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The Evolution of Human-Earth Relationships in Southern Shaanxi during the Neolithic Period

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Abstract. The article explores the human-earth relationship in the Neolithic period in southern Shaanxi, especially the interrelationship between the land-use pattern, the cultural distribution range, and the evolution of the local natural environment, in terms of the size and shape of the settlement sites of the archaeological cultures, and the characteristics of the assemblage of the production tools. The results show that the land-use patterns responded to by the archaeological cultures in southern Shaanxi within the Neolithic period are consistent, the cultural distribution range is affected by climate change, and the distribution density is affected by the geographic environment. Under the condition of small changes in the overall natural environment, there is no obvious change in the shape of production tools and land use patterns within each culture, and the changes in microclimate within the southern Shaanxi region affect the distribution of the archaeological cultures as well as the geographic environment of the southern Shaanxi region affects the size of the distribution density of the cultures.

Keywords. Neolithic period,southern Shaanxi,land use pattern,interrelationships

Introduction

The Southern Shaanxi Region, administratively comprising three prefecture-level municipalities (Shangluo, Ankang, and Hanzhong), occupies a strategic geographical position in southern Shaanxi Province, China (31°24'36"N–34°22'12"N, 105°27'00"E–111°01'48"E). Encompassing 70,200 km², this territory represents 34% of Shaanxi's total land area, equivalent to the combined surface area of Belgium and Luxembourg. The region is topographically bounded by the Qinling Mountain Range to the north and the Bashan Mountains to the south, forming the geomorphological complex known as the Qinba Mountain Area.This ecologically critical zone contains the headwaters and major tributaries of three principal river systems: the Han River, Jialing River and Dan River, conferring significant hydrological importance to the upper Yangtze River basin. Current biodiversity inventories document over 3,400 wild species, including 147 protected taxa under China's National Biodiversity Conservation Strategy, establishing the region as a vital ecological corridor in the Asian temperate-subtropical transition zone.

In recent years, the frequent occurrence of extreme weather events has made the relationship between environmental changes and human society a significant topic of

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discussion. Factors such as settlements, their scope, and modes of production can objectively reflect the relationship between humans and the environment at that time. Due to its unique geographical location, the production and lifestyle of humans during the Neolithic period in southern Shaanxi, as well as their interaction with the environment, are particularly worthy of exploration. Since the 1960s, more than 130 Neolithic human settlements have been discovered in the southern Shaanxi region. Research on these sites can be broadly categorized into several areas: archaeological reports and research reviews from various regions, changes in settlement environments and agricultural development, local climate evolution, and settlement distribution. Wei, J. & Y. Yang (1986) used archaeological findings to determine that the Laoguantai period in Shaanxi was still in the early stages of primitive agriculture. Ma, Q (1999) specifically noted that during the Neolithic period in the Hanzhong Basin, the area was densely forested, with crops such as rice, millet, and beans being important, though hunting still played a significant role in the economy (Ma, Q ,1998). Weining , T (2003) explored the distribution characteristics of Neolithic settlements in the Hanjiang Corridor from the perspective of site geomorphology, identifying two types: plain tableland and river valley terraces, and discussed their production methods based on geomorphology and production tools . While these studies each have their own characteristics, none have addressed the impact of climate change on human society. Additionally, scholars have discussed local climate changes.

Li, H.-C., et al. (2000) used isotope analysis of stalagmites in the Zhashui Cave to infer ancient climate and monsoon information. Zhu,Y.,et al(2010)established a chronological framework for environmental changes and archaeological cultural development over the past 10,000 years in the upper reaches of the Danjiang River through pollen analysis and magnetic susceptibility analysis. Zhongxiao, L (2002) summarized the natural environmental evolution of the Qinba Mountain region from the Stone Age to the Republic of China. In summary, existing research in the academic community has mostly focused on single sites or cultural types, with some attention paid to the distribution characteristics, production methods, and climate changes of Neolithic settlements in southern Shaanxi. However, there has been no systematic discussion of the organic relationship between climate change, geomorphological environment, and ancient human society, lacking a regional holistic research perspective. It is well known that the long-term settlement of ancestors in such locations was determined by a combination of various factors. The mountainous terrain of southern Shaanxi limited large-scale agricultural development. Climate change and geographical environment shaped the unique evolution of production methods, human settlement density, and distribution in southern Shaanxi. Therefore, this paper integrates research findings on climate change and site archaeology during the Neolithic period in southern Shaanxi, analyzing the organic relationship between climate change, geomorphological environment, and ancient human society from the perspective of human-environment interaction, revealing the evolution of human-environment relationships in the southern Shaanxi region during the Neolithic period.

Human-Environment Relationship during the Laoguantai Culture Period

The Laoguantai Culture, dating back to 8000-7000 years BP, represents an early Neolithic culture in the middle reaches of the Yellow River. In the southern Shaanxi region, a total of 17 Laoguantai cultural sites have been identified, with the most representative being the Lijiacun site in Xixiang County. The Lijiacun site is located on the first terrace on the south bank of the Muma River in Lijiacun Village, Xixiang County, approximately 2-3 meters above the riverbed and 1.5 kilometers east of Xixiang County. The site covers an area of about 2.6×10^4 m^2（Liao, C,1961）. Radiocarbon dating indicates that the Laoguantai cultural layer at this site

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dates back to 7000 years BP (Wei, J,1985). The site is situated in a flat area surrounded by mountains, with the Muma River flowing from west to east, converging with the Jingyang River before entering the Han River. The river's sedimentary processes have resulted in fertile and loose soil, and in ancient times, forests were nearby. The site has undergone two excavations, revealing 35 ash pits, remnants of a house, and a pottery kiln(Wei, J,1962). Clearly, this was a carefully chosen and well-planned Neolithic settlement.

The production tools discovered at Laoguantai cultural sites are currently limited to stone tool, primarily polished. The representative stone tool from the Lijiacun site is a flat, tongue-shaped double-arc polished stone shovel (Society, S. P. A,1986) , though only a few have been unearthed. Other tools include oval-sectioned stone axes, as well as stone adzes, stone knives, and stone shovels, with stone axes and adzes being the most numerous.

Although Neolithic production tools rarely show specialized division of labor, anthropological and experimental archaeological materials suggest that stone axes and adzes could be used for felling trees, were portable for self-defense or throwing at animals, but primarily served as tools for processing wood, bamboo, and bone in daily life. Stone shovels and hoes were the main agricultural tools; arrowheads were used for warfare or hunting fish, serving as primary hunting tools; and stone nets were typical fishing tools (Weining, T, 2003).

Notably, both comparisons with neighboring archaeological cultures and the production tools unearthed from Laoguantai cultural sites suggest the presence of agriculture in this Neolithic culture. However, the limited number of agricultural tools reflects the low level of agricultural productivity during this period. The large number of animal bones and stone axes and adzes found at the sites indicate that hunting played a significant role in the economy of the Laoguantai culture. Only three large settlement sites covering more than 10×10^4 m^2 have been discovered, indicating a limited population size and suggesting that agriculture was still in its early stages, unable to support large-scale population aggregation. In fact, the stable development of Laoguantai settlements was based on a composite (or broad-spectrum) land use model that combined primitive agriculture, gathering, and hunting.

Under current climatic conditions, southern Shaanxi remains generally warm and humid. During the Holocene Climatic Optimum (7200-6000 years BP), the average annual temperature in mid-latitude regions was 3-4°C higher than today, with increased precipitation, and the warm temperate deciduous broadleaf forest zone shifted northward by about three latitudes (Shi,Y et al.,1992). The Hejiawan site, located only 5000 meters from the Lijiacun site (with its fourth and fifth cultural layers belonging to the Laoguantai cultural accumulation), yielded a large number of animal bones from humid-adapted fauna of the eastern Chinese monsoon region, including species such as rhinoceros and water deer, which are now only found in some tropical rainforest regions of Southeast Asia (Cheng, Y, 1999). Cai et al. (2010) found that $\delta^{18}O$ values in stalagmites from the Jiuxian Cave in Ankang City, southern Shaanxi, remained relatively stable between 9000-5000 years BP, consistent with the Holocene Optimum proposed by Shi et al. (1992), indicating favorable climatic conditions during this period. It was under such natural conditions that a composite land use model emerged, dominated by hunting and gathering, with primitive agriculture playing a supplementary role.

When considering southern Shaanxi as a whole, internal climatic variations also existed.Li, H.-C., et al. (2000) analyzed the climatic implications of $\delta^{18}O$ and $\delta^{13}C$ in stalagmites from Zhashui County, Shaanxi Province, dividing the Holocene climate of the region into 18 distinct periods. The Laoguantai culture corresponds to the 16th period, characterized by "an initial rise followed by a decline, with an overall cold and humid climate." However, this cold and humid phase represents a relative climatic change within southern Shaanxi and does not

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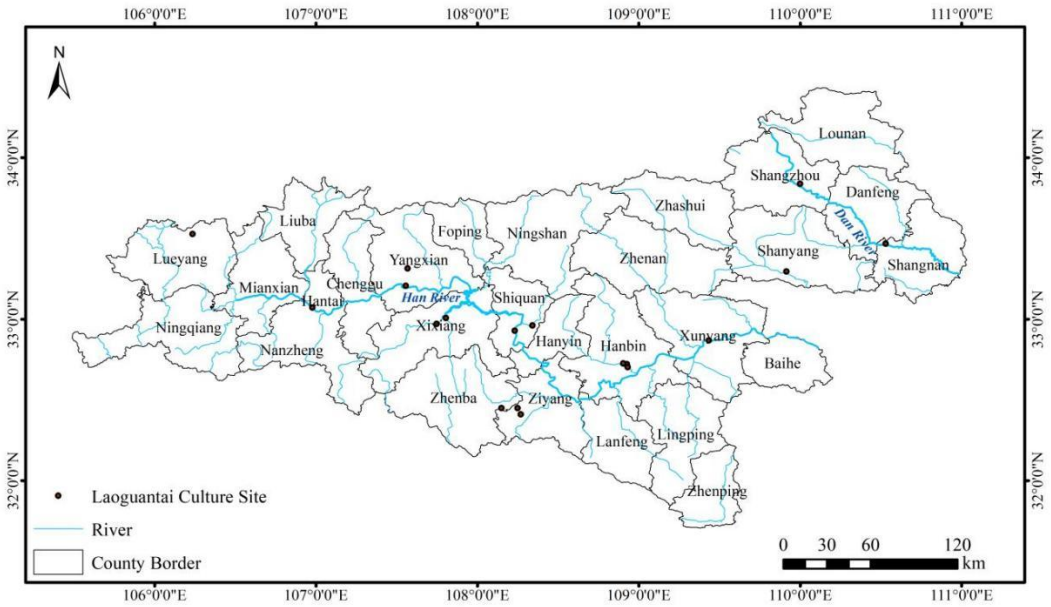
necessarily indicate temperatures lower than the average of the time (Wei, K. & R. Lin ,1994). It was under such climatic conditions that the distribution and characteristics of the Laoguantai culture in southern Shaanxi were determined.

The archaeological sites and remains of the Laoguantai Culture in southern Shaanxi exhibit a consistent spatial distribution pattern, predominantly situated on the first and second terraces of the Han River basin and its tributary valleys. These locations maintain close proximity to watercourses with minimal relative elevation, ensuring sufficient water supply. The distinctive "two mountains flanking a river valley" topography of southern Shaanxi imposed certain constraints on large-scale agricultural development, while simultaneously maintaining accessible distance from forested areas that retained substantial vegetation coverage during ancient times. Within this geomorphological context, the combination of red clay soils and fluvial deposits rich in organic humus enabled early inhabitants to practice agriculture using primitive stone tools. The adjacent river systems provided resources for fishing and mollusk harvesting, while the surrounding forests offered stable subsistence sources through hunting and gathering activities. Such environmental conditions constituted an optimal ecological niche for the development of Laoguantai Culture.

Geographically, the cultural distribution extends from the western bank of the Jialing River in the west to the upper reaches of the Dan River in the northeast, reaching southward to the present-day Ankang Reservoir (Figure 1-1). This spatial configuration reflects the formation of a human-land ecosystem complex adapted to specific environmental conditions during a defined chronological period. The southern boundary of Laoguantai Culture distribution not only demarcates the cultural sphere created by a specific prehistoric population but also represents the southernmost extension of the Neolithic cultural sequence in southern Shaanxi. This spatial pattern demonstrates how early human communities strategically utilized microenvironments characterized by transitional zones between mountainous terrain, alluvial plains, and riparian ecosystems.

Fig 1-1 Distribution of Settlement Scale of Laoguantai Culture Site in Southern Shaanxi Province



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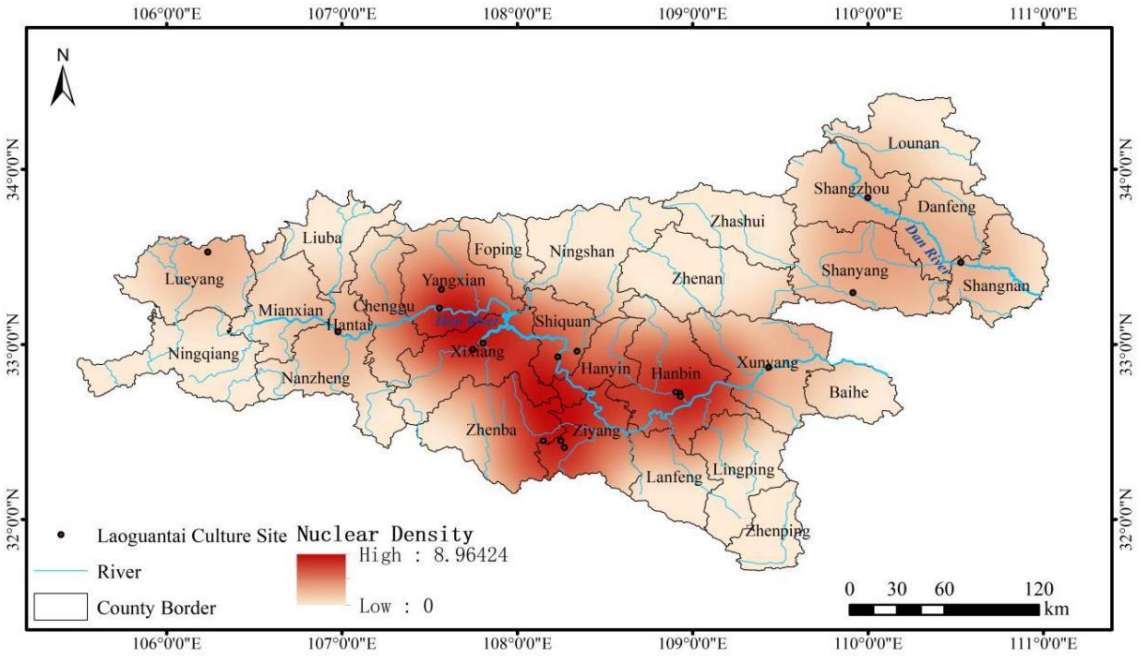
Regarding spatial distribution density, the Laoguantai Culture in southern Shaanxi demonstrates concentrated discoveries within the Han River corridor region, while exhibiting significantly sparser distribution in the upper Dan River basin (Figure 1-2). The author posits that while factors such as limited archaeological excavations and cultural diffusion patterns contribute to this distribution disparity, the fundamental determinant lies in the fluvial geomorphology of the upper Dan River. Originating from the southern foothills of the Qinling Mountains in northwestern Shangluo, the upper Dan River traverses mountainous terrain characterized by steep topography and limited basin resources. Its terraces formed through intermittent tectonic movements dominating mountainous orogeny, which transformed lateral river erosion into vertical incision processes (Qi C, 1984). These natural barriers inherently constrained cultural exchange and dissemination of the Laoguantai Culture, relegating the Shangluo region to peripheral status rather than a cultural core area.Archaeological manifestations of Laoguantai Culture in Shangluo include Phase I remains at the Zijing site, Liangjiawan site, and Houcun site. Although both Zijing Phase I and Lijiacun sites belong to the Laoguantai cultural complex, they exhibit distinct regional characteristics. The Zijing Phase I site represents a southern extension of the Guanzhong Laoguantai cultural sphere with localized variations, indicating its role as a southeastern expansion node of the Dadiwan cultural sphere into Shangluo (Liu, Y, 2019). Notably, the Houcun site along the Jinqian River tributary of the middle Han River yielded pottery fragments bearing Laoguantai cultural features, potentially serving as crucial evidence for investigating prehistoric connections between the Lijiacun Culture in the upper Han River and Laoguantai Culture in the upper Dan River basin (Zhou, X. & C. Wang, 1992).

Fig 1-2 Kernel Density Analysis of Laoguantai Cultural Settlement Sites in Southern Shaanxi Region



In summary, the combined effects of Qinling Mountain barriers and Dan River topography significantly restricted cultural dissemination, resulting in sparse site distribution

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across the upper Dan River region. This spatial pattern reflects the constraining influence of mountain-fluvial systems on Neolithic cultural expansion, while simultaneously highlighting adaptive strategies for cultural transmission along hydrological networks. A composite land-use patterns based on a hunter-gatherer economy, supplemented by primitive agriculture, was formed during the Laoguantai culture period in southern Shaanxi. This socioeconomic configuration can be attributed to the superior climatic environment during the climactic phase of the Holocene Megathermal Period. The spatial distribution of cultural remains, influenced by the region's overarching humid-cool microclimate, exhibited a broad dispersion pattern extending from the Jialing River basin to the Dan River basin. However, the Qinling Mountain range and Dan River system functioned as significant geographical barriers to cultural diffusion, resulting in a concentrated distribution of sites along the Han River corridor contrasted by sparse occupation in the upper Dan River basin. This dichotomy reflects the interplay between ecological advantages of alluvial corridors and the restrictive effects of mountainous topography on Neolithic cultural expansion.

Human-Environment Interactions during the Yangshao Cultural Period

Following the Laoguantai Culture, the Yangshao Culture emerged, with radiocarbon dating indicating a temporal range of 7000–4500 aBP(Zhang, X et al.,2013). Statistical analyses of archaeological reports and related studies reveal a marked increase in the number of Yangshao cultural sites within the study area compared to Laoguantai sites, accompanied by significantly expanded spatial distribution.

In southern Shaanxi, the Yangshao Culture comprises two distinct phases: the Banpo phase and the Miaodigou phase. According to Administration, N. C. H.(1998) and regional archaeological surveys, over 130 Yangshao cultural sites have been identified in the study area. Notably, large-scale settlement sites increased dramatically to 13, reflecting demographic expansion. Among these, 18 sites are definitively classified as Banpo phase, while 12 belong to the Miaodigou phase; the majority remain undifferentiated and are broadly categorized as Yangshao Culture .

Production tools from the Miaodigou phase have been documented at only six sites, these sites exhibit multi-phase cultural stratigraphy, often co-existing with Laoguantai Culture, Yangshao Banpo phase, and Longshan Culture layers. The Banpo and Miaodigou phases in southern Shaanxi, while chronologically distinct within the Yangshao cultural sequence, demonstrate minimal differentiation in climatic adaptation, tool typology, or subsistence strategies. Limited analytical data—particularly regarding environmental proxies and material culture variations—suggest that treating them as an integrated Yangshao cultural complex provides a more robust framework for examining human-environment interactions during this period. This unified approach accommodates the region’s cultural continuity while acknowledging subtle chronological developments in settlement patterns and resource utilization.

The Hejiawan site in Xixiang County, Hanzhong, serves as a representative example of the Yangshao Culture within the study area. Stratigraphic, typological, and radiocarbon dating analyses have confirmed a direct developmental relationship between the Lijiacun type of the Laoguantai Culture in the upper Han River basin and the Banpo type of the Yangshao Culture (Wei, J.,2014).

The Hejiawan site is situated in Hejiawan Village, Banqiao Township, Xixiang County, Shaanxi Province, located on the eastern margin of an intermontane basin within the Dabashan Mountains. It occupies the second terrace on the right bank of the Jingyang River,

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with geographical coordinates of 107°47′ E and 33°01′ N. The site extends 300 meters north-south and 150 meters east-west, covering a total area of 45,000 square meters.

While establishing a comprehensive chronological framework for the Yangshao Culture in southern Shaanxi remains challenging, the Hejiawan site provides valuable insights into the relationship between the Banpo and Miaodigou phases. The Banpo cultural layer at this site yielded 771 stone artifacts, predominantly polished tools, including 122 stone axes, 29 stone adzes, 12 stone spades, and 7 stone hoes. Additionally, 44 arrowheads (both stone and bone) and 3 bone fishhooks were recovered. In contrast, the Miaodigou cultural layer produced only 147 stone artifacts, primarily polished tools, with 40 stone axes, 21 adzes, 4 spades, 3 hoes, and 7 bone arrowheads. The tool assemblages from both phases indicate a subsistence economy centered on hunting and gathering, suggesting continuity in production modes throughout the Yangshao period (Archaeology, S. P. I. o. & S. A. H. S. R. A. A. Team,1994).

The Yangshao Culture represents a highly developed civilization, as evidenced by its architectural scale, ceramic craftsmanship, and stone and jade tool production. Despite this technological sophistication, the production tools from this period indicate that hunting and gathering remained the dominant economic activities, with primitive agriculture playing a supplementary role. This composite land-use strategy demonstrates that the natural conditions during the Yangshao period were at least as favorable as those of the preceding Laoguantai Culture. Such an environment enabled the support of a substantial population without relying heavily on agricultural development, highlighting the Yangshao people's exceptional utilization of natural resources.

The Yangshao Culture thrived during the climactic phase of the Holocene and its subsequent transition. In southern Shaanxi, the natural environment during this period was even more favorable than during the Laoguantai period. According to 18-stage climate classification of Li(2000), the Yangshao period corresponds to stages 12–15, characterized by a temperature shift from cold to warm, followed by cooling and gradual warming. Overall, temperatures were higher than in stage 16, with two distinct arid phases making the climate drier than in the preceding period. However, this relative aridity and warmth reflect regional climatic variations rather than absolute temperature increases. Cai et al. (2010) analyzed stalagmites from the Jiuxian Cave in Ankang, southern Shaanxi, revealing stable δ18O values between 9000 and 5000 aBP, consistent with Shi et al.'s (1992) proposed Holocene Optimum in central China, confirming favorable climatic conditions during this period.

Building upon the foundations of the Laoguantai Culture, the Yangshao period saw inevitable population growth due to human development and favorable environmental conditions. This demographic expansion led to a dramatic increase in settlement sites, with both spatial distribution and density far exceeding those of the Laoguantai Culture. However, the relatively arid climate and reduced river discharge in southern Shaanxi during this period constrained settlement patterns, concentrating Yangshao sites along the main river channels and larger tributaries. This distribution pattern is particularly evident in the Shangluo region, where only three Laoguantai sites (Liangjiawan, Houcun, and Zijing) have been identified, two of which are located in the upper Dan River basin.

During the Yangshao period, the combination of population growth and arid conditions posed significant challenges, particularly in the Dan River basin, which has the lowest discharge among Yangtze tributaries. The limited water resources in the upper Dan River could not sustain the growing population, necessitating migration along the river. This led to the eastward expansion of Yangshao sites to the middle Dan River basin, with some groups migrating northward to the upper Luo River, marking the northernmost extent of Yangshao cultural

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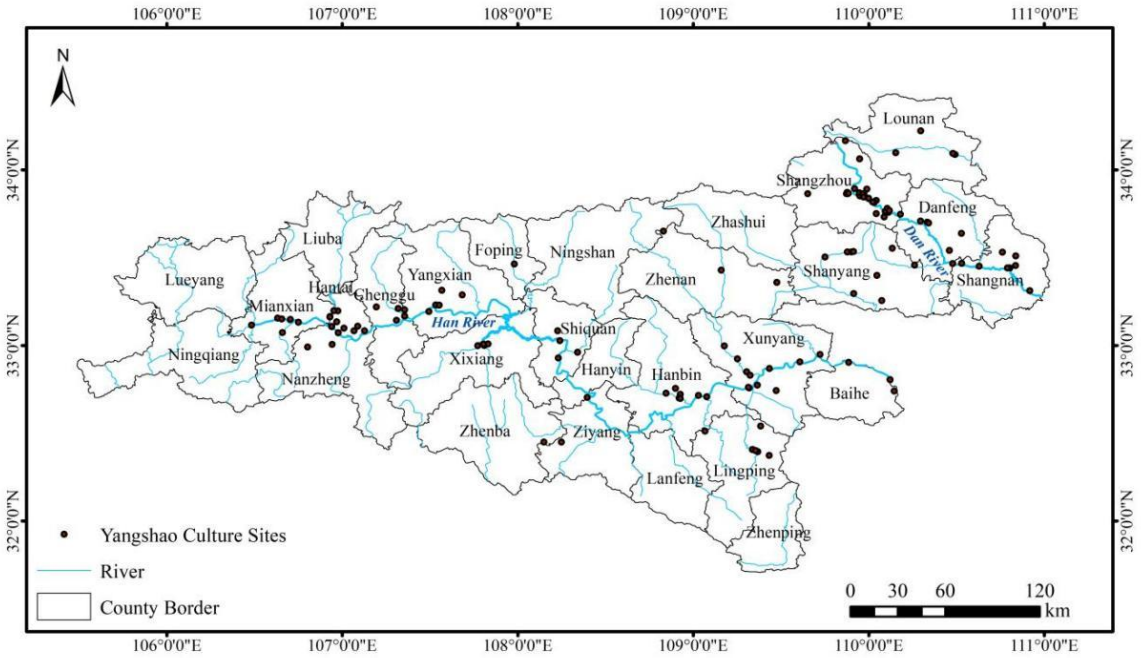
distribution in southern Shaanxi. Concurrently, the drying of some Jialing River tributaries caused a westward retreat of settlements toward the upper Han River (Figure 2-1).

Fig 2-1 Distribution of Yangshao culture site settlement size in southern Shaanxi Province



The kernel density map clearly illustrates that Yangshao cultural sites in southern Shaanxi exhibit a denser distribution in the upper Dan River basin compared to the more dispersed pattern observed in the Han River corridor (Figure 2-2). This spatial disparity arises from the extensive and interconnected nature of the Hanzhong and Ankang basins, which, despite hosting numerous sites, display a scattered distribution due to their vast area. In contrast, the Shangluo region, characterized by smaller and fewer basins, demonstrates a more concentrated site distribution. Furthermore, Shangluo served as a critical nexus connecting the Guanzhong Plain, western Henan, and the Jianghan Plain during this period. This strategic position is reflected in the profound cultural influences from these regions evident in Shangluo's Yangshao cultural remains (Liu, Y.,2019). The rapid increase in settlement sites, driven by intensified cultural exchanges, naturally resulted in a dense clustering within Shangluo's limited basin areas.

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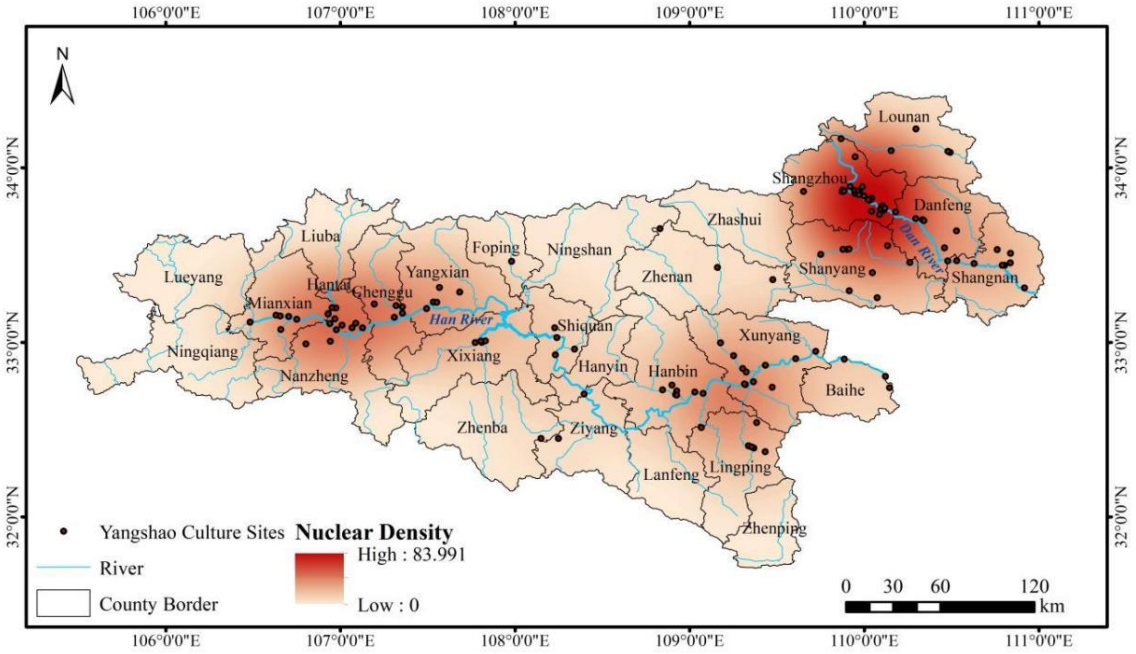
Fig 2-2 Kernel Density Analysis of Yangshao Culture Settlement Sites in Southern Shaanxi Province



In summary, a composite land-use patterns based on a hunter-gatherer economy, supplemented by primitive agriculture, was formed during the Yangshao Culture period in southern Shaanxi. However, site distribution was significantly influenced by regional microclimates. Under the overarching trend of warming and aridification, settlements gradually shifted eastward and expanded spatially. The development of productive forces during the Yangshao period, coupled with enhanced connectivity along the Dan River corridor, led to a rapid increase in site numbers. This growth resulted in a dense concentration of settlements within the confined basins of the upper Dan River, contrasting with the sparse distribution in the Han River corridor. This pattern underscores the Dan River basin's role as a vital cultural and economic conduit during the Yangshao period.

Human-earth relations in the Longshan culture period

The Longshan Culture, dating approximately to 4900–4000 aBP, is represented by 46 identified sites in southern Shaanxi. The majority of these sites (35) are concentrated in the Dan River basin, while only 11 are found in the Han River basin. Notably, no large-scale urban remains, jade artifacts, or bronze objects have been discovered in the Han River basin, suggesting a trend toward marginalization in the development of southern Shaanxi's Neolithic cultures following the Yangshao period (Liu & Wang, 2017). Compared to the Yangshao period, the number of settlement sites decreased by nearly two-thirds. Among the 44 sites with confirmed areas, the proportion of large settlements increased to approximately 15% (compared to about 10% during the Yangshao period), with nine sites exhibiting stratigraphic overlap with Yangshao settlements. This indicates continued development of settlements in southern Shaanxi during the Longshan period, particularly in the growth of large-scale settlements.

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The Zijing site is a representative Longshan cultural site in southern Shaanxi. Located approximately 7 km southeast of Shangzhou District, Shangluo City, it sits on the second terrace on the south bank of the Dan River, about 8 meters above the current river level, covering an area of approximately 100,000 m². The stratigraphic sequence at the site comprises seven layers, with five cultural phases, of which the third and fourth layers belong to the Longshan period(Library, S. C et al.,1981).

The Longshan cultural layer yielded abundant remains, including over 90 storage pits, two pottery kilns, and a rich assemblage of artifacts. Among the pottery, jars were the most numerous. The tool assemblage included over 150 stone knives, more than 70 stone axes and adzes, one stone hoe, 10 bone spades, and two bone fishhooks. Both the Zijing and Baimashi sites produced arrowheads, with a total of over 40 stone and bone arrowheads recovered (Library, S. C et al.,1981; Archaeology, S. P. I. o. & S. A. H. S. R. A. A. Team,1994). Longshan production tools were primarily made of stone and bone, with polished stone tools dominating the assemblage. Tool types included axes, spades, adzes, knives, and hoes. Notably, the proportion of agricultural tools such as hoes and spades decreased further compared to earlier periods.

As a late Neolithic culture, the Longshan period is generally characterized by settled lifestyles and significant agricultural development, which is presumed to have dominated the subsistence economy. However, evidence from the Zijing site suggests a different pattern of survival strategies among its inhabitants. Overall, the proportion and quantity of agricultural tools in the Longshan Culture are lower than those of the Yangshao Culture, indicating a relatively underdeveloped agricultural system, at least in comparison to the preceding Yangshao period. In contrast, the discovery of hunting and fishing tools, such as arrowheads and fishhooks, along with a substantial number of stone knives, points to significant advancements in hunting and fishing activities. These findings suggest that hunting and fishing played an increasingly important role in the economic structure of the Longshan Culture in southern Shaanxi. Notably, the stone knives were likely used for processing game rather than harvesting crops, further emphasizing the reliance on hunting.

The natural environment during the Longshan period was less favorable compared to the peak of the Holocene Megathermal Period around 5000 aBP. The northern edge of monsoon precipitation shifted southward, causing the agricultural boundary to retreat by one latitude. However, the impact on southern Shaanxi was relatively minor. Temperatures remained approximately 3°C higher than modern levels, and much of China continued to experience warmer and more humid conditions. For instance, Asian elephants, now restricted to tropical regions, were able to survive as far north as 41°N in Yangyuan, Hebei. Pollen data from multiple sites, including Gushantun west of Changbai Mountain, Qingfeng in Jianhu, Jiangsu, and Luojishan in Sichuan, indicate that the vegetation characteristics of the Megathermal Period persisted until around 3000 aBP before gradually declining (Shi et al., 1992).

Within southern Shaanxi, the Longshan Culture corresponds to climate stages 10–12 of the 18-stage classification, a period marked by increasing aridity and rising temperatures, representing an extremely hot and dry phase (Li, H.-C., et al.,2000). This is further supported by Cai et al's(2010) analysis of stalagmites from the Jiuxian Cave in Ankang, southern Shaanxi, which revealed a significant increase in δ18O values between 4500 and 2500 aBP, accompanied by centennial-scale oscillations, indicating a decline in summer monsoon precipitation in central China . Similarly, Tan et al.'s(2018) high-resolution δ18O records from four stalagmites in the Xianglong Cave on the southern slope of the Qinling Mountains documented a reduction

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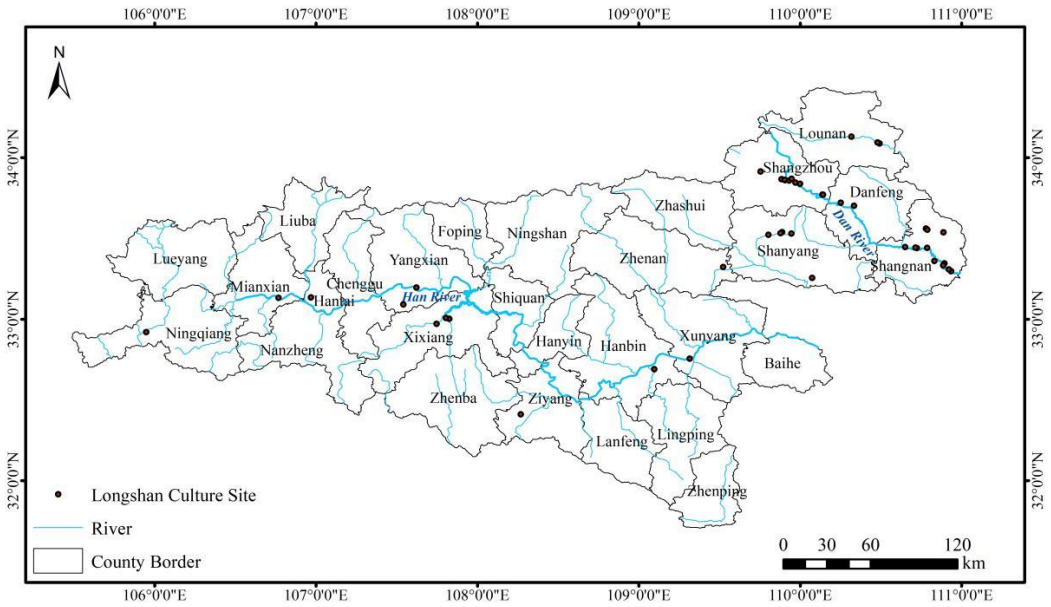
in monsoon precipitation between 5800 and 4900 aBP, corroborating the regional climatic trends.

Many Longshan cultural sites in southern Shaanxi exhibit stratigraphic overlap with earlier Laoguantai and Yangshao cultural layers, suggesting that the region remained suitable for human habitation and development. However, agricultural productivity appears to have declined during this period. The reduced number of Longshan sites implies a decrease in settled populations. Precipitation is a critical factor for agricultural production, and the increasing aridity within southern Shaanxi, despite the absence of significant changes in the broader natural environment, likely hindered agricultural development. Under these conditions, coupled with a decline in settled populations, there was less reliance on agriculture to provide additional food supplies. Consequently, the economic structure of the Longshan period continued to emphasize hunting and fishing as the primary subsistence patterns, with agriculture playing only a supplementary role.

The distribution of Longshan cultural sites in southern Shaanxi (Figure 3-1) reflects the impact of climatic aridity and reduced river discharge. The number of riverine settlements decreased significantly, a trend that, while partially attributable to the limited scope of archaeological discoveries (Ma, M., et al.,2018), clearly demonstrates the influence of regional microclimatic changes on settlement patterns. This is particularly evident in the Han River basin. As the largest tributary of the Yangtze River, the Han River historically supported high population densities. However, during the Longshan period, increasing aridity reduced the water resource capacity per unit area, leading to a decline in settlements to only 11 sites, with greater distances between them. Some populations migrated westward, expanding Longshan cultural distribution to the eastern bank of the Jialing River. In the south, the number of sites decreased to just one, while the northern boundary retreated to the southern bank of the Luo River, with a corresponding reduction in site numbers. Although the eastern boundary remained in the middle reaches of the Dan River, the number of sites also declined.

Fig 3-1 Distribution of Longshan Culture Site Settlement Scale in Southern Shaanxi Province



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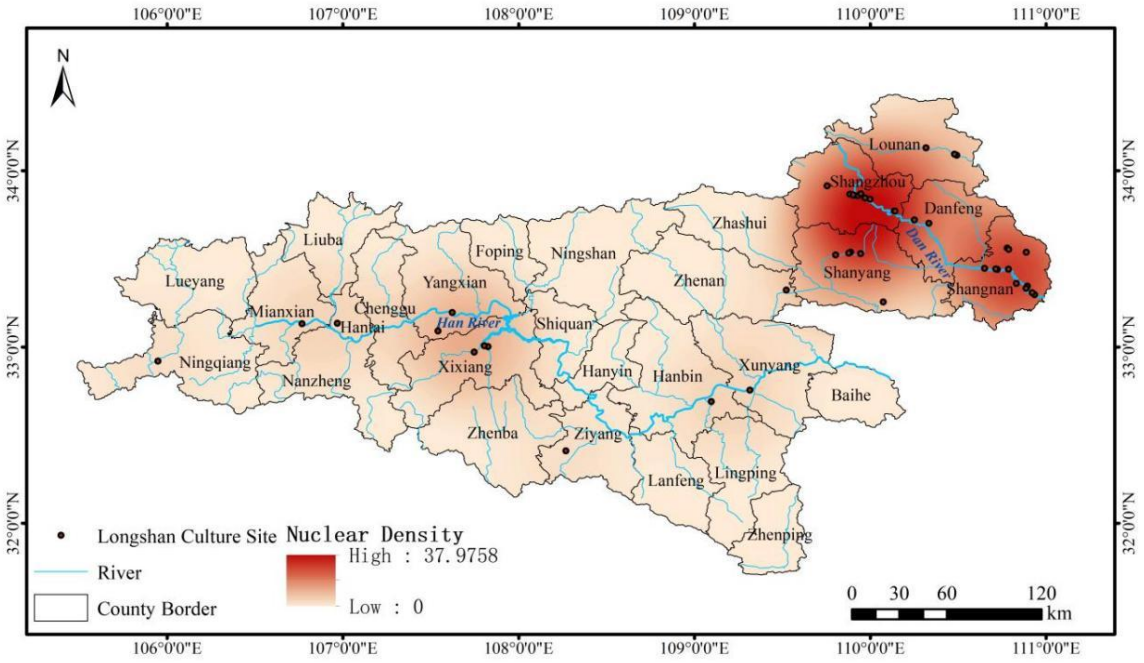
The kernel density map (Figure 3-2) reveals that the settlement density distribution in southern Shaanxi during this period continued the pattern established in the Yangshao period, with concentrations in the upper Dan River basin. Compared to the Han River corridor, Longshan cultural sites in this area exhibit richer cultural content.

Fig 3-2 Kernel Density Analysis of Longshan Culture Settlement Sites in Southern Shaanxi Region



The Longshan Culture, primarily distributed in the middle and lower reaches of the Yellow River basin, exerted significant influence on the Shangluo region. This is evidenced by the coexistence of multiple cultural phenomena within individual sites, a characteristic further supported by the geographical distribution of sites and their cultural connections with surrounding regions (Liu, Y., 2019). Additionally, the upper Han River experienced a floodplain flood around 4290±90 a BP and a super flood between 4390 and 3800 a BP (Tan, et al,2018), which directly impacted the density distribution of settlements. The penetration, dissemination, and integration of prehistoric cultures in the upper Dan River basin, the intermingling of diverse cultural groups, and the aforementioned geographical and natural disaster factors collectively shaped the density distribution of Longshan cultural sites in southern Shaanxi.

In summary, the tool assemblages from Longshan sites indicate that hunting and gathering remained the dominant economic activities in southern Shaanxi, with primitive agriculture playing a supplementary role. This suggests that while the broader Holocene climate was less favorable, its impact on southern Shaanxi was minimal, with no significant overall climatic changes. However, the increasing aridity and warmth of the regional microclimate led to a reduction in the number of sites and an expansion of intervals between them, with the distribution range receding to the Jialing River basin. The density distribution during this period thus inherited the pattern established during the Yangshao period.

Conclusion

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This study explores the human-environment interactions in southern Shaanxi during the Neolithic period, focusing on settlement patterns, tool assemblages, land-use strategies, cultural distribution, and the evolution of the local natural environment. The results reveal consistent characteristics in land-use practices across various archaeological cultures in the region, with cultural distribution influenced by climatic changes and settlement density shaped by geographical factors.

Under conditions of relatively stable overall environmental changes, the forms of production tools and land-use strategies within each culture showed no significant variation. Specifically, all cultures maintained a composite land-use system dominated by hunting and gathering, supplemented by primitive agriculture. However, shifts in regional microclimates influenced the distribution of these archaeological cultures, while geographical factors determined their settlement densities.

In summary, as a region situated along the Qin-Huai Line, the climatic boundary between northern and southern China, southern Shaanxi serves as a critical area for studying how global and regional environmental changes have impacted human societies and how humans have adapted to these changes. The use of ArcGIS to create settlement scale maps and kernel density analysis maps provides valuable insights with significant academic implications. Research on the evolution of human-environment relationships in southern Shaanxi contributes to the broader investigation of the origins of Chinese civilization and culture.

Southern Shaanxi, as a microcosm of global climatic studies, offers a unique perspective on the dynamic interactions between ancient humans and their environment. This study aids in reconstructing the survival strategies and lifestyles of ancient populations, providing historical insights into how humans adapted to and transformed their environment along the climatic boundary between northern and southern China. By examining local patterns within a global context, this research enhances our understanding of the complex interplay between climate, geography, and human cultural development during the Neolithic period.

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