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Cooperation and Competition: The Comparative Assessment of Tribal Dynamics in the Marginal Landscapes of the Wadi el-Hasa, in west-central Jordan in the Early Bronze and Iron ages

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Abstract

The issue of emergent social complexity has long been debated in the anthropological literature. In the eastern Mediterranean context, the archaeological discussions of social complexity focused largely on societies that showed centralized administration, hierarchic social formations, and large urban centers in temperate parts of the region. For the marginal landscapes in the eastern Mediterranean, such as semi-desert regions, scholars have long denied social complexity on the basis of lack of attributes listed in traditional frameworks of complexity. Recently however, alternate models of complexity have been developed for tribal societies following heterarchy and corporate mode of complexity. In these models, the concepts of group fusion (i.e., cooperation) and fission (i.e., competition) have significant roles and they need to be examined in more detail, especially about how we can identify these group dynamics in the archaeological record, specifically in the settlement systems.

This article focuses on the Early Bronze I-III (ca. 3,500-2,400 BC) and the Iron Age (ca. 1,200-500 BC) of the Wadi el-Hasa, in west-central Jordan, for the evolution of settlement systems as a result of tribal cooperation/competition strategies and the emergence of long-distance trade, which allowed tribes not only to thrive economically but also gain political significance in a marginal landscape in the southern Levant. The use of relatively new analytical methods in archaeology, such as the geographical information systems, for assessing temporal changes in spatial distribution of sites, identifying trade routes, determining the impacts of long-distance trade and other socio-political events in the region on the settlement systems of the Hasa has been discussed.

I-Introduction

The traditional and dominant definition of social complexity in the archaeology of the Levant and the Near East focuses on economic differentiation, class-based society, ruler-centric systems, centralized administration, and multi-tiered settlement systems with urban centers (Amiran 1960; Dever 1980; Richard 1987; Joffe 1993; Rosen 1997), which have been built on the philosophical foundation of the Western normative concept of state (Carneiro 1970), perceiving it as a monopoly of power while heavily emphasizing individual self-interest and personal networking for social change. Such frameworks rely on trait lists for identifying the level of complexity in social organization and prioritize the temperate regions of the eastern Mediterranean (i.e., along the coast and inland valleys along the Euphrates, Tigris and Jordan rivers) for the emergent social complexity while leaving out desert and steppe zones in the region for the discussions of social complexity¹.

Recently however, scholars have developed a variety of alternate frameworks discussing how socially complex organizations might have emerged in these marginal lands of the eastern Mediterranean as the body of archaeological data increased and our understanding of human-environment interactions have gained depth in terms of the diversity of adaptive responses, behavioral variations, and decision-making strategies (Johnson 1982; Feinman 2000; Chesson 2003). In this article, I use spatial and statistical methods for comparing the Early Bronze Age I-III –EB I-III hereafter– (ca. 3,500-2,400 BC) and the Iron Age –IA hereafter– (ca. 1,200-500 BC) settlement systems and assessing the changes in the Wadi el-Hasa (west-central Jordan), which is located in the semi-desert zone of the eastern Mediterranean. The interpretation of the results will follow the framework of the Synthetic Approach: a model that focuses on the tribal cooperation/competition strategies, the long-distance trade, and the changes in the political landscape of the region as the driving factors of emergent social complexity (see Section II for summary, also Arkan n.d.).

The organization of this article is as follows: the second section briefly describes the neo-evolutionary approach to identify social complexity and its shortcomings before presenting a summary of the Synthetic Approach as an alternate framework to explain the emergence of “atypical” social complexity in the marginal lands of the southern Levant. Also in this section, I outline my research questions and explain how the testing of these questions is done using the geographical information systems (GIS hereafter) and statistical methods. In the third section, I provide a concise cultural and environmental history of the research area in order to create a background for the ensuing arguments. The fourth section focuses on the research methods where I explain specific statistical and spatial methods for testing the research questions presented in second section. Finally, in the last section, I present the research results concerning how the settlement systems change from the EB I-III to the IA as a result of cooperation/competition, long-distance trade in the context of the IA territorial state formations.

¹ For the discussions of social complexity in these regions that focus on colonization and secondary-state formation please see Strange (2001) and Esse (1991).

II-The Synthetic Approach and Its Constituents

A) The Neo-Evolutionist Perspective of Social Complexity

Since the beginning of anthropology-oriented discussions of social complexity in 1940s, socio-cultural evolutionism has dominated the theoretical approaches and the definition of complexity in the context of pre-modern societies. Using the popular 18th-19th century “Asiatic Mode of Production” (after Marx, Blanton and Fargher 2010: 7), the Neo-Evolutionist approach, with partial influence of Marxism, attempted to re-formulate the emergence of social complexity by adapting a systemic and comparative perspective for analyzing archaeological data, as illustrated by works of Fried (1967) and Flannery (1972). The emergence of social complexity and statehood has been typically associated with abundant resources and dense population (Price and Feinman 2010: 3-4). The elite class emerged within the society by controlling resources, methods of production, and access to knowledge hence establishing a hierarchic social formation (Blanton and Fargher 2010: 8-10). Such socio-political formations focused on producing and manipulating surplus of goods (Hayden 1995:72) that created differences in wealth through redistributive economy, which in turn legitimized the higher status of elites in the society: the transformation of economic capital into political capital (Kristiansen 2010: 177). The inherent element in this definition has been the competitive relationships among the individuals in a society for increased surplus production and higher status that it would bring (Price and Bar-Yosef 2010: 148). This means that individuals that produce and accumulate more wealth do that at the expense of others in the society.

Although this can and has been a course to social complexity in the ancient Near East, it definitely is not the sole path for the emergence of complex social formations. The increasing body of evidence, new analytical methods, incorporation of new frameworks for analyzing data as well as the failure of the traditional hierarchic approaches to account for the variations in the archaeological record suggest that an alternative path to social complexity has also been possible, especially in the marginal lands where resource availability and population density are significantly low. It is possible to characterize these as “resource based corporate groups” (Hayden 1995:72) where sharing of resources and political power form the basis of social organization. This “corporate mode” emphasizes solidarity, interdependence of sub-groups, and collective identity for integrating all segments of society (Blanton et al. 1996: 5-6). The Synthetic Approach below discusses how complexity may emerge from such group-oriented social organization in the context of the southern Jordan.

B) The Synthetic Approach to Social Complexity

The marginal regions of the eastern Mediterranean have Irano-Turanian steppe (i.e., continental climate regime with severe aridity, evapotranspiration in summers as well as extreme differences in day and night temperatures) and xeric steppe-desert (i.e., arid and hyper-arid conditions) climate types. This zone extends from the east of the Jordan River to the east, towards the Arabian and Syrian deserts. The dissected topography and the limited, scattered nature of resources in these regions lower the carrying capacity, which in turn makes mobility a high priority for societies (Barth 1974; Khazanov 1994). Under these conditions, the Pastoral Mode (i.e., transhumance

–pastoralism with vertical seasonal movement– or nomadic pastoralism –horizontal seasonal movements–) emerges as the main subsistence type and its origins can be traced back to a period between 4,500 and 3,500 BC (Arıkan n.d.). This subsistence base is quite different from the Agricultural Mode (i.e., a system of mixed agropastoralism and horticulture) where it emerged in areas of non-irrigated agriculture (e.g., valleys and plains in the temperate zone) possibly by ca. 9,000 BC and was established around ca. 4,500 BC (Bar-Yosef and Meadow 1995; Arıkan n.d.).

The traditional frameworks of social complexity mentioned in the previous section were built on the concepts of Agricultural Mode and its extended family that inhabited the temperate zones. The subscribers of these theories excluded the marginal landscapes of the eastern Mediterranean, hence the Pastoral Mode and its nuclear family (i.e., households, see below), from these discussions on the basis of lack of attributes that they deemed to be reliable indicators of complex social organization as well as environmental and socio-economic unproductivity² (Arıkan n.d.).

The alternate models of social complexity (Johnson 1982; Feinman 2000; Chesson 2003) adapt a different perspective. Johnson emphasizes “group fusion” and “scalar communication stress” (Johnson 1982: 392-394, 408) as factors of social reorganization, transformation of economic, political, and social institutions in a group that lead to the emergence of different roles and responsibilities for individuals (Johnson 1982: 405-406). Feinman contributes to this perspective with the concept of the “corporate mode” (Feinman 2000: 32) that stresses sharing of power across the group and integrating different segments of groups (i.e., tribes) by building consensus³, which defines a different leadership role than the one assumed in the traditional frameworks. The Heterarchic Model (LaBianca 1990; Chesson 2003) highlights how tribes maintain a dynamic social organization and self-focused decision-making process that increases the flexibility of households in their adaptive responses, decisions, and actions (e.g., group fusion or fission along the lines of kinship), which contributes to the long-term stability

² This assumption is not valid. Recent research into the origins of animal domestication and the economic reasons for animal husbandry, such as Alvard and Kuznar (2001), suggests that husbandry-oriented subsistence patterns are capable of producing surplus, if societies pick the species of animals that breed faster, can be kept in high density, and offer high, sustainable yield (kilograms of biomass harvested per year per square kilometer) (Alvard and Kuznar 2001: 302). All these qualities are observed in sheep and goats, which are the first domesticates and the most popular herd animals in the eastern Mediterranean. The surplus in such economies would be a surplus on the hooves.

³ Consensus building is important in tribal social settings because the basal social unit (i.e., households) in marginal lands rely on the concept of kinship for survival (Barth 1974; Bates 1980; Khazanov 1994). This is a mechanism that regulates access to sporadic and critical resources such as pasture by establishing lineages and tracking the origins of each family to a certain lineage (Chesson 2003), thus controlling economic and social ties. Consequently, in the Pastoral Mode, kinship is the *only* socio-political mechanism that facilitates cohesion among different families.

in the social and economic system of tribes (La Bianca 1990; Greenberg 2003a; Greenberg 2003b; Levy 2009; van der Steen 2009).

The Synthetic Approach⁴ builds up on the alternate models mentioned above to create an explanatory framework to the emergent complexity in the marginal landscapes of the eastern Mediterranean. In addition to aforementioned social dynamics, the Synthetic Approach also argues that the group fusion may be the result of economic maximization attempts. Following Tainter's discussion, this can be explained as total increase in output per increase in input: the "marginal productivity" of Tainter (1990: 91-93 and Figure 1). Such attempts of economic maximization are possible through tribal cooperation, which opens up wider variety of landforms to human activities. As lineages aggregate in marginal landscapes, denser settlement activity and higher diversity of site types are observed (Arıkan 2010: Figures 26-29), which are otherwise not possible in marginal landscapes. Following Feinman's "corporate mode of complexity" (2000: 32), supra-household organizations emerge at this stage (Chesson 2003; Greenberg 2003).

The Synthetic Approach emphasizes that the social fluidity that allows tribal cooperation and aggregation may play a major role in reverting these dynamics when the economic maximization fails to sustain the economic gains and socio-political benefits due to natural environmental change or anthropogenic degradation. As reduced resource availability threatens the socio-economic cohesion of aggregates, group fissioning (i.e., competition) may serve to mitigate tensions by settlement dispersal where the individual tribes once again become economically self-sustaining, politically autonomous units. These socio-economic changes are reflected as lower settlement density, reduced site type diversity, and targeted use of select landforms (Arıkan n.d.). Against this backdrop of tribal dynamics, it is now possible to make a detailed discussion of the tribal cooperation/competition and long-distance exchange as factors of social change.

C) Competition and Cooperation

Based on the discussions of population aggregation and dispersal above, in a landscape like the Hasa, where resources (e.g., arable soil, water, grassland, timber) were already scarce and their distribution was sporadic, the Synthetic Approach asserts that the social dynamics changed and the security concerns could become more significant when the tribes had to compete for resources under deteriorating climatic and environmental conditions (e.g., Early Bronze IV-Late Bronze Age, ca. 2,400-1,200 BC, see Section III-B-3). The significance of security concerns might have been much less under phases of climatic and environmental stability as well as low population density, such as the Chalcolithic period. Inter-tribal cooperation is expected when group fusion took place with the aim of self-generated economic maximization through higher resource procurement. Although the population was high in these aggregates and occasional conflicts were predictable, tribal chiefs and council of elders maintained generally

⁴ The Synthetic Approach is originally called Hasa Synthesis (Arıkan 2010) however its focus is recently readjusted to make it a regional framework to cover the marginal landscapes of the eastern Mediterranean and recently relabeled as the Synthetic Approach (Arıkan n.d.).

peaceful co-existence among the tribes⁵. Such cooperation took place in the Hasa as early as EB I-III (see Section III-B-2). The security concerns would have been kept at the minimum in the IA, when the peripheralization of the Hasa by the Moab (see Section III-B-6) would have shifted the security concerns to focus more on protecting the borders and, more importantly, to protect the Arabian caravan route in the western Hasa that started operating in this period (Bienkowski and van der Steen 2001; Arikan 2010).

These expectations bring the following question: Could cooperation/competition strategies be reflected from the spatio-temporal changes in the military sites? This will involve the assessment of several aspects of the military sites (i.e., towers and forts) for changes at temporal scale using the statistical methods discussed in the Research Methods section below. First, I assess the changes in the ratio of towers to forts from one period to the other, which is expected to provide an insight about the nature of defensive organization. The military presence where towers are in majority may mean an organization that focused on observation as opposed to a fort-dominated distribution that suggests heavier military presence in the Hasa. Second, the temporal densities of military sites are compared to identify competition (i.e., denser presence of military sites) and cooperation (i.e., lighter presence of military sites) strategies. Third, the assessment of variations in spatial distribution of military sites in the Hasa is expected to reveal the establishment of a network of military sites in the Hasa for the first time in the IA. This implies a shift in the perception of issues related to security from the earlier periods that lacked such networks of military sites.

Consequently, the IA military network can be attributed to large-scale social negotiations (i.e., population aggregation) and cooperative dynamics (i.e., long-distance trade, see below) among the tribes. As part of testing such expectations, I will use the line of sight analysis in GIS (see the Research Methods section for discussion) where individual view sheds of each military site on the landscape are identified to create cumulative view sheds. These cumulative view sheds then, can be assessed whether they cover certain parts of the landscape such as the valleys where trade routes are located. Fourth, the temporal changes in size and internal complexity (i.e., the number of features) of military sites provide additional information about the society's ability to defend itself, and are an indicator of how seriously people assessed risks and threats. The security concerns could become more diverse from the EB I-III to the IA (i.e., from protecting local economic investments to defending the trade routes and border protection), which is reflected by increasing diversity in size and morphology of military sites.

Finally, the results of above tests may suggest more complex social organization in the Hasa during the IA, which might have come out largely as results of tribal cooperation and external political ties of the Hasa. The IA peripheralization of the Hasa then, can be contextualized as part of political and economic processes, which aimed to create a buffer with Edom in the south while controlling trade routes from the Arabian Peninsula. This is discussed in the following section as part of the IA socio-economic changes in the Hasa.

⁵ For a detailed perspective on how these councils worked, see Fleming (2004).

D) Trade and Exchange

The significance of long-distance exchange in pre-state societies has been discussed extensively in the evolution of archaeological societies (Feinman and Marcus 1998; Earle 2002). Long-distance trade has been perceived not only as a mechanism of economic exchange but more importantly it also creates a social context where ideas, technology, and information are exchanged. Therefore, the contribution of trade and exchange in the socio-economic and political evolution of societies has been significant. However, the identification of these relationships is difficult on the field unless direct evidence such as ancient records is found. Another reliable source of information is the trade routes, which needs to be analyzed in relation with the settlement systems. These routes, besides trade, could also act as corridors of social integration of one region to another (i.e., the integration of the Hasa to the Karak Plateau). Such integration however, should not be viewed as a one-way traffic of goods (i.e., the resource extraction from the Hasa), but rather a two-way road that also brought political and social influence from the north. In this sense, these routes may be viewed as sources of direct political and economic influence over the Hasa. An additional function of these routes can be military especially because the Hasa is a border between the Moabite and the Edomite states⁶.

The only ancient road that still survives, in parts in the Hasa is the Roman Via Nova that crosses the drainage from north to south at the mid-point, near Wadi Anmein, which mainly had a military function⁷. In the IA political context of southern Jordan, the relationships between probable IA trade routes and the Hasa settlement systems may provide information about the peripheral role of the Hasa to the Moabite state in the north. One such trade route that was highly active in the IA was the King's Highway⁸ –i.e., Arabian caravan trade– (Finkelstein 1992; Bienkowski 2001). Consequently, it is important to illustrate how the establishment of major trade routes, such as the King's Highway, might have affected the distribution of villages (i.e., major socio-political and economic hubs) and military sites in the Hasa with the help of various spatial analytical tools available in geographical information systems (see the Research Methods section for detailed discussion of the methods).

Based on the above discussions, the Synthetic Approach expects that valleys with long N-S passage (e.g., Afra, Anmein) in the Hasa might have been preferred for establishing trade routes that would connect the Karak Plateau on the north with the

⁶ For the resources of the Moab and Edom states, see Andrews and others (2002), Levy and others (2003).

⁷ See Politis and others (2007) for a detailed report on the recent identification of post-Roman period roads in the Hasa.

⁸ The route for the King's Highway is highly debated. Although a consensus has not yet been reached, the scholarly opinions favor two possible routes that originate in western Arabian Peninsula. The southern route reaches Edom, via the Wadi Arabah and then crosses the Negev, ending at Beersheba (Finkelstein 1992; 1995). The northern route continues into the Hasa, crosses Transjordan following the King's Highway (i.e., Via Nova in the Hasa) and ends at Damascus (Herr 1997; Bienkowski 2001).

southern plateau of the west Hasa (Figure 1). Assuming that such routes existed, it is expected that there would be significantly higher settlement density and diversity along them. The clustering of variety of sites along trade routes would be especially notable during the IA settlement expansion and economic intensification. Consequently, sites along or near roads may have been larger in size and had higher levels of internal complexity than the sites of the same period that were not located along these probable routes. The emergence of such settlement patterns has socio-political significance for the IA: implying that the group fusion and strategies of economic maximization suggested for this period, resulted in sufficient accumulation of goods for the establishment of exchange systems. This might have contributed to the emerging social complexity in IA by creating disproportionate accumulation of wealth, which then led to social and political differentiation as discussed by Johnson (1982), Feinman (2000), Bentley (2003a; 2003b), and Arıkan (2010). The maintenance, organization, and administration might have been the responsibility of a select group in the society, who made decisions about every aspect of production. Given the tribal nature of social organization, under economic maximization, only chiefs had sufficient social prestige to undertake such functions.

The following questions form the basis of testing of the expectations about trade and exchange: (1) is it possible to identify the possible trade routes? and (2) does the IA settlement pattern show changes in terms of site density, type diversity, internal complexity, and site size in relation to proximity to these routes? The first step of testing will involve the identification of possible routes for trade, which will employ several GIS modules that can calculate the least-cost paths between two points on the landscape –see the Research Methods–. Following this step, I will compare the settlement density and diversity along the identified routes between EB I-III and IA. Additionally, I will compare sites along trade routes with sites farther from routes in terms of size and internal complexity. It is expected that such comparisons of site density, diversity, and complexity between the EB I-III (i.e., the first phase when population aggregation took place and villages emerged in the Hasa) and the IA will make the role of long-distance trade clear in the increasing complexity of social organization during the latter period. Finally, the thematic GIS maps will be used to compare the settlement patterns from EB I-III and IA, which will create the context for discussing the social and political implications of temporal changes in settlement density, size, complexity, as well as changes in spatial coverage of villages and military sites in relation to the emergence of long-distance exchange networks in the Hasa.

III-The Cultural and Environmental History of the Levant from the Chalcolithic to the Iron Age (ca. 4,500-500 BC)

A) Research Area

The Hasa is located at the southwestern edge of the Irano-Turanian steppe vegetation, bounded on the east by the Arabian Desert (Figure 1, Harlan 1988; Hill 2002). The annual variance in rainfall is between 300 and 600 mm/year (Hill 2006: 8). Long and dry summers; short and rainy winters favor shrubs like artemisia, but numerous springs support mesic Mediterranean flora in patches along the wadi bed (Schuldenrein and Clark 2003: 1-3). Grasslands diminish to the southeast and deflated land surfaces are observed (Schuldenrein and Clark 1994; Schuldenrein and Clark 2003).

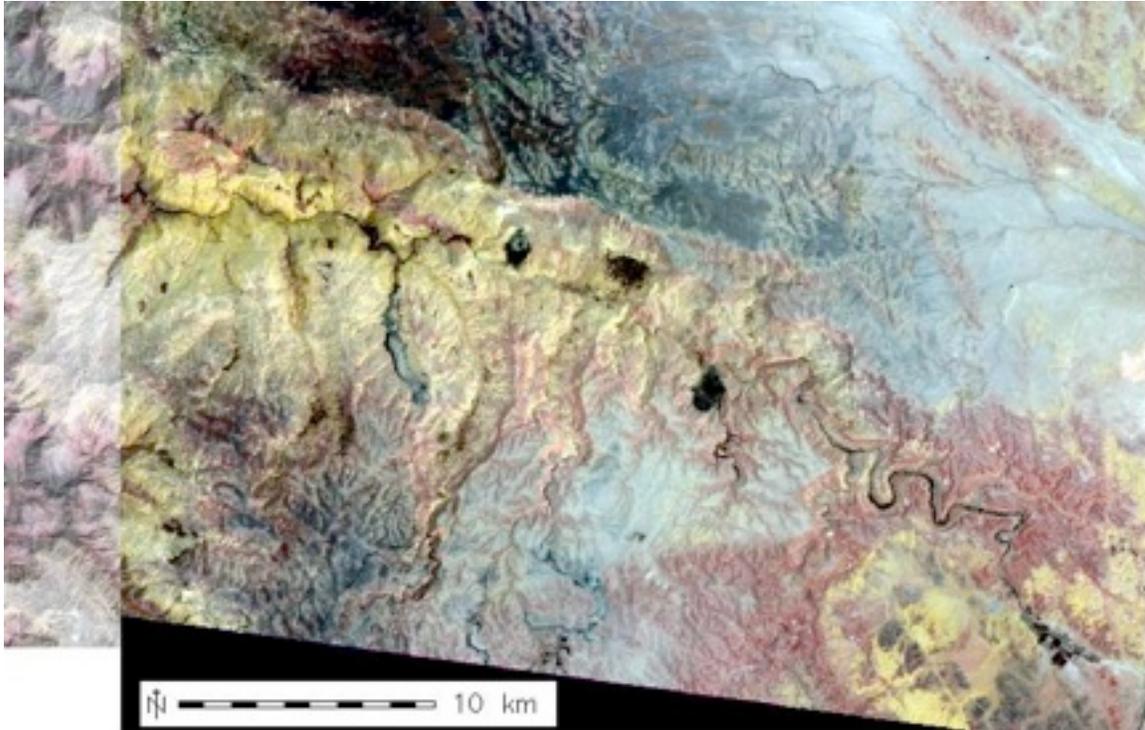


Figure 1. The Wadi el-Hasa as seen in ASTER imagery. The NW terminus is the Dead Sea, the drainage is between the Karak (due north) and the Edom (due south) plateaus.

The Hasa has widely varied and highly dissected topography, covering 972 square kilometers. Lacustrine marls and limestone dominate the east (the Upper Hasa), whereas on the west (the Lower Hasa), extensive alluvial terraces and talus deposits are observed due to long-term erosion and deep incision are observed (Schuldenrein and Clark 2001; Schuldenrein and Clark 2003). Today, the Upper Hasa is more suitable for low-intensity seasonal pastoralism while the Lower Hasa has been the locus of agricultural activity (Hill 2006: 73-89). Based on the past settlement systems, archaeological and ethnographic data, and these environmental conditions, there have been a consensus among the scholars that the social organization remained predominantly tribal throughout the prehistoric and historic periods (Hill 2006: 29-30). To the north and south of the drainage are the Moab (Karak) and Edom plateaus. The Karak Plateau receives more rainfall, is much less dissected, and is geologically more stable than Edom Plateau with thicker and richer soil for agriculture (Hill 2006: 40-43, 68-69).

B) The Cultural History of the Early Metal Ages in the Levant **1-Chalcolithic**

The Chalcolithic period (ca. 4,500-3,500 BC) in the Levant represents technological advancements, such as copper metallurgy, and the establishment of Agricultural and Pastoral modes, which suggests diversification in subsistence strategies to survive on environmentally marginal lands in the region (Bourke 2001; Arikan n.d.). During the Chalcolithic period the valleys are settled by large settlements and smaller

sites are found on the piedmonts surrounding them (Bourke 2001: 113-115). Consequently, this is the first period when human habitation extends into environmentally marginal and geologically less stable areas (Bourke 2001: 109-110).

2-Early Bronze Age I-III

EB I-III witnessed the establishment of complex irrigation systems across the Southwest Asia. Additionally, terrace agriculture originated in this period (Philip 2001: 184-187). These indicate the intensification of subsistence practices during this period. Agricultural and Pastoral modes continue, albeit at a larger scale than the Chalcolithic period (Philip 2001: 187). Based on the changes in economic and other archaeological evidence (i.e., burials, architecture), this phase seems to be a time when social differentiation becomes more visible, and different groups (i.e., pastoralists and agriculturalists) selectively settle on the landscape (i.e., highlands vs. lowlands) while maintaining symbiotic relationships. It is also suggested that corporate power strategies emerge within heterarchic social organization to protect interests of various groups in the society (Philip 2001; Chesson 2003, see Section II-A), contributing to the fluid political dynamics in the marginal landscapes of the southern Levant.

3-Early Bronze Age IV

EB IV (ca. 2,400-2,000 BC) shows major changes in terms of social organization and subsistence patterns. There is an ongoing debate about the reasons for the large-scale collapse of social complexity in the Southwest Asia at this time, emphasizing either environmental or political aspects (Dalfes, Kukla and Weiss 1998; Yoffee 2006). Political decentralization, decline in economic specialization, and social conflicts in this phase have long been associated with the rift between the rural and urban sectors of the Mesopotamian society (Liverani 1987: 69-70) hence contributing to the rise of dimorphic⁹ social structure (Marfoe 1979; Palumbo 2001; Nichols and Weber 2006). These changes in socio-economic complexity, evident from settlement patterns, show small sites across the landscape without any sign of population aggregation. They also include weakening of long-distance trade relationships, which, in EB I-III had grown extensively and even reached to the level of colonization in some parts of the southern Levant (Stein 1999). Although the archaeological record suggests that the subsistence patterns in this phase becomes regionally differentiated into nomadic pastoralists (i.e.,

⁹ The initial use of the term Dimorphic Society in Michael Rowton's research on the Middle Eastern pastoralist societies of 1960's and 1970's underlined his "Enclosed Nomadism" concept (Rowton 1974). Recently, scholars (van der Steen 2004; Szuchman 2009) criticize this concept for creating the illusion of two opposing forces in the political landscape of the region as well as being based on the modern nation-state ideology. Instead of perceiving pockets of nomadic pastoralists that were enclosed by urban formations in the Middle East, based on the archaeological record it is suggested that nomadism was much more common and it was enclosing the rare urban formations (Fleming 2004: 71). The Dimorphic Society concept I refer here is parallel to Leon Marfoe's use, which is significantly different from the original term and rejects the idea of opposing segments of a society.

southern Jordan) and sedentary agriculturalists (i.e., north and central-south Jordan¹⁰) (Nichols and Weber 2006: 45-46), due to the large-scale abandonment of sites and depopulation across the Levant, including the Hasa (Palumbo 2001: 236-240), this pattern may well be a result of the limited EB IV discovery of sites in the region.

4-Middle Bronze Age

The MB (ca. 2,000-1,500 BC) is viewed as a period of urban revival in Mesopotamia (Nichols and Weber 2006: 54-57) and in the Levant (Falconer 2001: 271). In Transjordan, the political and socio-economic revival is obvious from the re-emergence of settlement hierarchies on the north and central plateaus. On the Levantine coast however, the recovery of urban systems is much faster and more obvious than the interior (Falconer 2001: 276). The southern Levant, on the other hand, shows a different trend in which site density increases but the site size drops. These results suggest that following the EBIV disintegration, the social, economic and political revival is slower and communities continue to remain largely rural (Falconer 2001: 281-283). The settlement patterns on the Transjordanian Plateau mirror these observations: the settlement density is only half as much on the Karak Plateau (Miller 1991; Hill 2006).

5-Late Bronze Age

The LB (ca. 1,500-1,200 BC) is a less well-known period in the Levant due to lack of published results of research. This period is characterized by the Egyptian invasion and occupation of the greater portion of the Levant (Strange 2001: 292). The settlement patterns of the period suggest that people avoided marginal lands possibly due to increased aridity that is evident from the paleoenvironmental record of the region (Strange 2001: 293). Settlement activity declines on the Transjordanian Plateau in comparison with the previous period (Strange 2001: 297). In the areas pastoralist groups frequented, the settlement density remained low while cities continued to function, under Egyptian control, in other parts of the Levant (Strange 2001: 304). The subsistence of this period shows increasing specialization in addition to the emergence of long-distance trade in the eastern Mediterranean (Falconer 2001; Strange 2001). However, much produce may have been given to the Egyptian vassals as tribute (Strange 2001: 306).

6-Iron Age

The IA (ca. 1,200-500 BC) represents the emergence of territorial states in the Levant. On the Levantine coast, the state formation is initially observed in the north and south (i.e., Israelite and Judea); Saul unified them and under David the Israelites became a state in early 9th century BC (Finkelstein 1989; 1999). Following statehood, socio-economic changes occur; administration centers emerge across the Levantine coast, fortified settlements increase in number, a settlement hierarchy emerges, public and ideological architecture becomes more obvious in the archaeological record, and the significance of crafts in economy increases (Dever 1995; Finkelstein 1999).

¹⁰ For Tell el-Hayyat and Tell Abu en Ni'aj, see Falconer 1987 and 1995. For a regional synthesis, see Dever 1980 and 1987.

The socio-political and economic transformations on the Levantine coast contribute to social and political change on the Transjordanian Plateau. Here, the tribal states of Ammon (near Amman), Moab (on the Karak Plateau), and Edom (on the Edom Plateau) emerge (LaBianca and Younker 1995: 400-402). These tribal states have been defined as political entities where tribal identity has significance and the settlement systems are composed of self-sufficient sites, lacking economic specialization, with minimal settlement hierarchy (LaBianca and Younker 1995; LaBianca 1999). The development of the settlement systems in this period can partially be attributed to the long-distance trade relationships, such as the King's Highway (Herr and Najjar 2001: 325, 337), which follow a north-south route that bisects the Hasa (see Section II-D). The densest settlement activities are initially observed in the north around Amman and Madaba, where settlements are fortified and examples of public and palatial architecture are recorded (Herr and Najjar 2001: 326-327). The spread of these settlements into the southern areas takes place around 900 BC on the Moab and Edom plateaus (Herr and Najjar 2001: 331).

C) The Settlement Patterns of the Hasa between 4,500-500 BC

The Hasa reflects the regional, cyclical changes in the settlement density summarized above. Based on the survey results (MacDonald 1988; Coinman 1998; 2000), there are 335 sites in the Hasa between the Chalcolithic and the Iron Age. The definition and categorization of these sites are shown in Table 1.

Site Category	Type of Sites Included	Abbreviation in the Text
Large Economic	Villages	LGECON
Cave	Caves and rock shelters	CAVE
Military	Forts and towers	MLTRY
Activity-Facility	Aqueduct, caravansary, grinding, lithic and sherd scatters, mill, platform, quarry, terraces and camps	A_F
Small Economic	Domestic clusters, enclosures, farms, hamlets, structures and structure complexes	SMECON
Burial	Cemeteries and tombs	BURIAL
Ideological	Hermitage, petroglyph and temple	IDEOLOG
Undifferentiated Walls	Rock alignments, stone circles and walls	UNDIFF

Table 1. The classification table of the Hasa site types into categories. The abbreviations used in the text are also provided in the table.

The small economic sites constitute the majority (48.7%), followed by large economic (14.3%), activity-facility (13.4%), and military sites (10.4%). This breakdown attests to the tribal nature of social organization where households (i.e., farms, hamlets, etc.) make decisions regarding economy and politics (i.e., cooperation –group fusion– and competition –group fission–). The seesaw nature of temporal changes in settlement patterns during these four millennia can be summarized in Table 2 where temporal changes in site density and percentage of the Hasa occupied are shown.

Period	Number and Percentage of Sites	Total Settlement Area (sq km)	Site Density (site/sq km)	Percentage of Hasa occupied	Number of Sites per Century
Chalco.	37 / 11.04	0.0463	0.0380	4.77	0.0411
EB I-III	88 / 26.27	0.1147	0.0905	11.81	0.08
EB IV-LB	24 / 7.16	0.4840	0.0246	4.98	0.02
IA	186 / 55.52	0.4352	0.1913	44.78	0.465

Table 2. The changes in settlement density and the percentage of the Hasa occupied during the early metal ages.

Figure 2 on the other hand, graphically displays oscillations in the site density (i.e., the number of sites per square kilometer), which is scaled by the number of centuries in each period in order to prevent the overrepresentation from a single period. The significant increase in settlement activity from the Chalcolithic to the EB I-III is also apparent from the increase in site type diversity, including the emergence of large economic sites, although the settlement patterns never reached the density or hierarchic organization observed in the Karak Plateau during this period.

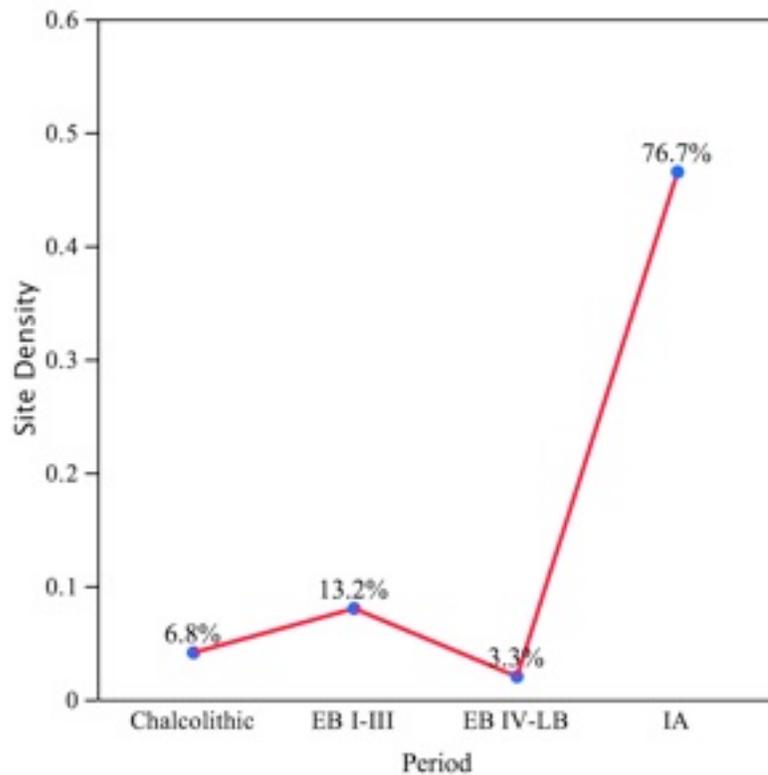


Figure 2. The line chart showing the changes in density of settlements and their percentages after the settlement frequency is scaled by unit time (i.e., the number of centuries in each period).

The sharp drop in settlement activity throughout EB IV-LB (Table 2, Figure 2) signals the regional abandonment and decline in site type diversity. However, the length of this phase of abatement in the Hasa is extraordinarily long: as discussed in the regional summary above, the regional revival of settlement activity takes place around the MB but this is not the case in the Hasa until the IA.

The second spike in Figure 2 suggests that the early metal age settlement activity in the Hasa reaches its peak during the IA, following the least dense settlement activity during the EBIV-LB. Such exponential increase, from EBIV-LB to IA, requires a significant population base, especially to allow the re-emergence of large economic sites, neither of which exists in EBIV-LB Hasa. Therefore, the Moabite peripheralization emerges as a plausible explanation (see Section V-F). The final note about the settlement patterns of the Hasa is the periodic emergence of large economic sites, which coincide with the phases of population aggregation, settlement expansion, and increased site type diversity. The patterns above suggest group fusion and cooperative dynamics among tribes in EB I-III and IA, which otherwise lived in dispersed mode and competed for resources, especially in EB IV-LB.

D) Paleoclimate

1-The Holocene Pattern in the southern Levant

The research on the past climates relies on the use wide variety of proxy data, which provide coarse-grained and incomplete data on the past environmental conditions. However, it is possible to reconstruct the paleoclimate by combining the results from several different methods (i.e., speleothems, paleolimnology, palynology, and geoarchaeology), which then can be checked against the archaeological evidence. The Levant has been subjected to different types of paleoclimatic research (Copeland and Vita-Finzi 1978; Horowitz 2001).

The overall pattern suggests two major phases in the Holocene since 12 Kyr B.P. The first phase had warmer and wetter conditions that persisted until 4,500 BP (i.e., the beginning of EB IV) (Bar-Matthews, Ayalon and Kaufman 1997; Frumkin 1997), which led to the early Holocene aggradation (Copeland and Vita-Finzi 1978) and increase in EB I-III settlement activity (Donahue, Peer and Schaub 1997: 134-135).

The climate became warmer and drier after 4,500 B.P., which suggested the onset of a warm, dry phase (Horowitz 2001: 612) that increased the frequency and the length of erosional cycles (Mabry 1992: 18, 20). The minor episodes of different climatic patterns (i.e., intervals) existed within each phase discussed above (Copeland and Vita-Finzi 1978; Hill 2006).

2-Macrophysical Climate Modeling (MCM)

Developed by Bryson (Bryson and DeWall 2007), this heat-budget model attempts to accurately identify the mean centers of high and low sea-level pressure that determine the weather and wind systems at mid-latitudes along with the jet stream (i.e., a narrow corridor of very strong winds in the upper atmosphere) and Intertropical Convergence (e.g., the boundary between the northern and southern hemisphere surface air) (Barry and Carleton 2001; Bryson and DeWall 2007). Using MCM, it is possible to mathematically estimate meteorological parameters such as precipitation, temperature, evaporation and stream discharge for as early as 40,000 BP, at 100-year intervals on the basis of the meteorological data between 1960 and 1990 from weather stations around the Hasa (Bryson and DeWall 2007: 4, 8, 33-44). The results of the MCM at individual weather station localities around the Hasa have been extended over the drainage by regression modeling as part of the MEDLAND Project (Barton, Ullah and Mitsova 2010).

Based on the modeling results from the MEDLAND Project, the estimates for the climatic variables of temperature and precipitation suggest significant changes, especially for the latter variable, between the Chalcolithic and IA in the Hasa. The MCM results are averaged for each period to represent the precipitation and temperature estimates of that particular phase.

Period	Mean Precipitation (mm)	Median Precipitation (mm)	CV
Chalcolithic	152.103	164.107	0.52
EB I-III	245.678	219.841	0.47
EB IV-LB	236.463	177.208	0.46
IA	155.383	136.597	0.60

Table 3. The summary table showing mean, median and CV values for precipitation from the Chalcolithic to the Iron Age. The values are calculated using the averaged precipitation values at sites from these periods.

Table 3 summarizes the mean and median precipitation values for each period along with the coefficient of variation¹¹ (i.e., CV). The general trend in the precipitation data suggests that climatic amelioration (i.e., moister) from the Chalcolithic to the EB I-III is followed by regional aridity after the late EB and dry conditions persist during the IA. The emergence of extensive settlement systems and economic organisation (i.e., group fusion and cooperation) during the EB I-III could have been a factor of climatically favorable phase. However, during the IA, which is the most arid phase of the early metal ages, the reappearance of an extensive settlement system at a much larger scale (i.e., in terms of population dynamics, complex social organization as indicated by villages) is only possible through external influence (i.e., the Moabite peripheralization) and major economic incentives, such as the Arabian caravan trade.

¹¹ The coefficient of variation (CV) is a more reliable indicator of the variation across space as a normalized measure (i.e., the standard deviation is divided by the mean) of the distribution when comparing a variable where the volume (i.e., density) matters, such as solid or liquid objects.

E) Overview

The regional paleoclimatic reconstructions and results of MCM suggest that the EB I-III environmental conditions are favorable for population aggregation, settlement expansion, and economic diversification, all of which contribute to the emergence of cooperative social dynamics by the end of the Holocene Climatic Optimum (ca. 5.5 Kyr B.P.). Based on the climatic data, especially the results of MCM for the Hasa, it is possible to suggest that starting with EB IV, the amount of precipitation drops (Table 3). MCM results also indicate that temperature does not change between the Chalcolithic and the Iron Age, which implies greater evapotranspiration starting around 2,400 BC. One factor that makes matters worse is the decrease in the number of rainy days, which is a variable calculated by MCM. The modeling results suggest that starting with EB IV, there are fewer rainy days in the Hasa (Arikan 2010: 256, Table 21). This implies that rainfall has torrential nature in the Hasa and it becomes the norm starting with this period.

Based on the climatic reconstructions above, the population aggregation and economic cooperation during the EB I-III in the Hasa is not surprising. Due to the marginal character of its landscape and scarcity of natural resources, it is also expected that the Hasa reflect regional abandonment events of the later Bronze Age at a much larger scale. However, it is interesting to observe that under progressive climatic deterioration (i.e., see Table 3 for the IA precipitation values), the IA Hasa produces similar socio-economic and political transformations to the EB I-III at a much larger scale (Figure 2). Therefore, the roles of competition/cooperation and long-distance trade need to be assessed for understanding of the IA settlement patterns under adverse climatic conditions.

IV- Research Methods

A) Estimating Site Size and Complexity as Indicators of Social Complexity

MacDonald (1988) and Clark (Coinman 1998; 2000) discovered a total of 2200 sites in the surveys of the Hasa drainage ranging in age from the Palaeolithic to the Medieval periods. The original database had a single size value for each site regardless of the length of time that particular site was occupied. Also, it lacked information on the number of features at sites. Considering that site size and the number of features at a site have been used widely in Near Eastern archaeology as an important indicator of function, type of subsistence, and complexity (Schwartz and Falconer 1994: 1-3), and that the research design focuses on temporal changes in land use and site types, such fine-grained data are of significant value. Consequently, for sites occupied or reoccupied over long time period, it is important to estimate the site size for each period of occupation and combine this information with the number of features from that period in order to approximate the site function with greater accuracy. Hence, I compared the total number of features with the number of features from each period of occupation at a given site. Converting the number of features to percentages from a given period yielded the significance of that period at the site. Then, I used these percentages as a weighting factor for maximum site size to approximate the site size during each period of occupation. These calculations yielded estimates of site size and the number of features for every period recorded at a site (Table 4).

Cat	Survey	Num	Max Area	Area Calc	Elev (m)	Type	Feat Calc
1	WHS	24	400	400	1148	TWR	2
2	WHS	31	3200	863	1117	FARM	1
3	WHS	39	5775	1689	1095	VLLG	2
4	WHS	45	25	25	816	CMTRY	0
5	WHS	58	2400	88	850	CAVE	0
6	WHS	144	18200	2810	465	STRCT	1
7	WHS	148	8000	637	290	VLLG	1
8	WHS	165	810	37	233	STRCT	1
9	WHS	171	40000	1144	870	VLLG	1
10	WHS	173	15625	14554	920	VLLG	7

Table 4. A sample of IA sites showing maximum area (Max Area), calculated area (Area Calc), and the calculated number of features (Feat Calc) after the process explained above.

B) Analytical Methods

1-Statistical Methods

I use a number of simple and well-known statistical methods to interpret temporal variations among the sites in terms of size, density, and internal complexity. The first method of the statistical testing is the analysis of variance (ANOVA hereafter), which is a powerful and widely used statistical application in testing the normality and visualizing how observations are distributed (Johnson and Berk 2000: 134-135). ANOVA focuses on the degree of variation in the dataset by comparing means between at least three groups (Johnson and Berk 2000:145) and it assumes equal variance in the sample and the samples are independent (Johnson and Berk 2000: 135). Therefore, the null hypothesis in ANOVA is that there is no difference in mean values while the alternative assumes some level of variation (Johnson and Berk 2000: 146). The significance of the results is expressed in probability (p), which means that any result that is less than 0.05 is commonly accepted as significant for ANOVA results (i.e., the null hypothesis is rejected) (Johnson and Berk 2000: 145-146).

The second statistical tool I use is the box plot (or box-and-whisker diagram), which is a convenient way to illustrate differences between groups of observations in data sets. The extreme observations that do not fit the general distribution pattern of data –i.e., outliers– as well as the symmetry and distribution of data are displayed (Johnson and Berk 2000: 93-94).

2-Spatial Methods

This research primarily relies on the use of various GIS tools for testing of the expectations about the early metal age settlement systems as discussed in the Synthetic Approach. GIS is an integrated technology for collection, analysis, and interpretation of spatial as well as space-time related aspects of human-environment interactions in archaeology (Conolly and Lake 2006:11).

The analyses in this research use GRASS GIS, which is open source GIS software especially useful for topographic analysis and modeling (Neteler and Mitasova 2008: xi) with powerful tools for spatial analysis of raster data. I use raster operations for analyses since the testing of hypotheses involves the landscape (i.e., calculating the least-cost paths and line-of-sight analysis, see below) and the nature of site distribution (i.e., whether the villages are near probable routes, whether military sites specifically protect villages).

a) Identification of Trade Routes and Assessment of Settlement Distribution:

Testing the role of trade and exchange in the Hasa settlement systems during the early metal ages requires several steps in GIS. As the first step, ‘r.walk’ and ‘r.drain’ modules of GRASS GIS are used to identify the least-cost paths in the west Hasa on N-S axis, which would connect the Karak Plateau with the southern plateau of the west Hasa. ‘r.walk’ is the module that uses the algorithm for calculating the costs of walking over a terrain, based on energy expended (Neteler and Mitasova 2008:139). The module also calculates the duration of travel in seconds from one point to another on the landscape. Then, using cost-distance maps created in ‘r.walk’, ‘r.drain’ calculates and maps the least-cost path between two specified points. These show optimal routes between the destination and the origin of trip (Neteler and Mitasova 2008:138).

Testing the predictions about the relationship between trade routes and settlement density, diversity and complexity is done by combining GIS and statistical applications. Once the least-cost paths are identified in the west Hasa, one-kilometer buffers are formed around these routes in GIS platform using ‘r.buffer’, which is a module that creates a zone (i.e., buffer) along routes, whose width can be specified in meters. Using ANOVA, the sites –from the EB I-III and IA periods– that are in the buffer are subjected to comparison with sites outside the buffer for diversity of types, size, as well as the level of internal complexity. The number of sites in the buffer is also used to calculate the density of settlement within the buffer and this is taken as a comparative index to measure the assumed impacts of exchange in the Hasa settlement systems.

At this stage, a complementary GIS analyses is the identification of view sheds. In GRASS GIS, using the line of sight analysis, it is possible to identify how much of the landscape is visible at a certain height above the ground from each site. Using this module, I prepare view shed maps for military towers, using 5 meters as the height above the ground. Then, for each period, I combine view sheds from each military site. Overlaying these view sheds on the sites and trade routes, a general idea of which parts of the Hasa landscape have been given priority in terms of defense can be obtained. This information then is used to identify whether certain trade routes fall in view sheds of more than one military site.

b) Analyzing Security Concerns:

I analyze changes in size (i.e., square meters) of military sites throughout the early metal ages in the Hasa, in order to assess the security concerns. Sizes of towers and forts are compared to each other through time in order to test whether expected changes in size took place. An additional dimension in this analysis is the comparison of forts and towers

of the same period in terms of internal complexity to verify if the expected functional differences between these military site types can be identified using this variable. Assessment of temporal changes in the density of military sites as well as the ratio of towers to forts are going to contribute to our understanding of how security concerns evolved through time in the Hasa.

c) Assessment of Networked Military Site Organization and of the IA Peripheralization of the Hasa:

The assessment of temporal changes in the mission of military sites (i.e., protecting sites vs. protecting economic infrastructure such as trade routes) is possible by preparing ‘r.walk’ maps for military sites of EB I-III and IA, and then comparing them. In this module, each military site is taken as the origin and distances of travel from individual military sites to any location on the landscape is calculated using the slope as a factor of cost of travel. Then, I limit the travel time to one hour (3,600 seconds) on the landscape in any direction from each military site at a given period. Once this procedure is repeated for each period, it is possible to compare the distribution of military sites in relation to the distribution of other sites. Once such maps are prepared for EB I-III and IA, they can be used to test whether military site distribution has a “networked” approach on the landscape, how much of the Hasa and what percentage of sites are covered, whether sites that fall outside the one-hour walking distances have a certain pattern.

The assessment of the IA peripheralization requires a comparative analysis of EB I-III and IA settlement patterns, in addition to the discussion about the military sites above, which involves thematic mapping of all sites from these periods, by function. These maps are then analyzed with respect to settlement densities and size differences on different terrain types in order to test the idea of “peripheralization” of the Hasa during the IA by assessing whether the settlement systems reached their most extensive scale during the IA suggesting the presence of an external political power in the region.

V- Results of Analyses

A) Spatial Distribution, Density, Size, and Internal Complexity of the Military Sites

The first part of this section focuses on addressing the cycles of competition and cooperation in the Hasa, as indicated by the military sites of the early metal ages. The thematic map (Figure 3) shows the spatial distribution of forts and towers from all four periods. Although the distribution differences maybe a function of sample size, two major points emerge from this map. Firstly, towers dominate the composition of military sites during the early metal ages in the Hasa. Towers cover the southern plateau and the eastern desert. Secondly, forts reveal a much more limited but specific distribution. They are denser in the select drainages of the eastern Hasa with a single exception in the southern plateau.

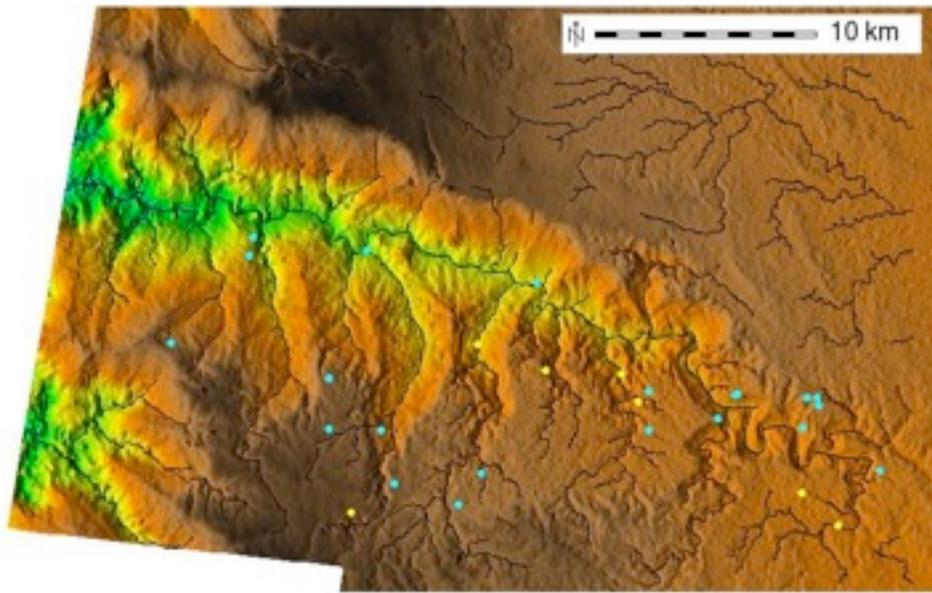


Figure 3. The thematic map of the military sites in the Hasa in relation with the stream network in the drainage. Forts are represented by yellow dots while cyan dots denote towers.

The temporal comparison of military site composition and their frequencies (Figure 4) reveal that with the exception of the abandonment phase (i.e., EB IV-LB), the military sites in the Hasa maintain a certain composition: there are more towers than forts. This pattern agrees well especially with the EB I-III and IA periods, which had heavier site density and other economic activities such as trade. On the other hand, the high frequency of military sites in the Chalcolithic is surprising. Given the limited geographic extent of the Chalcolithic settlements (i.e., in the Upper –east– Hasa), such high numbers of military sites suggest the need for protecting the economic investments. This pattern may be contrary to the presumed low population density of the area and relatively peaceful settlement in the Hasa during the Chalcolithic as discussed above.

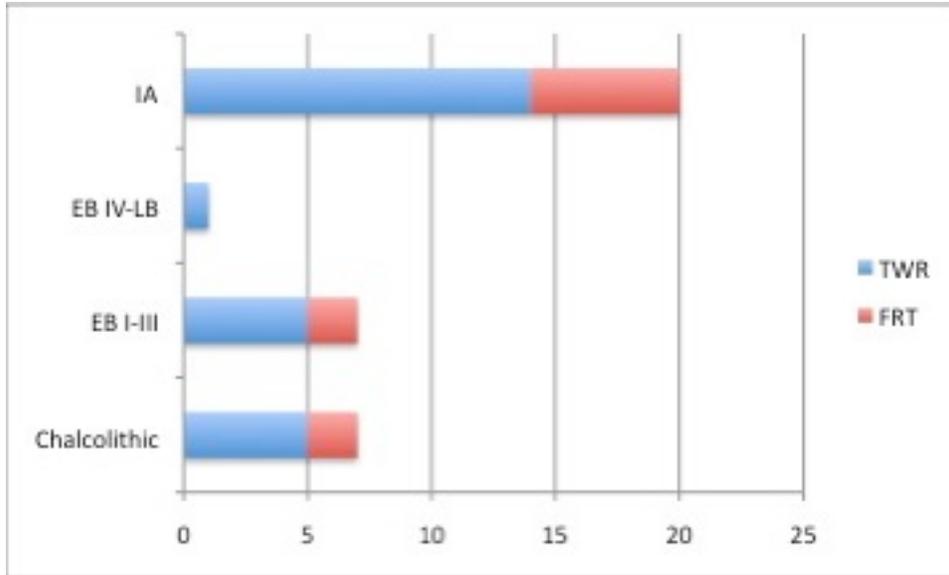


Figure 4. The stacked bar chart for towers and forts from each period (y-axis). The x-axis shows the counts of sites.

Two interesting patterns about the temporal changes in the settlement density of military sites emerge from Table 5. From the Chalcolithic to the EB I-III, the first phase of settlement expansion and the emergence of extensive economic organization, the military site density remains constant.

Period	Number and Percentage of Sites	Total Military Site Area (sq Km)	Site Density (site/sq Km)
Chalcolithic	7 / 19	0.0019	0.0072
EB I-III	7 / 8	0.0051	0.0072
EB IV-LB	1 / 4	0.0001	0.0010
IA	20 / 11	0.0186	0.0205

Table 5. The temporal density of military sites in the Hasa throughout the early metal ages.

Although the geographic locations of military sites in the latter period change (see Figure 12), the number does not change. The major change in EB I-III is the size of military sites, which increases almost three fold. The constant site density but changing locations and increasing size suggest that the “mission” of military sites are better defined in the EB I-III since there are larger sites in this period, which are distributed across the Hasa. This means that the organization and distribution of military sites in this period aim to create a network of military sites (i.e., covers larger area with military sites). This aspect of military sites is addressed in the section on the trade routes below (Figure 8). During EB IV-LB, there is only one military site and it is impossible to evaluate patterns on the basis of a single site. However, this lack of data also shows the scale of abandonment in the area. The IA pattern is interesting: the sudden and exponential increase of settlement density suggests the return of the extensive economic organization, however unlike EB I-III, it happens through peripheralization (see Section V-F). The total area covered by military sites increase significantly. More frequent military sites and larger area covered by them suggest another change in the “mission” of these sites that are discussed under the trade routes section.

The graphical comparison of the settlement density between the military and non-military sites (Figure 5) provides further support for the temporal shifts in the military site organization. It is striking to note that although the settlement density initially increased during EB I-III, the military site density remains unchanged. Following a general decline in settlement activity, the density of the military sites mimics the exponential increase in the settlement activity during the IA. This clearly suggests a new socio-economic and political phase for the occupants of the Hasa in the IA.

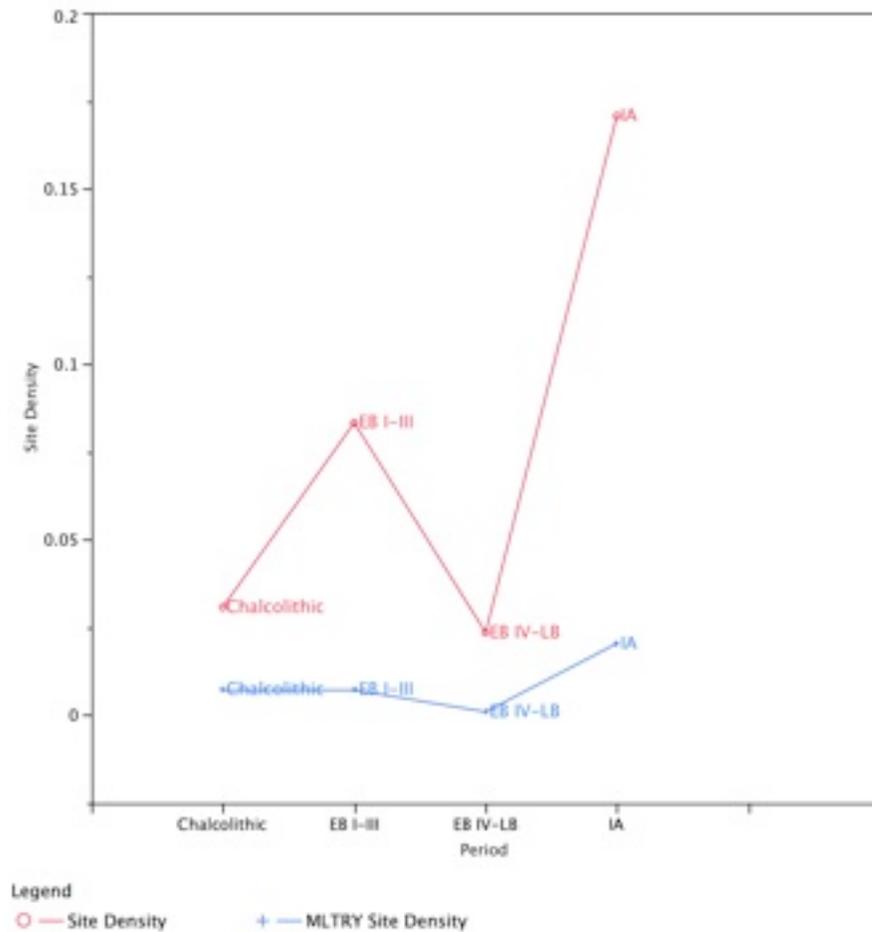


Figure 5. The graphical comparison of the military site density with the density of the remainder of the Hasa sites.

The ANOVA chart for temporal comparison of calculated size in military sites (Figure 6) does not suggest a significant change during the early metal ages. Although initially the military sites became larger in EB I-III, with the exclusion of the single EB IV-LB military site, the mean site size remains between 700 and 90 square meters.

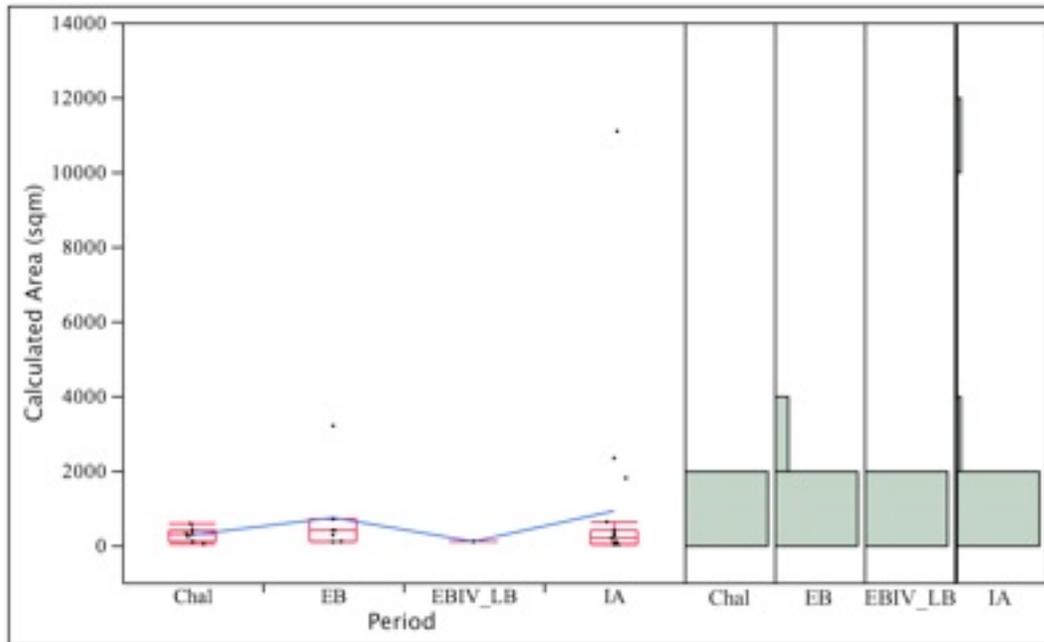


Figure 6. The ANOVA chart of the military sites (forts and towers combined) for the changes in calculated site size. The line connects mean size value in each period. The result does not suggest a major change in the level of complexity among the sites (p=0.8873).

Even when the outlier in Figure 6 (the site that was extremely large, approximately 11,000 square meters) is excluded the p value (0.5799) does not suggest difference among the observations. Similarly, the internal complexity (i.e., the calculated number of features) of the Hasa military sites does not show significant temporal changes either, when subjected to ANOVA (Figure 7).

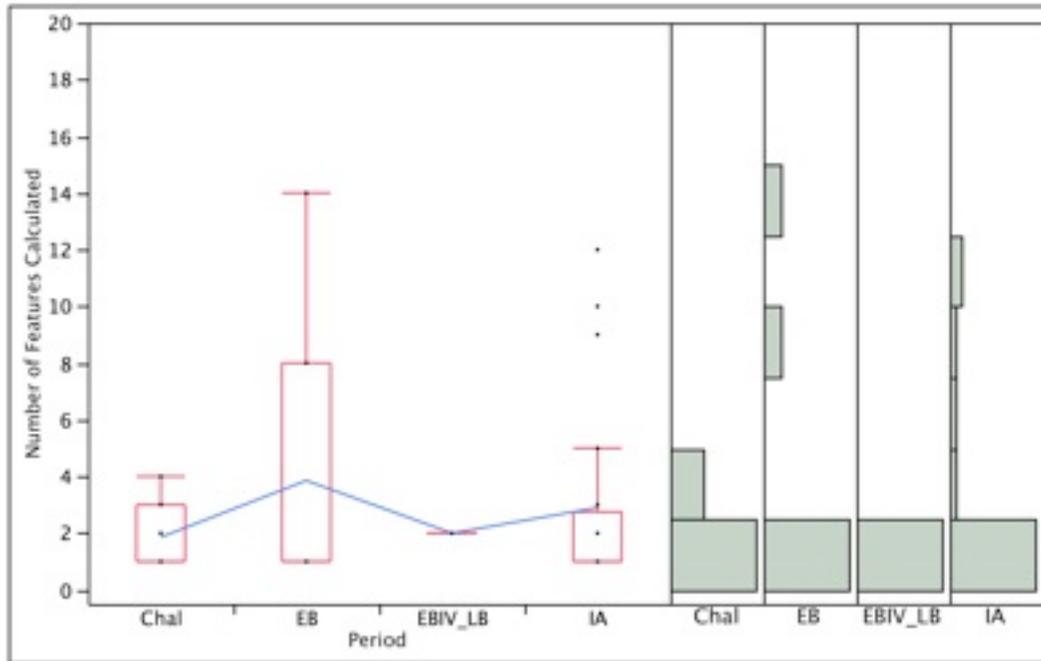


Figure 7. The ANOVA chart of the military sites (forts and towers combined) for the changes in level of internal complexity. The line connects mean number of features in each period. The result does not suggest a major change in the level of complexity among the sites ($p=0.7583$).

B) Assessing the Military Network

The significant increase in settlement activity, especially the frequency of villages in IA, and the integration of the Hasa with the rest of the region via long-distance trade relations bring the question of security and how the military sites functioned in the settlement systems of the Hasa in general. Following the earlier discussion, this section focuses on whether military sites created a network that would protect all or specific sites. Figures 8 and 9 show maps that result from GIS analyses of travel times from military sites of EB I-III and IA.

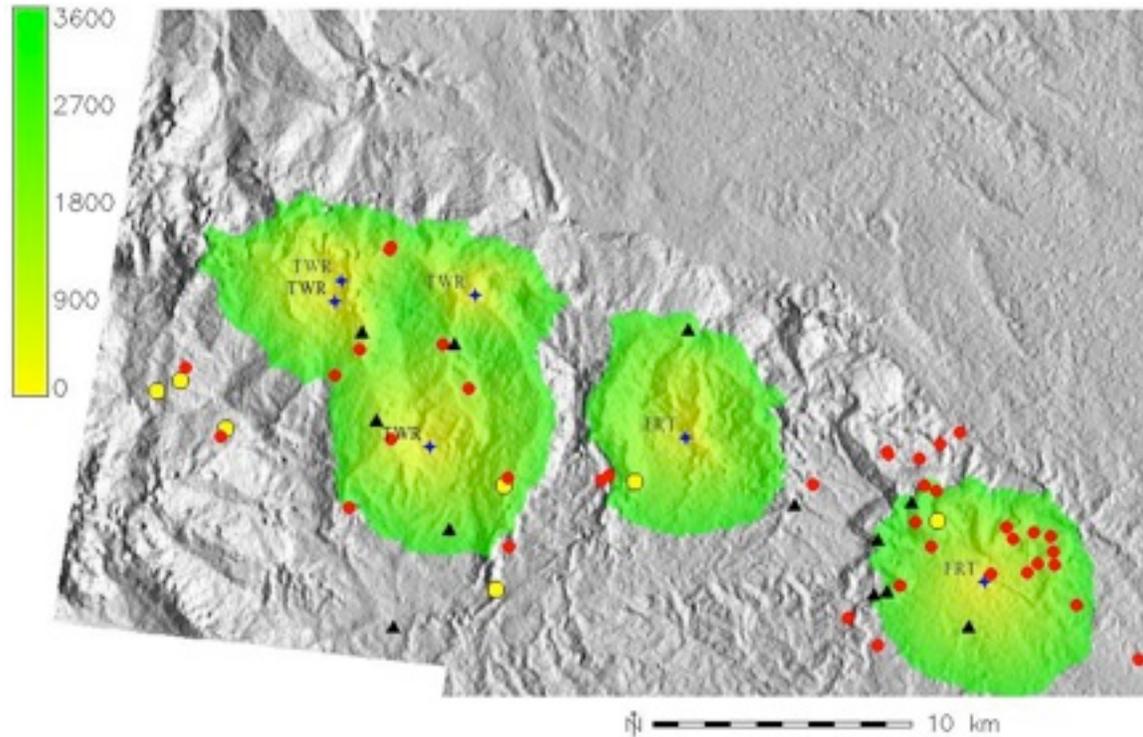


Figure 8. The map of the EB I-III military sites (blue crosses, labeled as towers or forts) in relation to small economic sites (red circles), activity-facility sites (black triangles) and large economic sites (yellow octagons). The yellow-green zone denotes the walking distance of one hour (3,600 seconds) from any military site in any direction. The legend shows different gradients of time in seconds.

The settlement expansion across the Hasa landscape in EB I-III also represents the beginning of extensive economic organization in the drainage. The higher frequency settlement activity takes place in the upper Hasa as well as a second nucleus of settlement in the west-central drainages, which supports the extensive economic organization in this period (Arkan 2010: 129-130). The one-hour walking distance map (Figure 8) of military sites supports this observation. Based on this map, there are few military sites in the east Hasa –where the small economic sites have the densest presence– and the central part of the drainage.

More frequent presence of EB I-III military sites are recorded in the west Hasa, where settlement density remains low mainly due to dissected terrain. The first villages in the Hasa seem to remain close to the southern plateau with few exceptions. These patterns suggest that the military sites may have the function of protecting trade routes, which are more common in the lower Hasa (see the section on the trade routes below and Figure 10), in addition to maintaining security at sites. There are numerous sites¹² left outside the walking zones and this can be a function of extensive economic organization,

¹² These are: 2 activity-facility, 13 small economic and 4 large economic sites, making up 21.6% of EB I-III sites.

which requires occupation of diverse landforms for taking advantage of wider resources rather than clustering sites on certain types of land to make intensive use of fewer kinds of resources. Consequently, the low frequency of the military sites in the east Hasa can be attributed to a new focus in the EB I-III: trade routes in the west Hasa.

The IA represents major transformations in terms of settlement expansion and increase in density, following a long period of abandonment and revival of habitation in a short period of time. Figure 9 shows that the east Hasa continues to be the major locale of attraction for small economic sites. There are several clusters of military sites in this area, which are usually towers. Unlike EB I-III (Figure 8), during the IA, the sites show more balanced distribution in the rest of the Hasa (i.e., spread across the landscape instead of zones of activity). The central drainages show slightly more settlement activity with numerous small economic, large economic and military sites. The lower Hasa shows more sporadic distribution of settlements and majority of these sites are small economic sites with several villages and few activity-facility sites. The military sites are more common on the southern plateau than the west Hasa, which can be a function of concurrent increase in the density of large economic sites here.

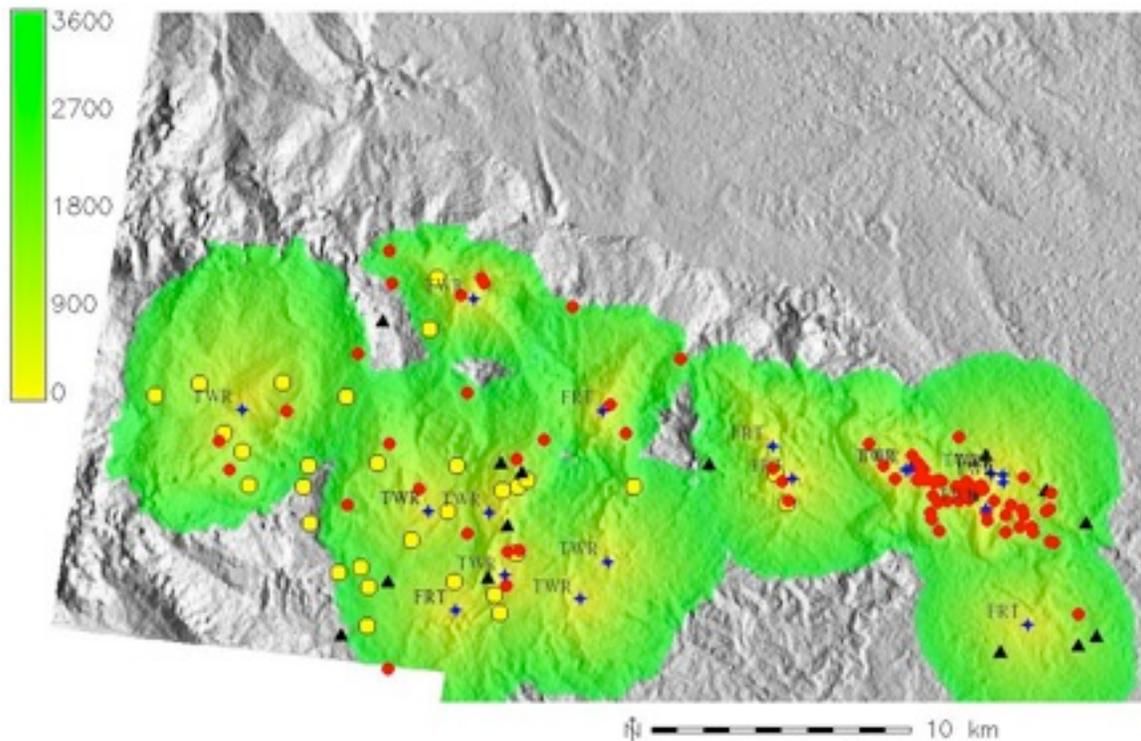


Figure 9. The map of the IA military sites (blue crosses, labeled as towers or forts) in relation to small economic sites (red circles), activity-facility sites (black triangles) and large economic sites (yellow octagons). The yellow-green zone denotes the walking distance of one hour (3,600 seconds) from any military site in any direction. The legend shows different gradients of time in seconds.

The one-hour walking distance map (Figure 9) shows that the military site network in the IA covers all of the settlements. This change in the coverage of military sites is clearly a function of the re-emergence of extensive economic organization. More importantly, the increased presence of military sites in the west Hasa (from four EB I-III to nine IA military sites), which are densely located around the large economic sites of the southern plateau, suggest additional functions for the military sites. Given the fact that the IA changes in settlement systems indicate peripheralization of the Hasa (see the related section below), the Hasa may act as a border between Karak and Edom, which requires patrolling of the Hasa more efficiently. Additionally, the rising significance of long-distance trade may require the re-arrangement of military sites in order to protect the trade routes more efficiently as well as maintaining security for the sites in the Hasa (see the section on the trade routes below). In short, the military sites of the IA show multi-purposed pattern of distribution. First, they protect economic investments (e.g., activity-facility, small economic sites), and provide security to villages. Second, the military sites control trade routes connecting the north and the south (Figure 11 below), via the west Hasa. Third, the military sites act as patrolling stations for the Hasa, which is possibly the border between Karak and Edom states.

C) Identifying Possible Trade Routes of the EB I-III and IA

Following the discussions about the significance of trade relations for the emergence of social complexity and their reflections in the settlement systems, this section focuses on the possible routes of trade and exchange for EB I-III and IA in the Hasa using GIS, which are shown in Figures 10 and 11.

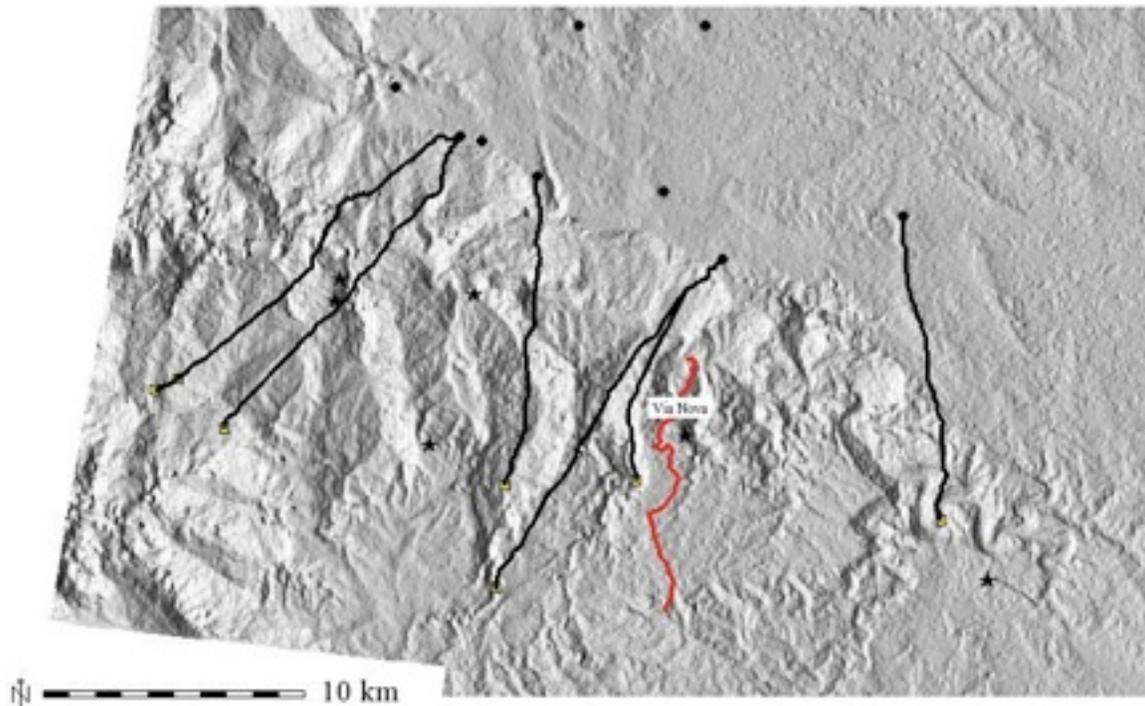


Figure 10. The map of EB I-III villages (black outlined yellow boxes), in relation with military sites (black stars), and the villages on the Karak Plateau (black filled circles). The red line is the Roman Via Nova. The black lines indicate possible trade routes between the Hasa and the Karak Plateau.

The pattern emerging from this analysis is not purely natural. As explained in the Research Methods section, the user has to specify the origin and destination of movement: the calculations are then based on these points and the landscape characteristics such as slope. Therefore, the maps in Figures 10 and 11 should not be interpreted as a clear and solid proof of the existence of roads and routes. Rather, the paths on these maps are suggestions: the least cost path of crossing the Hasa that one had to take in order to reach the Karak villages in EB I-III and IA. Therefore, the results here are only suggestions. On the other hand, it is possible to make the following observations about the settlement systems of these periods. The EB I-III villages mostly remained in the western half of the drainage but they were separated from each other, unlike the IA villages that formed clusters, especially on the southern plateau in the west Hasa. Consequently, this limited the number of possible crossing points on the main Hasa channel for the IA. Although there are 29 villages in the Hasa in this period, there are only eight paths identified in 'r.drain', as opposed to 7 villages and 6 routes in EB I-III, to cross the dissected landscape of the Hasa to reach the southern plateau.

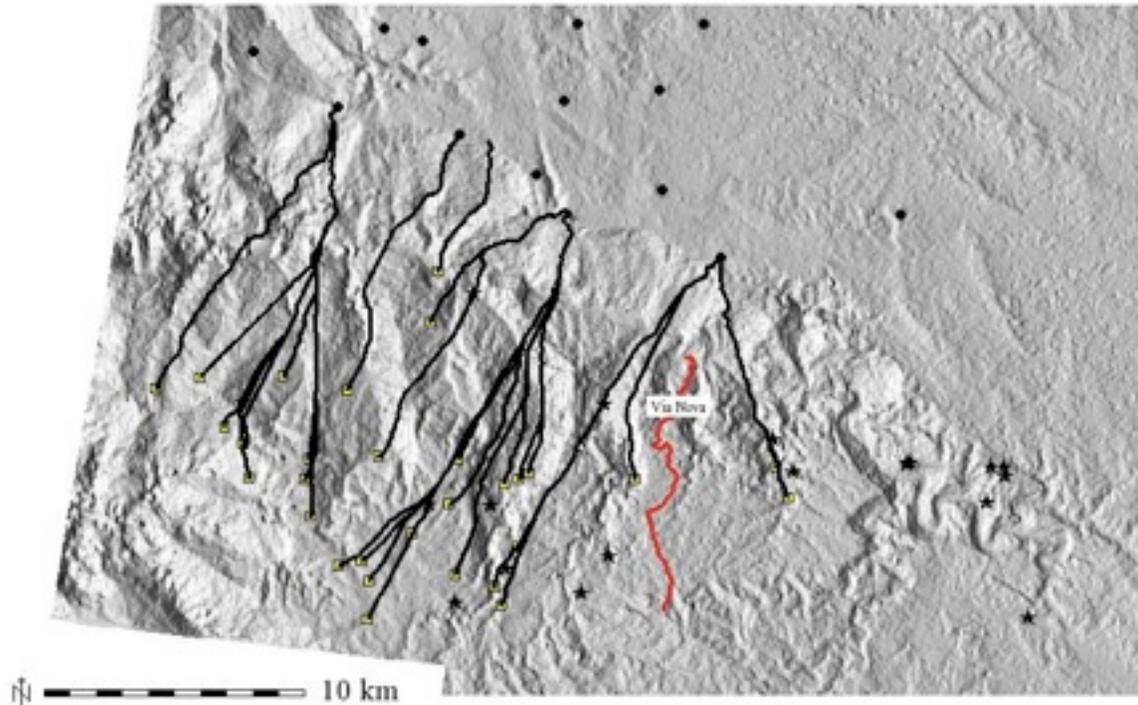


Figure 11. The map of IA villages (black outlined yellow boxes), in relation with military sites (black stars), and the villages on the Karak Plateau (black filled circles). The red line is the Roman Via Nova. The black lines indicate possible trade routes between the Hasa and the Karak Plateau.

D) View Shed Analysis of Military Sites

Combining the results of GIS analyses about the network of military sites and the trade routes, it is now possible to assess how much the trade routes were protected by the military sites, using the view shed analysis in GIS. Figure 12 shows the EB I-III view sheds in relation with the villages and trade routes. The map clearly indicates that the focus of the military sites in this period is the west Hasa, specifically the drainages of Afra and Thamad where the Hasa is much less dissected and the westernmost trade routes are located, and are “visually” covered by three military sites (also see Figure 8). Once the main Hasa channel is crossed using one of these routes, the military sites do not have extensive visual coverage of valleys leading into the southern plateau except for the west-facing bank of Thamad (Figure 12). Therefore, the pattern displayed in Figure 12 supports the statements about the function of the western Hasa military sites made in relation with Figure 8.

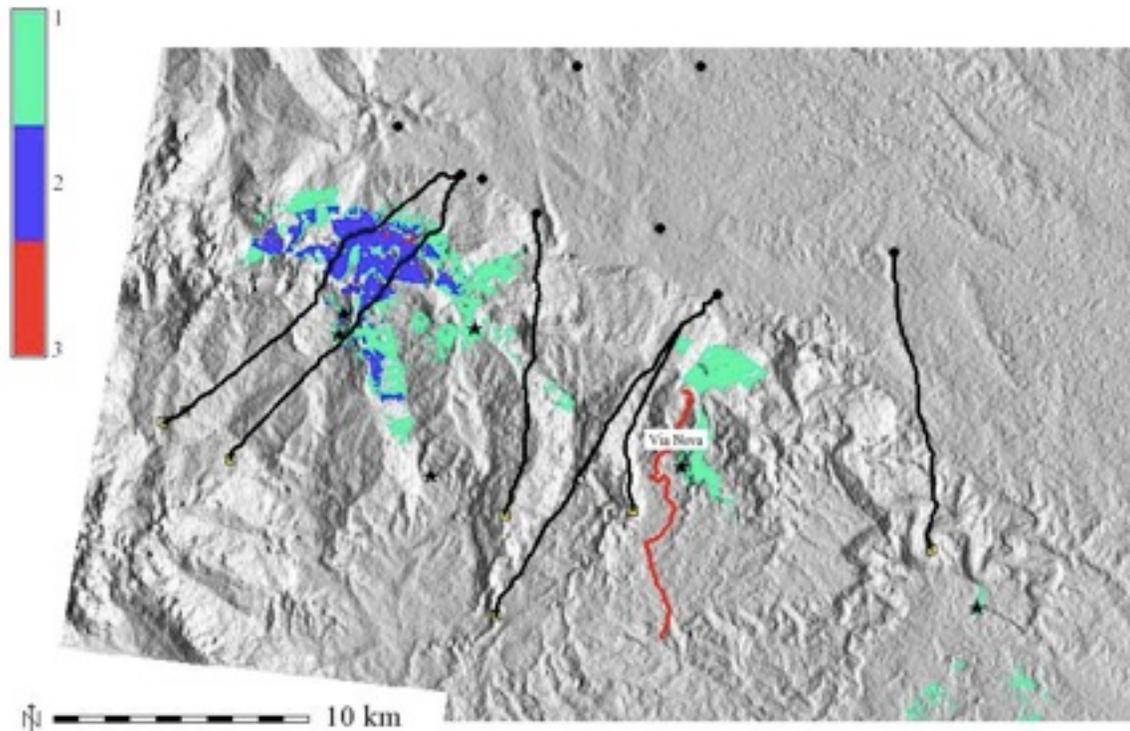


Figure 12. The map of EB I-III villages (black outlined yellow boxes), in relation with military (black stars), and the villages on the Karak Plateau (black filled circles). The red line is the Roman Via Nova. The black lines indicate possible trade routes between the Hasa and the Karak Plateau. The green to red zones are view sheds of the IA military sites. The scale shows how many military sites view a given spot on the landscape.

It is already clear from Figure 9 that the IA military sites are within easy reach of the villages and this is mainly the function of each military site being located at the branching off point of routes. Figures 11 and 13 show a total of five routes –many more if branches are counted– each of which is at least visible by a single military site. The major change from EB I-III to the IA in terms of the visual coverage of the military sites is the shift in the focus from the west Hasa to the east Hasa. In the IA, the military sites have more extensive coverage of the upper Hasa, where the majority of small economic sites are found (Figure 9). The heaviest visual coverage of the possible IA trade routes takes place in central Hasa drainages, an area of the Hasa where many roads were leading to the southern plateau.

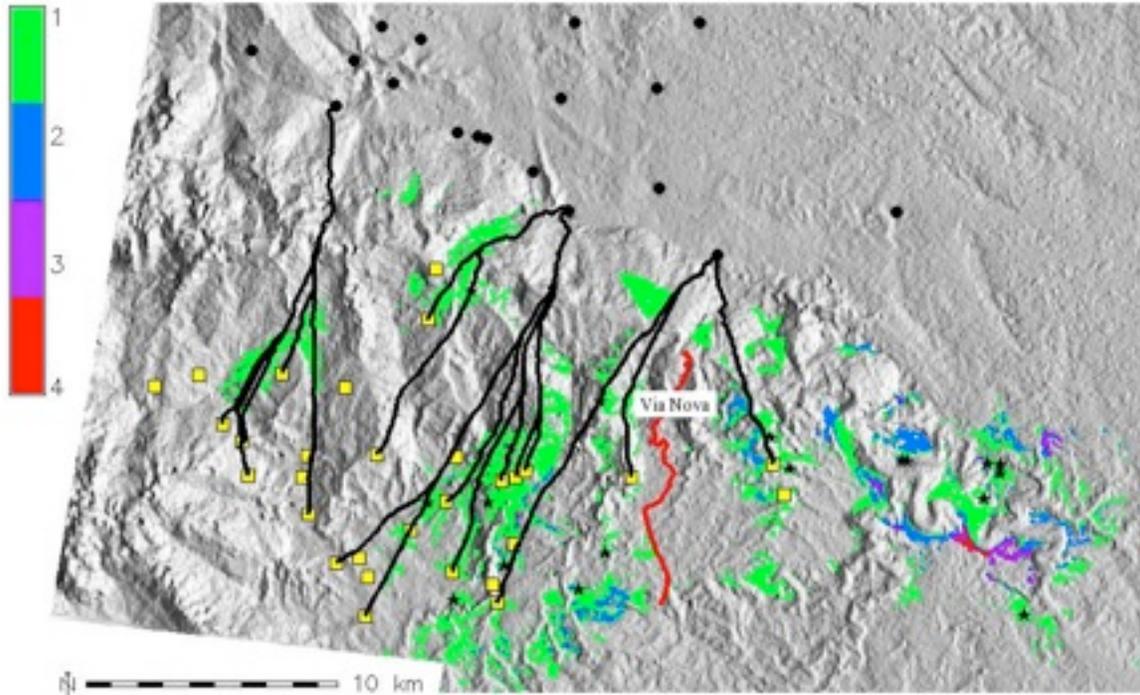


Figure 13. The map of IA villages (black outlined yellow boxes), in relation with military (black stars), and the villages on the Karak Plateau (black filled circles). The red line is the Roman Via Nova. The black lines indicate possible trade routes between the Hasa and the Karak Plateau. The green to red zones are view sheds of the IA military sites. The scale shows how many military sites view a given spot on the landscape.

E) Assessing the Settlement Activity around the Trade Routes

1-EB I-III

The significance of the trade routes identified above can be verified by the settlement activity around them by creating a 1 km-wide buffer around these routes and statistically assessing the variables concerning the settlement systems (i.e., settlement diversity, density, size, and internal complexity) as discussed in the Research Methods section. It is important to note that there are three buffer zones that result from this kind of analysis. The first zone is the origin of calculation (i.e., the route itself). The second zone covers 500-meter wide area on either side of the route whereas the third zone extends for another 500 meters from the route. Figure 14 shows the buffer zones around the EB I-III routes.

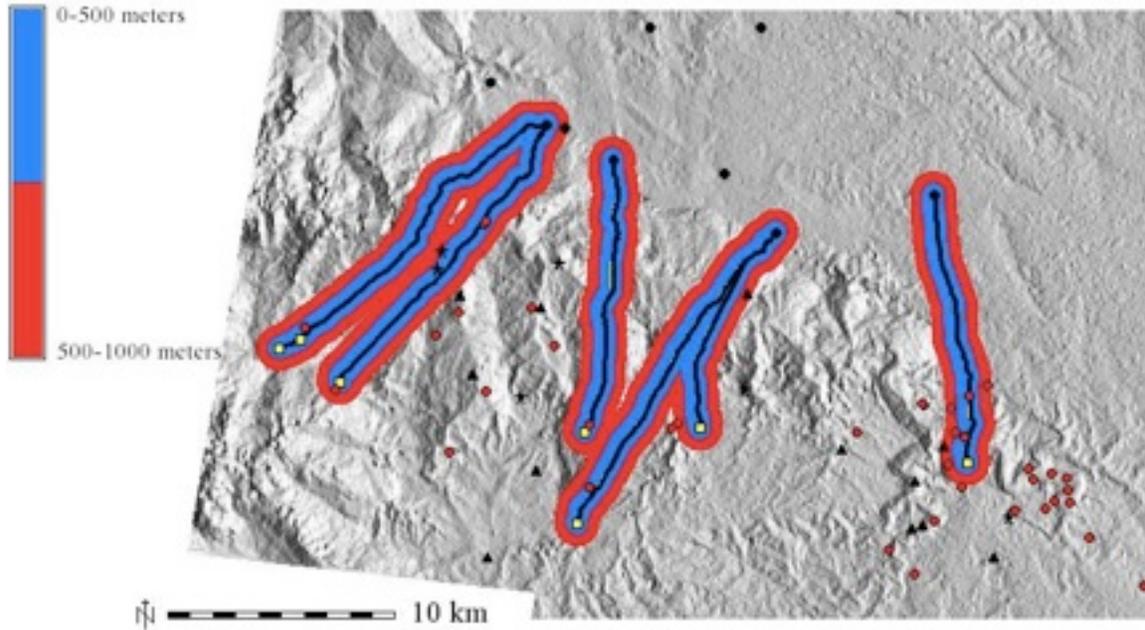


Figure 14. The map showing EB I-III villages (black outlined yellow boxes), military sites (black stars), small economic (black outlined red circles) and activity-facility (black filled triangles) sites. The black lines extending from the Hasa villages to the villages on the Karak Plateau are the suggested routes of communication by the ‘r.walk’ module. The blue-red zones around these routes show the 1 km. buffer (see the legend) around these routes.

The distribution of site types in each buffer zone as well as outside the buffer is shown in Figure 15. The large economic sites (i.e., villages) dominate the first buffer zone (Figure 15a) and this is mainly the factor of calculations involved in creating the buffers: the buffer zone 1 is established directly on the routes and because the routes are identified as the shortest routes between the villages in the Hasa and Karak, villages are the only majority in this buffer zone. In the buffer zones 2 (Figure 15b) and 3 (Figure 15c), small economic sites lead the distribution. Although the frequency of military sites remains the same in these zones, the activity-facility sites are more common in buffer zone 3. The reduced diversity of sites in buffer zones 2 and 3 suggests the lack of a clear pattern in the settlement activity within the buffers. This is also supported by the spatial distribution of sites in Figure 14 and the high diversity of sites outside the buffer (compare Figure 15b, c with Figure 15d).

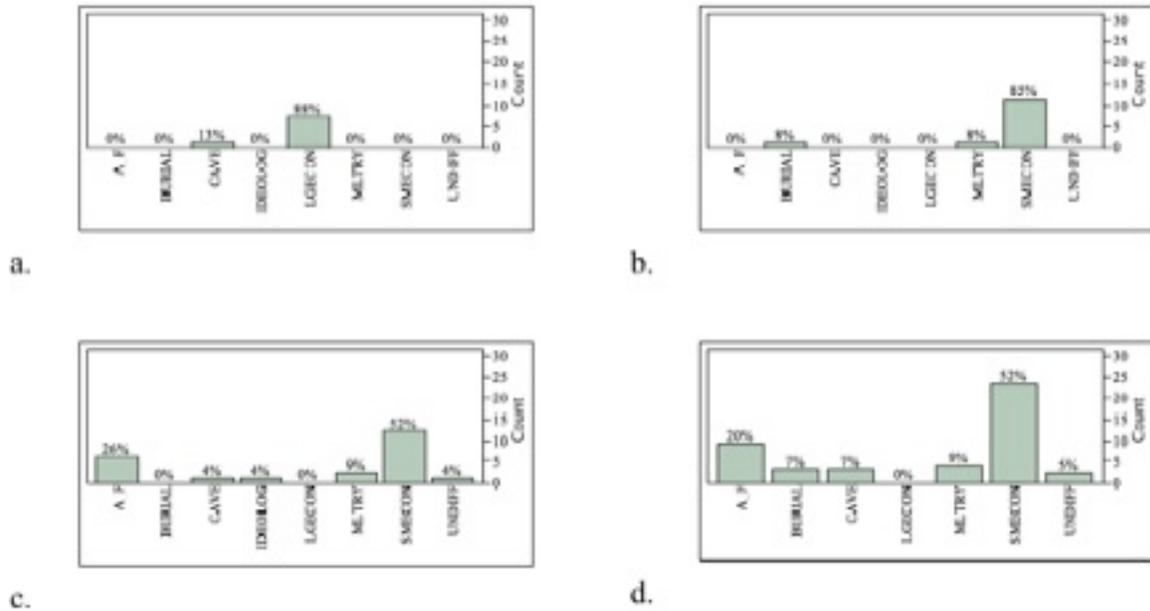


Figure 15. The EB I-III distribution of all site types in buffer zone 1 (a); buffer zone 2 (b), buffer zone 3 (c), and outside the buffer zones (d).

The EB I-III sites within three buffer zones and outside (i.e., labeled as Buffer zone 0) are compared in terms of variations in site size. Figure 16 shows the results of ANOVA where two extremely large sites –over 20,000 square meters– are excluded from the analysis as outliers. ANOVA does not show size-based differences among the sites.

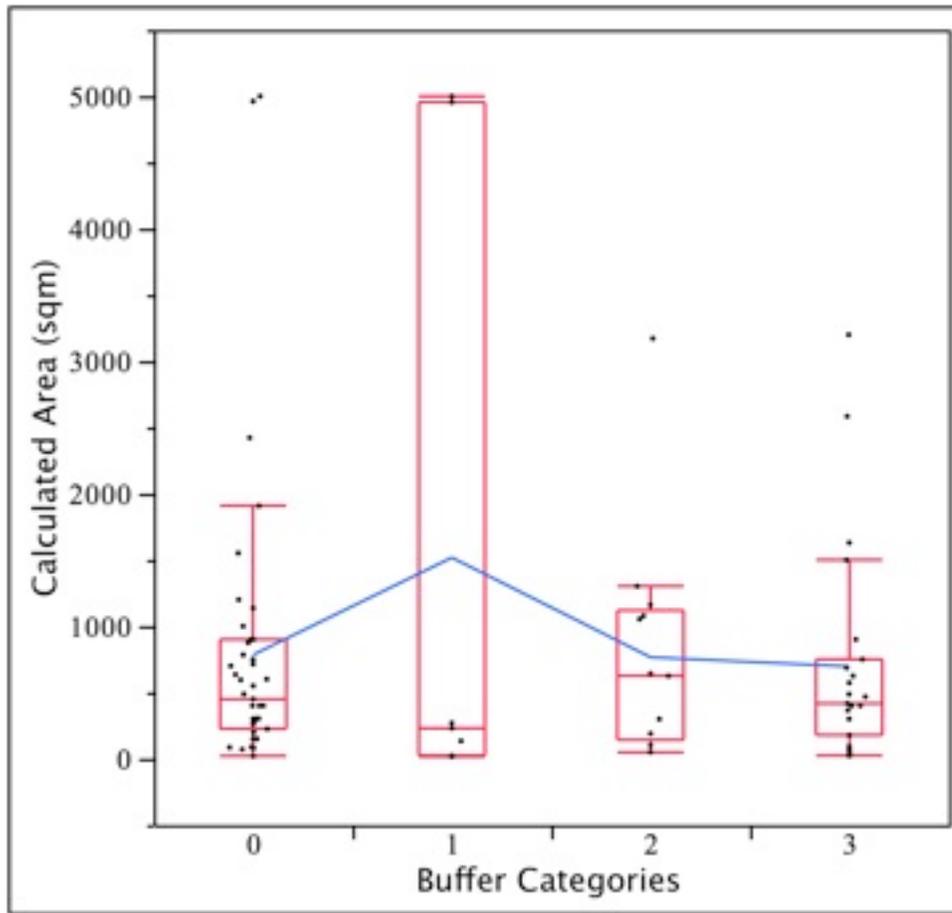


Figure 16. The ANOVA chart for EB I-III sites showing site size variations according to buffer categories ($p=0.3920$). The line connects mean number of features in each period. The result does not show significant change in terms of size of sites within or outside the buffers.

Similarly, ANOVA for the internal complexity of sites does not indicate any change according to this variable (Figure 17). Therefore, neither the site diversity (Figure 15) nor the site size (Figure 16), site complexity (Figure 17) suggests changes in settlement patterns within buffers.

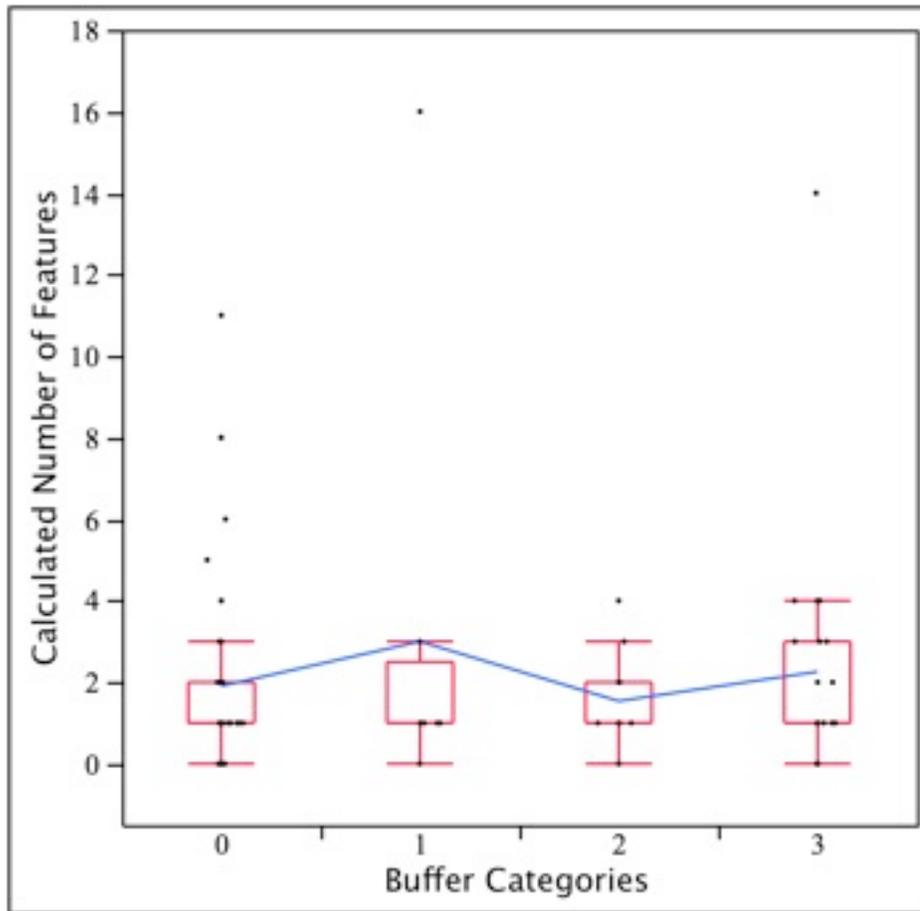


Figure 17. The ANOVA chart for EB I-III sites showing internal complexity variations according to buffer categories ($p=0.6519$). The line connects mean number of features in each period. The result does not show significant change in terms of site complexity within or outside the buffers.

2-IA

The buffer zones around the IA trade routes in the Hasa are displayed in Figure 18. The spatial distribution of the IA sites in this map, in relation to the buffers, is strikingly different than the EB I-III (Figure 14). In the IA, the west Hasa sites other than villages or military sites are also within the buffers with the exception of few sites. This suggests that if these routes were active, the sites (i.e., small economic and activity-facility sites) benefited from being close to them. This distribution becomes more striking when one considers that the majority of such sites are found in the upper Hasa.

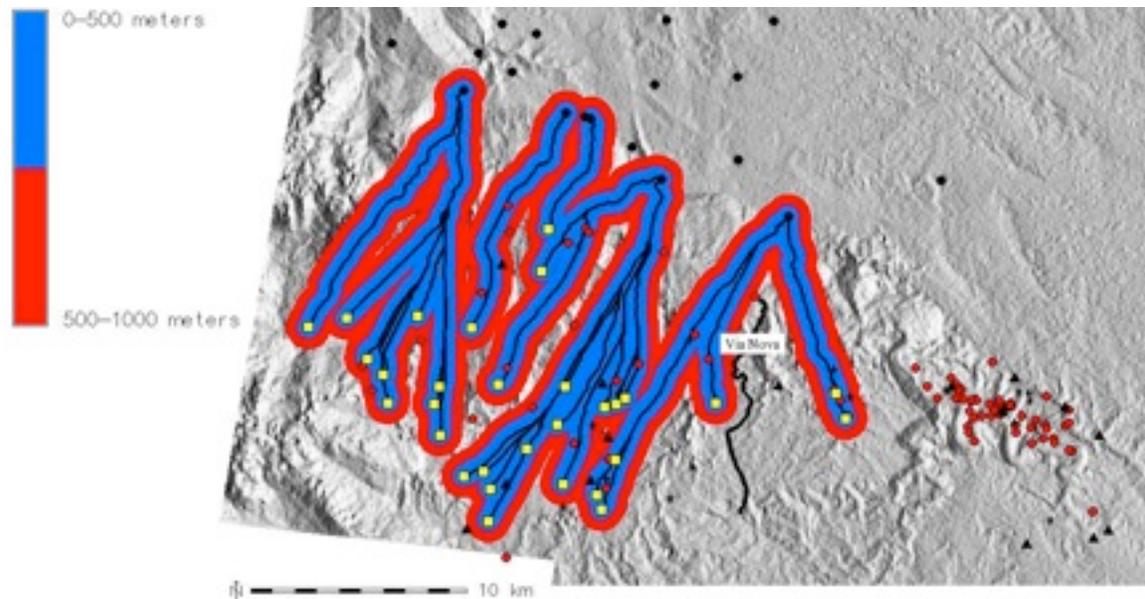


Figure 18. The map showing villages (black outlined yellow boxes), military sites (black stars), small economic (black outlined red circles) and activity-facility (black filled triangles) sites. The Roman Via Nova is labeled on the map. The black lines extending from the Hasa villages to the villages on the Karak Plateau are the suggested routes of communication by the ‘r.walk’ module. The blue-red zones around these routes show the 1 km. buffer (see the legend) around these routes. Note that all non-village sites are within these buffer zones.

The site type distributions according to buffer zones and outside the buffer are provided in Figure 19. The overall pattern in buffer zone 1 (Figure 19a) is similar to EB I-III (Figure 15a): the large economic site is the only type represented. In buffer zone 2 (Figure 19b) both the diversity of site types and the frequency of military sites increase. In the buffer zone 3 (Figure 19c) the site diversity is similar to EB I-III (Figure 15c) however, the important change in the IA is the significant decrease in the frequency of the military sites. Outside the buffer (Figure 19d) the IA patterns are similar to EB I-III (Figure 15d) however, it is important to remember that in the IA, there are very few sites that are immediately outside the buffer. In other words, the remainder of the IA sites, which are not near the trade routes, are actually located in a different part of the drainage (i.e., the east Hasa) than the routes in the west and central Hasa.

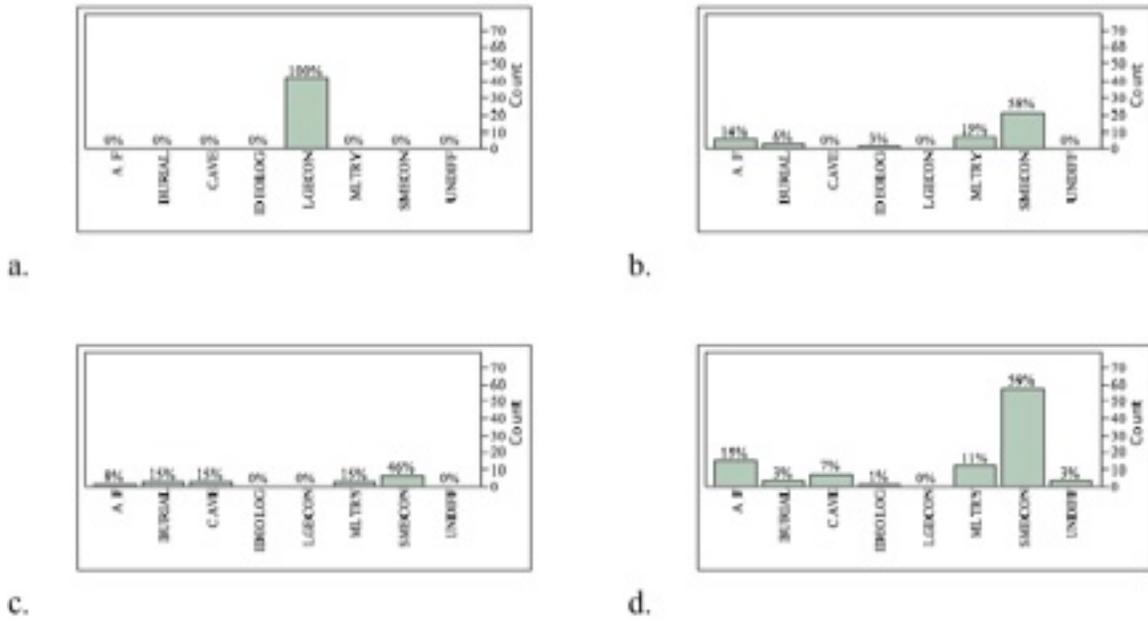


Figure 19. The IA distribution of all site types in buffer zone 1 (a); buffer zone 2 (b), buffer zone 3 (c), and outside the buffer zones (d).

The ANOVA chart (Figure 20), which is based on the site size variable, excludes three outliers that are larger than 35,000 square meters. Like the EB I-III (Figure 16), the result does not suggest significant change in terms of site size between buffer categories.

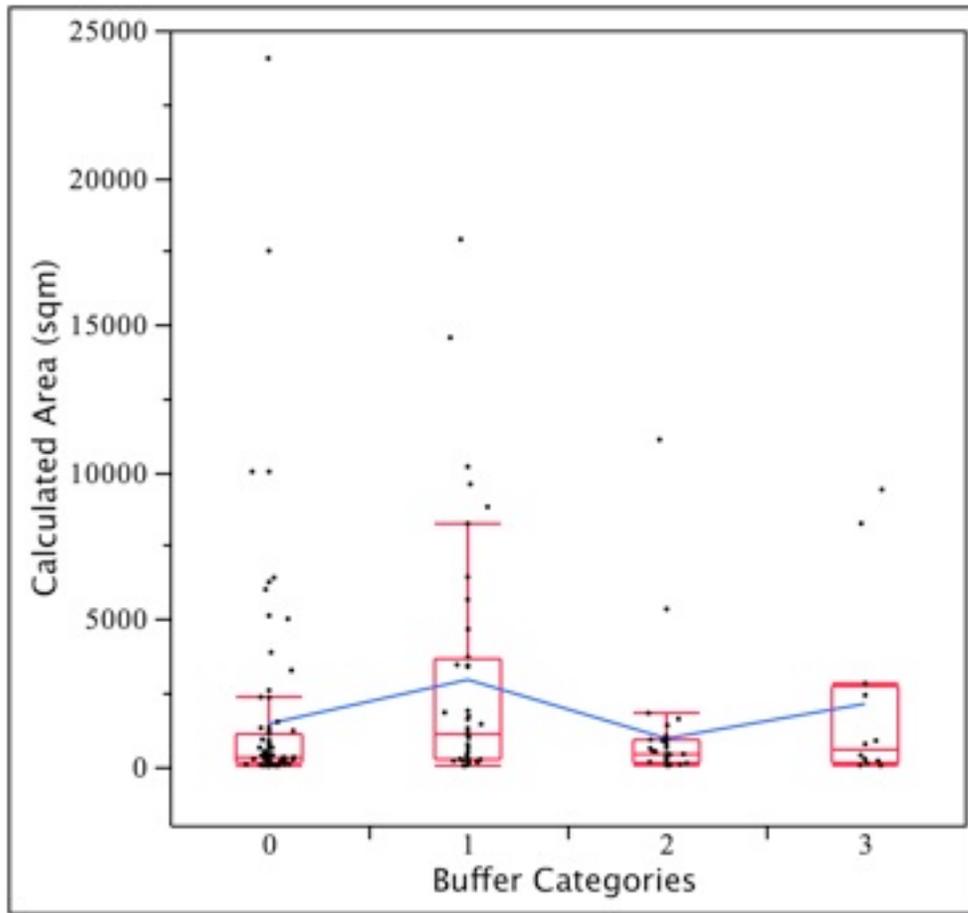


Figure 20. The ANOVA chart for IA sites showing site size variations according to buffer categories ($p=0.0537$). The line connects mean number of features in each period. The result does not show significant change in terms of size of sites within or outside the buffers.

However, the result of ANOVA for the internal complexity (Figure 21) is different than the EB I-III (Figure 17). In the IA, buffer zone 1 has the highest number of features, hence has the sites that are most complex, and this is because this buffer zone entirely consists of villages.

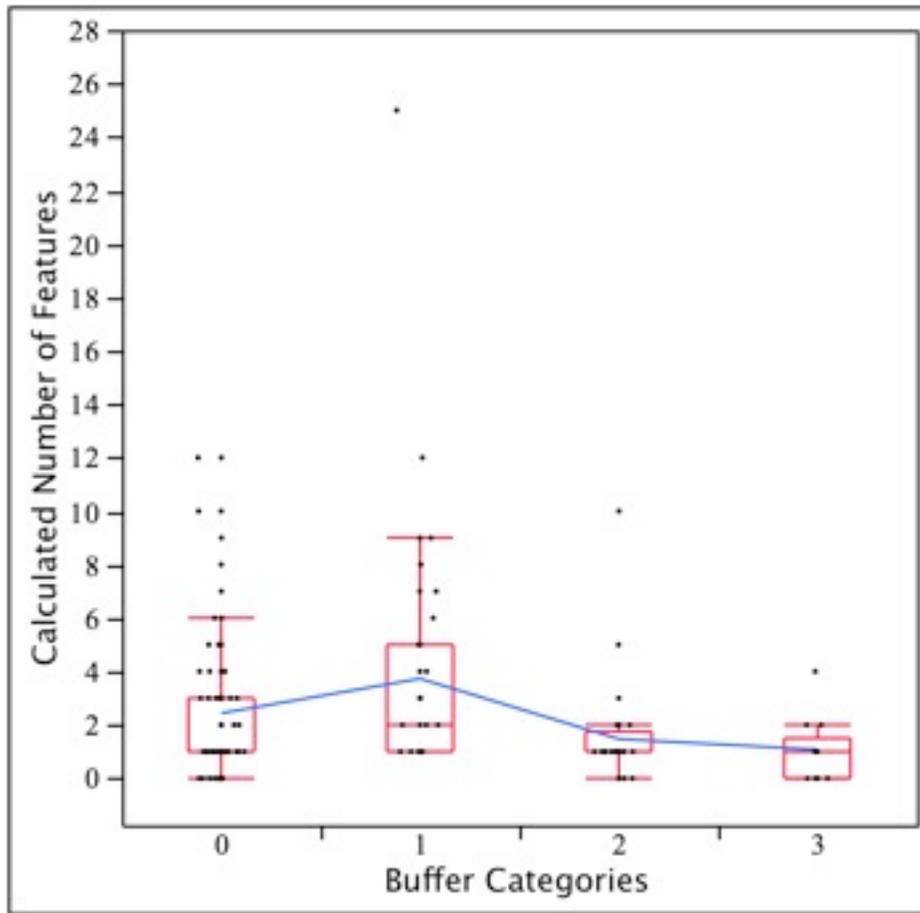


Figure 21. The ANOVA chart for IA sites showing internal complexity variations according to buffer categories ($p=0.0025$). The line connects mean number of features in each period. The result shows significant change in buffer category 1 in terms of internal complexity.

3-Site Density

The final measure to assess the impacts of trade routes on the settlement systems is the comparison of site density within the buffer zones and outside the buffer. The site density calculation is based on the area (in square kilometers) covered by each buffer zone, which can be calculated in GIS. The total area covered by three buffer zones is then subtracted from the total area of the Hasa to find the area that is out of the buffer (Table 6).

Buffer Category	Zone	Area of Buffer Zone (sq Km)	Military Density (Site / Sq Km)	Small Economic Density (Site / Sq Km)
EB z0		813	0.004	0.039
EB z1		0.545	0	0
EB z2		78.876	0	0.139
EB z3		79.412	0.025	0.226
IA z0		703	0.015	0.1
IA z1		1.342	0	0
IA z2		154.016	0.045	0.168
IA z3		114.083	0.017	0.061

Table 6. The area and respective site density data for each buffer zone along the trade routes in EB I-III and IA. Please note that the small economic site category includes the activity-facility sites as well.

Figure 22 is a bar chart comparison of data displayed in Table 6. The pattern displayed in Figure 22 supports the overall increase in settlement activity in the IA (i.e., compare EB z0 with IA z0: the areas outside the buffer). The major change from EB I-III to the IA is however in the spatial preference of military sites: during the EB, they are mostly located in buffer zone 3 (i.e., red column in EB z3 in Figure 22) whereas in the IA they moved closer to the trade routes and villages since they are heavily present in buffer zone 2 (i.e., red column in IA z2 in Figure 22). A similar change is also observed for the small economic sites –blue columns–. The comparison of EB z3 with IA z2 reveals that small economic sites –in the west and central Hasa– move closer to the routes hence they are always within the buffer zone.

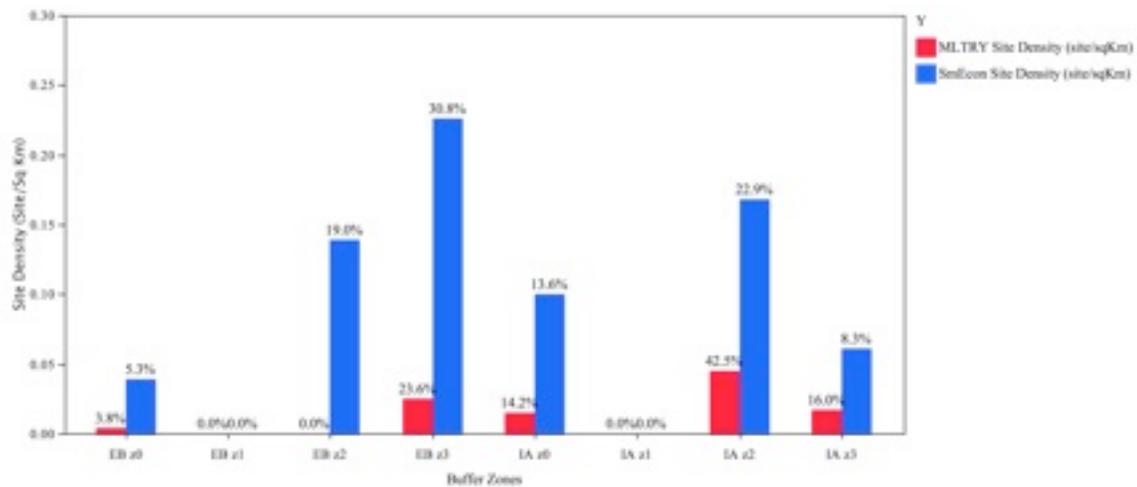


Figure 22. The bar chart comparing the percentages of sites in each buffer zone in the Hasa during EB I-III and IA. The y-axis shows site density in each buffer zone. The site types are color-coded (see the legend).

F) The Assessment of Peripheralization

The low frequency of villages in EB I-III suggests that the increase in the settlement density and diversity in this period can be the result of local (i.e., autochthon) changes (i.e., gradual population increase, warmer and wetter climate, population aggregation, and economic intensification through cooperation) when the Hasa was not fully integrated with the rest of the region via long-distance trade. The IA settlement systems suggest exponential increase in diversity and site density at a time when adverse climatic conditions were persistent. Therefore, the roles of long-distance trade as well as the regional political events of this period (i.e., the Moabite peripheralization of the Hasa) need to be addressed for better understanding of the IA settlement systems.

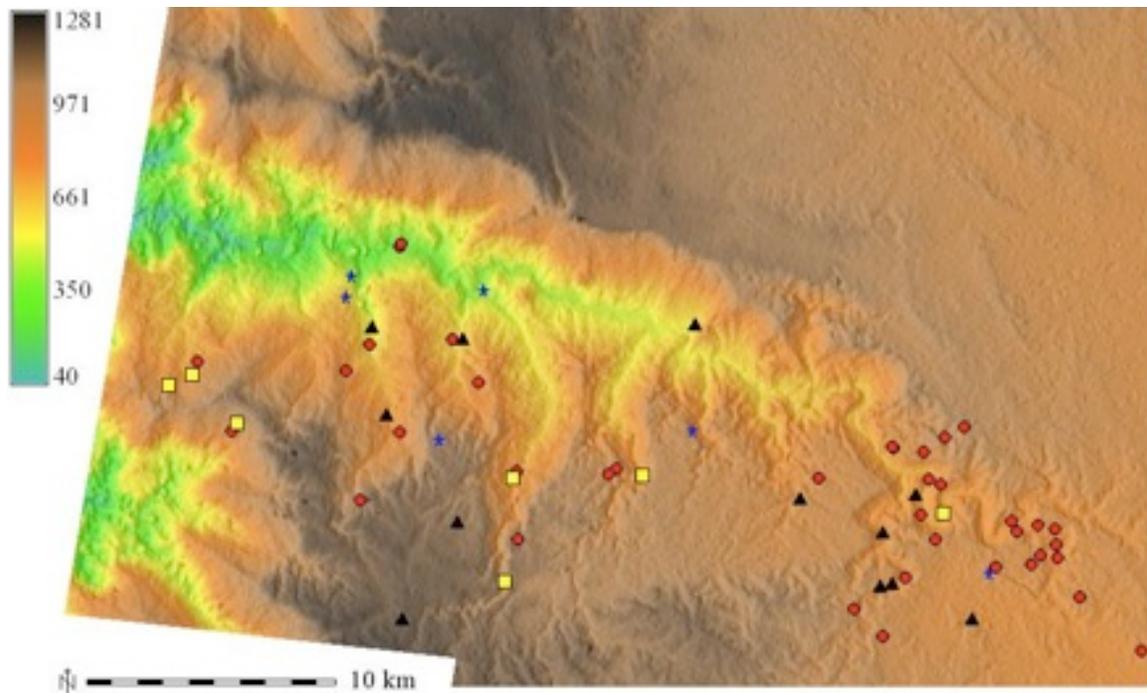


Figure 23. The EB I-III villages (black outlined yellow boxes), military (blue stars), activity-facility (black triangles) and small economic (black outlined red circles) sites. The majority of settlement activity is reserved to the upper Hasa but the west-central drainages show signs of lighter settlement activity with variety of site types. This is the major difference, other than the density of settlement, with the IA settlement system. The legend shows elevation (meters above sea level).

Comparing the IA site distribution (Figure 24) with the EB I-III (Figure 23), it is apparent that the IA site type variation is greatly reduced in the west-central portion of the Hasa. The IA sites here are mainly villages, with some military sites and few small economic and activity-facility sites. In the upper Hasa on the other hand, the composition of settlement does not change significantly: the frequency of small economic and activity-facility sites increase in IA accompanied by few military settlements. This creates an almost “divided” use of landscape where especially the southern plateau of the west Hasa is reserved for the IA villages as opposed to the upper Hasa being settled by sites that focus on direct production of foodstuff.

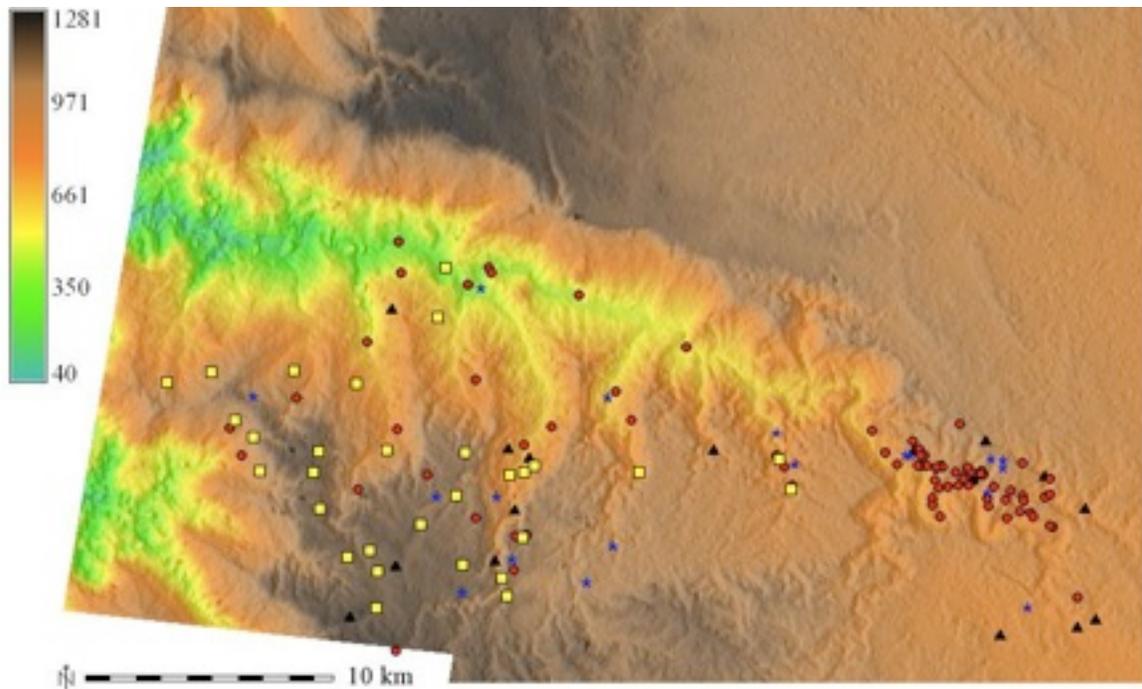


Figure 24. The IA villages (black outlined yellow boxes), military (blue stars), activity- facility (black triangles) and small economic (black outlined red circles) sites. The heavy settlement activity on the southern plateau, which is mainly consisted of villages, is striking in this period. It is notable that the small economic and activity-facility sites are denser in the upper Hasa, which creates rather sporadic distribution of such settlements in the lower Hasa, except for the military sites. The legend shows elevation (meters above sea level).

The IA clustering of villages on the southern plateau also needs to be considered from the aspect of long-distance trade as discussed above. Based on changes in settlement patterns and given the fact that the reduced population from the EB IV-LB cannot increase so significantly in such a short period (Figure 2), the presence of an external stimulus for IA settlements and source of population, such as the Moabite state, is likely.

VI- Conclusion and Broader Impacts

The focus of this article has been complementing the earlier work (Arıkan n.d. a; n.d. b) since the theoretical framework and the discussion of the IA settlement patterns have been explored from different perspectives in this article. The Synthetic Approach puts emphasis on the economic flexibility and dynamic social relationships among the tribal groups in marginal landscapes of the eastern Mediterranean for social change and emergent complexity. As part of this approach, two factors: cooperation/competition and trade/exchange have been analyzed for their possible roles in early metal age social transformations in the context of the Hasa, using the settlement data.

The analysis of data suggests that tribal cooperation and competition dynamics are clearly visible in the Hasa settlement systems from the Chalcolithic to the IA. Although the drainage suffers from a major depopulation and abandonment between

2,400 and 1,200 BC, it is clear from the results that prior to this collapse, the tribes in the Hasa make extensive use of resources and establish a military system for protecting the economic infrastructure (Figure 8). This military system reaches the level of network in the IA: during the time period when the aridity reaches its peak and environmental conditions make self-sustaining subsistence practices more prone to failure in marginal landscapes. The analysis of data suggests that the network of military sites diversify their functions by adding protection of trade routes that connect the Hasa with Karak in addition to securing the economically valuable portions of the area such as the Upper Hasa (Figure 9).

The changes in EB I-III and IA settlement systems (Figures 23 and 24) also suggest that the sudden and exponential increase in the settlement activity during the latter period cannot be explained in terms of gradual and local development, which has been the case for the EB I-III period. Subsequently, the assessment of the IA settlement patterns in the political and economic context of this period shows that the IA sites of the Hasa suggest the incorporation of the drainage into the Moabite sphere of influence –the peripheralization of the Hasa– since dense population, multi-tier settlement hierarchy, and intensive agricultural production have been known to exist in this part of Jordan as early as EB I-III (Miller 1991; Hill 2006). Under political conditions where territorial states gain significance in the political landscape of the southern Levant and with the growing competition among Israel and Edom, the Moabite state might have found it both economically feasible and politically just to expand into the Hasa proper. In doing so, the Moabite state not only secure its southern border with Edom by creating a buffer zone but also takes economic advantage of the Hasa through resource extraction and land use (i.e., mainly for grazing herds).

The last but more significant economic benefit of controlling Hasa is the King's Highway: an ancient trade route that bisects the Hasa at its western extremity. As the results suggested (Figures 11, 14), the IA villages are almost entirely located on the southern plateau, benefiting from higher rainfall while controlling trade between the Hasa tribes and the merchants using the road. This is further supported by the divided nature of the IA settlements: great majority of small economic sites occupying the Upper Hasa and military sites distributed to create a network that covers the whole drainage.

In this political and economic context of the IA, the social evolution of the Hasa tribes may take the path discussed in the Synthetic Approach (Arıkan n.d. a) and complex social organization may be possible following the scale-free networks concept (Arıkan n.d. b). These results are important in underlining the possibility that the marginal regions of the eastern Mediterranean cannot be excluded from discussions of emergent complexity without a readjustment in research focus and methods of analyses.

The research methods used here are standard, reliable, replicable, and flexible. Although the use of GIS is relatively new in archaeology, its analytical power is promising especially for enhancing our understanding of spatial aspects of archaeological data, human-environment interactions, and temporal changes in these variables. The use of GIS allows researchers to experiment with data and create alternative scenarios, which then contributes to the more comprehensive testing of research questions, leading to more

robust theories. As this research contributes to the social evolution of archaeological cultures in the dry lands of the eastern Mediterranean, several broader implications emerge. These can be summarized as: (1) replacing the predominant view that portrays tribal society as dependent to another group or assumes stagnant social organization with socially dynamic, economically flexible and resilient perspective, (2) applying alternate theories of social complexity to the regions of the eastern Mediterranean where climate and landscape show marginal characteristics, (3) developing research frameworks where human-environment interaction is a major focus and spatio-temporal variations or shifts are addressed as part of social, economic, and political reorganization rather than collapse, cultural apocalypse or other similar extreme interpretations, and (4) employing new methods that will complement the existing ones and will contribute to understanding the dynamics of coupled socio-ecological systems.

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