. 2003, 2006; Song and Zhang 2001). Without question, the uncooperative attitude of both archaeologists and natural scientists has seriously reduced the value and impact of current environmental studies.

A Deterministic Approach

A deterministic approach can be seen among both archaeologists and environmental scientists in Northeast China, and some research may be classified as environmental determinism (Coombs and Barber 2005), a problem that plagued many environmentally-focused archaeological studies in the Western world during the 1970s (Trigger 1971). In Northeast China, and in China as a whole, archaeologists do not explicitly recognize the term “environmental determinism,” although some research practices seem to slip unknowingly into this category. An example of this is the belief that almost every cultural change was caused in some way by environmental changes in prehistoric times, largely exclusive of purposive human agency. A number of publications (e.g., Delige'er 2004; Kong et al. 1991; Li and Zhang 2004; Y. Li et al. 2006; Teng 2004; Yang and Suo 2000) that generally discuss the relationship between pre-

historic economies and cultural shifts, and that focus on palaeo-environments in the western Liaoning region of Northeast China, are based primarily on a large-scale ecological reconstruction with little emphasis on the complex interactions between ecological factors and human decision making. Without the support of detailed environmental evidence, these studies conclude that in almost every case of economic change, cultural shifts (as suggested by archaeological evidence) are associated with, or possibly caused by, some nebulously defined environmental change. Due to the influence of environmental determinism, some studies have attributed later Neolithic cultural changes in the whole of North China around 5000–4000 B.P. to a drop in temperature: the “Cold Event” (J. Han 2006; Y. Li et al. 2003). These researchers maintain that the economic shift from farming to herding was caused solely by the so-called Cold Event, and furthermore that increased evidence for warfare was due to competition between rival groups for limited natural resources supposedly brought about by the Cold Event. It was speculated that the Cold Event appeared simultaneously over the marginal zone between farmland and steppe regions in North China, as well as in Northeast China, therefore justifying a pan-regional explanation of cultural change (J. Han 2006).

Instead of carefully analyzing the environmental data and connecting it in a more complex way to archaeologically documented cultural trends, these reports simply conjectured about the disastrous effects of the Cold Event (e.g., Y. Li et al. 2003), and some therefore concluded that the Cold Event had caused a widespread cultural shift from Hongshan to Xiaohayan. The problem is that there was no careful assessment of the practical consequences of the Cold Event for the people at the time (X. Yang 2001). The criteria for the classification of abrupt and far-reaching natural disasters have been summarized in past research (Shimoyama 2002), including volcanic eruptions, earthquakes, floods, and tsunamis (Torrence and Grattan 2002), but of course not limited to these. The researchers should at least have used these criteria to assess whether the Cold Event was a disaster or a more gradual shift in conditions, and more specifically what the effects of such climatic changes were on human behavior, before making these types of sweeping assumptions. If the Cold Event is to continue in future research to be considered a cataclysmic event and prime mover for human socio-economic change, one still needs to find out how and in what time frame human societies responded to it (Dincauze 2000:63; Madsen et al. 2007b).

Few have ever questioned the validity of such conclusions. Certainly, environmental change can potentially trigger large-scale social, economic, and cultural change. However, such conclusions should be made on the basis of thorough studies of local environmental settings and changes that are located within secure archaeological contexts, while also carefully scrutinizing any other possible factors that could have contributed to a recorded behavioral shift, such as cultural or traditional obligations, new social and political demands, and/or changing spiritual or religious requirements. Suggesting causal links between the environment and prehistoric economic and social strategies without examining these factors would mean falling into the trap of environmental determinism.

The Problem of Simplistic Research Strategies

Researchers have noted that a deterministic approach combined with simplistic research methods can lead to outrageous conclusions (e.g., Tarasov et al. 2006). Such

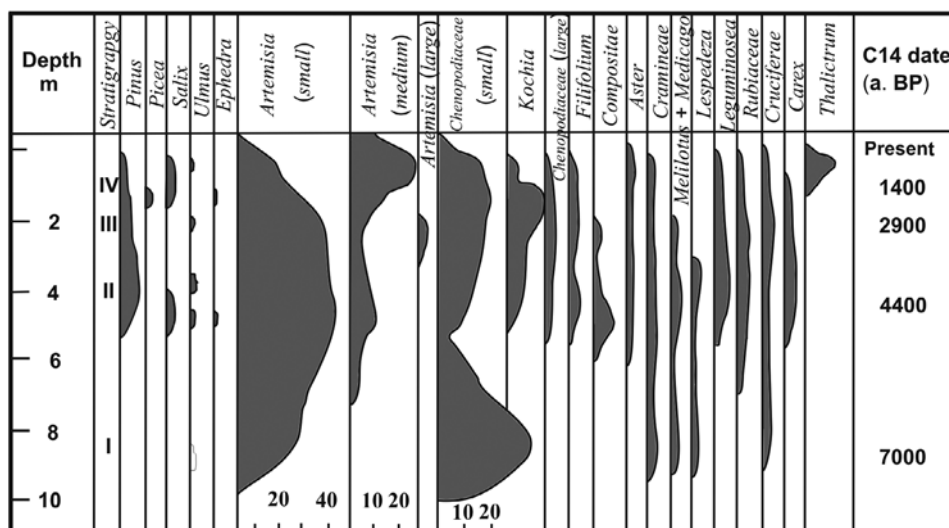


Fig. 2. Pollen data from the Dongweng'genshan (东翁根山) site (redrawn from Q. Ye 2000).

simplistic research behavior by some archaeologists may be driven by the excessive application of the most extremely deterministic forms of environmental archaeology, in the absence of adequate in-depth case studies. For instance, in a study of the Dongweng'genshan (东翁根山) site (Fig. 1) located at the Lower Nenjiang River area near the Tailai township (泰来县) (Q. Ye et al. 1991), it is argued that around 7500 B.P. (cal. B.P. 7744–7871) this site was warmer and wetter than in unspecified later periods, attested by remains of human occupation found around 7500 B.P. The researcher, along with other Chinese archaeologists, had simplistically assumed that human occupation signaled a warmer and wetter environment (P. Jia 2007: 39), with the assumption that humans would only use the site under optimal conditions. The pollen diagram presented in the article, however, revealed a different image of a possibly warmer but not wetter climate (Fig. 2) (Q. Ye et al. 1991: 189). Around 7500 B.P., about 30 percent of *Artemisia* and 40 percent of *Chenopodiaceae* were present in the pollen data, which indicates a very dry climate. If the climate had been wet, as had been assumed, these two species would have comprised less than 10 percent of the pollen in the data. In particular, *Chenopodiaceae* should have been less than 5 percent, because this species survives only in relatively dry conditions (G. Ren 1999).

Such simplistic research behavior could ultimately contribute to a superficial knowledge of human settlement strategies during the Holocene Climate Optimum (HCO), which has strongly influenced environmental studies in Northeast China and China in general. The HCO was originally described as a warm and wet period at its inception, then the temperature started to increase worldwide, reaching a peak during the mid-Holocene on a large temporal and spatial scale (Burroughs 2001: 98–99). In most regions of Europe, East Asia, and China during the mid-Holocene, warmer climate and increased rainfall were viewed as more conducive to plant growing, animal breeding, and the support of larger human populations than in the previous period. Even though it might have had some negative impact on humans (T. L.-D. Lu

2007), this particular period is nonetheless called the Holocene Climate Optimum (HCO). As result, warm and wet environments during the HCO have always been considered more conducive to human population, even though this is patently a false assumption. One may argue that, because constant high temperatures would result in high evaporation and drought, and excessive rainfall in a short period could easily result in flood, these conditions could just as easily be non-conducive to human population development.

The misnomer “Megathermal” (Danuan qi 大暖期) has been used to describe higher temperatures during the HCO, and this may also have contributed to simplistic research assumptions and conclusions. Wu et al. (1994) have demonstrated that researchers using this misnomer instead of HCO could easily have led to errors in environmental reconstruction, with studies merely considering temperature change but ignoring rainfall and humidity (or aridity) in the HCO period. In other words, archaeologists who have simplistically considered only temperature change presumed that warmer conditions made it favorable for human survival, and failed to take into account other climatic factors such as the amount of rainfall (appropriate or excessive), and the likely human responses. Take for example Northeast China during the HCO period (c. 9300–4500 B.P.). Following the global HCO trend, the average annual temperature increased by 1–3 °C, but annual precipitation decreased by around 45 mm from the preceding period (X. Li 2002: 88). The decrease in rainfall combined with the rise in temperature very likely resulted in a dry climatic condition, but whether this environment was conducive or unfavorable for human survival, or whether it led to economic and cultural change awaits further regional studies on possible interactions between human society and climate change.

SUGGESTED DIRECTIONS FOR ENVIRONMENTAL ARCHAEOLOGY

In order to improve current research in environmental archaeology in Northeast China, as well as in China as a whole, the problems listed above must be addressed. The conservative influences that infiltrate the Chinese academy, however, cannot easily be challenged. The archaeological study of China in the Neolithic and later periods has been subjected to Chinese historical interpretations. Change is likely to be gradual, but can be accelerated by introducing updated theories and methodologies to current university students. The ideal scenario is one in which both archaeologists and associated scientists actively engage in regional case studies of environmental archaeology rather than treating environmental research as “service science” (Boyd 1989). The environmental study of a cemetery dated to the eighth to ninth century A.D. in the Amur region of Russia that was conducted by Jilin University in Northeast China, provides a fine example. Using the framework of modern surface pollen as baseline and historiographical records, this study analyzed ancient pollen data to reconstruct the past environment. This adheres to the uniformitarian principle that is fundamental in environmental studies (Cameron 1993). The research found a relatively consistent dry and cold environment in this region, which was possibly one of the reasons why a hunting, gathering, and fishing economy continued during the eighth and ninth centuries in the western and southern neighboring areas (Tang et al. 2008). But again, social, cultural, and political reasons should also be considered alongside environmental change. Another good example of environmental archaeology is the systematic study of the relationship between geomorphic formation and population settlement

through history in the Chifeng region (Avni et al. 2009), in which it was observed that the rate of loess deposit indicated climate change, and that the rapid deposit of loess influenced the location of human settlement, particularly in the valleys. There can be different effects attributed to the same climatic conditions in different zones of the same region, so it is important to address those effects in order to understand human reactions to such environments. Worsening climate greatly influenced preferred settlement locations that were selected by ancient communities. Shelach's (2009a) study of environmental impact on economic change is another case that illustrates the shift from sedentary farming and mobile herding in response to environmental changes. He observed that climatic influences in the transition from the Lower to the Upper Xiajiadian had been greatly exaggerated in past research, and that economic change was not as dramatic as had previously been maintained (Shelach 2009b: 47–72). This is a good example of research that repudiates environmental determinism.

The success of these studies can be attributed to the active collaboration between archaeologists and palynologists and other associated scientists. In order to properly conduct environmental archaeology in a way that overcomes deterministic theoretical orientations as well as simplistic research methods, two fundamental research strategies are urgently needed: high resolution in reconstructing the time frame of regional environmental developments and the institution of quantitative approaches in this reconstruction.

High-Resolution Environmental Reconstruction

Palaeo-environmental research applied to archaeological studies requires high-resolution research, i.e., analysis that is strongly detail-focused and firmly grounded in specific time, space, and cultural contexts. However, the norm for such studies (e.g. J. Liu et al. 2007; S. Qiu 2008) is a long time frame covering a massive region that excludes the possibility of high-resolution research⁴ (Yang and Xia 2001). While this type of environmental study provides a preliminary understanding of the palaeo-environment that archaeologists can use for further interpretations with its relatively clear, simple, and accessible overview, it does not cater to in-depth regional research. Therefore, the high-resolution research of individual sites within relatively small areas and across narrow time periods is strongly recommended.

High-resolution research in terms of time span and ecological detail in environmental studies has been current in Northeast China for a decade, but while research findings have circulated within the geoscience disciplines, they remain unacknowledged by archaeologists involved in environmental research. Recent studies have used various methods and techniques to achieve high-resolution results. For instance, H. You (2007) used a multi-proxy method to reconstruct the ancient environment at Erlongshan Marr Lake in Northeast China (also see Q. Liu et al. 2005) and achieved a high-resolution result. Other studies are based on pollen analysis to infer ancient climate change with high resolution in time (e.g. Fang and Hu 2007; Hong et al. 2000, 2001; P. Jia 2007; H. Liu et al. 1999; Y. Liu 2004; Maher and Hu 2006; Ren 1999, 2000a; Z. Tang 2004b; Y. Yang 2003; Y. Yang and S. Wang 2003; Y. Yang et al. 2001; H. You 2007; Yu et al. 2008; X. Zhang 2006; K. Zhou et al. 1977, 1984). Phytolith, isotope, solar activities, and other techniques are also applied to synthetically trace the ancient climate to achieve high resolution in time (Y. Hong et al. 2000, 2001; Lai and Wintle 2006; Q. Liu et al. 2005; Schettler et al. 2006). By studying peat

bog sediment, the resolution of time could be as high as a single year or even a season within one year if there is sufficient data (H. You 2007:56). Unfortunately, the results of these studies have usually been broadcast only within their own disciplines.

Using results from high-resolution environmental studies is only part of the solution to improving research standards. Another important requirement for robust environmental reconstruction is a quantitative approach, such as the quantitative reconstruction of temperature and precipitation. Even though it is impossible to measure this directly, there are many published techniques for extrapolating such data from other variables. Despite many environmental reconstruction studies with a high resolution in time, researchers were unable to establish a formula for converting results into a quantitative description of temperature and precipitation, and their studies usually concluded with a vague description of “wet, dry, warm or cold.” Maher and Hu (2006) made a breakthrough with their research on Holocene rainfall from the western Chinese loess.⁵ Maher and Hu (2006) used stable isotopes (such as $\delta^{18}\text{O}$, $\delta^{13}\text{C}$) as proxy data and converted these into actual temperature and precipitation by the use of mathematical formulae. They then discovered that the local climate did not follow the macroclimate change. This is an excellent example of regional climate with an “anti-phase behavior” when compared to the general climate trends of the larger area. The mathematical conversion of limited proxy data such as pollen and phytolith into quantitative results for the study of environmental reconstruction has always been advocated by many influential studies (e.g., Schettler et al. 2006; Tarasov et al. 2006; K. Zhou 2005, 2006), and this form of quantitative approach to environmental study is quite popular in many regions in the West (e.g., Lim et al. 2007; Seppa and Birks 2001), but has been initiated only recently in Northeast China and China (e.g., X. Zhang 2006; X. Zhang et al. 2007; Zhao and Zhou 2006). Using limited pollen data from past studies, I have attempted to establish interpolated diagrams to demonstrate a quantitative change in temperature and precipitation during the Holocene period of Northeast China.

X. Zhang's Ph.D. dissertation is an outstanding example of palaeo-environmental research based on quantitative environmental reconstruction. Using phytolith data extracted from a peat deposit collected from 41 sites in Northeast China, she established a model that quantitatively reconstructed the climate change in high resolution for every 20 years over the past 3000 years. Her findings are supported by a study of different data sources that include phytolith and other plant relics such as pollen, C-O isotopes, and clay minerals, in addition conformed to solar and volcanic activities (X. Zhang 2006). Her research suggests the great potential for using phytoliths as a proxy for quantitative reconstructions of the ancient environment, particularly as a means to study climate change in a relatively small region for archaeological purposes. Apart from phytolith study, Zhao and Zhou (2006) also used pollen data to achieve a quantitative result for ancient temperatures during the past 2200 years in the Dunhua region of the Changbaishan Mountains in Northeast China. In terms of environmental archaeology, Tarasov and his team have presented a very good example of how to conduct a case study properly in environmental archaeology using a qualitative and quantitative approach (Tarasov et al. 2006). By using such quantitative results, researchers can easily track variations between small areas within a region that can be compared against trends of climate fluctuation in the larger region, and this would substantially reduce sweeping generalizations and simplistic overviews of past environments.

Equal Emphasis on the Study of Both Natural and Archaeological Deposits

A high-resolution quantitative environmental reconstruction based on a sample derived from a natural deposit near an ancient site is the baseline of environmental study without human disturbance, so it is significant for archaeological study. With this baseline for environmental reconstruction, archaeologists are able to compare cultural contexts with the changing environment of the past. However, the analysis of a sample derived from an archaeological site is just as important as the study of natural deposit, because due to human disturbance the result will differ from that obtained from the natural deposit. The variation could be used as a proxy to trace the ancient lifestyle and social activities that led to the amounts of pollen, phytolith, or other plant relics being different from the amounts in the natural deposit. For instance, a site that was occupied by an agricultural community would be expected to contain more cereal pollen and crop phytolith due to daily farming and crop food-processing activities than contained in the natural deposit. Furthermore, a site used by people for hunting, gathering, and fishing would have a larger amount of phytolith remains related to wild nuts, tuber foods, or other wild plants. The number of plant species in archaeological deposits may be the result of human intestinal collection that is dominated by preference, and this specific collection could be related to the social, cultural, economic, and even spiritual needs of ancient society. It is therefore highly recommended that equal emphasis be placed on the study of samples from both natural and archaeological deposits.

The establishment of a systematic strategy for the study of the regional palaeo-environment, starting from basic geomorphological analyses of local landscape formations and proceeding to the reconstruction of ecological settings throughout human history, would be the ideal long-term solution for improving current research in environmental archaeology in Northeast China. But, to make progress in the short term, archaeologists and associated scientists must begin to actively work together on a strictly collaborative basis on the same archaeological projects. It is only through interaction and the sharing of the expertise of archaeologists, botanists, zoologists, etc., that a more comprehensive understanding can be gained of ancient environmental conditions and their effect on human societies, as well as the interactions between human beings and their environment. If we are to transcend broad generalizations and address environmental and anthropogenic processes at the local level, we urgently require a high-resolution approach and quantitative data analysis that fully utilizes a range of available scientific technologies. Applied to both natural and archaeological deposits, such a formula for study will ultimately raise the standard of environmental archaeology in Northeast China, China, and other parts of the world.

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ENDNOTES

1. The administrative divisions in this area have been changed many times along with economic reform in China since the end of “Cultural Revolution” in 1976.
2. The two parts of archaeological studies (Palaeolithic and Neolithic onward) are discrete in the Chinese administrative system. Palaeolithic study is carried out by the Institute of Vertebrate Palaeontology and Palaeoanthropology in the Chinese Academy of Science (CAS), but the research on Neolithic onward is conducted by the Institute of Archaeology in the Chinese Academy of Social Science (CASS). One belongs to science a focus on environmental studies and the other is under social science with less concern about environmental study, particularly after the interruption of the “Cultural Revolution” (1969–1976).
3. For instance, the one edited by Z. Tang (2004a) was directly derived from manuscripts written by Dincauze (2000) and Reitz and Wing (1999).
4. A significant project with the high-resolution and quantitative approach of environmental reconstruction conducted by the Chinese Academy of Science in Southwest China is reaching its final stage in generating the model and result. This is a fundamental study that should be widely applied to many fields, including archaeology (from a personal conversation with Professor Lu, Houyuan).
5. They have finally generated quantitative results of rainfall based on analysis of concentration and magnetic grain size of the sediments (see Maher and Hu 2006).

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ABSTRACT

Environmental archaeology in northeastern China has reached a critical period of development, although the state of progress varies across this large geographical region. The lack of collaboration between archaeologists and associated scientists remains the main obstacle in current research. Almost exclusively conducted by dedicated scientists, research in the field is often ignored by archaeologists because it is not presented within an archaeological context. Furthermore, the research is not of a high spatial and temporal resolution: there is the tendency to make broad generalizations about large regions over long periods of time and to disregard areas that do not fit their general climatic models. Another problem is the misguided borrowing of concepts developed in other parts of the world, for example, the Holocene Climate Optimum (HCO), which is well defined in prehistoric Europe but is still being developed in China. Many researchers have simply applied this term to the same period in China and assumed that the climate around that period resembled that of prehistoric Europe, despite the fact that this is currently unsupported by local palaeo-environmental evidence. Other obstacles to the development of environmental archaeology include deterministic approaches and oversimplistic research procedures. To address these problems, a conversion of qualitative data to quantitative data on temperature and precipitation is required. Future research should be conducted by teams of scientists and archaeologists working collaboratively on both natural and archaeological deposits, in order to establish a strong foundation for further environmental reconstruction research. **KEYWORDS:** Northeast China, environmental archaeology, environmental determinism, high resolution, quantitative approaches.