



Review Article

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Prehistoric Water Resources Management: Based on Evidence from Tepe Damghani, Sabzevar Plain, Northeastern Iran

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Abstract

Tepe Damghani is a prehistoric settlement in the northeast of Iran on the outskirts of the modern city of Sabzevar, which is formed in the desert margin ecosystem (36° 11' 57"N, 57° 42' 26"E). Ecological constraints in this area during Chalcolithic and Bronze Age have made human settlements dependent on water flows almost constant. Thus, all prehistoric settlements identified in this ecosystem have been formed near these streams and on their alluvial fans for easy access to water and soil suitable for drinking, agriculture, pottery etc. Therefore, human settlements have always interacted with these water flows, due to climatic constraints and high dependence on valuable water resources in this ecosystem. This has led to the identification of evidence of management and control of water resources in the form of various structures in the Chalcolithic and Bronze Age in the Tepe Damghani, which is interesting in its kind.

Keywords: Sabzevar plain, Tepe Damghani, Chalcolithic and Bronze Age, Water resources management, earthen-mud bricks dam

Introduction

Sabzevar plain in northeastern Iran is a desert margin ecosystem that in the Chalcolithic and Bronze Age, flowed only two almost permanent streams, Kal Eidgah and Geliyan Flows in the east and west Fouache et al., [1]. Based on archaeological surveys, all prehistoric sites have been identified due to ecological constraints

along these two streams Sabori et al., [2]. Tepe Damghani is a large settlement in the southern plain of Sabzevar, which is located next to Kal Eidgah and on its alluvial fan (Figures 1 & 2). This site was first surveyed in 2003 Garazhian & Papoli [3] and excavated on a small scale by the Joint Iranian-French Archaeological Commission in 2008 Vahdati & Frankfort [4].

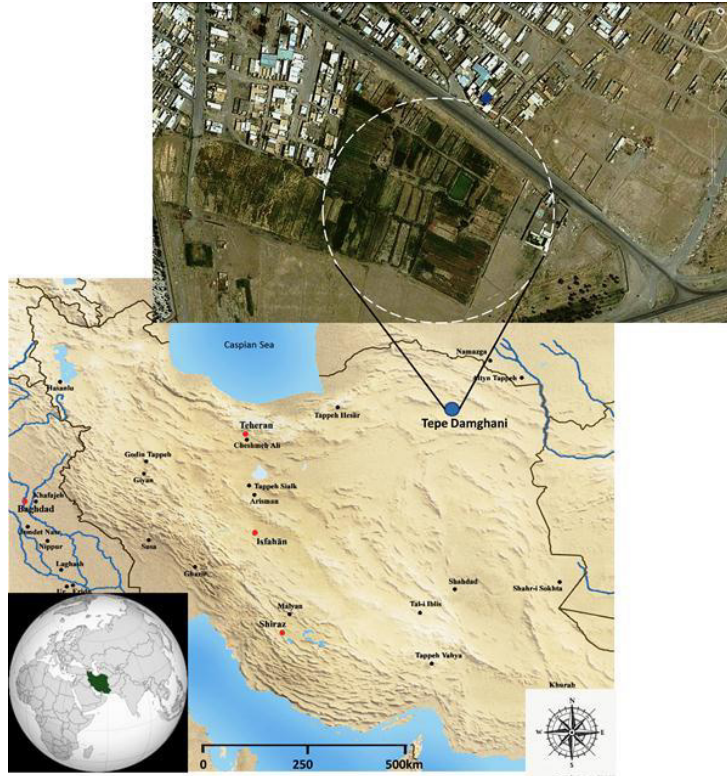


Figure 1: Location of Tepe Damghani in northeastern Iran (Figure by authors).

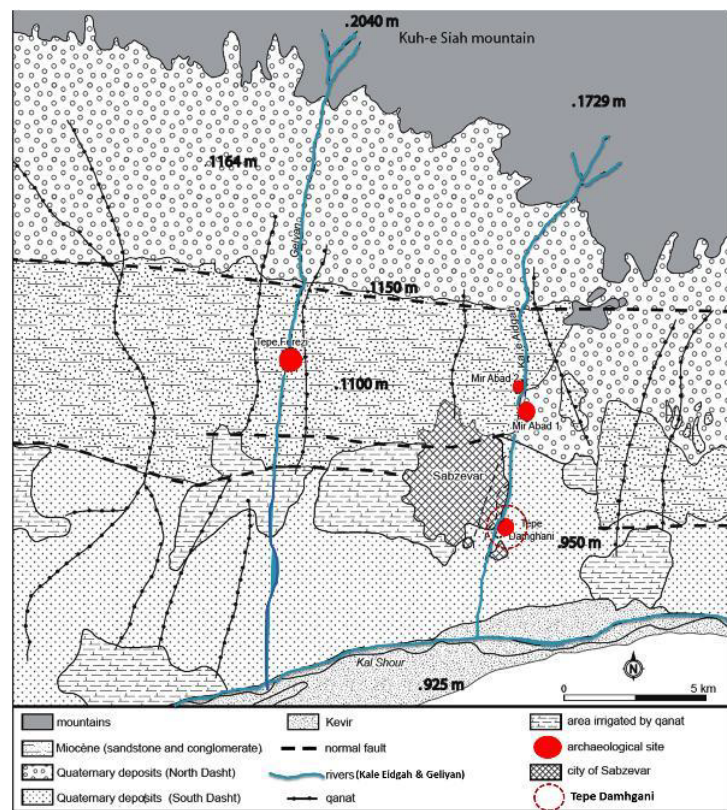


Figure 2: Geological conditions, location of two main waterflows in Sabzevar plain and settlement pattern of prehistoric sites(Figure by Fouache et al., 2010 Fig.2).

Due to the importance and richness of cultural data, in 2012 and 2015, with the aim of evaluation to create an open-air museum, Extensive archaeological excavations were carried out at the site Garazhian [5]; Garazhian [6]. Based on these excavations were identified architectural structures, burials and cultural materials related to the Late Neolithic, Chalcolithic, Bronze, Iron age and Historical periods (5th millennium to the first millennium BC)

(Figure 3). During archeological excavations, significant findings were identified that are structures related to control and water resource management in the Late Chalcolithic and Early Bronze Age. In fact, the purpose of this article is study these structures in order to better understand the management of natural resources in prehistoric period.



Figure 3: A number of significant objects obtained from the archeological excavations of Tepe Damghani related to Chalcolithic and Bronze Age (photograph by authors).

Methodologies and Instrumentation

The existence of earthen-mud brick dams in older periods in arid and semi-arid regions of Iran and the Middle East has also been identified Hadian Dehkordi et al., [7], Arab Khederi and Hakim Khani [8], Akbari et al., [9]. However, the limitation of identifying the remains of such structures if they were built with soil accumulation is a fundamental limitation in prehistoric studies and requires detailed studies with the cooperation of interdisciplinary experts

Morgenstein & Redmount [10], Trzciński et al., [11]. It is important to mention that in relation to the research method, in addition to using the in-depth and at the same time relative method, due to the lack of written sources from pre-history, the extensive archeological landscape method has been used to complete the reconstructions and basic knowledge beyond the settlement scale Buttzer [12], Stafford [13], Ashmore & Knap [14], Anschuetz et al., [15], Hehl-Lange [16]; Niknami [17].

Results and Discussion, Water Resources Management Structures



Figure 4: Earthen-mud Brick dam structures identified in the north of Tepe Damghani along the Kale Eidgah flow route to control and direct it in the Late Chalcolithic and Early Bronze Age(photograph by N.Bayani).

Archaeological excavation in Tepe Damghani was done in three separate parts: Northern, Central and Southern part. The oldest information has been identified from the northern part, which is related to the Chalcolithic and Bronze Age. According to archeological excavations, the Kale Eidgah stream flowed through the northern edge of Tepe Damghani in prehistoric period. Based on archaeological excavations at the northern edge of the site, revealed large structures of irregular earthen-mud bricks dam (Figure 4). The effects of erosion and remnants of river sediments on these mud bricks show that this dam-like structure was created in order

to control and direct the Kale Eidgah at the Late Chalcolithic and Early Bronze Age (4th millennium BC). These mud bricks are made of local materials and are made using local soil and even sediments around the river, using primary molds and sand temper and dried in the sun. The average size of these mud bricks is $14\text{-}9 \times 24\text{-}20 \times 47\text{-}40$ cm. Of course, it seems that the standard dimensions of these mud bricks are $10 \times 24 \times 42$ cm, which in some cases have become slightly smaller and larger. In some cases, have been used half-bricks with dimensions of $10 \times 24 \times 24$ cm (Figure 5).



Figure 5: The identified structure related to water control and management inside residential and settlement spaces in the south of Tepe Damghani (Photograph by N. Bayani).

The question may arise that the use of mud bricks in the construction of water structures is not very common. So how and for what purpose were these materials used in the mentioned periods? Certainly the first logical reason is the use of local and available materials, but more importantly, the type of soil and its compositions that have been used consciously or unconsciously by the Chalcolithic and Bronze Age communities. In fact, this part of the Sabzevar plain, due to its proximity to the Kale Shur river as well as the underground aquifers of saline water, has soil with special compounds that become saline over time and do not dissolve in water. This factor makes this type of soil more impermeable to water. It seems that these communities over time and repeated experiences, recognizing such potentials of the environment, have used it to deal with natural hazards.

Conclusion

According to the obtained evidence, what is certain is that not only mud brick has many different functions in the settlements of dry areas, including Damghani, but also the surface water stored at the level of the settlement for various exploitations, including conditioning the settlement space, drinking, animal husbandry and of course, agriculture and industrial applications have been used (Watanabe et al., [18], Kalantari et al., [19], Khora Sanizadeh [20], Tao et al., [21], Anabestani [22], Ayoob et al., [23], Aristeidis & Dimitrios [24]).

To date, little information is available on water resource management in prehistoric Middle Eastern settlements. Evidence obtained from Tepe Damghani is the product of human interaction

with ecological constraints and excessive dependence on water for survival. By changing the riverbed and moving it, settlements were also relocated and inevitably, in order to manage and control water flows in order to make the best use of these resources, they have made innovations that are significant in their time scale. In general, in Tepe Damghani in the 5th and 4th millennium BC, we are faced with an advanced collection of water management technology (Figure 6). By constructing a flood barrier and a large earthen-mud brick dam in the north of the Tepe Damghani in along the Kal Eidgah flow, they directed the water flow to the settlement spaces in the south of the site and transferred it to the residential spaces by sloping and purposeful leveling. This level of development in relation to water resources management technology seems to be due to human adaptation to hard environmental conditions in prehistoric periods. Perhaps these valuable experiences led to the invention of the Qanat (aqueduct or subterranean canal) system in such ecosystems in Iran for the first time in the first millennium BC in order to exploit groundwater [25,26].

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Conflict of interest

None.

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