SETTLEMENT IN SOUTHERN JORDAN DURING THE IRON AGE: A GIS ANALYSIS

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Introduction

Settlement studies are an informative method for investigating socio-political systems (Feinman 2001: 13937). They provide an underutilised tool for understanding the dramatic changes, which transformed the socio-political landscape in southern Jordan during the Iron Age. Although there is evidence for continuous settlement in the region from the Pre-Pottery Neolithic A until the early Bronze Age, the archaeological evidence for occupation during the middle and late Bronze Age is sparse (MacDonald 1988; MacDonald 1992; MacDonald *et al.* 2004; Hauptmann 2007; Finlayson and Mithen 2007; Barker *et al.* 2007; Smith 2009; MacDonald *et al.* 2012; Parker and Smith 2014). Following the late Bronze Age settlement hiatus, the region witnessed an unprecedented era of resettlement. Neither the reasons for the abandonment of settlements in the middle Bronze Age, the impetus for the re-establishment of settlements during the Iron Age or their socio-political organisation is known.

Based on two Neo-Assyrian references to military campaigns, with references to southern Jordan, dated to the reigns of Adad-Nīrārī III, 805-752 BC (Luckenbill 1926: 262) and Assurbanipal, 668-626 BC (Luckenbill 1927: 314) it has been suggested that the Iron Age re-settlement of southern Jordan was a result of its assimilation into the Neo-Assyrian empire (Hart and Falkner 1985: 268; Bienkowski 1992a: 8; Knauf 1992: 50; Porter 2004: 388; LaBianca 2009: 3). It has been argued that the resulting political stability encouraged sedentarisation of the indigenous nomadic population, and the migration of agriculturalists from the north (La Bianca and Yonker 1998: 410) and west (Knauf 1992: 48). In 796 BC, the Neo-Assyrians embarked on a successful military campaign against Damascus. There is no evidence to support either a subsequent southern advance (Siddal 2013: 67) nor textual or material evidence for the presence of Neo-Assyrian officials in southern Jordan following this campaign.

That there were interactions between the Neo-Assyrian empire and Iron Age southern Jordan is indicated by architectural similarities in the design of buildings at Buṣayrāh and the open-court architecture of Neo-Assyrian residencies (Porter 2004: 385), as well as a textual reference to the payment of tribute to Nineveh by Edom (Luckenbill 1927: 119), a term used to describe Iron Age southern Jordan, which commenced following Adad-Nīrārī III's southern campaign. The comparable architectural styles at Buṣeyrāh and Neo-Assyrian sites are evidence of cultural interactions (Tyson 2015: 218), but not an indicator of either a Neo-Assyrian presence or the existence of Neo-Assyrian political control over the region (Stein 2002: 907). The single Neo-Assyrian reference to the payment of tribute to Nineveh from Iron Age southern Jordan has been the basis of the argument for the re-settlement of southern Jordan during the Iron Age in terms of the core-periphery model (Wallerstein 2011: 349). Although tribute can function as a form of economic exploitation, it can also be interpreted as evidence of a political alliance (Siddal 2013: 69-70). The absence of evidence to support a Neo-Assyrian presence in the region, combined with the interpretation of tribute as an indicator of an alliance, negate the argument that the Iron Age resettlement of southern Jordan was a result of its incorporation as a peripheral entity into the Neo-Assyrian empire.

The internal socio-political organisation of Iron Age southern Jordan has been informed by both the core-periphery model and Biblical references (Whiting 2002: 3). The region has been described as a kingdom with Buṣeyrāh its capitol, governing a defined geographical area defended by watchtowers and fortresses. Arguments for this early state model have been supported by evidence for a culturally unified region, as indicated by shared ceramic, linguistic and religious traditions (Tebes 2010: 146). This early state model was first proposed in the early twentieth century by Glueck (1935: 64). Although Glueck's thirteenth century BC date for the origin of this kingdom was revised following Bennett's excavations in the 1960s and 1970s to the eighth century BC (Bennett and Bienkowski 1995: 103; Bienkowski 2002: 305) the theoretical framework used in interpreting the archaeological evidence remained the same. More recent scholarship (Levy, Najjar and Ben-Yosef 2014: 981-986; Tebes 2014: 16) has questioned this traditional explanation. These authors have emphasised the importance of regional interactions in defining the socio-political organisation of the region. The current evidence for regionalism in southern Jordan during the Iron Age is limited to typological differences in kraters (Bienkowski and Adams 1999: 152) and inter-site differences in the proportions of vessel types (Whiting 2002: 222).

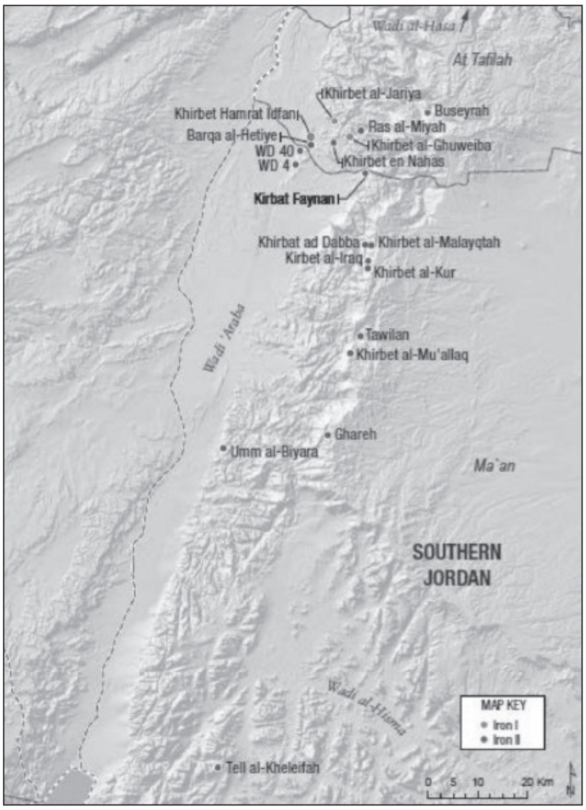
It has been argued that settlement studies are a more exact indicator of socio-economic frameworks than any other aspect of material culture (Wiley 1956: 1). However, their applicability in defining these processes using regional analyses is limited by the methodological difficulties associated with data collection over extensive areas. Although remote sensing using kite or drone mounted cameras is being increasingly used in archaeological surveying, data from most regional surveys is obtained from pedestrian surveys, which are rarely based on total coverage. Purposive surveys are the most frequently used method for data collection; only areas identified as yielding the highest probability of find sites are surveyed. Hence, they are biased by the possibility of under-estimation. Randomisation using computer based programmes has been used to overcome this bias. It has been argued that these traditional survey methods are "ill-suited" for investigating settlement patterns in southern Jordan, because of its mountainous terrain and the fact that find sites in this region are frequently small and unobtrusive (Knapp *et al.* 2015: 366). Despite the inherent methodological difficulties associated with pedestrian surveys, they remain the most informative method of obtaining evidence of settlement patterns in large scale regional studies.

Site identification using pedestrian surveys is based on the identification of diagnostic sherds. As a result, data from these surveys cannot be used to determine functionality. In addition, temporal relationships must be interpreted with caution, as the ceramic chronologies used in defining find sites often encompass hundreds of years.

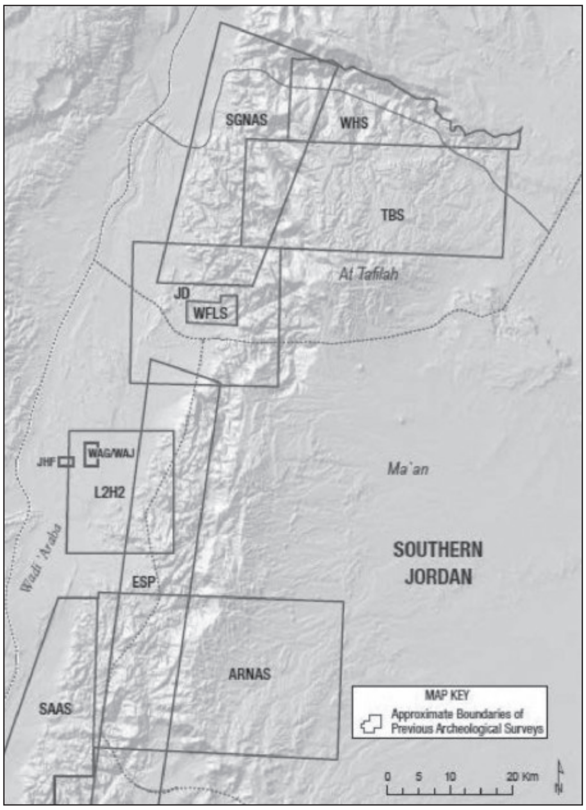
Regional settlement studies can provide information that enhances our understanding of the socio-political organisation of pre-historic societies. The recent accessibility of Geographical Information Systems (GIS) has provided researchers with a means of expanding the study of settlement patterns, using sophisticated technology which provides an integrated data management and analytical system. This information is invaluable in furthering the understanding of the socio-political organisation of an era such as the Iron Age in southern Jordan, where theoretical discussions are informed by finds from a limited number of excavated sites (**Fig. 1**).

There are nineteen published excavation reports pertaining to the Iron Age in southern Jordan. Two of these (WD 40 and WD 4) are cemetery sites (Beherec *et al.* 2014) and three (Khirbat al-Ghuwaybah, Khirbat Ḥamrat Ifdān and Khirbat al-Jāriyah) have been defined as small scale independent production centres (Ben-Yosef and Levy 2014: 855). Of the remaining fourteen sites only one, (Khirbat an-Naḥās) has been dated to early Iron II (Levy *et al.* 2014: 110); the other thirteen sites have all been dated to late Iron II. Inferences regarding the socio-political organisation of Iron Age southern Jordan based on these reports is limited by the small size of this cohort.

This paper investigates the socio-political organisation of Iron Age southern Jordan by examining evidence for settlement patterns us-



1. *Excavated Iron Age Sites in Southern Jordan. Tall al-Khalīfah (Glueck 1940); Gharēh (Hart 1989); Barqa al-Hētiye (Fritz 1994); Tawilan (Bennett and Bienkowski 1995); Khirbat al-Mu'allaq (Linder et al. 1996); Khirbat ad-Dabba (Whiting et al. 2008); Buṣayrah (Bienkowski 2002); Umm al-Biyāra (Bienkowski 2011); Khirbat Faynān (Levy et al. 2012); WD 40 and WD 4 (Beherec et al. 2014); Rās al-Miyāh (Ben-Yosef et al. 2014); Khirbat Ḥamrat Ifdān, Khirbat al-Guwaybah and Khirbat al-Jāriyah (Ben-Yosef and Levy 2014); Khirbat an-Naḥās (Levy et al. 2014); Khirbat al-Malāyqtah, Khirbat al-Iraq and Khirbat al-Kur (Smith et al. 2014).*



2. *Survey Boundaries Abbreviations: WHS=Wādī al- Hasa Survey (MacDonald 1988); ESP=Edom Survey Project (Hart 1989); SGNAS=Southern Ghors and Northeast Arabah Survey (MacDonald 1992); JHF=Jabal Hamrat Fidan Survey (Levy et al. 2001); WAG/WAJ= Wādī al-Guwayb and Wādī al-Jariyeh Surveys (Levy et al. 2003); TBS=Tafilā-Busayra Survey (MacDonald et al. 2004); WFLS=The Wādī Faynān Landscape Survey (Barker et al. 2007); JD=Deutsches Bergbau Museum Survey (Hauptmann 2007); L2H2=The Lowlands to Highlands Survey (Smith 2009); ARNAS=The Ayl to Rās an-Naqab Survey (MacDonald 2012); SAAS=The Southeast Araba Survey (Parker and Smith II 2014).*

ing GIS analysis. The area under investigation is defined by the Wādī al-Hasā in the north, the Wādī 'Araba in the west, and the southern border by the Wādī al-Ḥismā. The eastern border lacks a clear demarcation.

Method

The data used in this analysis was obtained from a review of all systematic archaeological surveys conducted in the region between 1979 (1399 AH) until 2013 (1434 AH) (**Fig. 2**).

These used a range of survey methods, including one hundred percent coverage (Levy *et al.* 2001; Levy *et al.* 2003; Barker, Gilbertson and Mattingly 2007), purposive surveys (MacDonald 1988; Hart 1989; MacDonald 1992; Smith 2009; Parker and Smith II 2014) and surveys based on randomisation (MacDonald *et al.* 2004; MacDonald *et al.* 2012). Sites identified by non-systematic surveys were excluded. Over this thirty-four-year period, the ability to accurately record the geographical location of find sites has changed. In contrast with the earliest surveys, which used the K737 map series (United States, Army Map Service 1966) to identify site locations, more recent surveys recorded geographical locations using Global Positioning Devices (GPDs). The accuracy of the earliest surveys is estimated to be between 200 and 300 meters (Arikan 2010: 78), whereas the surveys which used GPDs are able to record geographical locations with an accuracy of less than 3 meters.

Inconsistencies identified by the author between the published co-ordinates and site descriptions were clarified by discussions with the original surveyors where possible, and comparisons of topographical descriptions with imagery from both Google Earth® and topographical maps for the remainder. This was not possible for one site, which was excluded from the analysis. Sites were also recorded using different geographical co-ordinates; the Palestine grid, latitude and longitude, and UTM. All co-ordinates were converted into decimals, and the data entered into a GIS database. Some surveys overlapped, with the result that some sites were recorded more than once; when this was identified, only one set of co-ordinates was entered into the database.

Designation of find sites as Iron Age was based on the identification of diagnostic sherds. The chronology used in differentiating Iron I and Iron II was the simplified version of the Palestinian Iron Age, as proposed by Bienkowski (1992a: 7), which dates Iron 1 from 1200-1000 BC and Iron II from 1000-569 BC. Six hundred and thirty-three sites were identified; fifty-four Iron I sites, five hundred and sixteen Iron II sites and eighty-eight undefined Iron Age sites. Twenty Iron I sites had evidence of occupation during Iron II. Only sites categorised as either Iron I or Iron II were included in the final analysis.

Bienkowski (1992b: 258) questioned the validity of dividing find sites into Iron I and Iron II, arguing that all of these should be classified as Iron II. This argument is based on the ceramic finds from a single sounding at ash-Shurabāt (Bienkowski and Adams 1999: 157). This site was originally dated to Iron I (MacDonald 1988: 169-70) and subsequently re-dated to Iron II. Bienkowski's criticism is refuted by radiocarbon dates from Khirbat al-Ghuweibā. The original dating of this site to Iron I (MacDonald 1992: 73) has been substantiated by radiocarbon analysis (Levy *et al.* 2014: 848). In this study, the dates proposed by the surveyors is accepted.

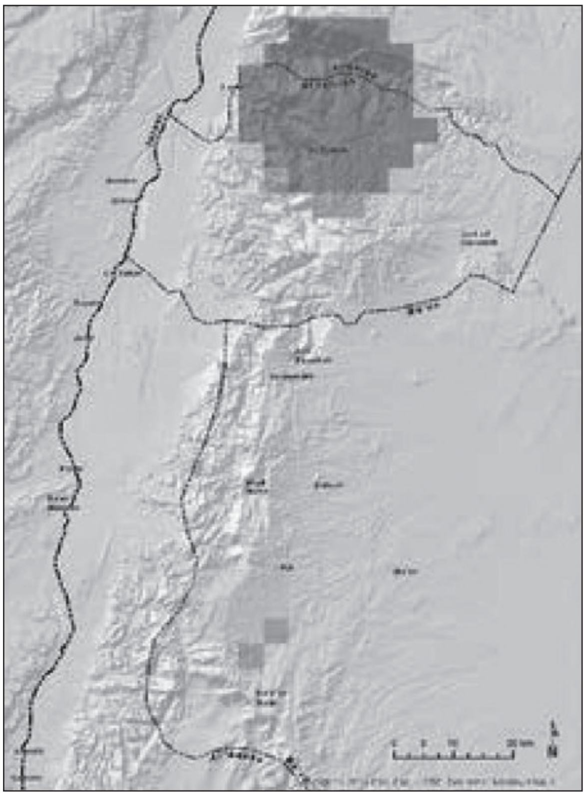
Evidence for clustering was analysed using the Getis-Ord Gi (Getis and Ord 1992). This analysis examines both the spatial relationships between points and the number of observations at each of these points. By ensuring that the spatial patterning of individual observations does not bias the results, the Getis-Ord Gi provides a robust method for identifying areas of interdependence, which may not be detected using a statistical method such as K means, which is based on the measurement of distances between individual sites (MacQueen 1967). A viewshed analysis was also conducted, to identify visible regions in the landscape from specific locations. These results can be used to infer the defensibility of a site, based on the assumption that sites with larger fields-of-view are defensive (Jones 2006: 525). The analysis used in this investigation was based on the assumption that the viewer had a height of 1.5 meters and was standing. The site data was combined with ASTER GDEM®, a product of METI and NASA. Both the cluster and viewshed analyses were performed using the ESRI Spatial Analysis tools in ArcGIS® 10.1.3.

Results

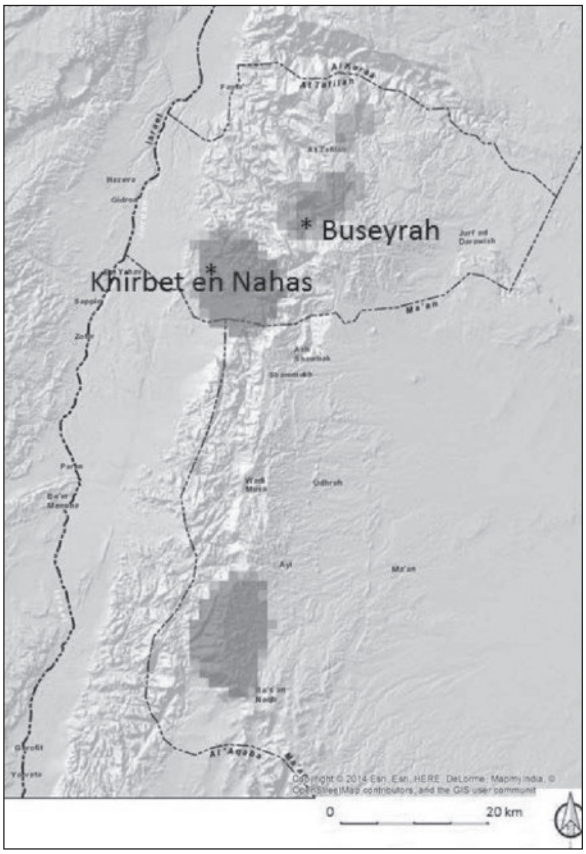
The cluster analysis of Iron I sites revealed two statistically significant clusters ($p < 0.05$). A northern cluster extending southward from Wādī al-Ḥasā, and a southern cluster extending northward from Ras an-Naqab (**Fig. 3**). Three statistically significant Iron II clusters ($p < 0.05$) were identified in the northern region (**Fig. 4**). Both Iron I and Iron II clusters in the northern and southern regions varied in size, from between 30 to 200 square kilometres. The size of these clusters limits the measurement bias associated with the recording of site locations based on the K737 map series.

The largest of the Iron II clusters, which is approximately 200 square kilometres, incorporates the mining sites at Faynān. A second Iron II cluster of approximately 140 square kilometres, which includes the site of Buṣeyrāh, was identified northeast of the Faynān cluster, with a third Iron II cluster of approximately 30 square kilometres located north of the cluster associated with Buṣeyrāh (**Fig. 4**). The location of the Iron II southern cluster, although larger than the cluster identified as Iron I, was in the same geographical area.

The viewshed analysis for Iron I clusters revealed restricted inter-site visibility in both the northern and southern regions, with visibility



3. Cluster analysis for Iron I sites; 1200-1000 BC (Z score ● p < 0.025 ● p < 0.05).



4. Cluster analysis for Iron II sites; 1000-569 BC (Z score ● p < 0.025 ● p < 0.05).

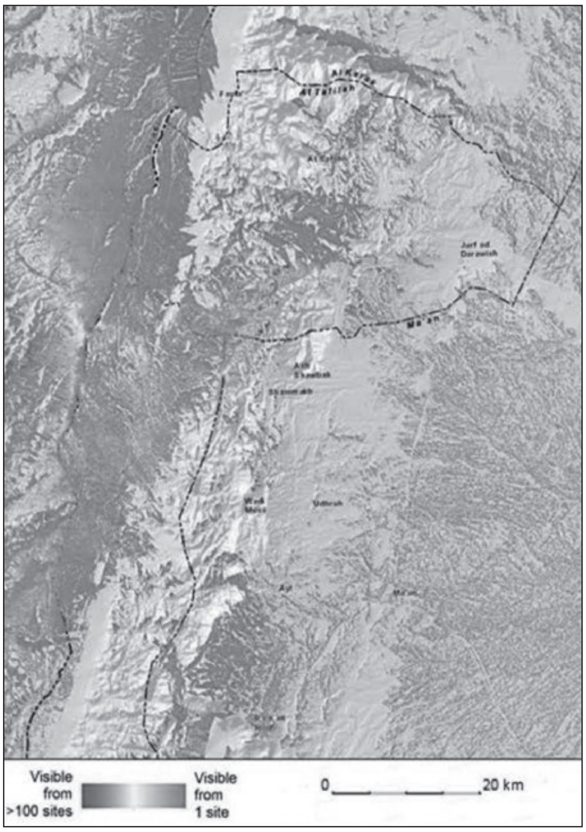
limited to only one other neighbouring site. A similar pattern was evident for the Iron II southern cluster (**Fig. 5**). This contrasted with Iron II clusters in the northern region, where an arc of sites with large fields-of-view, (that is, a visibility of more than one hundred other sites) was identified, extending from the southern border of the central northern cluster associated with Buṣeyrāh to the eastern/south-eastern border of the southernmost northern cluster associated with Faynān (**Fig. 5**).

Discussion

Iron I settlement in southern Jordan was localised to two areas; a northern region extending southward from Wādī al-Ḥasā, consistent with southward migration of settled communities from the north, and a southern region, which may also have resulted from the migration of settled communities moving northward from the oasis settlements in the Hijāz. The location of these sites on the Jordanian plateau, with their limited inter-site visibility, suggests that these were semi-autonomous agricultural communities.

The northern/southern divide evident in Iron I was also present in Iron II. Although the concentration of settlements in the southern region increased in Iron II, these were located in the same geographical area as those in Iron I, with no evidence of defensive sites, as indicated by limited inter-site visibility. It is possible that the socio-political organisation of the southern region in Iron II was similar to that in Iron I.

The settlement pattern in the north differs between Iron I and Iron II. The single Iron I cluster south of Wādī al-Ḥasā was replaced by three clusters, with the highest density of sites located in the south. The concentration of sites in the south of this northern area was associated with the copper mines at Faynān. This large scale, specialised industry operated by semi nomadic people (Levy, Najjar and Ben-Yosef 2014: 901) is estimated to have produced 36,000 tonnes of copper at the beginning of Iron II (Ben-Yosef 2010: 936). This industrial-sized operation must have been dependent on a complex infrastructure for supplies of food and fuel. It is



5. Viewshed analysis for Iron II sites; 1000-569 BC, located within a significant cluster (p< 0.025).

questionable whether the Iron Age agricultural fields in Wādī Faynān (Barker *et al.* 2007: 283) would have had the potential to meet requirements. Most of the food and fuel required for smelting was probably imported from the agricultural areas in the north.

This trade in commodities from the agricultural areas in the north to the copper mines at Faynān would have provided the stimulus for the development of a political economy (Earle 2002: 9). Buṣayrah is a mere eighteen kilometres from Khirbat an-Nuḥās, the most extensively excavated Iron II copper processing site in Faynān (Levy *et al.* 2014; 89-243). Buṣeyrāh was a wealthy stratified settlement, as evidenced by its monumental architecture (Bienkowski 2002: 69-70; 199). It has been suggested that its wealth was a result of its role in the overland trade route from the Arabian Peninsula (Bienkowski and Van der Steen 2001: 24). Although the coastal site of Tall al-Khēleifah probably functioned as a trading site (Bienkowski and Van der Steen 2001; 37), there is no evidence for the existence of an Iron Age overland trade route connecting the Arabian Peninsula with the Jordanian plateau. It is more likely that, during the Iron Age, the overland trade route from Tāymā transported goods to Mesopotamia via the north-eastern city state of Hindanu (Magee 2014: 267). It is the author's opinion that Buṣeyrāh's wealth was a result of its relationship with Khirbat an-Nuḥās, as evidenced by both its geographical proximity and the existence of an interconnected defensive system, located on the southern border of its settlement cluster with the eastern and south-eastern border of the cluster associated with Faynān. Although the temporal relationship between these sites is unknown, their spatial continuity is suggestive of a political association.

Settlement in and around Buṣayrah continued after the abandonment of settlement at Khirbat an-Nuḥās, which has been dated to the ninth century BC (Levy, Najjar and Ben-Yosef 2014: 986). The results of cluster analysis suggest that Buṣeyrāh's administrative and political influence during the latter part of Iron II was limited to an area of approximately 140 square kilometres. Its relationship with the smaller cluster to the north cannot be established with certainty. The absence of defensive sites linking this smaller site to the cluster associated with Buṣeyrāh suggests that this smaller northern cluster may have been an autonomous settlement. The complexity of ancient administrative systems can be inferred from the size of their jurisdictions (Blanton *et al.* 1993: 210). Although the monumental architecture at Buṣeyrāh suggests this site was a central administrative centre, the size of its settlement cluster suggests that its political economy functioned within the context of a localised traditional system.

This investigation into Iron Age settlement patterns in southern Jordan provides evidence for regionalism. Two distinct regional entities (north and south) were identified for Iron I, while three regional entities in the north and a single entity in the south were identified for Iron II. This analysis suggests that these northern and southern regions, although linked by cultural ties, were autonomous political entities in both Iron I and Iron II.

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