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Analysis of Settlement Patterns of Chalcolithic Sites in Eslamabad-e Gharb Using GIS Models

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ABSTRACT

The Chalcolithic period is one of the significant prehistoric phases in Iran, emerging as a continuation of Neolithic developments. The Central Zagros, particularly the Eslamabad-e Gharb Plain in western Kermanshah, contains numerous Chalcolithic settlements. Despite the cultural richness of this region during the Chalcolithic, no systematic study has been conducted to clarify the status of its settlements from this period. This research seeks to answer the following questions: What were the settlement patterns of the Eslamabad-e Gharb Plain during the Chalcolithic? How can the changes in settlement patterns across the Early, Middle, and Late Chalcolithic phases be analyzed? It appears that several factors, including water resources, elevation above the plain, and communication routes, influenced the formation of settlements in this region during the Chalcolithic. Surveys and studies conducted in this plain have identified 65 archaeological sites associated with the Chalcolithic period. Some of these sites contain evidence from all three phases: Early, Middle, and Late Chalcolithic. The spatial data collected in this study were analyzed using Geographic Information System (GIS) methodologies and processed in ArcGIS software. The analysis was based on the distance of each settlement from the nearest river or water source, its elevation relative to the Islamabad Plain, and other influential factors. All sites were incorporated into analytical maps, which were generated for each of the three Chalcolithic phases in the Islamabad Plain.

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Introduction

The study of ancient societies within their environmental context dates back to the emergence of modern archaeology between the 1940s and 1960s. Settlement pattern studies have since played a crucial role in understanding how human groups organized themselves concerning environmental resources and energy acquisition. This approach is central to processual archaeology, pioneered by scholars like Gordon Willey, who emphasized the importance of settlement pattern analysis in comprehending population changes and human activities within landscapes (Willey, 1953). By mapping and analyzing archaeological sites, researchers can identify shifts in settlement distribution over time, offering insights into cultural evolution and adaptation (Schreiber, 1996; Feinman, 2015).

The central Zagros region, particularly the Islamabad Plain in western Kermanshah, is a key area for studying settlement patterns during the Chalcolithic period. This region has long been recognized for its rich archaeological record, shaped by its unique topography, intermountain plains, and abundant water sources. The area's strategic position along ancient trade and migration routes made it an attractive location for human settlements throughout prehistory. Despite the wealth of archaeological data, systematic studies focusing on the Chalcolithic settlement patterns in this region remain scarce.

This study seeks to address this gap by investigating settlement distribution in the Islamabad Plain during the Chalcolithic period. Key research questions include: What were the settlement patterns of the Islamabad Plain during this era? How did these patterns change across the Early, Middle, and Late Chalcolithic phases? It is hypothesized that factors such as proximity to water sources, elevation, and connectivity to trade routes played a significant role in settlement distribution. Utilizing spatial analysis techniques within a Geographic Information System (GIS) framework, this study examines 65 identified Chalcolithic sites in the region to assess these variables and their influence on settlement choices over time. The findings contribute to broader discussions on cultural development and human-environment interactions in prehistoric Iran.

Literature Review

The Central Zagros is one of the most significant archaeological regions in Iran, recognized as an early center for animal and plant domestication. Systematic research in this area began with the Prehistoric Project of Western Iran, led by Robert Braidwood (Braidwood, 1960a,b; Braidwood *et al.*, 1961). Between 1956 and 1961, Braidwood's team conducted excavations at key sites such as Tepe Sarab, Asiab, and Morian. During this period, a subgroup led by Bruce Howe carried out Paleolithic studies in the caves of Mount Peraw and the Warwasi rock shelter.

In the 1970s, further research was undertaken in western Iran. Louis Levine, the director of the Prehistoric Project of Mahidasht, excavated sites such as Choghamaran and Siahbid between 1978 and 1979 (Levine & McDonald, 1977). Around the same time, Thomas Cuyler Young, along with a team that included Philip Smith and Levine, conducted surveys in the plains of Borujerd, Malayer, Nahavand, and Kangavar (Young, 1966). Subsequently, extensive excavations were carried out at Godin Tepe by the University of Ontario, and Levine initiated excavations at Seh Gabi to establish the cultural sequence preceding Godin VII (Levine, 1974).

In 1975, Young and Mehdi Rahbar conducted surveys in the Kangavar Plain (Young, 1975). Early archaeological investigations in the Central Zagros date back to the early 20th century when Ghirshman and Contenau excavated Giyan Tepe between 1931 and 1932. Later, in 1961, Rosalind Howell conducted surveys in the Malayer plain (Howell, 1979). Additionally, significant research on the Chalcolithic period in the Central Zagros has been carried out by scholars such as Goff, Levine, Young, Mortensen, and Abdi, with Elizabeth Henrickson's contributions in the Mahidasht Archaeological Project being particularly noteworthy (Henrickson, 1991).

In Islamabad Plain, the earliest known surveys were conducted by E. F. Schmidt in 1936, including aerial photography of Chogha Gawaneh. Around the same time, Sir Aurel Stein also carried out brief surveys in the area (Stein, 1940). In the 1990s, Kamyar Abdi conducted extensive surveys across Islamabad, Mahidasht, Hassanabad, and surrounding areas, highlighting the region's strategic role in nomadic pastoralist movements (Abdi, 1999).

In 1998, the Islamabad Archaeological Project was launched with the aim of identifying and recording archaeological sites, establishing ceramic sequences, and analyzing settlement patterns. The project included three phases of surveys and excavations at Islamabad Plain, Chogha Gawaneh, Tuw-e Khoshkeh, and Warwasi Cave, providing crucial data on the Pleistocene, Neolithic, and Chalcolithic periods (Abdi *et al.*, 2002).

Methodology

This research employs a spatial analysis approach to investigate Chalcolithic settlement patterns in the Islamabad Plain. The study is based on archaeological survey data collected through systematic field reconnaissance, which identified 65 sites dating to different phases of the Chalcolithic period. The primary method of analysis involves GIS-based spatial modeling to evaluate key environmental and locational factors influencing site distribution.

The study integrates multiple variables, including distance to water sources, elevation, and proximity to trade routes. These factors are analyzed using ArcGIS software, allowing for the visualization and statistical examination of settlement distribution trends. Each site is georeferenced and incorporated into analytical maps representing the Early, Middle, and Late Chalcolithic phases. The analysis follows a comparative approach, assessing how settlement patterns evolved across the three sub-periods. This includes identifying clusters of habitation, examining shifts in site density, and correlating settlement locations with ecological and economic factors. The goal is to determine whether settlement patterns were primarily dictated by environmental constraints or influenced by broader socio-cultural dynamics.

Using GIS-based spatial analysis, this research provides a systematic and quantitative assessment of Chalcolithic settlement organization in the Islamabad Plain, contributing to a more comprehensive understanding of prehistoric human adaptation in the central Zagros region.

Discussion

Various environmental and socio-economic factors influence the spatial distribution of archaeological settlements. In the case of the Chalcolithic settlements in the Islamabad Plain, western Iran, elevation, proximity to water sources, and communication routes played crucial roles in shaping settlement patterns. This study aims to analyze these factors by examining settlement distributions from the Early, Middle, and Late Chalcolithic periods.

Elevation and Settlement Distribution

Elevation has always been a determining factor in human settlement patterns, influencing access to resources, climate conditions, and agricultural potential. In the Islamabad Plain, the settlement distribution across different elevation bands reveals a preference for lower altitudes. The study area is divided into six elevation categories: 1200–1300 m, 1300–1400 m, 1400–1500 m, 1500–1600 m, and 1600–1700 m (Figs. 1, 2, 3).

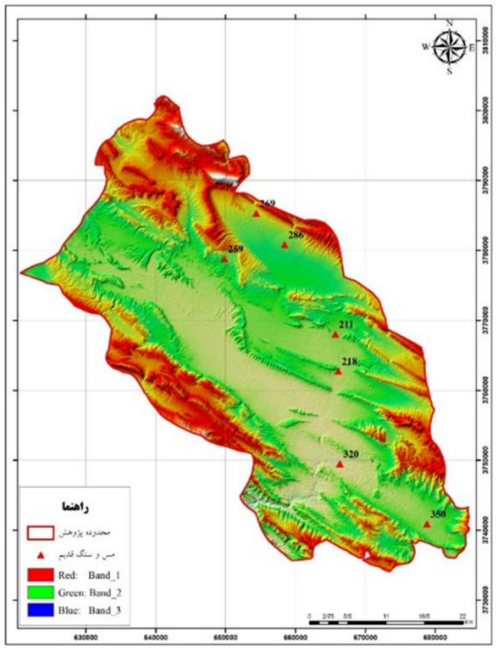

Figure 1: Elevation above sea level of Early Chalcolithic sites.

During the Early Chalcolithic period, settlements were mainly concentrated in the eastern part of the plain, ranging in elevation from 1296 m to 1562 m. The number of settlements decreases as elevation increases, and no sites were found above 1600 m. This suggests that the inhabitants preferred the lower, more fertile areas suitable for pastoral activities and early agriculture. In the Middle Chalcolithic period, settlements became more widely dispersed across the plain, ranging from 1294 m to 1725 m. However, the general trend of decreasing settlement numbers at higher elevations persisted. Similarly, in the Late

Chalcolithic period, settlements were distributed between 1343 m and 1713 m, with only one site found above 1700 m. These patterns indicate a continued preference for lower elevations throughout the Chalcolithic period, reflecting environmental constraints and subsistence strategies.

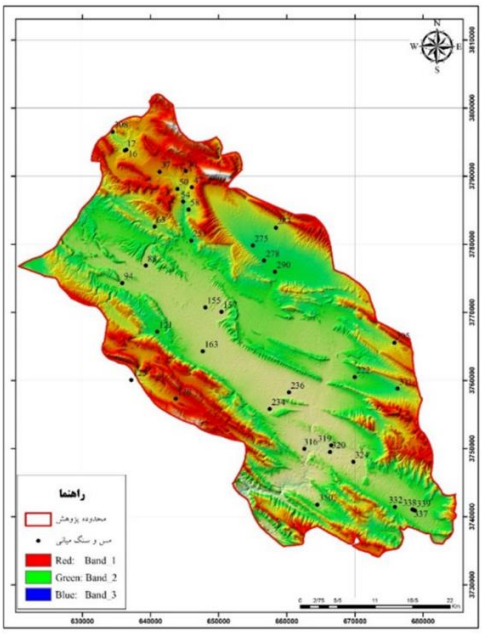

Figure 2: Elevation above sea level of Middle Chalcolithic sites.

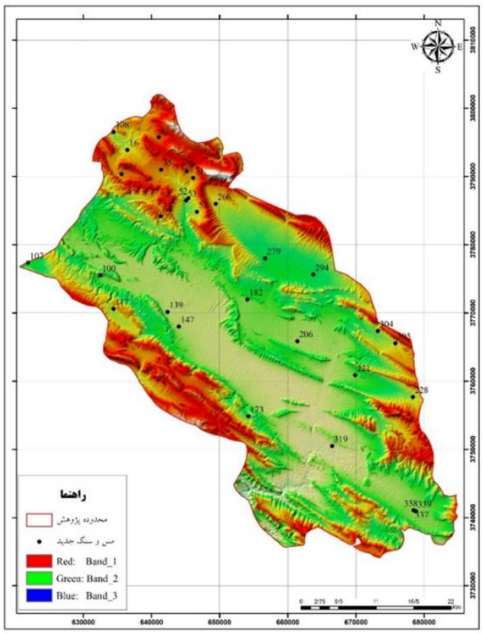

Figure 3: Elevation above sea level of Late Chalcolithic sites.

Proximity to Communication Routes

Transportation and trade networks have historically played an essential role in shaping settlement locations. The distribution of Chalcolithic sites in the Islamabad Plain suggests a strong correlation between settlements and ancient communication routes. In the Early Chalcolithic period, more than 50% of identified settlements were located within 1 km of known ancient routes. This suggests that mobility and trade were significant factors in site selection. The Middle Chalcolithic period saw a slightly different pattern, with settlements positioned in relation to natural passes through the surrounding mountains.

Only 5 out of 38 identified sites were located more than 5 km from these primary routes, indicating that connectivity remained a critical factor. In the Late Chalcolithic period, 18 out of 30 settlements were within 3 km of established trade routes. The observed pattern suggests that proximity to transportation networks continued to influence settlement decisions as communities relied on these routes for trade, resource distribution, and social interactions.

Access to Water Resources

Water availability is one of the most crucial determinants of settlement sustainability. The Islamabad Plain is characterized by a network of permanent and seasonal water sources, which significantly influenced settlement distribution. In the Early Chalcolithic period, a classification of site proximity to water sources revealed that 71% of settlements were within 500 m of a river. This highlights the critical role of water access in site selection, particularly in an era when irrigation technology was limited. The Middle Chalcolithic period continued this trend, with most settlements located near permanent water sources, though some sites were positioned at greater distances, possibly relying on now-vanished springs or seasonal watercourses (Figs. 4, 5, 6). During the Late Chalcolithic period, 15 out of 30 settlements were within 500 m of a water source, further supporting the hypothesis that settlements were predominantly established in locations with reliable water access. However, a few settlements were situated farther from known water sources, which could be attributed to environmental changes, the presence of ancient wells, or other now-extinct water management systems.

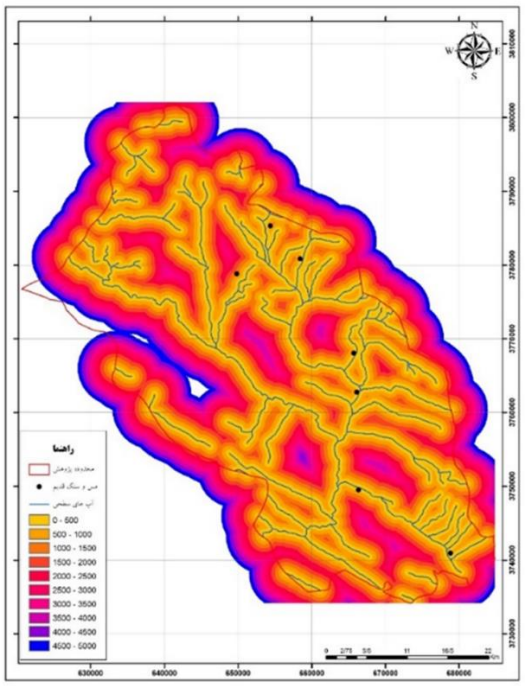

Figure 4: Location of Early Chalcolithic sites in relation to surface water sources.

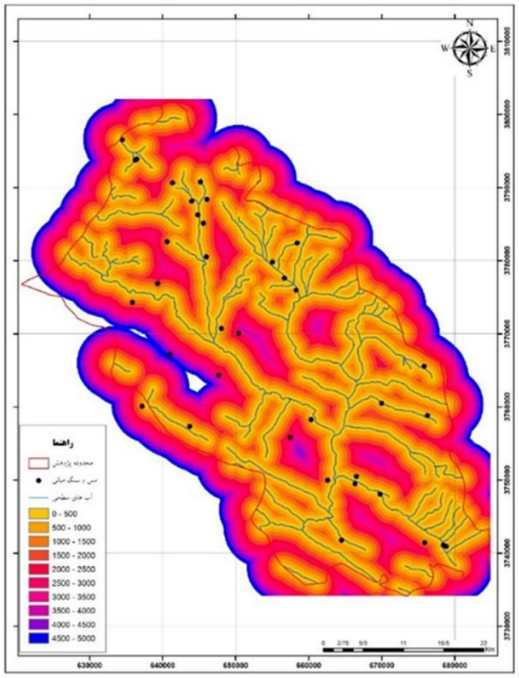

Figure 5: Location of Middle Chalcolithic sites in relation to surface water sources.

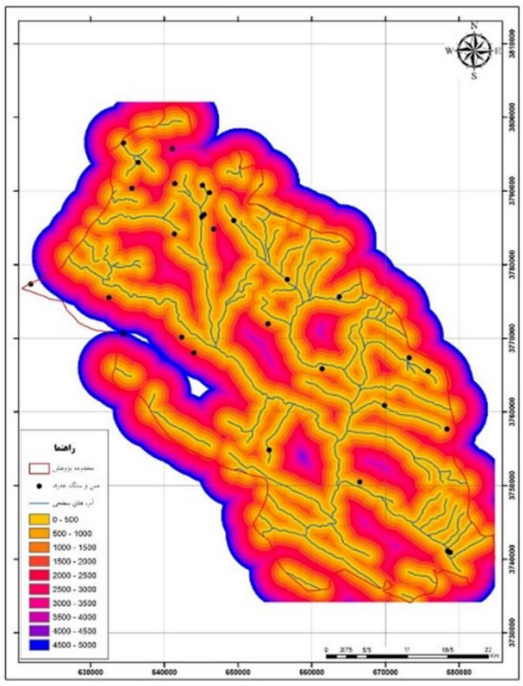

Figure 6: Location of Late Chalcolithic sites in relation to surface water sources.

Summary

The distribution of Chalcolithic settlements on the Islamabad Plain reflects a clear preference for lower elevations, proximity to trade routes, and access to water resources. These factors collectively influenced human habitation patterns, shaping the economic and social structures of Chalcolithic communities. The preference for lower elevations suggests a reliance on agriculture and pastoralism, which were more viable in these areas due to favorable climatic conditions and fertile soils. The strong correlation between settlements and communication routes highlights the importance of trade and mobility in Chalcolithic societies. Finally, the concentration of settlements near water sources confirms the fundamental role of water availability in sustaining human communities.

The findings of this study contribute to broader discussions on settlement archaeology in the Zagros region, emphasizing the interaction between environmental constraints and human adaptive strategies. Further research incorporating paleoenvironmental studies and GIS-based spatial analyses could provide deeper insights into the long-term settlement dynamics of the region.

Conclusion

Archaeological studies in the Central Zagros, particularly in the Eslamabad-e Gharb region, indicate that this area played a crucial role in the transformations of prehistoric societies due to its geographical location, natural resources, and communication routes. From the Chalcolithic period, permanent settlements, agricultural and pastoral developments, and extensive trade networks emerged, establishing significant interactions with Mesopotamia. The analysis of regional pottery reveals cultural exchanges between Mesopotamia and the Zagros, as evidenced by the presence of J Ware, Dalma-Ubaid, and buff ceramics with black motifs, reflecting the influence of neighboring cultures.

Settlement pattern analyses suggest that archaeological sites were predominantly located near water sources and communication routes, which played a vital role in subsistence strategies and cultural development. Certain sites, such as Chogha Gawaneh, provide evidence of long-term occupation, while shifts in subsistence patterns during the late Middle Chalcolithic indicate a decline in some settlements. Extensive research, including studies by Braidwood, Abdi, and Razmpoosh, has provided valuable insights into the region's chronology and cultural interactions. However, further investigations are needed to better understand Eslamabad-e Gharb's role in prehistoric trade and cultural networks. Given its strategic location along key communication routes, this region has consistently been engaged in interactions with neighboring societies, significantly contributing to the formation of Iran's prehistoric cultures.

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