Confronting scales of settlement hierarchy in state-level societies: Upper Mesopotamia and Central Anatolia in the Middle Bronze Age

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Confronting Scales of Settlement Hierarchy in State-Level Societies: Upper Mesopotamia and Central Anatolia in the Middle Bronze Age

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Abstract: In this article, I adopt a long-established method known as rank-size analysis to detect particular settlement patterns in the Khabur Triangle (KT) and central Anatolia (CA) during the Middle Bronze Age. Archaeologists must be particularly careful when applying rank-size analysis to a given study area as the results can change at a different spatial scale. With these premises in mind, in this work, I first show the results produced by performing rank-size analyses on the two whole study areas and assess comparatively any difference in the observed patterns between them. Second, I break down each study area into smaller window analyses in order to detect how settlement size distributions change at a more local scale. The results show that at a larger regional scale, both central Anatolia and the Khabur Triangle in the Middle Bronze Age are characterized by fragmented politically landscapes of competing independent polities loosely integrated. By contrast, at smaller local scales central Anatolia and the Khabur Triangle show a different picture. In central Anatolia settlement systems appear more nucleated in large centres dominating their surrounding rural hinterlands and strong political and economic centralization is evident at Kültepe and Boğazköy. On the other hand, in the Khabur Triangle settlement primacy is less accentuated and the polities are more loosely integrated. These examples demonstrate the advantage of using rank size analysis at different spatial scales for having a complete understanding of the dynamics behind the observed empirical data.

Keywords: Rank-size analysis, cluster analysis, settlement hierarchy, city-states, urban systems, Near East, Middle Bronze Age, Upper Mesopotamia, Central Anatolia

1. Introduction

Identifying regional settlement hierarchy by using site size has been a common practice among geographers, economists and archaeologists in the past decades (Zipf 1949; Crumley 1976; Dziewonski 1972; Kowalewski 1990; Krugman 1991a-b; Roberts 1996; Pumain and Moriconi 1997; McAndrews *et al.* 1997; Brakman *et al.* 1999; Blank and Salomon 2000; Clauset et *al.* 2009; Berry and Okulicz-Kozaryn 2012; Cristelli *et al*. 2012; Jiang et al. 2015). In particular, urban primacy (or nucleation), in the form of an excessive concentration of population in a few central cities, and dispersion as a population evenly distributed across settlements of equal size represent the extreme patterns among a wide range of possible site size structures (see Jones 2010; Peterson and Drennan 2011; Crema 2013; Duffy 2015; Altaweel *et al.* 2015). In this perspective, the rank-size graph has been used in archaeology for over 40 years for studying population distributions and regional settlement patterns (e.g. Johnson 1972, 1977 and 1980; Blanton 1976; Crumley 1976; Pearson 1980; Adams 1981; Kowalewski 1982; Paynter 1982; Falconer and Savage 1995; Savage 1997; Fall *et al.*1998; Savage and Falconer 2003; Drennan and Peterson 2004 and 2008; Wossink 2009, 89-91; Marzano 2011; Crema 2013 and 2014, Duffy 2015; Smith 2015, 326-328). Many scholars have legitimately criticised a linear relationship between site size and settlement hierarchy in middle-range and stateless societies (see Crumley 1979; Kantner and Kintigh 2006; Peterson and

Drennan 2011; Duffy 2015) and emphasized how settlement size distributions can be the product of other factors such as climate events (Habu 2001; Chatters and Prentiss 2005), subsistence strategies (Vita Finzi and Higgs 1970; Flannery 1976; Kohler 2004; Ullah 2011; Crema 2013 and 2014), seasonal occupation (Flannery 1976; Price and Brown 1985; Kelly 1992), group fission (Forge 1972; Johnson 1982; Crema 2013) and functional specialization (Renfrew 1974; Renfrew and Level 1979; Pearson *et al.* 2006). However, when dealing with state-level societies, characterized by territorial compactness and a capital city or town economically and politically integrated with its immediately surrounding rural hinterland, an association between site size hierarchy and political centralization is still valid (see Wright 1978 and 1986; Hinsley 1986, 22-26; Trigger 1993, 8-14; Charlton and Nichols 1997; Fall *et al*. 1998, 111-112; Hansen 2000 and 2002; Savage and Falconer 2003; Smith 2003, 149-183; Ur 2013; Altaweel *et al.* 2015; Palmisano and Altaweel 2015a).

Bearing in mind the above issues, in this article I investigate in a comparative perspective, which different dynamics produced past human settlement hierarchy in the Khabur Triangle (KT) and in Central Anatolia (CA) during the Middle Bronze Age (ca. 2000-1600 BC; MBA). In this period, the distribution of settlement sizes in these regions was relatively broad, with numerous small and medium sized sites and only a few large sites. This settlement structure arguably reflects the actual political landscape in the early second millennium, which was fragmented into several independent city-states (for CA see Veenhof and Eidem 2008, 147-179; Barjamovic 2011, 6; Barjamovic *et al.* 2012, 48-50; Palmisano 2014; Palmisano and Altaweel 2015a and 2015b; for the KT see Charpin and Ziegler 2003; Veenhof and Eidem 2008, 290-321; Ristvet 2008 and 2012; Palmisano 2015; Palmisano and Altaweel 2015a and 2015b; Altaweel *et al.* 2015). Hence, I use in combination two long-established methods such as rank-size and *k*-means analyses to respectively assess settlement size structures and identify spatial clusters of settlements as an approximation of spatially defined political units. I will use a multi-scalar approach to detect specific spatial and functional patterns on both local and regional scales and to tackle possible misunderstandings derived from analysing data just on a single scale of analysis (see discussion in Daly and Lock 2004; Mathieu and Scott 2004; Lock and Molyneaux 2006). Scholars have pointed out how different scales of approach may produce different results and mask significant spatial variations detectable only at a specific scale of analyses (Bird 1989, 22; Goodchild and Quattrocchi 1996, 5; Harris 2006, 48-50). In particular, Drennan and Peterson (2004, 535-539) have emphasized this problem by comparing the results of rank-size analyses obtained with sample blocks of four different sizes. More recently, Cristelli *et al.* (2012) advocated a broader use of multi-scalar approaches since economic and political integrated settlement systems are discernible only at a given geographical scale (e.g. the national state in the modern European Union).

I firstly begin with a review of state-level societies and in particular of city-states. I then provide background about the two case studies in the section below. Then, I introduce and explain the rank-size and *k*-means methods and the advantages of multi-scalar modelling approaches. Subsequently, the modelling results, including outputs from the two different methods used, are provided. Finally, conclusions are drawn with regard to the methodology and its potential for understanding the development of settlement hierarchies.

2. Background

2.1 Defining cities, states and city-states

Archeologists, sociologists, anthropologists, and historians have attempted to classify states according to a wide range of different criteria. Some scholars have focused on the administrative and bureaucratic apparatus, framing the state within either a simpler or more elaborated structure (Weber 1978, 1028-1031), or they have offered a more complex taxonomy based on the development of social and hierarchical ties among different political agents (Claessen and Skalník

1978, 22-23; Crumley 1995). Other scholars have preferred to emphasise a close relationship between early urbanism and complex forms of social organization and how the economic and political centralization of the state manifests itself in the form of nucleated settlements (see Fox 1977; Ades and Glaeser 1995). Fox pointed out that the administrative and centralized structure of the state is an extension of the bureaucratic city, due to its capability to extract sources and labour from the surrounding rural hinterland (1977, 34-37). On the other hand, Trigger separates the discussion between urban and state formation by asserting that states can exist without cities, but not vice-versa (1972, 576). Trigger is even more categorical by recognizing only two kinds of states: city-states and territorial states. The first one indicates an urban centre and its hinterland, while the latter one was a larger entity with multiple administrative centres ruled by residents linked to the state (Trigger 2003, 266-267). Nevertheless, Hansen (2000, 16) objects to this dichotomy and says that a city-state is merely a territorial state with a small territory and well-defined borders. In addition, he suggests that it is more appropriate to replace the misleading term “territorial state” with “macro-state” to denote those “states in possession of a large territory dotted with urban centres, of which one is capital” (2000, 16). Hence, the city-state is one of the most common forms of micro-state. Slightly different is the position of Marcus (1998, 92), who argues that territorial and city-states “were often different stages in the dynamic cycles of the same states, rather than two contrasting socio-political types,” and that the clusters of city-states in a specific area was the result of the political collapse of earlier unitary states.

Our understanding of city-states as socio-political unit has been significantly enhanced by the massive comparative study of thirty-six city-state cultures promoted by Hansen (cf. Hansen 2000 and 2002). Hansen deliberately draws an idealised picture (2000, 17-19), in which a city-state is a highly institutionalized and centralized political unit characterized by one capital city or town that is well-integrated socially with its surrounding hinterland and inhabited by a stratified population in which there are citizens, foreigners, and slaves. Within the city-state territory there could have been other nucleated settlements apart from the major urban centre, but in such cases, they are second-order settlements (Fig.1). The territory is also sufficiently small that its boundary can be reached in a day’s walk out or less[1], and hence the number of people acting as privileged political actors is also small[2]. Hansen (2000, 15) argues that the population of a city-state may share an ethnic identity with the population of neighbouring city-states, as its sense of political identity is primarily embodied via the city itself and differentiated from other city-states (see also Emberling and Yoffee 1999). On the other hand, some scholars have conceived the city-state as ethnically distinct from other neighbouring city-states (cf. Burke 1986; Marcus 1989, 201; Trigger 1993, 8-14; Charlton and Nichols 1997, 1).

Numerous pieces of archaeological evidence suggest that urban centres did not have enough land to sustain their population, and thus they relied upon food surplus produced by rural communities dispersed around the cities (Wattenmaker 2009, 116).

The city-state is not necessarily independent and can be tributary polity or domain of another city-state, or of a territorial state (Hansen 2000). Perhaps boundaries between city-states were continuously contested and centres competed with one other in order to guarantee the control of natural resources, with particular geographical features having a strategic military role (e.g. mountain passes, commanding views over landscape from the top of hills, fords, etc.), and grazing lands (Yoffee 2004, 56). Both settlement patterns and texts reveal that the city-states were often part of a “peer-polity system,” a world of politically independent but economically and socially interdependent and roughly equivalent polities (Renfrew 1986, 1; Wattenmaker 2009, 118,123).

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[1] The ideal maximum extent of the surrounding hinterland has been defined by Hansen of around 30 km and, generally, the size of a city-state ranges between 10 and 3,000 square kilometers (2000, 17).

[2] A city state has usually a population of several thousands of inhabitants (Hansen 2000, 601). Nevertheless, very small city-states can also have a population lower than one thousand inhabitants (Di Cosmo 2000, 397), while over-sized city-states may reach 100,000 number of inhabitants (Hansen 2000, 18; Yoffee 2004, 62).

The success of the larger territorial states depended on the ability of the new rulers to coerce and co-opt the urban elites of the former city-states within the structural and political texture of their regional kingdoms (Roth 1997, 76-81; Garfinkle 2013, 116). Those elites, in fact, were at the centre of the ideological and redistributive networks of the cities, as administrative, religious and military officers. The study of the available archaeological end textual evidence has revealed that the political landscapes of western Asia probably witnessed a series of repeated cycles from small political entities to large territorial states over the course of the period from the fourth to the first millennium BC (Marcus 1998; Strange 2000; Thuesen 2000; Hansen 2002, 13; Yoffee 2004, 131-160; Ur 2010a, 404-414; Ur 2013, 148-152). During this period, city-states remained the more stable and longest-lasting political unit, while the larger regional kingdoms were often politically fragile and could last only one a generation or a single dynasty (Garfinkle 2013). At this point, “one can present a model of Mesopotamian history in terms of a pendulum swinging between periods of political fragmentation and central rule” (Barjamovic 2013, 123). At times, the region was divided into hundreds of city-states and tribal communities, and at other times a large and centralized state imposed its authority upon numerous and weaker existing political entities. The political centre of a larger territorial state may have been a former city-state that rose to supremacy (see Carneiro 1970 and 1981; Turchin *et al.* 2013; Altaweel *et al.* 2015).

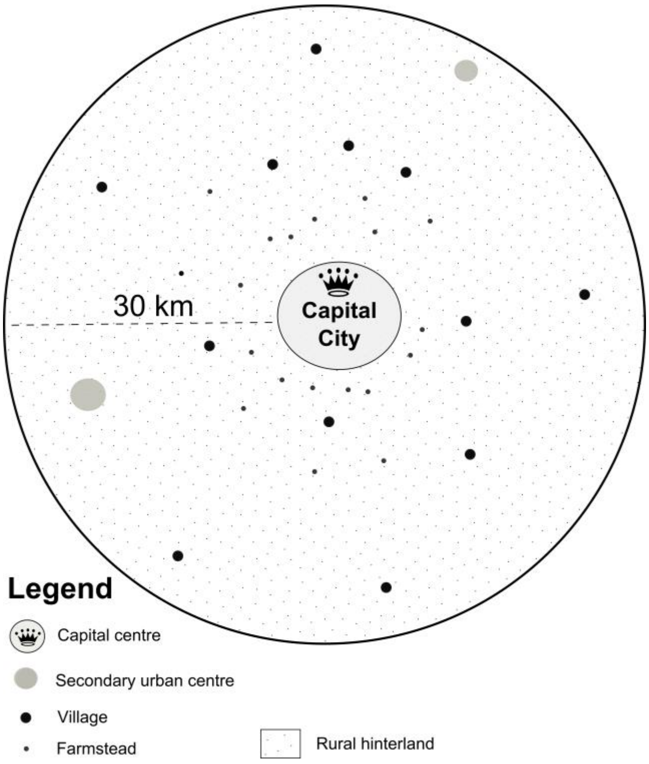

Figure 1. A schematic, highly stylised model of city-state (based on Hansen 2000).

2.2 Case studies and historical background

For the purpose of this project, two different well-defined regions have been chosen. The first case study is the KT (Fig. 2a), an area located within the Syrian Jazira, measuring some 16,500 km^2 and extending between the Tigris and Euphrates Rivers, bounded by what is today the Syrian/Iraqi border to the east, the Syrian and Turkish border to the north, the Jebel Sinjar and by the Jebel 'Abd-al-Aziz to the south and the Khabur River to the west. The second case study is CA (Fig. 2b), a region covering a total area of about 71,000 km^2 between the Pontic Mountains to the north and the Taurus mountains to the south. The choice of the two regions has been influenced (1) by the limited number of regions where a sufficiently high intensity of archaeological excavations and surveys has been conducted, and (2) by the need to provide a coherent framework for analysing settlement systems in two regions characterized by a similar patchwork of numerous small city-states during the MBA and two different geographical settings, an open tableland in the KT versus a mountainous inland area with large intermountain river valleys in CA.

The surviving cuneiform corpus from Upper Mesopotamia has yielded few textual clues for the first two centuries of the second millennium BC. On the other hand, the scantiness of written sources from the first two centuries of the second millennium BC (*ca.* 2000-1800 BC) contrasts with its richness in the 18th century BC. In fact, the archives from Tell Leilan, Tell al-Rimah, Mari, Tell Šemšara and Chagar Bazar have provided a large amount of data for reconstructing the political and economic geography of Northern Mesopotamia in the 18th century BC. Tell Leilan's Eastern Lower Town Palace archive has yielded 600 clay tablets (e.g. administrative texts, letters, and political treaties) retrieved during the archaeological excavations carried out in 1985 and in 1987 (see Eidem 2010). These documents are important for reconstructing the history of Šubat-Enlil/Šehna during the period of its last three kings Mutiya, Till-abnû and Yakūn-Ashar (*ca.* 1750-1728). Mari has yielded a huge amount of written sources (*ca.* 22,000 clay tablets) that have allowed scholars to reconstruct the political geography in the Middle Euphrates and in Northern Mesopotamia during the period of Yashmakh-Addu and Zimri-Lim's kingdoms (*ca.* 1800-1758 BC). Other texts come from Tell Šemšara (146), Tell al-Rimah (269), Tell Taya (2), Chagar Bazar (218), Tell Ashara (ca. 550), and Tell Bi'a (ca. 380). From the available textual evidence, it seems that the Khabur Triangle was fragmented into several city-states in the first two centuries of the second millennium BC (2000-1800 BC). Tell Leilan was not occupied during the Leilan Period IIc (*ca.* 2200-1900 BC). In the late 19th century BC and in the first half of the 18th century BC the Khabur Triangle was under the control of several short-lived regional states able to conquer large territories as a consequence of military successes. Šamši-Adad conquered Aššur in 1808 and then extended his dominion westward to Tuttul on the Balikh River, and he founded a new royal capital at Šubat-Enlil, modern Tell Leilan (Villard 1995, 873; Charpin and Ziegler 2003; Van de Mieroop 2007, 107). In order to control a so large kingdom Šamši-Adad I (1808 – 1776 BC) put his sons on the throne at two strategic locations. The eldest, Išme-Dagan (1775-1761? BC), was appointed king of Ekallatum, a kingdom stretching from the Zagros mountains to the Tigris River, while the younger Yasmakh-Addu became king of Mari. After Šamši-Adad I's death, Yasmakh-Addu was defeated by the king of Yamkhad Yarim-Lim, who helped Zimri-Lim (1780 – 1758 BC) to become the new king of Mari and establish his power over the northern Jazira. In the second half of the 18th century the Khabur Triangle once again became a patchwork of several small city-states characterized by fluid and ambiguous borders (Eidem 2000 and 2008; Ristvet 2008).

In central Anatolia, most written sources (c. 22,500 clay tablets) come from the archaeological site of Kültepe and a little more than one hundred from other sites in central Turkey such as Bögazköy (72 texts), Alişar Höyük (63), Kaman Kalehöyük (2), and Kayalıpınar (1; see Michel 2003, 2006 and 2011). The textual evidence reveal that central Anatolia was balkanised into several independent city-states distributed in five different zones (Barjamovic 2011): the Middle Euphrates (Nehria, Batna, Zalpa, Uršu, Hahhum, Mamma); the territory within the Kızılırmak basin (Kaneš, Amkuwa, Samuha); Konya plain (Purušhaddum, Ulama, Wahšušana, Šalatuwar); the Halys region (Hattuš, Karahna, Durhumit) and the Pontus (Zalpuwa). In the 18th century, some sizeable territorial states made their first appearance in central Anatolia. Kaneš (Kültepe) imposed its power over Amkuwa, Lakimišša, Salahšuwa and Taišama (Barjamovic et al. 2012, 49-50). Then, the king of Kuššara Pithana, a city likely located to the southeast of Kizilirmak basin, conquered Neša (Kaneš) and captured its king Waršama (Hamblin 2006, 293). After his death, Pithana's son and successor Anitta extended his kingdom over the southern half of Central Anatolia (Barjamovic et al. 2012, 50). However, Anitta's power was not long to last, and a successful revolt of vassal cities resulted in the destruction of the city of Neša and in Anitta's empire fall (c. 1725 BC). The political landscape of Central Anatolia returned instable and fragmented, and in this new situation Zuzu, king of Alahzina, conquered Kaneš and took himself the title of Great King.

2.3 Archaeological data

Archaeological excavations and surface surveys carried out across the KT and CA provide the bulk of data about the spatial location and extent of settlement at both regional and local scales, as well as about settlement occupation histories. Nevertheless, the actual available data can be problematic; site densities from surveys carried out in CA are far lower (ranges from 0.4 to 5 sites per 100 km^2) than those recorded in systematic and extensive regional surveys performed in the KT (around 10 or more sites per 100 km^2; e.g., Ristvet, 2005; Wright et al., 2006–2007; Ur and Wilkinson, 2008; Ur 2010b) and just a few have been intensively carried out in Paphlagonia (Matthews and Glatz, 2009), in Gordion (Kealhofer, 2005), in the Lower Euphrates basin (Özdoğan, 1977), and around Boğazköy (see Fig. 2a-b and Table 1 for a list of surveys carried out in the KT and CA). In addition, existing publications indicate only the overall extent of mounds but neither the size for a particular chronological phase nor the extent of the surrounding lower town. Therefore, we can provide only very rough estimates of the empirical extent of MBA sites in the KT and CA, and any results derived from the analyses of the archaeological surveys' data have to be interpreted cautiously, as constituting evidence only about the patterns exhibited by relatively large, sedentary farming communities. Nevertheless, the larger and smaller mounds do likely present themselves as relative proxies for sites that were possibly greater or smaller than surrounding settlements.

In addition, without the support of stratigraphic data from excavations, sites' occupation periods can be only established on the basis of the chronological resolution of a given pottery type. For example, in the Khabur Triangle, surveyed sites have been commonly dated to the Middle Bronze Age (ca. 2000-1600 BC) by using Khabur Ware as a chronological marker. The problem with this diagnostic pottery is that, on the basis of small potsherds collected from surface, the "Early" (phases 1-2: ca. 2000-1750/30 BC) and "Late" (phases 3-4: ca. 1750/30-1400 BC; see Oguchi 2006 for this periodization) versions of Khabur Ware are difficult to distinguish archaeologically. In north/central Anatolia the conservative aspect of the pottery assemblage of second millennium BC makes any dating from surface collection possible in only very broad terms and divide the second millennium into early, middle and late phases (cf. Schoop 2003, 2006 and 2009; Glatz et al. 2009, 108-110).The early phase comprises broadly the Old Assyrian Colony period or Middle Bronze Age (ca. 2000-1600 BC). Hence, when we analyse the sites dated on the basis of these long-living pottery types, we should take into account that the available picture under the assumption that sites dated to the same archaeological phase are contemporaneous is biased.

In the KT, relevant survey data include: Meijer (1986), Eidem and Warburton (1996), Lyonnet (2000), Ristvet (2005), Wright et al. (2006–2007), Ur and Wilkinson (2008), and Ur (2010b; see Fig. 2a and Table 1). Other nearby surveys (Algaze 1989; Wilkinson and Tucker 1995; Ball 2003) have been left out of the analysis, as these are not as continuous as the others. Within the KT, 439 were occupied in the MBA (Fig. 2a). In the eastern KT, the Tell Leilan survey's area alone has 157 sites during the MBA (Ristvet 2005). Here, the dominant role of Tell Leilan is clear, which had an area of ca. 90 ha with many surrounding small villages. Other major centres include Tell Farfara (ca. 70 ha) and Tell Muhammed Diyab (ca. 35 ha). Along the Wadi Jaghjagh, the main settlements were Tell Brak (ca. 20 ha) and Tell Barri (ca. 9 ha).

Within CA, 440 sites were occupied during the MBA (Fig. 2b and Table 1). Other nearby archaeological surveys have been left out of the analysis because these are not as continuous with the others and there are gaps in the archaeological dataset. The settlement system in the Anatolian central plateau is characterized by few large sites such as Kültepe (ca. 50 ha), Acemhöyük (ca. 55 ha), Bögazköy (ca. 25 ha), Yassihöyük (ca. 25 ha), Varavan Höyük (ca. 25 ha), and Alişar Höyük (ca. 20 ha), with many surrounding small settlements.

In the Khabur Triangle the extremely favourable conditions of site visibility and obtrusiveness allow archaeologists to reach acceptable levels of intensity by making use of remote sensing data (e.g. CORONA, ASTER satellite imagery) without necessarily adopting pedestrian transects (Ur 2010b, 40-41). In this perspective, a combined spectral-spatial analysis of satellite images (ASTER, CORONA, SPOT) and elevation models (SRTM) has allowed the researchers to map the anthropogenic soils and identify around 15,000 sites in the Khabur Triangle (see Menze et al. 2007; Menze and Ur 2012a-b and 2013). A simple visual inspection of the anthropogenic soils detected shows that there is not a significant difference in settlement density between the western and eastern KT[3].

On the contrary, archaeological survey data provide a different picture: the eastern Khabur Triangle shows higher site density than the western Khabur Triangle. This aspect could be a reflection of ancient settlement strategies, but it is most likely biased by the intensity of the archaeological surveys carried out in the area. In fact, just two archaeological surveys have been carried out in the western Khabur Triangle (Lyonnet 2000; Ur and Wilkinson 2008) and they strongly differ in terms of site density (18.28 sites x 100 sq. km of Ur and Wilkinson 2008 versus 3.15 sites x 100 sq. km of Lyonnet 2000; see Table 1). Most of the western Khabur Triangle has, therefore, been surveyed extensively and low-intensively by Lyonnet (2000) and shows a lower site density if compared with the eastern side more intensively surveyed (see site density of the surveys no. 3-5 in the Table 1). Hence, the overall picture of the Khabur Triangle, in terms of site density, is perhaps distorted by the different methodologies of the archaeological surveys carried out. On the other hand, what is undoubtedly evident is that in the eastern Khabur Triangle there are larger settlements than in its western part during the Middle Bronze Age.

In central Anatolia, a lower site visibility and obtrusiveness, when compared with the Khabur Triangle situation, perhaps should have made the adoption of walking transects a necessity. Instead, the vast majority of archaeological surveys carried out in central Anatolia fall within the “extensive" category and we have just a few examples of regional investigations undertaken by using walking transects (see Matthews and Glatz 2009). In fact, site densities from surveys carried out in central Anatolia (see Figs. 105-107) are far lower (ranges from 0.4 to 5 sites per 100 sq. km.) than those recorded in systematic and extensive regional surveys performed in the Khabur Triangle (around 10 or more sites per 100 sq. km; e.g. Ristvet 2005; Ur and Wilkinson 2008; Ur 2010b) or in other parts of Anatolia (range from 6 to 10 sites per sq. km.; e.g. Boyer et al. 2006; Abay 2011).

Topographic variability is another issue to be considered in the Anatolian context. Central Anatolia is characterized by lowland areas, high intermountain valleys and plateaus framed by the Pontic Mountain and the Taurus ranges, which respectively reach up to ca. 3,000 and 3,700 meters above sea level. Mountainous fringes and areas with rugged topography are marginal zones that have not commonly received as detailed archaeological attention as lowland areas for a series of practical reasons such as difficult terrain and dense vegetation cover (see Banning 1996; Wilkinson 2003, 185). In central Anatolia there is just one example of an archaeological survey including higher-altitude landscapes in its investigations (see Matthews and Glatz 2009).

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[3] See the results in the “Harvard-Heidelberg Atlas of Settlement Patterns at the Upper Khabur River” available online: http://www.habur.org/

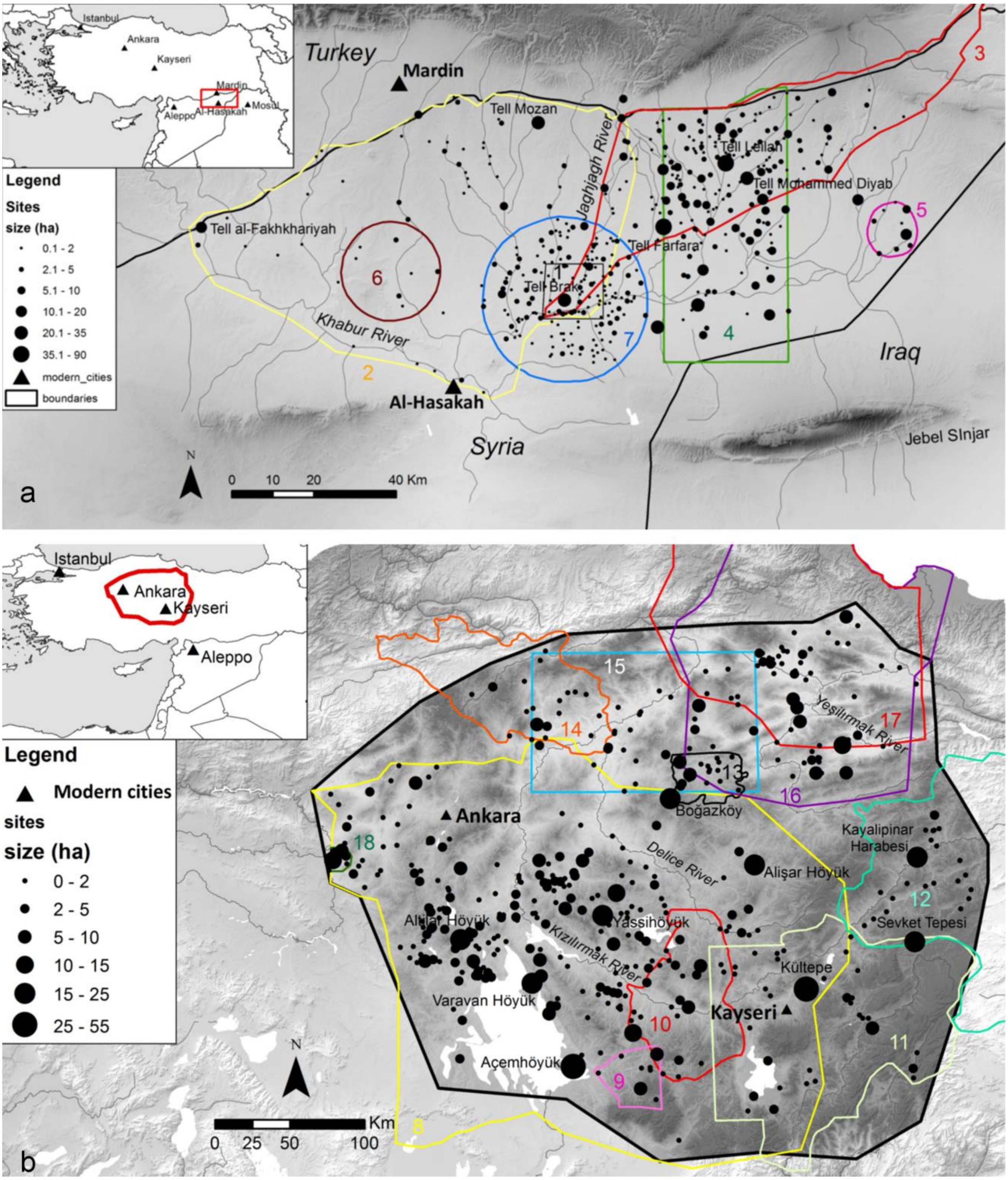

Figure 2. Map showing the case studies and the archaeological surveys carried out in the Khabur Triangle (a) and in central Anatolia (b).

Khabur Triangle						
Map no.	**Season**	**Reference**	**Area (sq. km)**	**Total n. sites**	**n. MB sites**	**Sites density (x 100 sq. km)**
1	1988	Eidem and Warburton 1996	193	56	19	29.01
2	1989-1991	Lyonnet 2000	5,100	161	45	3.15
3	1976-77; 1979	Meijer 1986	2,296	290	152	12.63
4	1984; 1987, 1995; 1997	Ristvet 2005	1,919	335	157	17.45
5	1999-2001	Ur 2010b	127	60	9	47.24
6	1997-98	Ur and Wilkinson 2008	454	83	7	18.28
7	2002-2003	Wright *et al.* 2006-2007	1,275	268	74	21.01
Central Anatolia						
8	1990	Omura 1992	58,847	53	36	0.09
	1991	Omura 1993	6,899	30	11	0.43
	1992-93	Omura 1994 and 1995	4,322	102	48	2.36
	1994	Omura 1996a-b	12,143	54	25	0.44
	1995	Omura 1997	1,634	43	12	2.75
	1996	Omura 1998	1,037	51	8	4.91
	1999-2000	Omura 2000 and 2001a	6,152	66	18	1.07
	2000	Omura 2001b	2,057	64	18	3.11
	2001	Omura 2002	4,555	68	33	1.49
	2002	Omura 2003	1,786	106	10	5.95
	2005	Omura 2006	2,672	46	13	1.72
	2006	Omura 2007a	3,529	40	13	1.13
	2003-06	Omura 2007b	7,988	190	56	2.39
	2007	Omura 2008	1,435	53	20	3.69
9	1993	Gülçur 1995	1,341	61	9	4.54
10	1997-98	Senyurt 1998 and 1999	5,804	53	16	0.91
11	2008-10	Kulakoğlu *et al.* 2009 - 2011	19,194	87	43	0.45
12	1992-95, 97-99; 2007	Ökse 1994-97, 1999-2001; Engin 2009	27,789	476	31	1.71
13	1988-89	Süel 1989 and 1990	1,440	28	9	1.94
14	1997-2001	Matthews and Glatz 2009	7,737	337	19	4.35
15	1996-1997, 2002,2006	Sipahi and Yildirim 1999-2000, 2004, 2008	13,964	66	20	0.47
16	1989, 1995-98, 2001-05, 2007	Özsait 1991,1998-2000, 2002-07, 2009; Özsait and Özsait 2001	26,454	411	26	1.55
17	1997-99	Dönmez 1999-2000, 2002	23,408	85	32	0.36
18	1996-2002	Kealhofer 2005	200	25	9	12.5

Table 1. List of archaeological surveys carried out in the Khabur Triangle and central Anatolia.

3. Methods

3.1 Rank-size analysis

The "rank-size" rule was originally presented by Auerbach (1913), who observed that "the cities of modern industrial nations, when ranked according to their population, are distributed such that the largest city is twice the population of the second-ranked city, three times the population of the third-ranked city and so on". According to this rule, in a given settlement system the size of the *n*th-ranked site is predicted by dividing the size of the largest settlement by its own rank. Therefore, in a settlement system whose largest site is 12 ha, the rank 2 settlement would be 6 ha, the rank 3 settlement 4 ha, and so on. Zipf (1949) theorised that the rank-size relationship was the result of two different forces: a "Force of Unification," which encourages settlement aggregation and a "Force of Diversification," which defines settlement dispersion. When they are in balance, the various settlements conform to the rank-size rule (Savage 1997, 233). Zipf (1949) expressed this rule with the following formula:

$$P = K \times r^{-q} \qquad (1)$$

where the size of a given observation (*P*) can be predicted if its rank *r*, the size of the largest observation (*K*), and the constant *q* are known. When *q* is greater than 1, we have settlement systems characterised by a few large dominant centres, while when *q* is lower than 1, the settlement system is less integrated and a more uniform distribution of sizes can be observed. Instead, when these forces of unification and diversification are in equilibrium, *q* will be equal to 1, and we will have a so-called ‘Zipf’s Law’of settlement size distribution. For graphical simplicity, rank-size graphs are usually plotted on a log-log scale, so that expected rank-size rule (Zipf’s Law) results in a straight line from the upper left to the lower right corner of the plot (Fig. 3a).

In archaeology, the distributions of settlement size often do not conform to the rank-size rule and plotted settlement size distributions can be steeper (*primate distribution*, Fig. 3b) or shallower (*convex distribution*, Fig. 3c) than the Zipf’s Law (Fig. 3a). However, these deviations from the expected rank-size rule usually do not follow a straight-line, and in some cases the force of unification and diversification act at different rank levels, resulting in a mixed and non-linear relationship between rank and size. Hence, researchers have also introduced the idea of *primo-convex* distributions when respectively at higher and lower ranks a primate and convex pattern are evident (Fig. 3e) or even *double-convex* distributions when two convex patterns are evident at different rank levels (see Fig. 3d; Falconer and Savage 1995, 39-41; Savage 1997, 234).

A wide range of explanations has been proposed for interpreting those types of rank-size distribution that differ from Zipf’s Law (for a summary of the explanations provided for various rank-size outcomes see Savage 1997, table 1). *Primate* distributions imply that in a settlement system there are one or only a very few large centres and a higher number of smaller settlements. This could indicate strong vertical integration and extraordinary centralization of political and economic functions exerted by a dominant centre over many others (Berry 1973; Smith 1976; Johnson 1977; Kowalewski 1982, 65; Paynter 1982; Falconer and Savage 1995, 40; Ades and Glaeser 1997; Drennan and Peterson 2004). By contrast, in a *convex* distribution there are many large settlements of roughly the same size in proportion to the number of small settlements. This could indicate population dispersion throughout a given area in sites that are of similar size and thus more competition and less integration between communities (Johnson 1980; Paynter 1982; Falconer and Savage 1995; Wossink 2009, 63-64; Crema 2013 and 2014). On the other hand, there can be other interpretations of such patterns. For instance, limited conflict encourages more widespread settlement and movement, while concentrated settlement could occur due to conflict. In addition, convex distributions are often the result of pooling more than one settlement system in the same analysis and consequently convexity indicates the existence of several independent communities (Johnson 1977). In yet another attempt at rank-size interpretation, some have argued that a convex distribution may result in a stepwise ranking, which may reflect a central place settlement system where highest-order large sites of equivalent political-economic function are equivalent in size (see Crumley 1976; Johnson 1977; Falconer and Savage 1995, 40-41). The primo-convex distribution could indicate the contemporaneous presence of two distinct settlement systems in a region: a centralized system (the primate upper distribution) superimposed on a lower level system loosely integrated or central place organization (the convex lower curve; Johnson 1977 and 1980; Falconer and Savage 1995, 41). The double-convex distribution either indicates multiple settlement systems operating on two different rank levels within a single region or derives from pooling two primate distributions into the same window of analysis (Falconer and Savage 1995, 52; see Fig. 5e; Falconer and Savage 1997, 235).

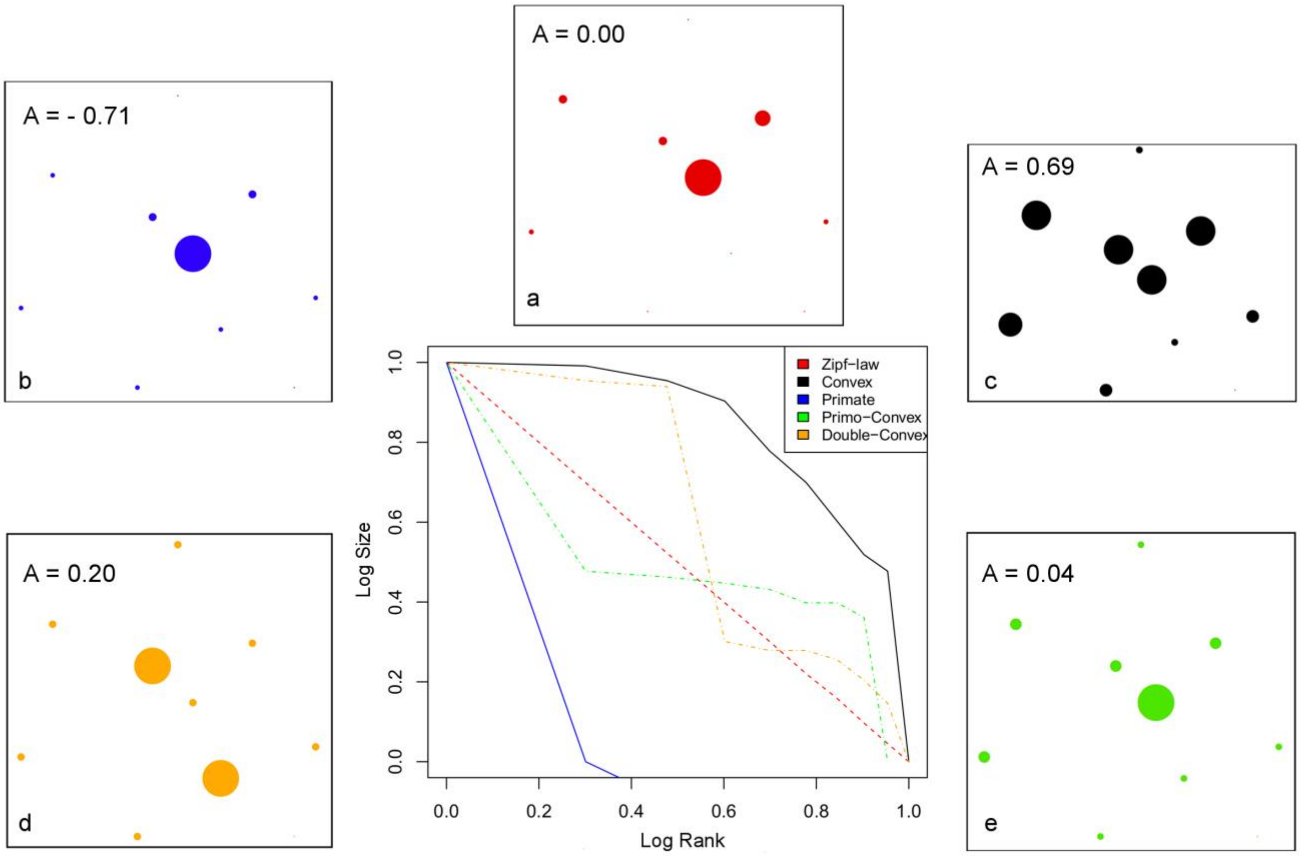

Figure 3. Different examples of rank-size curves and settlement patterns: *Zipf-Law* (a, red), *Primate* (blue, b), *Convex* (c, black), *Double-Convex* (d, orange), and *Primo-Convex* (e, green).

Several authors have used basic statistical analysis to test the significance of deviations from Zipf's law in observed settlement size distributions (cf. Falconer and Savage 1995; Savage 1997). Drennan and Peterson (2004), instead of using K-S tests and/or Monte Carlo sampling, introduced a useful summary statistic in this regard. They propose an *A*-coefficient, which calculates the area of the shape of the rank-size curve above and below a standardised log-log plot (see also Wossink 2009, 62-63, 89-91; Crema 2013 and 2014 for the application of this method). This can be achieved by first scaling the rank–size plot, so that the plot has a square shape and the Zipf's law is the diagonal cutting the square into two parts of equal size (Fig. 4). In this way, the *A* value represents the portion of the shaded area between the Zipf's law line and the observed rank-size curve (see Fig. 4). Hence, the area above the Zipf's law curve and below the observed rank-size curve (*A1*) will have positive values (Fig. 4), and then the area below the Zipf's law curve and above the empirical data (*A2*) will have negative values (Fig. 4). Notice that the maximum value for *A1* is by definition 1, while *A2* could exceed -1 for strongly primate systems where one or more observed settlements are smaller than the expected smallest settlement predicted by the Zipf's law. According to this method, convex settlement size distributions will have positive *A* values (Fig. 3c), while primate curves have negative *A* values (Fig. 3b). Even though the *A* values are useful to assess quantitatively convex and primate curves, they do not provide any information about the shape of the observed settlement size distributions because different rank-size curves can produce similar *A* values. This is the case of a primo-convex size distribution, where the difference between the positive *A*1 values of a convex curve and the negative *A2* values of a primate curve can produce an overall *A* value close to 0 (see Fig. 3e) Therefore, the calculation of *A*-coefficient must always be combined with the visual inspection of the size distribution.

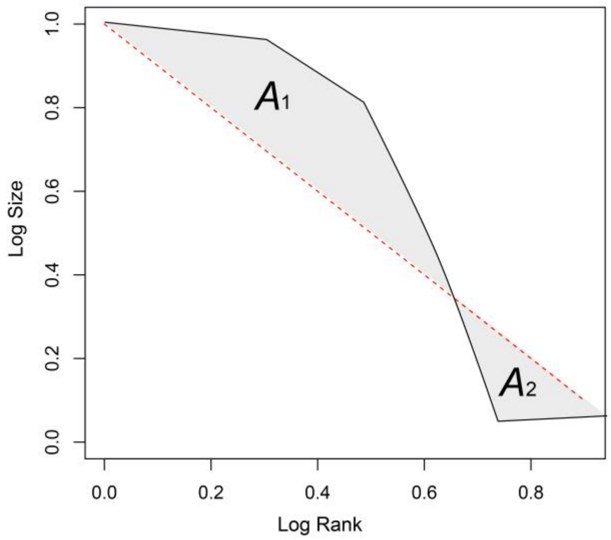

Figure 4. Areas in a rank-size graph used as positive (A_1) and negative (A_2) components of the coefficient A.

Because Drennan and Peterson noticed that the *A*-coefficient is strongly affected by the sampling frame, they suggested the use of a bootstrap statistical technique to test the statistical significance of the *A* values (Drennan and Peterson 2004, 539-543). This technique calculates the confidence interval of *A* values by resampling with replacement the observed settlement sizes with 1000 samples randomly selected. Each sample draws the same number of settlement observations as the original observed dataset, but duplicates the result of some observations, while others are omitted. For each of the 1000 samples, the resulting *A*-coefficient is calculated and readjusted in order to produce a confidence range within the *A* value of the original size distribution will probably fall. The resulting distribution is not always normally shaped, and thus a quantile-based definition of the 95 % confidence interval should be used. If the confidence interval is narrow, it is very likely that the observed pattern depicts a good picture of the reality. On the other hand, if the confidence interval is wide, we have to recognise that the observed pattern provides just a fuzzy picture of its real dynamic.

Archaeologists must be particularly careful when applying rank-size analysis to a given study area. It is most profitable when the spatial extent of a specific settlement system is known. In contrast, failure to identify its boundaries can heavily distort the results. This is a problem for archaeologists, who often deal with data from arbitrarily defined regions. In fact, defining exactly the boundaries of a settlement system in a given period is potentially a fruitless task, and the observed settlement patterns in a specific region should be considered only as a sample of larger spatial systems. It is therefore very likely that pooling more than one settlement system in the same analysis will result in convex settlement size distributions (Johnson 1977, 498). Drennan and Peterson (2004, 535-539) have emphasized this problem by comparing the results of rank-size analyses obtained with sample blocks of four different sizes. Therefore, smaller sample blocks are the least convex (see Fig. 5a-d), while larger blocks result in increasingly convex rank-size curves (Fig. 5e-g). Therefore, it is rather clear how samples of different size can determine settlement patterns occurring at different spatial scales of the analysis (see various examples in Fig. 5). Put simply, the larger the window of analysis the higher the chance of pooling more than one settlement system and then obtaining more convex rank-size curves. With these premises in mind, researchers must be aware of spatial patterning at different scales and possibly break down a larger original study area into smaller window analyses in order to detect how settlements patterns change at the local level.

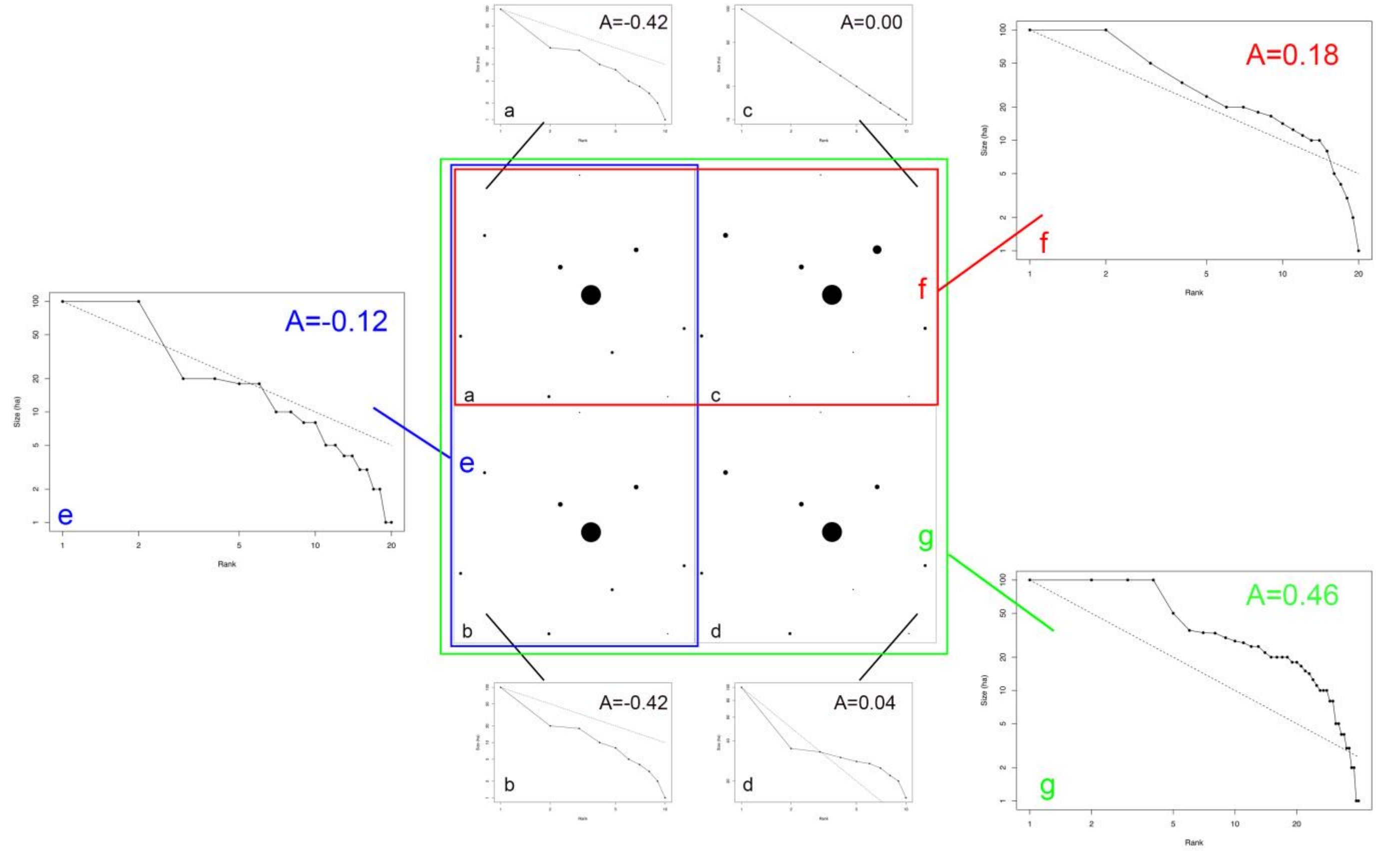

Figure 5. Schematic representation of how changing spatial scales of the analysis result in different settlement size distributions. Settlement size distribution on a local scale: *Primate* (a and b), *Zipfian* (c), and *Primo-Convex* (d). Rank-size curves with larger windows of analysis: *Double-Convex* (e), and *Convex* (f and g).

3.2 k-means clustering

The use of *k*-means as a partitioning clustering technique is justified by the fact that in city-states cultures clusters of settlements around prominent urban centers may represent an approximation of spatially defined polities (see Hodder and Orton 1976, 85; Charlton and Nichols 1997; Hansen 2000, 17; Hansen 2002, 13; Thuesen 2000 and 2002; Pollock 2001, 194–195; Strange 2002; Savage and Falconer 2003, 35; Garfinkle 2013; Ur 2013, 139-147). With this premise in mind, I do not assume that the detected clusters are to be considered as a straightforward political map of the case studies under investigation, but rather as a useful spatial approximation for understanding at which geographical scale a well-integrated settlement system is observed during the MBA in CA and the KT.

Spatial *k*-means clustering is a method quite often used in archaeology for analyzing spatial scattering of points at both intra-site and inter-site scale of analysis (see Koetje 1987; Blankholm 1991; Roberts and Parfitt 1999; Vaquero 1999; Ladefoged and Pearson 2000; Savage and Falconer 2003, 35-39; Dixon et al. 2008; Lemke 2013). Recently Baxter (2015, 2-3), in his review comparing different spatial clustering methods, has stated that some critiques on *k*-means have been overstated and that exploring different cluster solutions (*k*) can be, instead, very useful if framed into a multi-scalar approach.

The *k*-means method attempts to group points into a specified number of *k* clusters by minimizing the intra-cluster variance and maximizing the inter-cluster distances (Kintigh and Ammerman 1982; Kintigh 1990, 184-185). The locations of the *k* centroids are the result of an iterative process, where the *k*-means algorithm[4] 1) locates *k* centroids randomly, 2) assigns each point to its closest centroid, 3) recalculates the centroids as the mean of all points coordinates in a cluster, 4) and repeats steps 2 and 3 until the resetting of the centroids no longer changes, or the maximum number of iterations (I used 100) is reached. Once all points have been grouped, each cluster's sum of squared error (SSE) is calculated. SSE is the sum of the squared Euclidean distance between each member of a cluster and its cluster centroid and can be seen as a measure of within cluster's variance (Kintigh and Ammerman 1982, 39; Kintigh 1990, 185). Clearly, for a data set, the greatest SSE occurs when all points belong to one cluster, and it is equal to zero when each point constitutes its own cluster. In fact, as the number of clusters increases, the SSE (or variance) decreases because the size of the clusters is smaller and, therefore, the points within each cluster are closer. One of the greatest drawbacks of *k*-means analysis is to know the number of clusters in advance. A common way to determine the optimal number of clusters is to plot in a graph the SSE (or its logarithm) against an increasing number of cluster solutions (*k*), and to see at which point the rate of reduction of the SSE begins to decline significantly, thereby creating an inflection point or "elbow" in the plot (see Kintigh 1990, 185, Fig. 16; Ladefoged and Pearson 2000, Fig. 4). However, in situations where the points distributions are not highly clustered, there is not a clear inflection point in the plot of the SSE against the number of clusters (*k*). One further solution is the average silhouette method, which determines how well each point lies within its cluster (see Rousseeuw 1987; Kaufman and Rousseeuw 1990). Average silhouette method computes the average silhouette of observations for different values of k. The optimal number of cluster (*k*) is the one that maximizes the average silhouette width over a range of possible values for *k*.

4. Results

In this section, I will first show the results produced by performing rank-size analyses on the KT and CA and assess comparatively any difference in the observed patterns between them[5]. Second, I will break down each study area into smaller window analyses in order to detect how settlement size distributions change at a local scale. Third, rank-size analysis will be performed on the spatial clusters detected by applying *k*-means partitioning technique.

4.1 The Khabur Triangle versus central Anatolia

Figures 6 and Table 2 provide a picture for each study area of the most central group of settlement sizes (in hectares). We can see that the midspreads of the KT (the fifty percent of values between the 3rd and the 1st quartiles values; that is between 1 and 3.1 ha) and CA (between 1 and 2.8) match almost perfectly, and the values of median (1.7 vs. 1.5) differ just minimally. A Whitney–Wilcoxon test shows (p-value = 0.09) that there is little difference between the KT and CA in terms of the variability of observed settlement sizes.

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[4] I used the algorithm of Hartigan and Wong (1979) in R statistical computing language (https://www.r-project.org).

[5] The two present study areas have been designed and adapted to the boundaries of the archaeological surveys carried out in the Khabur Triangle and in central Anatolia.

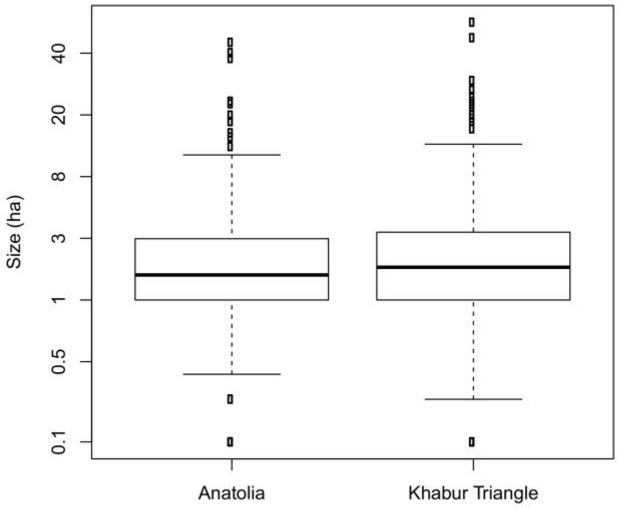

Figure 6. Box and whisker plot of size (in hectares) of Middle Bronze Age settlements in the Khabur Triangle and in central Anatolia.

Region	no. sites	Minimum site size	1st quartile	median	mean	3rd quartile	St. dev.	Maximum site size
Central Anatolia	440	0.1	1	1.5	2.7	2.8	5.47	55
Khabur Triangle	439	0.1	1	1.7	3.2	3.1	6.62	90

Table 2. Summary of central tendency and dispersion of settlements size (ha) in central Anatolia and in the Khabur Triangle in the Middle Bronze Age.

Figures 7a and 10a show a rank-size analysis for each study area. At first glance, both size distributions appear similarly convex. For the KT, the calculation of *A*-coefficient (0.26) and the 95% confidence error range (0.15 – 0.50) from the bootstrap technique tell us that the rank-size curve is convex (Fig. 7a). For CA, the *A*-coefficient (0.31) and the 95 % confidence error range (0.24-0.53) show that the rank-size curve is significantly convex (Fig. 10a).
Therefore, both results in the KT and CA show a convex distribution for settlement size and rank. These results indicate that there is little political and economic integration among different independent and competing settlement systems occurring in the KT and CA. This could well reflect the fragmented political situation occurring in both areas in the Middle Bronze Age, where city-states fought with each other and shifted alliances for exerting their power over the surrounding areas.

4.2 The Khabur Triangle

After performing the above analysis on the entirety of the two study regions, it is worth breaking down each region into smaller areas in order to assess how the settlement size distributions change on a local scale. First, we can divide the KT into an eastern (to the east of the Wadi Jaghjagh) and a western part (to the west of the Wadi Jaghjagh) and then perform rank-size analysis for each of these two areas separately (see Fig. 7b-c). The choice to split this region into two sub-areas is based on a debate over the past two decades about perceived differing sites densities in the eastern and western KT during the Middle Bronze Age (see Lyonnet 1996 and 2000; Wilkinson 2002; Fleming 2004; Ristvet 2005, 123-124; Ristvet 2012). This difference has been explained as due to presence of a more nucleated settlement pattern and small, more pastoral kingdom that made up the Ida-

Maraş confederacy in the western KT (Charpin and Ziegler 2003, 53; Durand 2004, Fleming 2004), and a more dispersed settlement pattern characterised by more numerous and larger settlements in the eastern KT (Charpin 1987; Ristvet 2008). Two further sub-areas matching with the boundaries of the archaeological surveys carried around Tell Brak (Wright *et al.* 2007, see also Colantoni 2012) and Tell Leilan (Ristvet 2005) have been subject to rank-size analysis (Fig. 7d-e).

Region	**No. sites**	**Minimum site size**	**1st quartile**	**median**	**mean**	**3rd quartile**	**St. dev.**	**Maximum site size**
West KT	141	0.1	0.8	1.5	2.3	3	3.71	30
East KT	298	0.1	1	1.8	3.4	4	6.84	90

Table 3. Summary of central tendency and dispersion of settlements size (ha) in the western and eastern Khabur Triangle in the Middle Bronze Age.

Table 3 highlights the fact that there are indeed far more settlements and a greater diversity of settlement sizes in the eastern KT, where the largest sites have a bigger extent of the largest sites located in the western KT. We can see that the midspreads of the western KT (between 0.8 and 3 ha) and of the eastern KT (between 1 and 4) do not differ strongly, and the values of median (1.5 vs. 1.8) differ just minimally. A Whitney–Wilcoxon test shows (p-value = 0.01) a statistically significant difference in site size distribution between the eastern and western parts of the KT. This can be explained by the fact that, overall, the settlements in the eastern KT are larger than those in the western KT. In a natural log scale the rank-size curves of eastern and western KT are convex and appear very similar except for the scale of magnitude (Fig. 7b-c). Then, the *A*-coefficient has been calculated on both areas. For the West KT the calculation of *A*-coefficient (0.28) and the 95% confidence error range (0.17 – 0.55) from the bootstrap technique tell us that we are 95% confident that the rank-size curve is convex (Fig. 7b). In the East KT, the *A*-coefficient (0.22) and the 95 % confidence error range (0.10-0.49) show that the rank-size curve is significantly convex (Fig. 7c). Furthermore, a log-scale plot of the rank-size curve of the area around Tell Brak shows a primo-convex distribution with the overall *A*-coefficient (0.27) resulting in the difference between the positive *A*1 values of the convex curve (0.30) and the negative *A2* values of the primate curve (0.03; Fig. 7d). The 95% confidence error range for A1 (0.12-0.62) and A2 (-0.01 − -0.08) shows that the rank-size curve is significantly primo-convex (Fig. 7d). A rank-size plot of the area around Tell Leilan shows a double-convex distribution of settlement sizes and the calculation of an overall *A*-coefficient (0.11) and the 95% confidence error range (-0.07 – 0.41) shows that the curve is significantly double-convex (Fig. 7e).

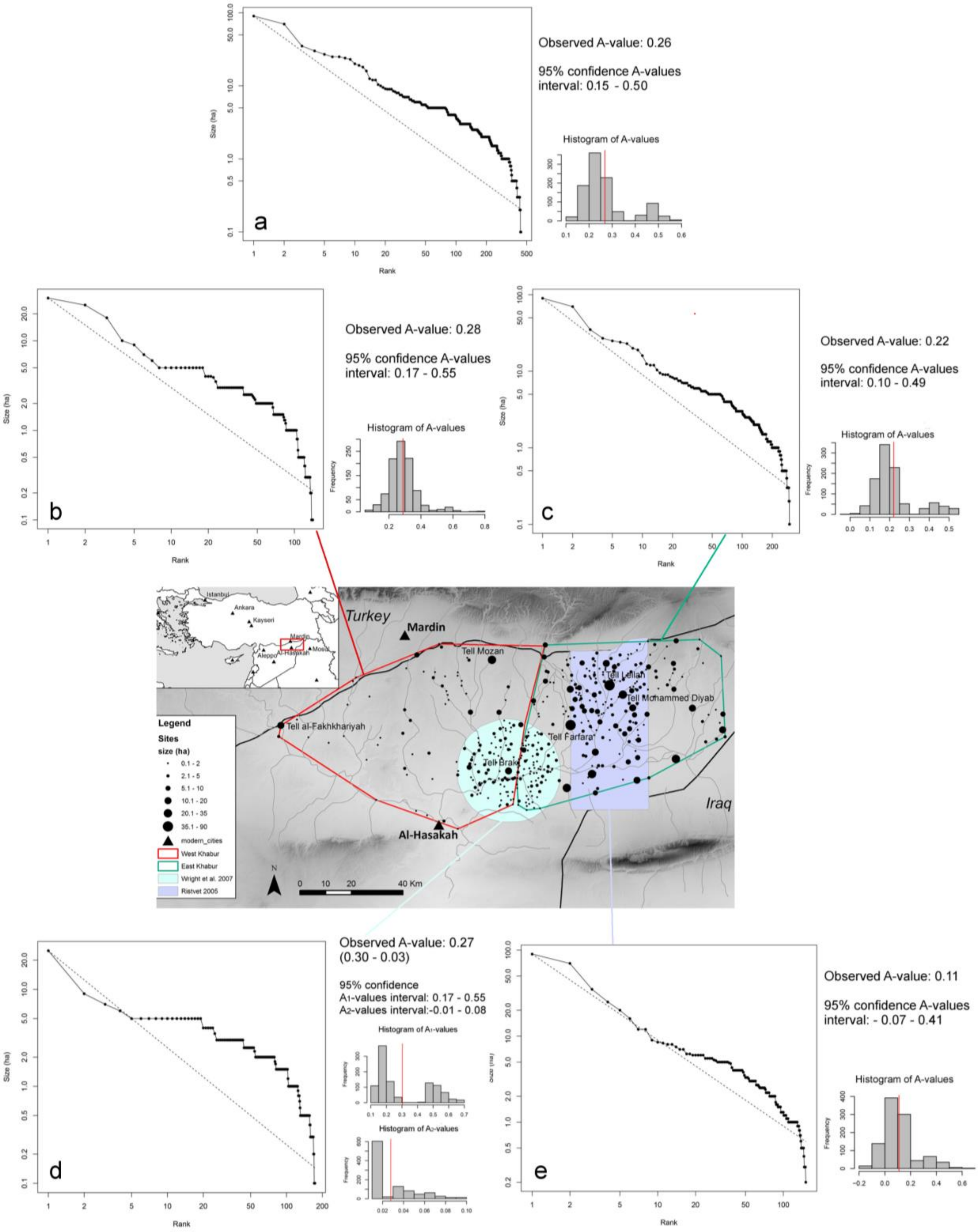

Figure 7. Rank-size graph and histogram of 1000 bootstrapped *A*-coefficient values of the Khabur Triangle dataset. The histograms show the distribution of the simulated *A* coefficients, along with the observed one (the red line).

A further step was to use the *k*-means partitioning method in order to break down the study area into smaller window analyses and investigate how settlements size structures change at a more local scale. First, the analysis generated clustering solutions between 1 and 15 ranges. Second, the SSE (and its logarithm) was plotted against an increasing number of cluster solutions (*k*) in order to choose the optimal cluster level. Fig. 8a-b shows that there is an inflection point or “elbow” on the graph at solution four clusters. This is more evident in Fig. 8b, where the rates of decline of the SSE drastically decreases at four clusters. In order to be sure about the cluster solution (*k*), I computed the average silhouette of observations for different values of k. The resulting graph (Fig. 8c) shows the highest average silhouette width at two and four clusters. Because the two-cluster solution would basically divide the settlements into two partitions roughly corresponding with the sub-areas Western and Eastern KT discussed above, and so not useful for the purpose to scale down our analysis, the four-cluster solution has been chosen as the optimal one.

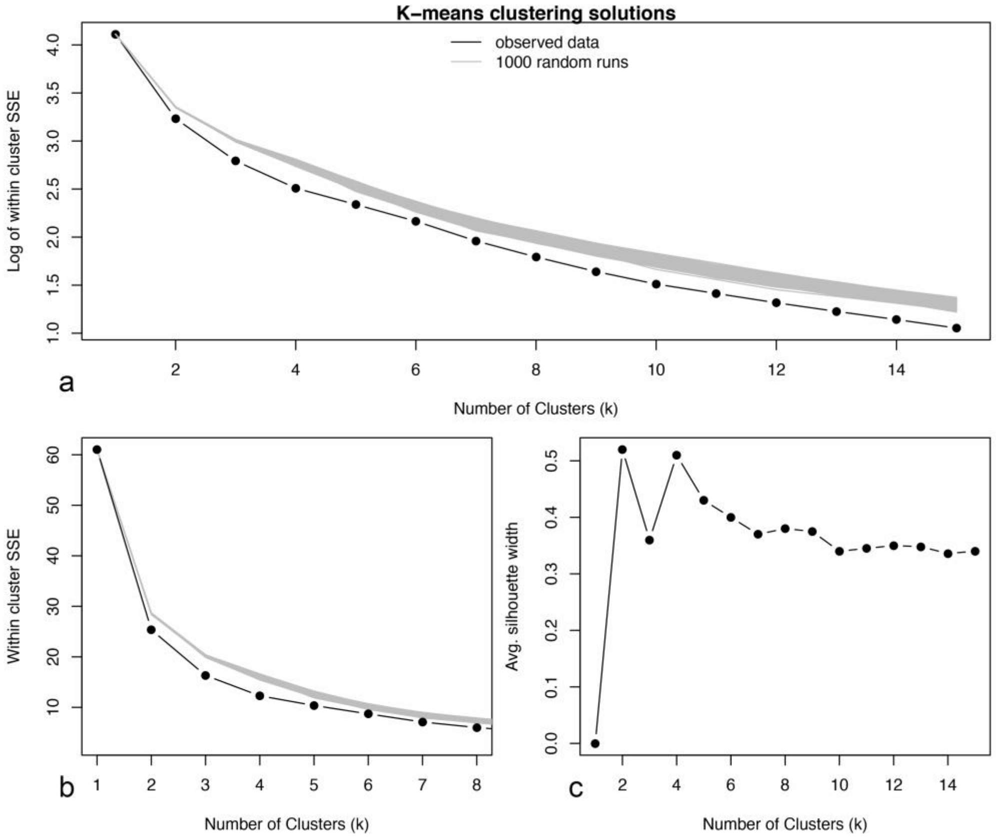

Figure 8. Graph of the log (a) and normal value of SSE (b) for each cluster solution (*k*). Average silhouette width for the cluster configurations (c).

Finally, the SSE plot of the observed data have been compared with the SSE plots of 1,000 randomized data in order to assess if the settlements of the KT are significantly clustered (see Kintigh and Ammerman 1982, 46-47; Kintigh 1990, 185)[6]. Randomisation is accomplished by creating new datasets where the eastings (x) and northings (y) of the observed data are drawn separately and then randomly associated (Kintigh and Ammerman 1982, 45-46; Kintigh 1990, 185). Therefore, each randomized dataset will have the same mean and standard deviation on each spatial dimension (x and y) and the total SSE as the observed data. If the settlements are significantly clustered, the SSE of the observed data will be below the envelope of the randomized data (in grey

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[6] This was done by using a modified version of Peeples' script written in R for *k*-means clustering analysis (2011).

in figure 8a-b). Otherwise, it will fall within the envelope of random data. The Fig. 8a-b shows that the settlements are significantly clustered at each cluster solution (*k*). After detecting the optimal cluster solution *k*, I performed a fuzzy *k*-means. This method allows addressing some drawbacks of the *k*-means as "crisp" clustering method such as the tendency to produce circular clusters of similar size and the inability to deal with noise (e.g. points belonging to no cluster, see discussion in Baxter 2009 and 2015, 4). To do so, I used the R statistical language's package *vegclust* (De Cáceres 2016; De Cáceres and Wiser 2016) in order to assign a fuzzy cluster membership for each settlement. In fact, for some sites the distance to the closest cluster's centroid does not differ much from the distance to second closest one. Fuzzy *k*-means is expressed, for each cluster solution (*k*), through a degree of membership bounded between 0 (e.g. the settlement does not belong to any cluster at all) and 1 (i.e. the settlement belongs completely to a given cluster). Therefore, I set 0.5 as a threshold to classify all settlements with less than fifty percent of probability to belong to any cluster as noise. Hence, the resulting clusters are represented as convex-hulls in the Fig. 9a.

In the end, the rank-size analysis was performed for each cluster detected in the KT. A log-scale plot of the rank-size curve of the clusters 2, which almost entirely match with the archaeological survey's area around Tell Brak, shows a significant primo-convex distribution with the overall *A*-coefficient (0.27) resulting as the difference between the positive *A*1 values of the convex curve (0.30) and the negative *A2* values of the primate curve (0.03; Table 4). Even cluster 1, which covers a large portion of the western KT, shows a primo-convex curve and a slightly negative *A*-coefficient (0.03, Table 4). As the positive *A*1 values show a quite wide 95% confidence interval, it is possible that the pattern could have a higher convexity. In addition, in this case, the settlement size distribution results convex if we remove the 1st ranked site Tell Fakhkhariya (18 ha), which is the westernmost site of the cluster 1 (see Fig. 9a) and could be part of a different settlement system. Cluster 3 is characterized by a rank-size curve slightly convex in its upper portion and then slightly primate and convex in its lower component. The confidence range of both *A*1 and *A*2 values suggests that the primateness and convexity of this curve could be more accentuated (see Table 4). Finally, the *A*-coefficient (0.25) and the 95% confidence error range (0.10 – 0.51) from the bootstrap technique suggest that the rank-size curve is significantly convex for the cluster 4 (Fig. 9a, Table 4). It is important to notice that some settlements to the north of the cluster 2 and to the south of the clusters 3 and 4 (see Fig. 9a) have been classified as noise as their cluster membership was not so clear. This result makes sense if you consider that among those "noisy" points there are prominent sites such as Tell Mozan, Dumdum and Hansa. These sites could be the capital cities of different city-states, and it is not surprising that they have not been assigned to any cluster. The fact that they do not constitute a cluster by themselves is biased by the lack of intensive archaeological surveys carried out in their surrounding hinterlands, which results in a very low density of sites. Overall, both the western and eastern KT show a very similar dispersed pattern that could be the result of pooling in the same analysis different competing city-states and petty kingdoms occurring in both areas (Fig. 7b-c). The difference between the two parts of the KT is in the magnitude of the settlement sizes, where the settlements distributed in the eastern KT are far larger than the settlements in the western KT. Nevertheless, if we perform rank-size analysis on a smaller local scale, we can detect some differences between the settlement patterns occurring in the two areas. In fact, the area around Tell Brak to the west of the Wadi Jaghjagh is characterized by a primo-convex distribution, where the largest site (Tell Brak) imposes a centralized system on a lower-level settlement system of satellite communities and medium-small villages (Fig. 7d; Fig. 9, cluster 2). On the other hand, a double-convex curve in the Tell Leilan area represents the presence of two contemporaneous settlement systems operating within the same region at different scales (Fig. 7e; Figure 9, cluster 3). More precisely, the upper convex curve represents the largest sites of the east KT (Tell Leilan and Tell Farfara) superimposed on a more loosely integrated system (the lower of the two convex curves).

Khabur Triangle						
Cluster No. In the map	**No. sites**	**Area Km sq.**	**Largest site (approx. ha)**	**Observed A-coefficient**	**Error range (95 % confidence)**	**Curve Shape**
1	39	2,625	18	- 0.03 (0.04 – 0.07) (A_1 - A_2)	A_1 = 0.49 (0.1 – 0.50) A_2 = 0.23 (- 0.01 − -0.24)	Primo-Convex
2	173	1,352	20	0.27 = 0.30 - 0.03 (A_1 - A_2)	A_1 = 0.49 (0.12 – 0.61) A_2 = 0.07 (- 0.01 − -0.08)	Primo-Convex
3	105	973	90	- 0.07 = 0.02 – 0.09 (A_1 - A_2)	A_1 = 0.49 (0.1 – 0.50) A_2 = 0.25(- 0.01 − -0.26)	Double-Convex
4	86	1,676	35	0.25	0.41 (0.10 – 0.51)	Convex
Central Anatolia						
5	19	2,861	6.3	0.23	0.42 (0.10-0.52)	Convex
6	25	1,995	25	-0.17	0.38 (-0.06 – -0.44)	Primate
7	27	1,522	7.5	0.35	0.47 (0.14-0.61)	Convex
8	23	1,454	10.5	0.27	0.45 (0.05-0.50)	Convex
9	26	2,564	15	0.03 = (0.04 – 0.01) (A_1 - A_2)	A_1 = 0.39 (0.1 – 0.40) A_2 = 0.16 (- 0.01 − - 0.17)	Primo-Convex
10	32	1,655	18	0.08 = (0.13 – 0.05) (A_1 - A_2)	A_1 = 0.54 (0.1 – 0.55) A_2 = 0.15 (- 0.02 − - 0.17)	Primo-Convex
11	31	1,790	24	0.06 = (0.14 – 0.08) (A_1 - A_2)	A_1 = 0.52 (0.2 – 0.54) A_2 = 0.21 (- 0.07 − - 0.28)	Primo-Convex
12	34	1,793	25	0.02 (0.07 – 0.05) (A_1 - A_2)	A_1 = 0.38 (0.2 – 0.40) A_2 = 0.16(- 0.01 − - 0.17)	Primo-Convex
13	37	3,934	55	-0.53	-0.76 (-0.23 – -0.99)	Primate
14	18	2,190	6	0.37	0.52 (0.13 – 0.65)	Convex
15	18	4,417	50	-1.03	1.22 (- 0.49 – - 1.710)	Primate
16	18	1,779	20	-0.59	0.90 (-0.26 – -1.16)	Primate

Table 4. *A*-coefficient values and bootstrapped error ranges for log scale rank-size curves of the clusters in the Khabur Triangle (KT) and central Anatolia (CA).

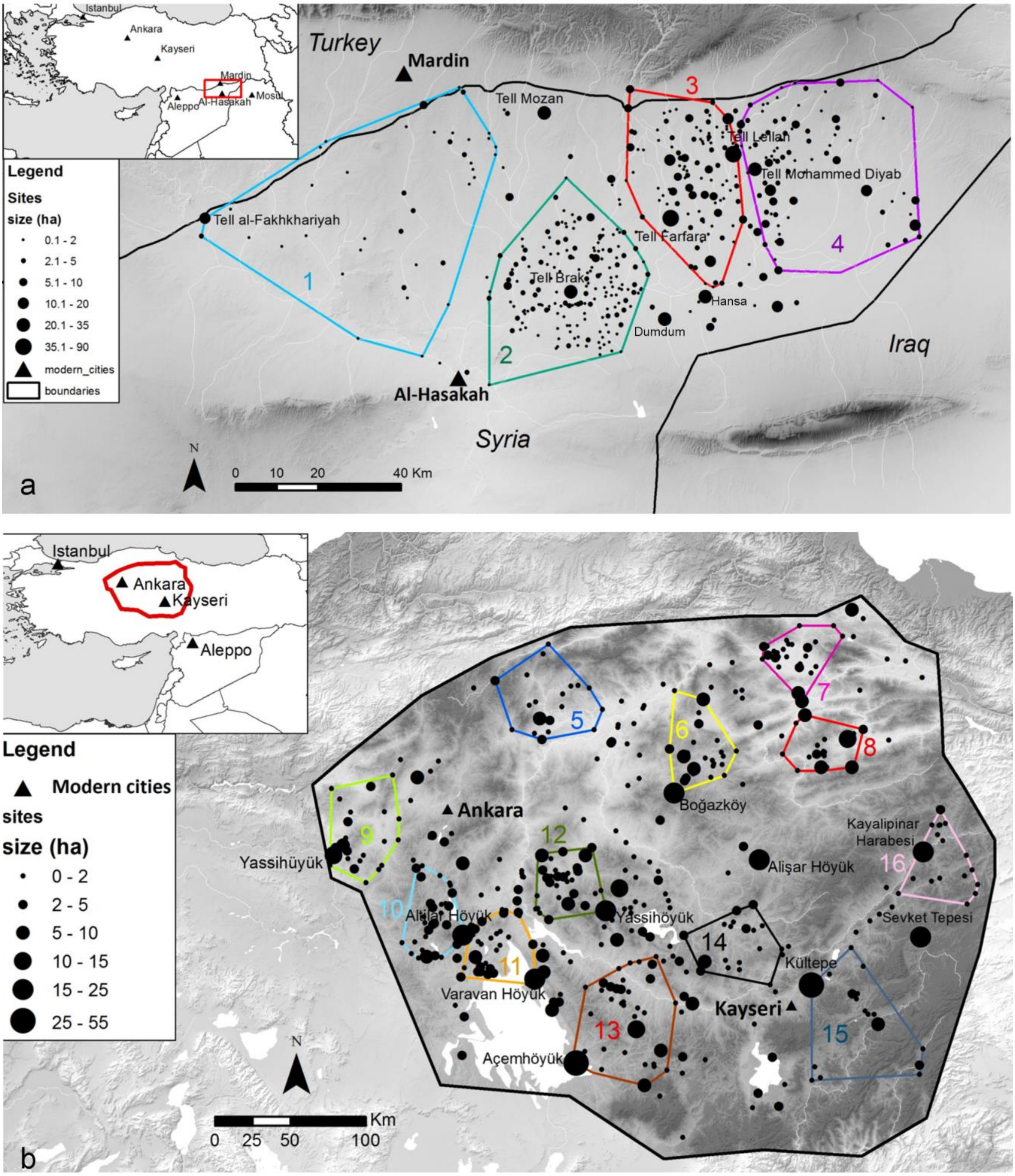

Figure 9. Plot of the 4-cluster solution in the Khabur Triangle (a) and of the 12-cluster solution in central Anatolia (b). The points outside the clusters are noise.

4.3 Central Anatolia

We can now perform the same break-down of the central Anatolian region into smaller areas in order to assess how the settlement size distributions change at smaller local scales. The study area can usefully be divided into four smaller windows of analysis matching with the boundaries of archaeological surveys carried out in the area around Kayseri (see Kulakoğlu et al. 2009-2011, Fig. 10b), Varavan Höyük and Altilar Höyük (Omura 1997 and 2003-2007; Fig. 10e), Yassihöyük (Omura 2001-02 and 2008; Fig. 10d), and with a geographically defined area around Boğazköy in the Bozok plateau between the Delice River to the west and the Yeşilırmak River to the north-east (see Fig. 10c).

A log-scale plot of the rank-size curve of the area around Kayseri shows a primate curve with the A-coefficient (- 0.40) and the 95% confidence error range (-0.09 – 0.79) suggesting that the rank-size curve is primate (Fig. 10b). This primate distribution might be stronger if we remove the 2th ranked site Sevket Tepesi (25 ha), which is the easternmost site of the window of analysis and could be part of a different settlement system (see Fig. 10b). In the area surrounding Boğazköy, the rank-size curve is primo-convex with the overall *A*-coefficient (0.2) resulting in the difference between the positive *A*1 values of the convex curve (0.9) and the negative *A2* values (0.07) of the primate curve (Fig. 10c). The 95 % confidence error range shows that the settlement size distribution is likely primate (Fig. 10c). Furthermore, a log-scale rank-size curve of the area around Yassihöyük is convex and both the A-coefficient (0.21) and the 95% confidence error range (0.04 – 0.50) show a significant convex settlement size distribution (Fig. 10d). A rank-size plot of the area to the north of Tuz Gölü lake shows a double-convex distribution of settlement sizes and the calculation of an overall *A*-coefficient (0.29) and the 95% confidence error range (0.10 – 0.63) show that the curve is significantly double-convex (Fig. 10e).

As already done for the KT, the *k*-means partitioning technique was used in order to break down the area into smaller window analyses. The SSE (and its logarithm) was plotted against an increasing number of 15 cluster solutions (*k*) to choose the optimal cluster level. The Fig. 11a-b shows that the settlements are significantly clustered at each cluster solution (*k*). Nevertheless, the graph indicates that an inflection point or “elbow” in the SSE curve is not so evident and further evaluation is needed (Fig. 11a-b). The highest average silhouette width is at two and twelve-cluster solutions (Fig. 11c). As in the case of the KT, a two-cluster solution is not so useful for the purposes of this paper because it would divide the settlements into two distinct large partitions respectively to the north and the south of the Kızılırmak River. Thus, a twelve-cluster solution was chosen as the optimal one. The resulting twelve fuzzy clusters are shown as convex-hulls in Fig. 9b.

Rank-size analysis of individual clusters shows strong primate distributions for the clusters 6, 13, 15 and 16, where the dominant sites are respectively Boğazköy, Acemhöyük, Kültepe, and Kayalipinar Harabesi (Fig. 9b; Table 4). The clusters 9, 10, 11 and 12 show a primo-convex distribution due to a large settlement in the upper part of the curve superimposed on a tier of many smaller sites of the convex lower curve (Fig. 9b; Table 4). In these three groups, the dominant centres are respectively Yassıhüyük, Altilar Höyük, Varavan Höyük, and Yassıhöyük. Among the clusters detected in Anatolia, four clusters (5, 7, 8, and 14; see Table 4 and Fig. 9b) show significant convex distributions and are characterized by poor settlement integration and the lack of a dominant urban centre. Among the “noisy” points are noticeable Alişar Höyük and Sevket Tepesi, two large sites (approx. 25-20 ha) that could be the dominant centre of two distinct clusters and so city-states (Fi. 9b). As in the case of the KT, the result is biased by the total lack of archaeological sites carried out in the surrounding hinterland of those two sites. Alişar Höyük has been identified with the ancient Amkuka, which during the Old Assyrian period (ca. 1950-1700 BC) was an Anatolian city-state and seat of an Assyrian commercial settlement *kārum* (Barjamovic 2011, 312-313).

Overall, it seems that in CA most clusters show a high settlement primacy, which is typical of city-states. Only the area to the east of Yassihöyük, between the Delice River to the north and the Kızılırmak River to the south (Fig 9b, cluster 14), and three clusters to the west (Fig. 9b, cluster 5) and the east of the Bozok plateau (Fig. 9b, clusters 7 and 8) show a dispersed pattern and a poor integration between communities.

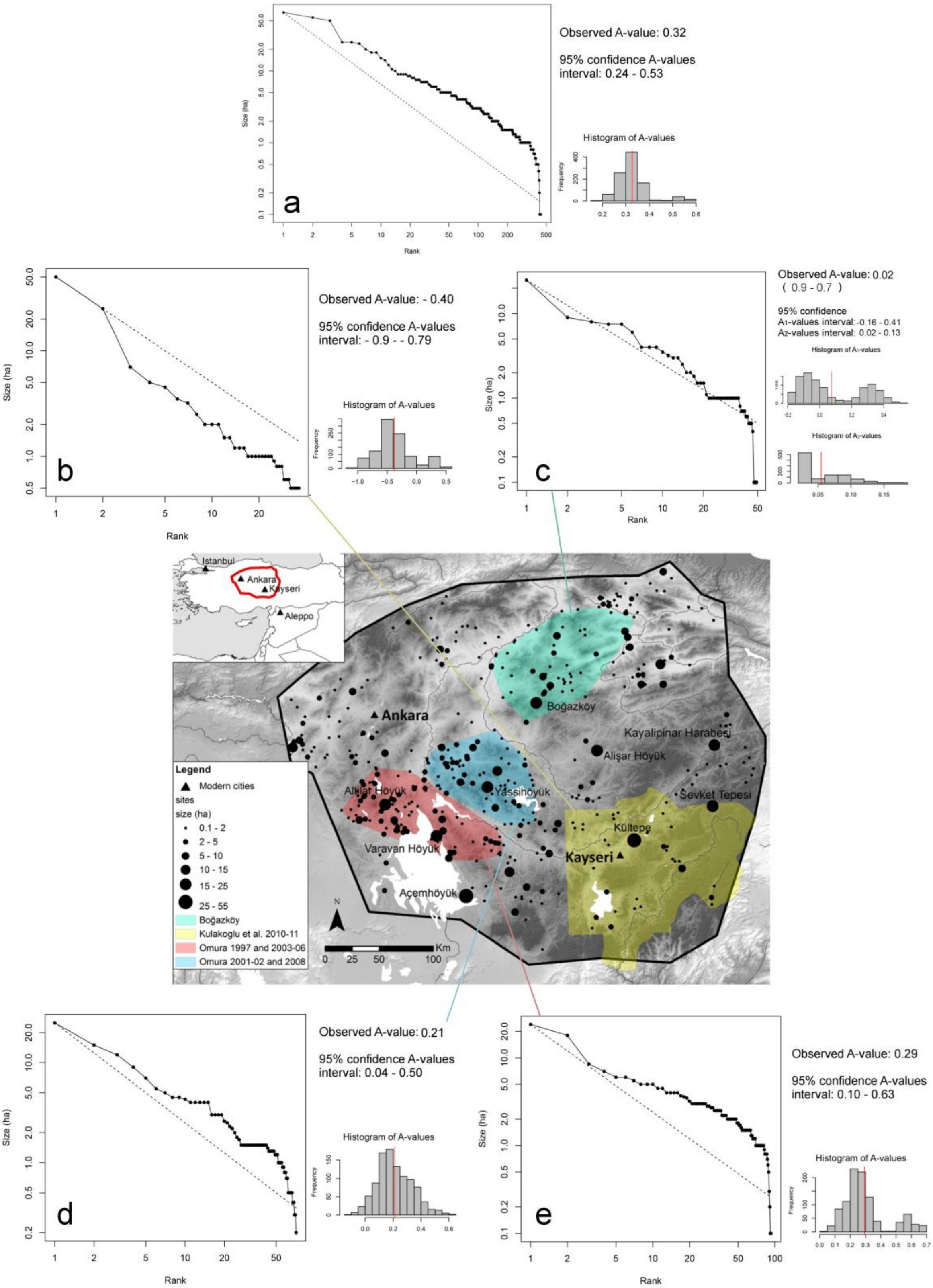

Figure 10. Rank-size graph and histogram of 1000 bootstrapped *A*-coefficient values of central Anatolia dataset. The histograms show the distribution of the simulated *A* coefficients, along with the observed one (the red line).

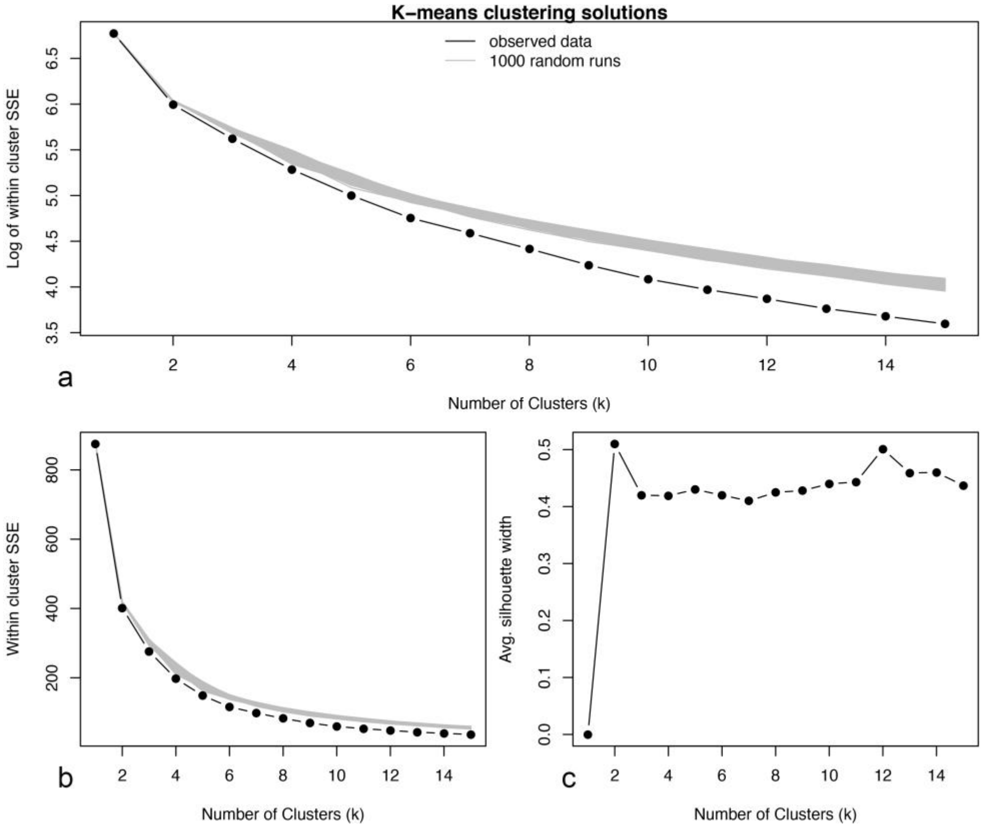

Figure 11. Graph of the log (a) and normal value of SSE (b) for each cluster solution (*k*). Average silhouette width for the cluster configurations (c).

5. Discussion

Despite the surviving archival data, defining the political landscapes of Upper Mesopotamia and central Anatolia in the early second millennium BC remains a big challenge, especially in the light of the uncertainties present in the available archaeological and textual dataset. However, as I showed in this paper, there are advantages in applying a multi-scalar approach to settlement pattern analysis.

I have first provided a global picture of regional settlement patterns occurring in central Anatolia and the Khabur Triangle, and then focused on how settlement size structures change at different spatial scales of analysis. Both central Anatolia and the Khabur Triangle show very similar dispersed settlement patterns when considered as a whole (see Figs. 7a and 10a) but these results can be explained as the consequence of pooling different settlement systems into the same window of analysis. In other words, at this larger regional scale, both central Anatolia and the Khabur Triangle in the Middle Bronze Age are characterized by balkanized landscapes of competing independent polities loosely integrated (for central Anatolia see Veenhof and Eidem 2008, 147-179; Barjamovic 2011, 6; Barjamovic *et al.* 2012, 48-50; Palmisano and Altaweel 2015a and 2015b; for the Khabur Triangle see Charpin and Ziegler 2003; Veenhof and Eidem 2008, 290-321; Ristvet 2008 and 2012; Palmisano 2015; Palmisano and Altaweel 2015a and 2015b; Altaweel *et al.* 2015). The second step was to break down these two regions into smaller window analyses matching with the boundaries of some archaeological surveys carried out both in central Anatolia and the Khabur Triangle (Figs 7d-e and 10b-e). However, this approach can be problematic as arbitrarily defined boundaries of survey areas are nearly impossible to encompass specific unitary polities and settlement systems changing across space and time (see discussion in Schiffer et al. 1978; Plog et al. 1978, 384; Banning 2002, 22-25; Ur 2010b, 42). In fact, the results show a double-convex distribution in the area around Tell Leilan (Fig. 7e), and convex-distributions (Fig. 10d-e) or not particularly strong primate distributions in central Anatolia (Fig. 10b), which is the result of pooling distinct settlement systems in the same window of analysis. A further step to address this issue was to use fuzzy *k*-means partitioning technique in order to detect clusters to be interpreted as a spatial approximation of city-states' territories (see Fig. 9a-b). The results show that the geographical scale for both the Khabur Triangle and Central Anatolia, at which a well-integrated and centralized settlement system is observed, is the city-state as a compact and modestly-sized political unit characterized by a dominant centre (see Fig 12a-b; Table 4). Therefore, central Anatolia and the Khabur Triangle were marked by a network of politically independent but economically linked and roughly equivalent polities, in which each one controlled its surrounding rural hinterland via more or less obvious forms of centralised control.

The eastern and western parts of the Khabur Triangle show similar dispersed settlement patterns (Fig. 7b-c) that probably reflect the presence of different independent competing city-states in both areas and a central-place settlement structure, where bigger urban centres were surrounded by secondary towns, villages, small farmsteads, and seasonal campsites. At this scale, the difference between the two areas is characterised by the differing size of the largest settlements, with those in the eastern Khabur Triangle having a bigger extent than those in the western Khabur Triangle. The available survey data allow us to investigate more deeply the settlement patterns in Tell Brak and Tell Leilan's areas (respectively the areas surveyed by Wright et al. 2007 and Ristvet 2005), and for Tell Brak's area the settlement system is more nucleated in one big centre (Tell Brak), with a contemporaneous settlement system of nearby satellite medium-small size villages. On the other hand, in the Tell Leilan area, the general settlement pattern appears more dispersed among large settlements of equivalent economic or administrative function (Tell Leilan, Tell Farfara, Tell Mohammed Diyab, Tell Aid, Hansa, and Dumdum) superimposed on a more loosely integrated settlement system of medium-small settlements (Ristvet and Weiss 2010, 27). It also seems that the Khabur Triangle was less densely populated in the western part and more densely populated in its eastern part (see Table 2). This dual pattern has been explained by Ristvet and Weiss (2005 and 2010) as the result of lower rainfall to the west of the Wadi Jaghjagh and a more nucleated pattern of smaller overall settlements, perhaps with closely packed domestic quarters in the western Jazira (e.g. Chagar Bazar, Tell Mozan, and Tell Arbid). This explanation via rainfall is however disputed, as the only fairly slight differences in precipitation from east to west probably cannot explain such marked difference in settlement alone. Weiss and Ristvet's observation about domestic quarter packing could be more plausible but remains difficult to validate given the patchiness of the available archaeological data. Their argument about different population densities occurring in the western and eastern Khabur Triangle remains possible, but could also be the result of the different archaeological survey recovery methods applied to the two areas with no intensive surveys in the west except immediately around Tell Beydar (Ur and Wilkinson 2008; for extensive coverage, see Lyonnet 2000 and Meijer 1986), especially in light of the recent work by Colantoni (2012), which shows a heavily populated area around Tell Brak. On the other hand, this dual pattern remains a possibility, and if valid, could be elucidated with reference to the suggestions in the textual evidence of a rough coalition of kinglets (the Ida-Maraş confederacy) along and to the West of the Wadi Jaghjagh, predominantly sustaining themselves on pastoral or semi-pastoral economy, which would explain the more ephemeral archaeological evidence, and the territory near Šubat-Enlil/Šehna (Tell Leilan), which was mostly agricultural (see Joannés 1996, 344-345; Lyonnet 1996 and 1997; Wilkinson 2000 and 2002; Ristvet and Weiss 2005 and 2013; Lawrence et al. 2015, 17-18).

Central Anatolia is mostly characterized by primate rank-size distributions (8 clusters out of 12; see Fig. 12a), and the results show that Acemhöyük, Boğazköy, Kültepe, and Kayalipinar Harabesi have strong vertical primacy with one large centre dominating over smaller sites. On the other hand, dispersed settlement patterns and no particular predominant urban centres characterize the areas to the north of the central Anatolian plateau, both to the west and the east of the Bozok plateau. This fits well with the central Anatolian political landscape suggested by the texts, which is fragmented into numerous independent city-states during the Old Assyrian Colony Period (ca. 1970-1700 BC; see Barjamovic 2011, 6; Barjamovic *et al.* 2012, 44-49). It seems that Böğazköy could have naturally exerted a dominant influence within the northern bend of the Delice River, which could also have played as physical and political boundary. Other highly integrated polities seem to emerge to the south of the Kızılırmak River: Acemhöyük, Altilar Höyük, Kültepe; Sevket Tepesi; Kayalipinar, Varavan Höyük, and Yassihüyük. Instead, across the basin between the Delice and the Kızılırmak Rivers, Yassihöyük could have exerted its power.

The rank-size analysis' results show some differences between central Anatolia and the Khabur Triangle at smaller local scales. In fact, in central Anatolia settlement systems appear more nucleated in large centres dominating their surrounding rural hinterlands and strong political and economic centralization is evident at Acemhöyük, Boğazköy, Kültepe, and Kayalipinar Harabesi (Table 4). On the other hand, in the Khabur Triangle settlement primacy is less strong and polities are more loosely integrated. In central Anatolia, a more remarkable vertical integration is the result of an even spatial distribution of large settlements that could then dispose of large rural hinterland over imposing a more centralized political and economic control. On the contrary, in the Khabur Triangle the largest sites were packed in a smaller plain area, where the lack of marked topographical features (e.g. wide rivers, mountain ranges) could have further enhanced competition between large city-states of comparable size and political prominence and determined unstable territories (cf. Eidem 2000, 257).

Overall, these patterns are to be considered as a "fuzzy" picture of the political landscapes occurring in central Anatolia and the Khabur Triangle in the early second millennium BC. To the lack of a complete picture about settlement patterns from the archaeological survey record, we have to add further uncertainty of chronology and site size estimates due to the conservative characteristic of the early second millennium BC pottery assemblages used as chronological marker (Schoop 2006 and 2009 for a discussion about central Anatolia; see Oguchi 2006 and Kolinski 2014 for the Khabur Triangle) and unwillingness or inability of existing archaeological surveys to offer period-specific size estimates apart some exceptions (see examples for Tell Brak, Tell Beydar and Tell Hamoukar in the Khabur Triangle; Ur 2010b; Ur and Wilkinson 2008; Ur *et al.* 2007 and 2011). In addition, from textual evidence emerge that city-states were involved in ever-shifting alliances, and fought each other to gain control over strategic resources and "fluid" territory with often ambiguous and not contiguous boundaries (Eidem 2000, 257; Ristvet 2008, 592; Osborne 2013, 787). Moving on now to a more diachronic perspective, during the Middle Bronze Age I (ca. 2000-1800 BC), the political landscapes of central Anatolia and the Khabur Triangle were divided into hundreds of city-states and tribal communities. The situation partially changed in the MBA II (ca. 1800–1600 BC), when large and centralized territorial states imposed their authority upon numerous and weaker existing political entities. In this period, the Khabur Triangle was part of Šamši-Adad I's kingdom (ca.1808–1776 BC) and subsequently of Zimri-Lim's kingdom (ca.1780–1758 BC), two territorial states which exerted their authority over most of Upper Mesopotamia (Villard 1995; Charpin and Ziegler 2003; Fleming 2004, 26-103; Van de Mieroop 2007, 107). In particular, the Khabur Triangle played a prominent role in the international political scenario of the early 18th century BC as the seat of the capital of Šamši-Adad I's kingdom (ca. 1808–1776 BC) at Šubat- Enlil/Šehna (Tell Leilan). In the second half of the 18th century, Anitta (?-1725 BC) was able to impose his power over the southern half of central Anatolia, and the texts suggest he took the title of Great King (Hamblin 2006, 293-294; Barjamovic et al., 2012, 50). Nevertheless, the city-states remained the more stable and longest-lasting political unit, while the larger regional kingdoms were often politically fragile and could last only one generation or a single dynasty (Barjamovic 2013, 123; Garfinkle 2013).

6. Conclusions

The observed rank-size distributions have demonstrated the importance of a multi-scalar modeling approach to have a better and fully understanding of settlement hierarchies. In particular, zooming in and out in a given study area allows researchers to assess variations in spatial patterning and detect certain settlement structures only at a specific geographical level. In practical terms, this approach has shown that in the MBA balkanized landscapes of central Anatolia and the Khabur Triangle, a well-integrated political system is discernible at the spatial level of modestly-sized city-states. A first inference of the political dynamics occurring in central Anatolia and the Khabur Triangle has been made possible through the textual evidence from Tell Leilan (Eidem 2000 and 2008; Ristvet 2008, 586-592) and Kültepe (Veenhof and Eidem 2008; Barjamovic et al. 2012, 35-51). In this paper, the picture provided by the historians is, therefore, supplemented with quantitative analyses of archaeological settlement data investigating past human landscapes both at a global and local scale.

Apart from the case of very few sites that, to some degree, have yielded a quite clear chronological sequence, most sites have offered only a coarser temporal resolution. Therefore, a diachronic development of political MBA cannot be offered in detail, but only roughly treating the MBA time span as a whole. A further improvement of this research could involve aoristic models to address the temporal uncertainty in the archaeological dataset (see Crema et al. 2010; Crema 2012; Orton 2017). Finally, a future research endeavour should apply a multi-scalar approach to a longer-term chronological framework in order to assess how settlement hierarchies change over the *longue durée* in periods of political fragmentation and unification.

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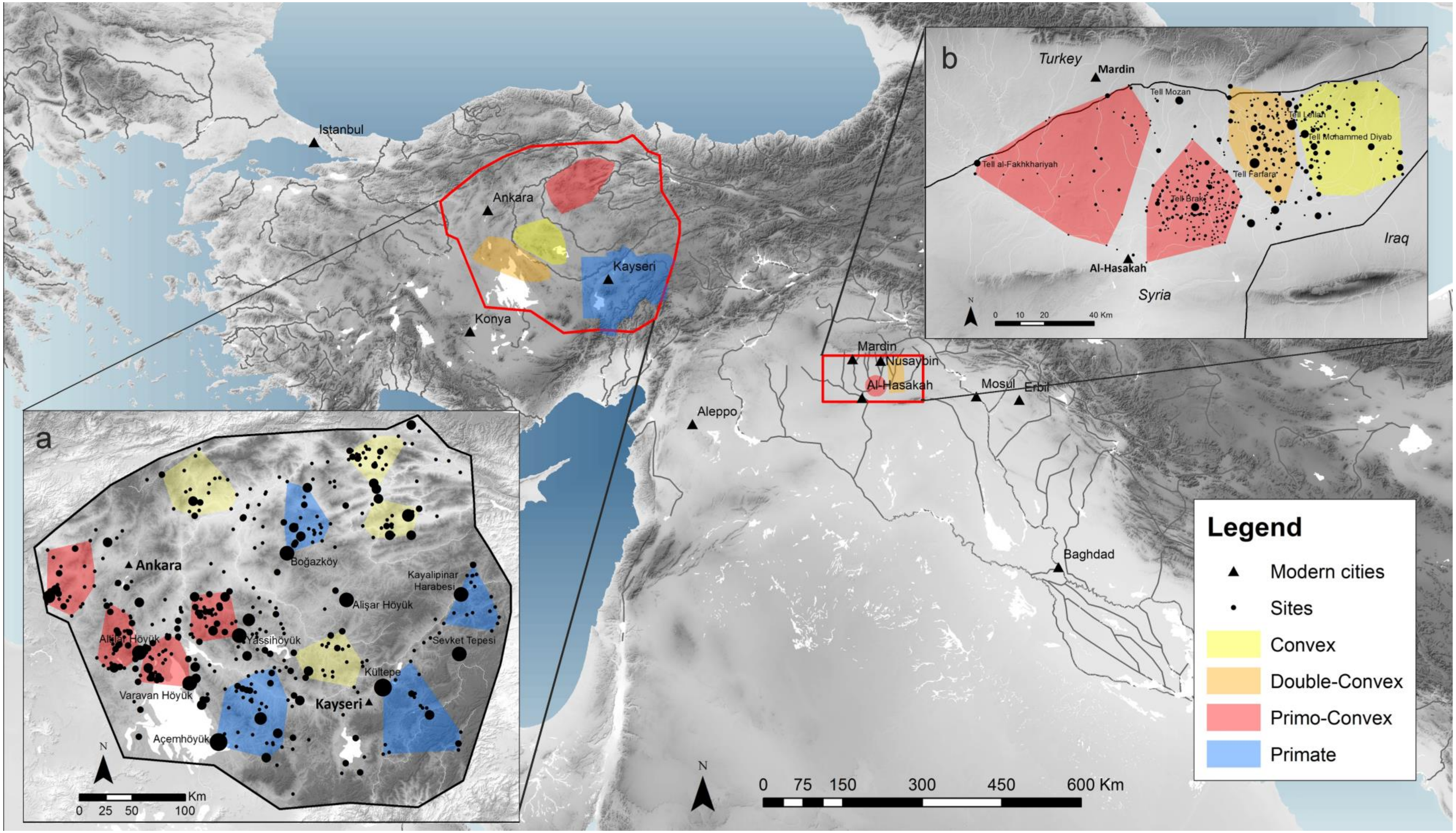

Figure 12. Spatial distribution of rank-size patterns in central Anatolia (a) and the Khabur Triangle (b).

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