Spatial and Statistical Inference of Late Bronze Age Polities in the Southern Levant

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The Late Bronze Age (ca. 1500–1200 B.C.) marks the earliest opportunity to apply substantial historical archives to the inference of spatially defined polities in the southern Levant. A series of analyses of the Amarna Letters suggests numerous, small, bellicose "city-states" differing considerably in political prominence and demographic composition. We propose quantitative methods for analyzing archaeological settlement data to explore the spatial configuration of Late Bronze Age polities and their varying hierarchical structures. This approach provides an independent test of the historical method, which identifies capital cities and assumes the adherence of surrounding communities, by discerning polities from constellations of settlements, large and small, amid the abundantly available regional survey data for the southern Levant. We infer a political landscape that corresponds well with many aspects of historical reconstruction and propose new ideas on the configuration and structure of Late Bronze Age polities. In particular, the readily apparent balkanization of the southern Levant is founded on significant structural variation between settlement and polities on the Coastal Plain, the Central Hills, and the Jordan Rift. These results carry connotations for the study of earlier and subsequent political dynamics. Our methods and inferences are readily applicable to other cases of emergent political complexity in the southern Levant and elsewhere, particularly those lacking historical documentation.

INTRODUCTION

Archaeological settlement patterns afford particularly accessible and regionally comprehensive avenues for interpreting societal change according to a variety of themes, many of them overlapping. Most political reconstructions derived from pre- or protohistoric settlement patterns infer the political status of whole societies. This macroscopic approach is exemplified by the definition of "states" as societies with specialized central political control, which are manifested by demonstrably hierarchical settlement systems (e.g., following Wright and Johnson 1975; Wright 1986). According to the same logic, "pre-state" societies (often subsumed under the terms "chiefdom" or "complex chiefdom") are conceptualized as antecedent societal forms that lack some aspects of specialized political control and are reflected by less hierarchical settlement patterns (e.g., Earle 1987; 1991; Wright 1984). Even when heeding calls for conceptual flexibility (e.g., Rothman 1994), this approach implicitly assumes a linear evolutionary progression from chiefdom to state (following Carneiro 1981; see critique in Yoffee 1993), which may engender correspondingly constrained, linear interpretations of prehistoric political trajectories.

In the case of the southern Levant (roughly the region of modern Israel, the Palestinian Authority, and western Jordan), these considerations are especially pertinent because Bronze Age society, while demonstrably complex as indicated most obviously by the rise of early cities, does not fall neatly into a standard anthropological category of "chiefdom" or "state." For example, Levy's (1995) synthesis of chiefdom-style organization during the Chalcolithic period (ca. 4500–3500 B.C.) points out that state-level society did not arise in the Levant until the late Iron Age, approximately two and one-half millennia later. Traditional interpretations of Levantine sociopolitical organization during the intervening Bronze Age generally appeal to the less rigorously defined concept of "city-state," which may be characterized as a compact, independent political unit consisting of a capital and its hinterland, with correspondingly limited political cohesion and power (see discussions in Griffeth and Thomas 1981; Maisels 1990: 10–13; Charlton and Nichols 1997). Yoffee (1997) has pointed out that the city-state concept seems so intuitively obvious that it often eludes rigorous or consistent definition. Not surprisingly, the inference of city-state configurations on archaeological landscapes also commonly lacks methodological rigor.

The challenge of tailoring analytically provocative *and* archaeologically accessible lines of sociopolitical interpretation may be addressed by exploring the organization and interaction of political units *within* societies, rather than attempting to characterize these societies as whole political entities. This approach avoids unwarranted assumptions of political cohesion, as may be entailed when pigeonholing an emergent complex society settled over a large region as "chiefdom-" or "state-level." Renfrew's idealized "early state module" (ESM) provides one vehicle for conceptualizing the spatially defined political units that might have comprised many early complex societies. This concept arises from the proposition that "in most, perhaps all, early civilizations there function a number of autonomous central places which, initially at least, are not brought within a single unified jurisdiction" (Renfrew 1975: 13). Among many potential functions, each center administered a territorially defined sociopolitical unit, or "polity" (Renfrew 1986: 1–2). Analyses of the interactions between polities of equivalent scale and status (i.e., "peer polity interaction") avoid the pitfalls of essentially taxonomic descriptions of complex societies as "state" or "non-state" in favor of focusing on the dynamics between ESMs and changes in those dynamics over time.

This approach normally entails the archaeological or historical identification of political centers and the subsequent extrapolation of their surrounding ESMs, which may be depicted "notionally" as Thiessen polygons[1] (e.g., Renfrew 1975: fig. 2; 1986: fig. 1.1). However, this entrée may prove less satisfactory for societies lacking large central places or in which large places were not necessarily "central." Primary attention to political centers also tends to downplay the spatial implications of the remaining communities in regional settlement systems. All these considerations pertain to the study of early complex society in the southern Levant, where Bronze Age settlement trajectories feature persistent rural communities and more transitory towns and cities (Falconer 1994; Falconer and Savage 1995).

The Bronze Age is epitomized traditionally as the first era of urbanized society and "city-state" formation in the southern Levant (Dever 1987; Richard 1987; Leonard 1989; Bunimovitz 1995; Gophna 1995; Ilan 1995), which may be associated culturally with the Canaanites of the Old Testament and other ancient texts (Matthiae 1981: 187; Bunimovitz 1995: 320; Ilan 1995: 297). These developments are signaled by the advent, growth, and periodic collapse of fortified towns and cities, although the sizes of Levantine cities are modest compared with those of neighboring regions (Falconer 1994). Bronze Age diplomatic records, recovered primarily from Egypt, also imply the nature of regional and local political relations involving the cities of Canaan.

Levantine urbanization departs intriguingly from prototypical patterns seen on grander scales elsewhere in the Near East (e.g., Mesopotamia; Falconer and Savage 1995). Further elucidation of these differences requires the dissection of localized settlement patterns within the subregions of the southern Levant. We propose an archaeologically based, quantitatively rigorous approach to the spatial analysis of emergent polities and political trajectories. In this pursuit, the interpretation of archaeological settlement patterns need not be limited to corroborating or refuting textual indications of political relations. Instead, we treat texts and settlement patterns

[1] Thiessen polygons divide a landscape into regions by choosing prominent sites as centers, sketching connecting lines between a center and its nearest neighbors, and then drawing boundaries that bisect these connecting lines. The boundary lines are then extended to define closed polygonal territories around each center. This method invariably centers polities around a major settlement, reifies an assumption of firm boundaries, and overlooks surrounding networks of smaller communities.

as independent aspects of the archaeological material record, each requiring circumspect interpretation, and each providing intriguing commentary on the other.

DOCUMENTARY EVIDENCE OF LATE BRONZE AGE POLITIES

A variety of ancient texts allude to the highly fragmented political structure of Canaanite society, usually as it impinges on foreign relations with Syria and, especially, Egypt. The most robust and systematic accounts of local and international Levantine political relations appear in the "Amarna Letters," a diplomatic archive that includes numerous communiqués between Canaanite rulers and the pharaohs Amenhotep III and Amenhotep IV (Akhenaten). These letters, written in Akkadian cuneiform over about 25 years in the mid-14th century B.C., form part of the royal archive brought by Akhenaten from the former capital, Thebes, to his new capital Akhetaten (Amarna) approximately 190 miles south of Cairo (Moran 1992: xiii; Naʾaman 1992: 276). Subsequent pharaohs abandoned Akhetaten and, beginning in 1887, local villagers began unearthing tablets from Amarna's relatively shallow remains. Whole and fragmentary tablets now constitute approximately 382 texts, which museums and individuals have acquired from the antiquities market and made available for analysis (Artzi 1988; Moran 1992: xiii–xviii).

These texts voice the largely acrimonious interactions of local Levantine polities and their petty leaders, usually referred to as "mayors," or less commonly as "rulers," "kings," or "princes" (Moran 1992: xxxii; Naʾaman 1992: 178). Although prior Egyptian intervention in the southern Levant was minimal (Ahituv 1978: 105; Weinstein 1981: 10), Egypt established garrisons and administrative outposts during the Late Bronze Age to secure tax revenue, conscript labor, and political allegiance (Naʾaman 1981: 177; Weinstein 1981: 12–17). With increased Egyptian military and political investment by the end of the Late Bronze Age, Canaan apparently assumed a loose colonial role within the imperial economy (Naʾaman 1981: 184; Weinstein 1981: 17–18). Six or seven of the recovered Amarna Letters were sent from Pharaoh to Canaanite rulers, and their blunt language conveys the unequivocal material demands of the crown.

The much more numerous letters from Canaanite mayors to Pharaoh begin with a "prostration formula" that the author usually claims to perform "seven times and seven times," often "(both) on the belly and on the back" (Moran 1992: xxvi–xxxiii). These authors adopt a recurrent theme in proclaiming their undying allegiance to Pharaoh and the treacherous deceit of their neighbors. In so doing they refer to their "cities" and other territorial holdings, as well as to alliances between towns and internecine quarrels over material goods or the favor of the crown. Two unmistakable political subtexts pervade this correspondence: very unequal power relations between Canaan and Egypt, and serious political fragmentation and volatility within Canaan.

Successive descriptive analyses of the Amarna Letters offer historical appreciations of the Canaanite political landscape. Helck (1962) attempted the first Amarna-period political map of the entire eastern Mediterranean seaboard by plotting the location of towns that appear prominently in the Amarna Letters. He then sketched territorial divisions from his reading of the texts, segregating 23 Canaanite polities in the southern Levant as we define it here (Helck 1962: 191).

Subsequently, Naʾaman (1988; 1992) used the Amarna Letters, supplemented with Egyptian topographical lists, royal inscriptions, biblical inferences, and selected archaeological data, to identify 25–32 Canaanite "city-states" and autonomous towns lying west of the Jordan River, along with six Egyptian garrison towns whose local rulers were deposed and replaced by the Egyptian crown. Naʾaman proposes a political landscape in which city-states of "higher rank" influenced and sometimes dominated those of "lesser rank" (1988: 18–19). Only Hazor and Shechem, which apparently subordinated smaller nearby cities, and possibly Gezer, which controlled coastal and inland trade routes, were the heads of "territorial kingdoms." Each remaining city-state merely incorporated a "capital" city surrounded by villages and hamlets (1988: 18). He also suggests that the Galilee and parts of the Levantine hill country were "barely inhabited," representing "a kind of no-man's land" occupied by "nomadic groups" (1988: 19).

This largely descriptive analysis inspired Bunimovitz to infer his own matrix of polities, each "roughly of the same size range, well below 1000 km^2," with a radius less than 20 km (1995: 326; following Naʾaman 1988; 1992). He depicts the territorial holdings around 18 capital cities as Thiessen polygons (1995: fig. 6). This approach gives predominant weight to historically selected political centers between which equidistant territorial boundaries are assumed (following, e.g., Haggett, Cliff, and Frey 1977: 436–39). Bunimovitz likens the political configuration of the Late Bronze Age to a scaled-down version of Renfrew's ESM pattern for early civilizations (1975: 12–18). This interpretation fills the political map of the southern Levant, implicitly denying Naʾaman's notion of settlement voids in the hill country. However, he does note that the modest scale of Levantine polities reflects a significant recession in the number and size of cities between the Middle and Late Bronze Ages (1995: 326; see also Gonen 1984; Falconer 1994). This diminished scale enabled lesser towns and city-states to enjoy political autonomy, even when in close proximity to major city-states.

Building on this prior scholarship, Finkelstein (1996; see also Strange 2000) presents the most strident reconstruction of the Late Bronze Age political landscape based overwhelmingly on evidence from the Amarna Letters, augmented by regional settlement data. Spurning Naʾaman's no-man's land, he draws a political map "of the 14th century B.C.E." whereby "all of Canaan was divided between directly adjacent polities with shared boundaries" (Finkelstein 1996: 225–26). This study identifies Late Bronze Age political centers, then draws rough polygons "to establish the theoretical, schematic boundaries between the territories" (Finkelstein 1996: 226, maps 1–2). By excluding 15 of Naʾaman's centers (because they are judged arbitrarily to be too small, too close to other centers, or without obvious hinterlands), Finkelstein proposes a network of 14–17 city-states. Paralleling Naʾaman and Bunimovitz, Finkelstein argues for significant variation between polities in territorial extent, resident population, and labor force. For example, he suggests that the highland city-states of Jerusalem, Shechem, and Hazor, with their vast territorial holdings, rugged topography, and limited settled population, differed "in every possible respect" from the smaller lowland city-states (1996: 243). Echoing Bunimovitz's commentary, he notes that this Late Bronze Age configuration reflects a regional "demographic crisis," featuring a shortage of human labor in many polities (1996: 243–45).

In sum, these historically based studies portray the Amarna Age southern Levant as fragmented into a relatively large number of modestly sized polities, generally referred to as "city-states." These entities, which vary significantly in size, include larger hill country polities (e.g., those around Shechem and Jerusalem), with less dense, less sedentary populations, and smaller lowland polities with more aggregated agrarian towns. There is a general consensus that this pattern reflects a decline in the number and size of towns, as well as regional population, over the Middle Bronze/Late Bronze Age transition. Although the term "city-state" is used axiomatically, there is no suggestion that Late Bronze Age society involved state-level administration on a local or regional scale.

The Amarna Letters provide the best, although clearly less than exhaustive, documentation of Canaanite political structure (e.g., see discussions in Naʾaman 1988: 17–21; 1992: 276–78). We compare the evidence from this correspondence, written over the course of about one generation, to settlement data that span roughly three centuries (ca. 1500–1200 B.C.). In doing so we do not claim to delineate Canaanite polities at any specific point in time. Our more modest goal is to propose and apply a quantitatively based method with which we might approximate the general structure and configuration of the Levantine political landscape in the Late Bronze Age. We compare historical reconstructions of Canaanite polities with our independent settlement pattern analysis to assess the degree to which the two approaches approximate the same political landscape, thereby providing a particularly robust portrait of Late Bronze Age political structure.

QUANTITATIVE INFERENCE AND ANALYSIS OF POLITIES

The southern Levant may be divided into a series of longitudinal physiographic zones, including a low elevation Coastal Plain, the Central Hills, and Galilee (where maximum elevations exceed 1000 m asl), and the Jordan Rift (which drops to 400 m bsl at the Dead Sea) (fig. 1). The Jordan Rift stretches north to include the Huleh Basin and communicates with the Coastal Plain via the Jezreel Valley. Our spatial analysis explores the Late Bronze Age political landscape using site location and size data, gleaned from a variety of published surveys and from the records of the Israel Antiquities Authority, that provide continuous coverage from the Mediterranean coast to the eastern side of the Jordan Valley (Ibrahim, Sauer, and Yassine 1976; 1988;

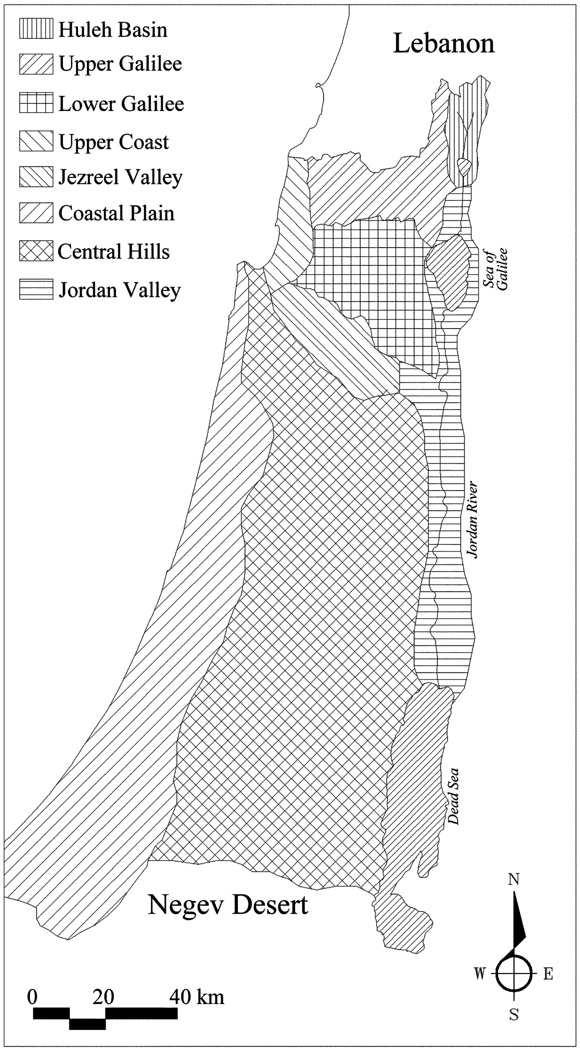

Fig. 1. Aggregate survey coverage and physiographic regions within the southern Levant considered in this study.

Broshi and Gophna 1984; 1986; Gophna and Portugali 1988; Joffe 1991; 1993; Finkelstein and Gophna 1993). We use k-means and rank-size analyses to explore these data as they reflect the political landscape of Late Bronze Age Canaan. Our application of k-means analysis considers site locations and identifies clusters of settlements that, it may be argued, represent approximations of spatially defined polities. Rank-size analysis examines relative site sizes to generate a quantified portrait of settlement hierarchies. When used in combination, they provide a quantitative means for integrating archaeological and textual data to elucidate Late Bronze Age and other ancient political landscapes.

There are several reasons why the spatial patterning of settlements in early complex societies may reflect geographically defined political units. A fundamental tenet of locational analysis holds that settlements may cluster around important geographical features, local resources, or prominent centers (Hodder and Orton 1976: 85). This notion is pivotal for archaeological analyses based on distance-decay relationships or gravity models. Simple economic considerations, such as the cost of moving produce in agricultural societies, suggest that people tend to interact more frequently with the members of nearby communities than with those of more distant settlements. This observation is so fundamental to spatial analysis that it very often goes unstated, becoming a sort of "first postulate." The transition to agriculture and sedentary life engendered increasingly "nodal" settlement systems. "Relatively speaking, spatial order now became structured around points and localities in place of vast distended ranges, and around daily patterns of movements in place of annual or seasonal migrations. . . . In short, increased social interaction and social integration was used to compensate for reduced spatial mobility" (Dodgshon 1987: 86–87). As this nodality and interaction increased, new societal forms developed, based increasingly on spatial organization. "Spatial propinquity bred social propinquity . . ." (Dodgshon 1987: 86). That is, people living in nodes on the landscape that were closer to each other tended to interact more frequently. Settlement clustering undoubtedly was molded by a variety of social and economic factors, among which the spatial definition of polities must have figured prominently. We should not presume that these clusters constitute a straightforward political map. Accordingly, we do not propose borders between polities, even in the "notional" sense implied by Thiessen polygons. We postulate simply that these clusters of sites may be used to interpret the spatial implications of Late Bronze Age political organization.

K-Means Cluster Analysis

We infer site clusters using k-means analysis, a form of divisive cluster analysis that is particularly amenable to the analysis of spatial coordinates. Our k-means analysis uses Palestine Grid coordinates for 474 Late Bronze Age site locations in the southern

Levant, rendering each east site coordinate as an *x*-axis value and each north coordinate as a *y*-axis value. Each analysis begins with all site locations in a single cluster, then divides the locations into two clusters, then into three, and so on, until each observation forms a cluster by itself or until a user-requested maximum number of clusters is reached. Each site location is included in the cluster with the nearest center, based on a Euclidean distance calculation. Through several passes, k-means analysis minimizes the variance (i.e., the distance between observations and cluster centers) at each clustering level. As a result, it tends to form circular clusters, and, accordingly, has been called "pure spatial clustering" in archaeological literature (e.g., Kintigh and Ammerman 1982).

Clearly, the variance for a data set is greatest when all its observations are in one cluster and reaches zero when each observation constitutes its own cluster. For most analyses, the optimal clustering solution lies somewhere in between. The analyst must choose which clustering level or "solution" is most appropriate for the data under consideration. We use the program KMEANS (Kintigh 1994) to generate a series of clustering solutions for each data set, beginning with one cluster and continuing to the program's maximum of 30. KMEANS calculates a statistic (Sqrt[SSE/N]) for each solution that reflects the relative "tightness" of clustering within each of its constituent clusters. This calculation begins by summing the squared distances between each site and its respective cluster center. This value (SSE) is divided by the total number of sites under analysis (N) to determine an average squared distance for each solution. We calculate the square root of SSE/N at each clustering level to measure the "unsquared" average distance between sites and their cluster centers, which is expressed in kilometers. Absolute values for this statistic, Sqrt(SSE/N), may be compared usefully between solutions. More importantly, a comparison of Sqrt(SSE/N) for observed data versus Sqrt(SSE/N) for randomized data provides the basis for determining an optimal clustering solution for each k-means analysis (see below).

KMEANS identifies the constituent sites for each cluster and calculates a cluster center and root mean square (RMS).[2] The center of a k-means cluster is, more often than not, simply a point in space around which a group of sites clusters. The RMS indicates the average distance of all sites in a cluster from their cluster center and provides the radius for each cluster circle. Smaller RMS circles indicate tighter clustering of constituent sites. Since all sites are considered equally (i.e., there is no weighting of sites according to size or presumed function), a cluster's "center of gravity" is pulled toward the greater number of sites in that cluster (fig. 2).

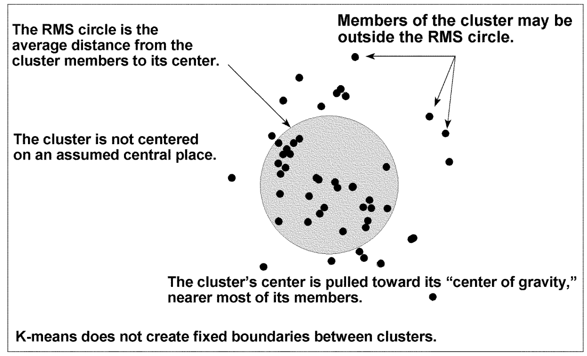

Fig. 2. Spatial representation of a k-means cluster, summarizing several basic concepts of k-means clustering.

KMEANS addresses the issue of whether the data are clustered meaningfully by comparing the observed data to a series of random runs. The program stores the observed *x*-axis (east) and *y*-axis (north) coordinates in arrays. For each random run, a *y*-axis value from the array is randomly assigned to an *x*-axis value from the array. Once all the *x*-values have been assigned *y*-values, the program generates a full range of k-means cluster solutions, each with its own Sqrt(SSE/N) statistic. This process is repeated 100 times (the program's maximum). The summary statistics for the observed data are then compared with those for the random runs at each clustering level to determine which solution is optimal (see application below).

[2] K-means cluster analysis starts with an observed distribution of points and determines their most likely patterning of clustering. We use the program KMEANS to generate a series of clustering solutions (1-cluster, 2-cluster, 3-cluster, . . . , 30-cluster) for Late Bronze Age site locations. In each clustering solution, every site is assigned to the closest cluster center, forming circular clusters. Each cluster can be depicted on a map by drawing a large circle (the RMS circle), whose radius is equal to the average distance of the cluster's members from the center of the cluster. Figure 2 depicts several salient concepts underlying k-means analysis.

Late Bronze Age Settlement Clusters

An optimal clustering solution for Late Bronze Age settlement is determined from three particularly important statistics. First, the %SSE value is calculated at each cluster level. This statistic expresses the percentage of the SSE in the observed data set at each cluster level compared with the SSE in the one-cluster solution. In effect, this value measures the amount of residual variance in the data set at each cluster level; it is 100 percent at the one-cluster level, and would be zero if each site were in a cluster by itself. Clearly, lower values of %SSE are preferred, and values over 5 percent probably should be avoided. Our analysis of Late Bronze Age settlement data generated clustering solutions ranging between 2 and 30 clusters. We remove the two- through ten-cluster solutions from consideration, due to residual variance greater than 5 percent, as indicated by the %SSE values (table 1).

Second, we subtract the Sqrt(SSE/N) for the observed data from the mean Sqrt(SSE/N) from the 100 random runs for each cluster level to calculate the "Sqrt(SSE/N) difference." Since the Sqrt(SSE/N) indicates the average distance between site locations and their cluster centers, this value compares the clustering of randomized locations with the clustering of observed data. The difference is plotted at each cluster level to show peaks (greater distances between observed and random clustering) that suggest preferred cluster levels. Peaks for the Late Bronze Age data narrow the range of preferable solutions to 11, 14, 18, and 24 clusters (fig. 3).

Third, we calculate a z-score for the SSE at each cluster level by subtracting the mean SSE for the random runs from the SSE for the observed data, dividing the result by the standard deviation of the random runs. The resulting z-score is always negative in our analyses since the observed clustering is always tighter than the random clustering. Z-scores are normally distributed, and their associated probability values may be read from statistical tables (e.g., Shennan 1988: 338–39). Lower (in this case, more negative) z-scores indicate decreasing probabilities that the observed clustering reflects a random distribution of sites. Hence, we prefer clustering solutions with lower z-scores, especially those scores that differ most from z-scores for adjacent solutions. The 24-cluster solution emerges as the optimal solution, based on a z-score that is lowest among these solutions and most different from scores for adjacent solutions (in this case, the 23- and 25-cluster solutions) (table 1).

TABLE 1. Residual Variance Values (%SSE) and Z-Scores for Late Bronze Age K-Means Clustering Solutions

Clusters	*% SSE*	*Z-score*
1	100.00	0.00
2	27.67	−1.25
3	20.02	−1.73
4	15.14	−2.89
5	11.28	−2.77
6	9.53	−2.28
7	8.41	−2.02
8	7.21	−2.09
9	6.17	−2.22
10	5.13	−2.52
11	4.30	−2.76
12	3.77	−2.85
13	3.25	−3.04
14	2.81	−3.25
15	2.60	−3.32
16	2.39	−3.45
17	2.18	−3.51
18	2.01	−3.54
19	1.92	−3.48
20	1.80	−3.44
21	1.68	−3.47
22	1.58	−3.57
23	1.50	−3.56
24	1.39	−3.66
25	1.35	−3.62
26	1.30	−3.68
27	1.25	−3.69
28	1.21	−3.66
29	1.18	−3.57
30	1.13	−3.57

NOTE: The preferred solution is shown to be at 24 clusters.

This solution proposes a number of clusters comparable to the number of polities expected by Helck (1962), at the lower end of the range suggested by Na'aman (1988; 1992), and greater than suggested by Bunimovitz (1995) and Finkelstein (1996). Our solution contrasts with those of Bunimovitz and Finkelstein due to our inclusion of East Jordan Valley Survey data and Finkelstein's exclusion of many potential political centers. More importantly, the detailed results of this solution may be compared

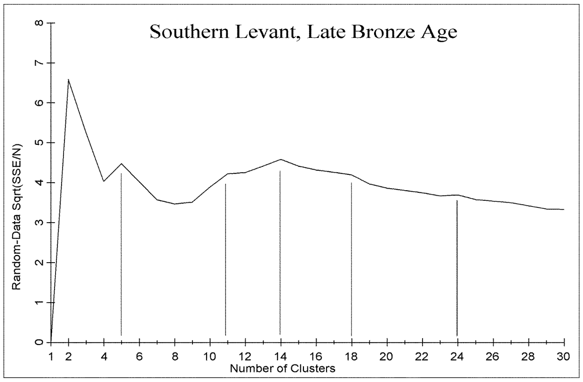

Fig. 3. Values for the "Sqrt(SSE/N) difference" [observed Sqrt(SSE/N)—mean random Sqrt(SSE/N)] for Late Bronze Age k-means clustering solutions, showing preferred solutions at 11, 14, 18, and 24 clusters.

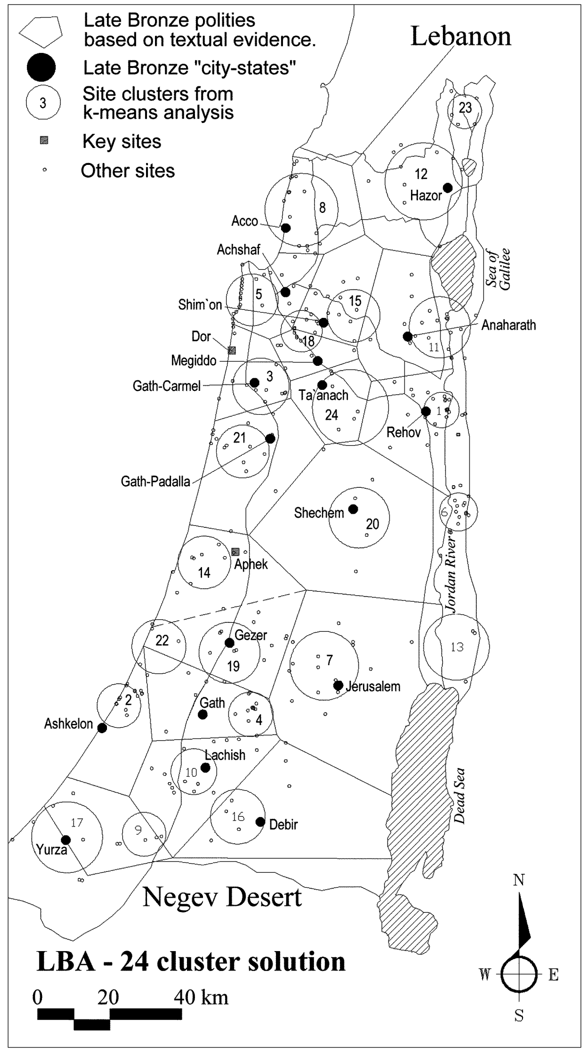

Fig. 4. A comparison of Late Bronze Age city-state capitals and territories (shown as Thiessen polygons) inferred historically by Bunimovitz (1995: fig. 6) with settlement clusters produced by k-means cluster analysis in this study. Cluster circle sizes correspond to RMS radii; smaller circles indicate tighter clustering.

with historical reconstructions as each method sheds light on the configuration of Late Bronze Age polities.

The Configuration of Late Bronze Age Polities

Most generally, there is a remarkable correspondence of k-means settlement clusters with the geographical configuration of polities inferred historically from the Amarna Letters (e.g., as plotted by Bunimovitz 1995: fig. 6) (fig. 4). This agreement is particularly strong for the Coastal Plain, the Jezreel Valley, and the Central Hills. In a smaller number of areas, incongruities may be interpreted in light of Amarna-period politics, Levantine geography, or the details of archaeological and historical methods of inference. For example, our inclusion of data from the East Jordan Valley Survey extends our database slightly east of the regions discussed by Naʾaman, Bunimovitz, and Finkelstein. As a result, two k-means clusters, one east of Shechem and the other just north of the Dead Sea, are added to their reconstructions. When the East Jordan Valley sites are excluded from our k-means analysis, these clusters are omitted accordingly.

Other specific questions of congruence involve historical contention. For instance, Helck (1962) proposes two polities in the Huleh Basin headed by Hazor and Samhuna, which parallel the two k-means clusters shown by our analysis, while the other authors suggest a single municipality centered at Hazor. On the southern Coastal Plain, Naʾaman (1988) and Finkelstein (1996) do not include Gath-Carmel among their city-states, whereas our analysis concurs with Bunimovitz in suggesting a polity in this area. Other historical evidence suggests that Bunimovitz's Gezer polity should be subdivided, as suggested by three k-means clusters in that polygon. Beck and Kochavi note that "Late Bronze Age Aphek, which is mentioned in the time of Thutmose III and Amenhotep II as a Canaanite city-state, probably became an Egyptian fortress during the time of Ramesses II, as did nearby Jaffa [Yafo]"

(1993: 68). These two centers figured prominently in Egyptian grain exports from Palestine, as attested by a letter from Ugarit found in the Late Bronze Age Governor's residence at Aphek (see Owen 1981; Singer 1983).

The lack of glaring discrepancies suggests that both methods are indeed approximating a common political landscape, including a combination of well-defined probable polities and a much smaller handful of more debatable entities. In light of previous active discussion of the relative cohesion and dynamic interplay between these polities, we use rank-size analysis to consider structural variations between polities and their likely implications for Levantine political dynamics.

Rank-Size Analysis

Rank-size analysis provides a quantitative means of assessing the political and economic integration of modern and premodern complex societies. The "rank-size rule" states that in mature, well-integrated settlement hierarchies, the size of any *n*th-ranked place may be predicted by dividing the size of the largest place by *n*, such that the rank and population of these communities describe a straight-line log-normal distribution when plotted logarithmically (Zipf 1949; see discussions in Falconer and Savage 1995; Savage 1997). Such log-normal distributions "appear to be typical of larger countries with a long tradition of urbanism, which are politically and economically complex" (Berry 1961: 582). Since archaeological settlement hierarchies rarely adhere to the rank-size rule, their interpretation generally derives from the manner and degree to which rank-size distributions depart from log-normal (e.g., Johnson 1972; 1977; 1980; Blanton 1976; Crumley 1976; Adams 1981; Paynter 1982; Wright 1986; Gophna and Portugali 1988; Finkelstein and Gophna 1993; Bunimovitz 1995; Falconer and Savage 1995; Liu 1996; Harrison 1997; Savage 1997). Site distributions with slopes steeper than predicted by the rank-size rule are referred to as "primate," and those with shallower-than-predicted slopes are "convex," while compound curves with a primate upper element and a convex lower component may be labeled "primo-convex" (see Falconer and Savage 1995: fig. 1). These departures are molded especially by the "closure" of the settlement system under study (i.e., the degree to which interactions are bounded within that system) and the "integration" of communities within a system (i.e., the relative frequency of interaction between them) (Vapnarsky 1968; Johnson 1980).

Archaeological interpretations often rely simply on judgmental appraisals of the shapes of rank-size distributions. This approach avoids the issue of how far a distribution must depart from log-normal to be considered "primate" or "convex." Some studies use the Kolomogorov-Smirnov one-tailed goodness-of-fit test (the "K^- test") to determine whether an observed rank-size plot differs significantly from a log-normal curve predicted by the rank-size rule (see discussion in Sokal and Rohlf 1981).[3] Traditionally, a value (the "K^- statistic") is calculated as the maximum deviation between the observed set of site sizes and a log-normal distribution (Thomas 1986: 322–37; Shennan 1988: 53–61). The K^- statistic is compared with predetermined threshold values to determine whether the observed departure from log-normal is statistically significant (Thomas 1986: 504–6).

Traditional applications of the Kolomogorov test, however, assume that the data under analysis represent complete, clearly bounded settlement systems. While this may be true for studies of modern nations, rank-size analysis of prehistoric settlement must accommodate the effects of sampling on archaeological data. Therefore, we apply the K^- test using Monte Carlo simulation to estimate the probability that an observed departure could be equaled or exceeded by drawing sites at random from a log-normal population (see Falconer and Savage 1995; Savage 1997). Unlike traditional applications of the K^- test, this method provides a quantified basis for judging whether any given rank-size curve departs sufficiently from log-normal to merit interpretation as "primate" or "convex." This method provides an archaeologically appropriate means for the structural

[3] We use the K^- test to assess the null hypothesis that any given rank-size distribution simply reflects a random departure from log-normal. The test calculates the absolute maximum deviation between an observed rank-size distribution and the distribution that is expected according to the rank-size rule. The K^- statistic expresses the proportion of observed cases that are "out of place," in the sense that they are smaller or larger than the expected according to the rank-size rule. The value of the statistic ranges, therefore, between 0.0 (indicating strict adherence to the rank-size rule) and 1.0 (reflecting pervasive departure from the rank-size rule). The K^- statistic may approach, but will never reach, 1.0 because the size of the largest site provides the starting point for an expected log-normal distribution and, therefore, always conforms to the rank-size rule.

TABLE 2. Results of Late Bronze Age Regional and Subregional Rank-Size Analyses*

Region	Number of sites[a]	Sample proportion[b]	Number of sites in population[c]	Observed K^- value	Probability[d]	Curve shape
Southern Levant	369	.75	492	.495	<.001	Convex
Southern Coastal Plain	105	.75	140	.371	<.001	Convex
Central Hills	108	.75	144	.407	<.001	Convex
Jordan Valley	60	.75	80	.233	.543	L-normal

* Cf. Falconer and Savage 1995: table 4.
[a] Includes only sites of known size.
[b] See discussion in Falconer and Savage 1995: 41–44.
[c] Number of sites in population = number of observed sites *x* (1/sample percent).
[d] Probability of drawing a K^- value greater than or equal to the observed value at random from a log-normal population, based on 1,000 random runs for each row.

assessment of settlement clusters and the polities they may approximate.

Structural Variation of Late Bronze Age Settlement Clusters

Fundamental contrasts between regional systems (including early states) and localized city-states lie not only in their geographical extent, but in their political and economic structure. Coherent regional systems incorporate communities varying in size and function over large areas using a hierarchy of administrative centers (e.g., Maisels 1990: 10–13; Trigger 1993: 8–9). In contrast, city-states are characterized by territorial compactness and tight integration based on the dominance of a capital over its subordinate hinterland (Griffeth and Thomas 1981; Maisels 1990: 10–13; Trigger 1993: 8–14; Charlton and Nichols 1997).

Well-bounded and integrated regional systems should be reflected in log-normal distributions. However, rank-size analysis of Late Bronze Age settlement data (using 369 sites of known size) produces convex curves for the southern Levant generally and for the subregions of the Coastal Plain and Central Hills, and a log-normal distribution only for the Jordan Valley (table 2). These results most likely indicate a pattern of regional and subregional "pooling" of multiple localized systems, with the possibility of a more bounded and/or integrated settlement system along the Jordan Rift.

In contrast, tightly integrated city-states with prominent capitals should produce primate distributions reflecting the local dominance of these centers. In addition, documentary analyses of Late Bronze Age polities concur that we should expect basic differences in political and economic structure between subregions (most notably between the less sedentary Hill Country and the more densely populated Coastal Plain and Jordan Valley) and between individual polities of varying political consolidation and power.

Rank-size analyses of individual k-means settlement clusters show marked contrasts in the structure of polities within and between the subregions of the southern Levant (fig. 5; table 3). The most pronounced pattern shows consistently convex distributions for the Hill Country clusters along the Central Hills and the Jezreel Valley. Among these 10 clusters only Cluster 19 has a primo-convex curve, with a slightly primate upper portion to accompany its convex lower component. In contrast, all of the log-normal and primate distributions correspond with clusters along the Coastal Plain and the Jordan Rift. This pattern seems to corroborate Naʾaman's and Finkelstein's suggestion of a basic structural dichotomy between the Levantine uplands and lowlands. The convex curves for the upland clusters suggest polities marked by varying combinations of poorly defined boundaries, minimal settlement integration, and the lack of a prominent capital. These characteristics accord well with Finkelstein's portrait of large polities, including those around Jerusalem and Shechem, populated with only a limited sedentary population (1997: 243). The lone deviation from this pattern stems from the large size of Gezer (in Cluster 19), which is seen as the capital of a leading Canaanite city-state by Naʾaman (1988: 18) and Finkelstein (1996: 233).

The clusters of the Coastal Plain include an array of different rank-size distributions denoting varying degrees of integration and prominence among their

TABLE 3. Results of Rank-Size Analysis of 24 Late Bronze Age Settlement Clusters Identified by K-Means Cluster Analysis*

Subregion	*Cluster*[d]	*No. of sites in K-means cluster*[e]	*No. of sites in rank-size curve*[f]	*Observed K- value*	*Probability*[g]	*Curve shape*
Coastal Plain[a]						
	2	28	21	.333	<.001	Convex
	5	31	19	.368	<.001	P-convex[h]
	8	24	21	.286	.084	L-normal
	9	11	10	.600	<.001	Primate
	14	17	15	.333	<.001	Primate
	17	7	6	.500	<.001	Convex
	21	22	17	.235	.453	L-normal
	22	7	5	.400	<.001	Primate
Hill Country[b]						
	3	16	13	.385	<.001	Convex
	4	37	31	.290	.032	Convex
	7	18	9	.500	<.001	Convex
	10	30	29	.310	<.001	Convex
	15	25	23	.522	<.001	Convex
	16	11	8	.375	<.001	Convex
	18	36	34	.324	<.001	Convex
	19	20	16	.375	<.001	P-convex[h]
	20	6	4	.500	<.001	Convex
	24	9	5	.400	<.001	Convex
Jordan Rift[c]						
	1	46	43	.442	<.001	Primate
	6	19	4	.500	<.001	Primate
	11	28	24	.208	.320	L-normal
	12	16	7	.429	<.001	Primate
	13	4	0	-	-	-
	23	6	5	.600	<.001	Primate

* Note that small sample sizes for some clusters may make their interpretation less conclusive.
[a] Includes Northern and Southern Coastal Plain
[b] Includes Central Hills, Jezreel Valley, Upper and Lower Galilee
[c] Includes Jordan Valley and Huleh Basin
[d] Cluster numbers are assigned randomly by KMEANS
[e] Includes all Late Bronze Age sites
[f] Includes only Late Bronze Age sites of known size
[g] Probability of drawing a K- value greater than or equal to the observed value at random from a log-normal population, based on 1,000 random runs for each row
[h] Primo-convex curve

capitals. The coastal clusters that include larger possible capitals (Acco, Gath-Padalla, Achshaf, Aphek, Jaffa) produced log-normal, primo-convex, or primate curves, suggesting the varying prominence of those cities, while clusters with smaller potential centers (Ashkelon, Yurza) revealed convex curves. This pattern brings to mind Naʾaman's suggestion of "higher rank" polities influencing or dominating those of "lesser rank" (1988: 19) and suggests the possibility of particularly acute political inequity and volatility along the coastal lowlands.

The Jordan Rift is marked by commonly primate rank-size distributions (for four out of five clusters) that suggest a series of well-integrated city-state polities, headed by clear capital communities. Clusters 1 and 11, with capitals possibly at Rehov (or

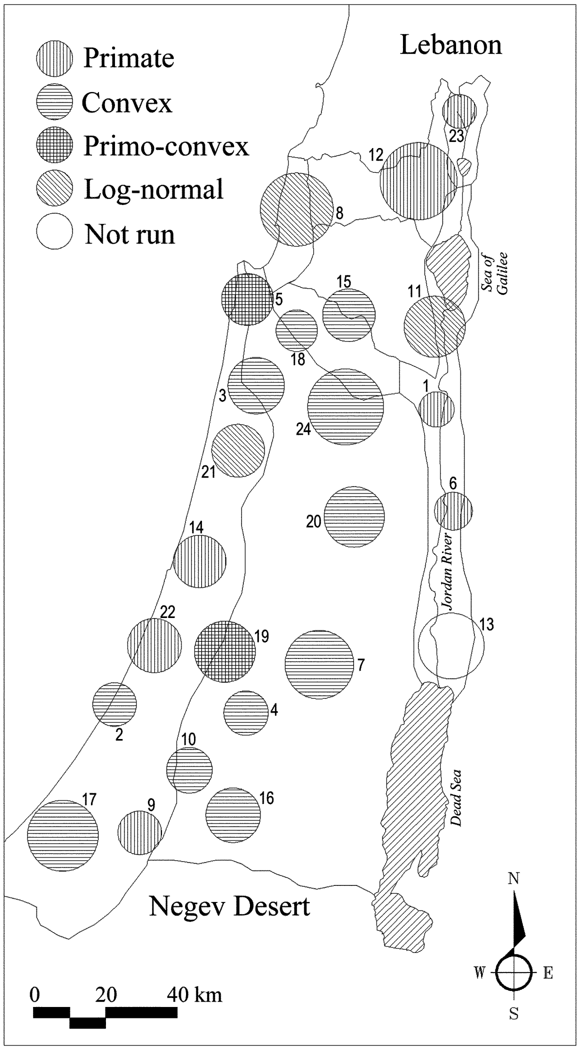

Fig. 5. Geographical distribution of k-means settlement clusters and their structures as interpreted from rank-size analyses in this study. Cluster numbers are assigned arbitrarily by the program KMEANS. Cluster 13 contained sites of uncertain size and was not analyzed (see table 3).

Pella) and Anaharath, respectively, represent heavily populated polities with modestly sized centers. To the north lie two clusters with fewer hinterland villages, but pronounced primate curves indicative of the prominence of their larger leading cities. Cluster 12 is particularly noteworthy because the primacy and precociously large size of Hazor reinforce its likely importance as a crucial node of political and economic ties with the nearby Damascus Basin.

This study portrays the southern Levant with three distinct political patterns as revealed by quantitative analysis of regional and local settlement patterns. The Coastal Plain, the setting for the region's largest political and economic centers, conventionally seen as the hearth of Canaanite civilization, emerges as a hodge-podge of polities with highly variable structures and their attendant political connotations. The Jordan Rift, normally seen as a smaller-scale backwater off the Mediterranean littoral, features settlement patterns most consistent with a series of highly integrated peer polities or city-states, and subregional political coherence. In contrast to both of these lowland areas, the settlement clusters of the Hill Country are more dispersed, with consistent evidence of less settlement integration. When considered structurally, these results suggest three fundamentally different bases for political development in a region normally viewed as a single, albeit fractious, social and cultural entity during the Late Bronze Age. These distinctions help illuminate the foundations of the particularly volatile political dynamics of the southern Levant.

CONCLUSIONS

The Late Bronze Age of the southern Levant has received considerable attention as the nexus between materially based analyses of prehistoric societies and textually based analyses of the subsequent historical era. Among textual sources, the Amarna Letters provide the earliest archival source to support robust inferences of Levantine political dynamics. Historical appreciations of the Amarna Age, which tend to use archaeological data primarily in the service of the written word, now may be supplemented with independent quantitative analyses of settlement data toward a fuller appreciation of the Late Bronze Age political landscape. A major goal of this study is to provide a quantitative means of applying the abundantly available settlement data of the southern Levant to explore local and regional political dynamics more fully and fundamentally.

Our study corroborates the venerable interpretation of a fractious and volatile countryside balkanized into a relatively large number of modestly sized polities that varied considerably in extent and composition. In particular, we note considerable disparity in polity size throughout the region, and most notably in structure when comparing highland and lowland polities and subregions. We suggest that these structural disparities in particular lie at the heart of Late Bronze Age political contentiousness. Given the general congruence of our settlement analysis with previous historical interpretations, the methods we propose hold promise for inferring longer-term patterns in the deeper past (e.g., during the emergence of Bronze Age urbanism). Moreover, many of the patterns we infer (most notably the dichotomy between highland and lowland political configurations and structure) hold considerable significance for the historical periods that follow (e.g., regarding the Iron Age emergence of Israelite ethnicity and statehood).

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