

The Desert and the Pastoralist: An Archaeological Perspective on Human-Landscape Interaction in the Negev over the Millennia

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Abstract: Analysis of patterns of settlement over the long term in the Negev, the desert of southern Israel, reflects repeated cycles of demographic decline and florescence, ostensibly cycles of desertification and re-colonization or growth. Although these periods of decline can be associated with parallel declines in production, and sometimes landscape degradation, these episodes of desertification cannot be tied to pastoral over-exploitation. The linkage between overgrazing and desertification in the Negev appears to be exclusively a modern one, and extrapolation of modern processes and conditions into the deep past is unwarranted.

Key words: Negev, pastoralism, overgrazing, nomadism, desertification.

Pastoralism as a human economic activity began in the Near East with the domestication of the goat, *Capra aegreus hircus* (alternatively *Capra hircus*) about 10,000 years ago, most likely in the Zagros/Taurus region, in the heartland of the natural distribution of the wild species (e.g., Zeder and Hesse, 2000; Hesse, 1982). The goat was domesticated in the context of early Neolithic farming villages, and not by hunting-gathering band level societies prior to the advent of village farming, as proposed in early formulations (see Childe, 1951:59). Within a period of less than 500 years, and perhaps significantly less, either the domesticated goats themselves or the idea of herding them spread throughout the cultural and economic matrix of early Neolithic society throughout the Near East, excepting the desert regions. Domestic goats (and not too long thereafter sheep) supplanted wild species (gazelle, wild goats, etc.) as the primary sources of meat for Neolithic village farming societies (e.g., Davis, 1984; Horwitz *et al.*, 1999; Legge, 1996; Vigne *et al.*, 1999). By 7600/7500 BC Cal, the Middle/Late Pre-Pottery Neolithic B (PPNB), the Mediterranean zone Levant was essentially agro-pastoral in its basic subsistence (e.g., Hole, 1996; Kuijt and Goring-Morris, 2002). The prosperity and stability of this village agro-pastoral adaptation is reflected well in the development of substantial settlements, sometimes on the order of 10 hectares in area, with populations of hundreds and perhaps a thousand inhabitants. Although no one has directly attributed this development to the adoption of village pastoralism, the general adaptation was clearly effective.

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Ca. 6700 BC Cal, this system underwent a general social collapse entailing abandonment of most sites and significant shrinkage of those which remained inhabited (Kuijt and Goring-Morris, 2002; Simmons, 2007; Rollefson and Kohler-Rollefson, 1989). The causes of collapse have been discussed extensively in the literature and explanations include such factors as climatic deterioration (e.g. Perrot, 1968; Moore, 1973), invasions (Mellaart, 1975; Kenyon, 1980), epidemics (especially resulting from newly evolved zoonotic diseases) (Hershkovitz and Gopher, 1990), and internal social stress and dysfunction (Bar-Yosef, 2002). Among these, Rollefson and Kohler-Rollefson (Rollefson, 1996; Rollefson and Kohler-Rollefson, 1989) have suggested that severe overgrazing abetted by deforestation caused by fuel demands for lime plaster production resulted in a regional environmental degradation in the semi-arid Mediterranean zone and consequent social collapse; that is, uncontrolled and unrestricted pastoralism caused desertification, which led to the collapse of PPNB civilization. Rollefson (1996) refers to the Near Eastern black goat as "the Black Plague of the Near East".

There are good scientific and historical reasons for rejecting this hypothesis (cf. Bar-Yosef, 2002; Kuijt and Goring-Morris, 2002). Kohler-Rollefson (1992) posits the development of a large population of external herders and the fissioning of PPNB society into peripheral pastoralism and village farmers; however, the absence of any evidence for herders' camps or other sites associated with peripheral pastoralism in the archaeological record until after the PPNB

collapse (Garrard *et al.*, 1996; Martin, 1999; Betts, 2008), renders causality a moot point. Evidence for regional environmental deterioration or land degradation at the end of the PPNB is also lacking, and for an environmental collapse large enough in magnitude to entail a general Near Eastern social collapse, and a relatively rapid one, such evidence is certainly to be expected (compare, for example, to the 4.2 k event and the controversies of a well-established environmental change and its relation to social collapse [Rosen, 2007]). Evidence for environmental deterioration, on a world-wide scale, is in fact evident ca. 6200 BC (the 8.2 k event) (Rosen, 2007), but is far too widespread to attribute to Near Eastern overgrazing, and too late to explain the PPNB collapse. In this context, in terms of the destruction of forests for fuel consumption, analyzing PPNB plaster floors (the primary proposed use for the lime plaster), Goren *et al.* (1991) have concluded that the amount of genuine lime plaster was limited, and that the bulk of the floors were made of crushed limestone. Thus, the estimates for fuel consumption are greatly overestimated. The degradation model also seems to assume modern Bedouin parameters of 40-50 goats per nuclear family for basic subsistence and thus large populations of animals engaged in the constant destruction of the countryside. Besides the problem with the population estimates (see following), the assumption that Neolithic village societies had herds of 40-50 goats per family is unsupported by any evidence except analogy. In fact, the villages show only limited evidence for features and installations which might service animals (Effenberger, 2012).

Finally, the populations of the Neolithic Near East were simply limited. Even with a few 10 hectare sites, and even assuming that archaeology has uncovered only a fraction of the sites that once existed, Neolithic populations of Palestine, on both sides of the Jordan would not have been more than several tens of thousands of people (e.g. Hassan, 1981), not enough to cause general regional environmental collapse. In fact, simulations of environmental effects of ancient villages in Jordan (Ullah, 2011), indicate that such villages could only have limited and local impacts. In short, a causal relationship between Neolithic overgrazing, desertification, and ultimate social collapse cannot be supported.

The general idea of human impact on the environment in ancient times is, of course

legitimate and important to examine (e.g., Butzer, 1982; Rosen, 2007). Beyond this however, Rollefson and Kohler-Rollefson's argument exemplifies some of the problems involved in examining the pastoralist - desert(ification) interaction. The uncritical adoption of analogy with modern Bedouin, with a stress on modern, informs much of the historical thinking on nomadism in general, and on overgrazing, pastoral societies, desertification and historical process in the Near East in particular. The fact is that the modern context is unique and cannot be applied uncritically to the past, even when there are seemingly parallel contexts and processes.

Rollefson and Kohler-Rollefson seem to have drawn on received wisdom concerning the negative effects of grazing on landscape (although not scholarly consensus; Thomas and Middleton, 1994; Reynolds and Stafford-Smith, 2002; Warren and Maisels, 1977; Kates *et al.*, 1977 for just a few more balanced views). In the deserts of the Near East and North Africa a causal relationship between overgrazing by pastoral societies and desertification has long been assumed by geographers, ecologists, historians, and not least, politicians. As early as the late 19th century, Edward Palmer (1872) directly blamed the Bedouin for the creation of desert landscapes. Landscape degradation and denudation, and related proxies for desertification such as decreased floral diversity and cover, increased run-off, increased erosion, and expansion of the desert zone as defined by decreased economic productivity have all been attributed at one level or another to unchecked grazing by domestic herd animals (e.g., Warren and Maisels, 1977 for Australia; Otterman, 1974, Schecter and Gabai, 1980 for Israel; Mainguet, 1994 for the USA; Dregne, 1986 for the Sahel), in turn usually associated with peripheral pastoral groups, as opposed, for example, to village based-pastoralism. (e.g., Lowdermilk, 1945; Reifenberg, 1955 for mid-20th century views on land degradation and nomadic societies, including the effects of overgrazing).

To be sure, **overgrazing** is indeed a cause of landscape degradation; however, simple grazing is not, and even heavy grazing need not equate with overgrazing. In fact, grazing may enhance rangeland vegetation systems and stabilize land forms (e.g., Zonn and Orlovsky, 1986; Ash *et al.*, 2002). The long term grazing associated with the arid and semi-arid regions of the Near

East, and the southern Levantine deserts in particular, resulted in the co-evolution of stable interactions between plant communities and herds (Perevoletsky, 1995; for other regions e.g., Nyerges, 1980; Janssen *et al.*, 2000; Kuznar, 2001). The presence of grazing, even over the long term, and even intensive grazing, need not result in land degradation or vegetation instability and decline. In order to establish causality one must be able to define the intensity of grazing relative to the environment. The coincidence of pastoral presence and desertification is not sufficient for defining causality. Even the presence of environmental change need not imply desertification, since desertification is a negative impact, not merely an impact.

Causality itself is also difficult. Overgrazing is really a symptom of large-scale perturbations in the social and ecological system (e.g., Carr, 1977). Thus, for example, discussions of the famous aerial photograph(s) of the border between Egypt and Israel showing the effects of overgrazing in Egypt versus the non-grazing zone in Israel (Otterman, 1974; Danin, 1983: Fig. 8; also well evident on Google Earth) rarely consider the effects of the border fence on previously stable patterns of seasonal migrations, and how they might have actually caused the overgrazing on the Egyptian side of the border. Desertification results from systemic change. Overgrazing can at most be a single proximate cause (cf. Thomas and Middleton, 1994) among many; pastoralists do not overgraze as a matter of course, and traditional grazing systems have built-in regulatory mechanisms for maintaining stability (Swift, 1977).

Linked closely to causality, defining desertification is also difficult. Recent definitions have focused on net land degradation, with consequent declines in productivity, sometimes measured with respect to general biomass and sometimes with respect to human economic activity (Reynolds and Stafford-Smith, 2002; Thomas and Middleton, 1994; Glantz, 1977; Mainguet, 1994). In turn, these changes may be linked to reversible or irreversible effects and changes in basic states (Safriel, 1987), such as plant community composition, alluvial regime, or climate change. The issue of human influence is sometimes linked to the definition so that processes of change determined by climatic change are not always classified as desertification (although in these days of human

induced global warming, this issue may also be moot). Emphasis in recent research has also been on quantification of the processes to precisely define when desertification is occurring or occurred, but of course this is dependent on the baseline or starting point of measurement, in turn dependent on time-scales. Of course, different processes may operate on different time-scales so that amplification of desertification processes may occur if the harmonics of the processes operating on different scales coincide.

Desertification and Pastoralism in the Negev

If defining desertification and its causes is difficult in the present, it is all the more so for the deep past, dependent on various proxies of varying reliability and always hard to precisely date. For Rollefson and Kohler-Rollefson (1989), the collapse of PPNB society was sufficient evidence to conclude that desertification had occurred and to the degree that desertification has been defined as the conversion of productive lands to non-productive, their conclusion conforms to the definition. The link between pastoralism and land degradation, of course, was not demonstrated. The remainder of this paper will be devoted to an exploration of this proposed link, or rather more generally the relationship between pastoralism and environmental change in the Negev, based on long term trends as reflected in both the archaeology and paleoenvironmental reconstructions.

The Negev

The Negev as a geographic unit is a modern construct defined by the political borders between Israel and Egypt (Sinai) in the west, Israel and Jordan (the Syro-African Rift Valley, the Wadi Araba=Arava) in the east, and a more vague delineation in the north extending roughly from the coastal plain of the Gaza region to the Dead Sea (Fig. 1). It is not to be confused with the biblical Negev, which comprised only the northernmost areas of the modern region.

The region exhibits a marked environment gradient from north to south, reflected in several parameters. Rainfall, following a Mediterranean pattern of winter rains and summer droughts, declines from 200-300 mm per year in the northern areas (notably within the practicability

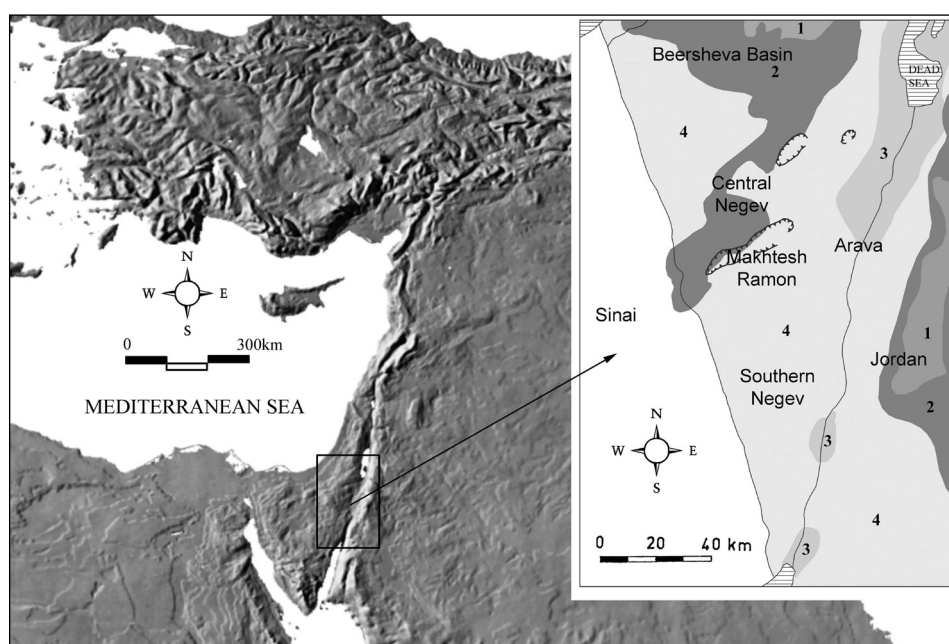


Fig. 1. Map of the Negev in the Mediterranean Levant with phytogeographic regions. 1. Mediterranean vegetation; 2. Irano-Turanian steppe vegetation, 3. Sudano-Deccanian tropical vegetation, 4. Saharo-Arabian desert vegetation (after Danin, 1983).

of subsistence dry farming) to 100-150 mm per year in the central Negev, and to 25-50 mm per year in the southern Negev. The Arava is also hyper-arid, a rain shadow desert in addition to its general southern location. Precipitation also varies considerably from year to year (Evenari *et al.*, 1982; Bruins, 2012).

Vegetation varies in accordance with the rainfall gradient and local topography (Danin, 1983). The northern regions are Irano-Turanian steppe, and to the extent that they extend into the hills, may include elements of Mediterranean vegetation communities. Degraded steppe vegetation characterizes the central Negev, a result of the higher altitudes (up to 1000 mamsl) of this region relative to adjacent regions. The southern Negev is characterized by sparse cover of Saharo-Arabian vegetation and the Rift Valley is a mosaic of relict Sudano-Deccanian tropical vegetation around the oases and Saharo-Arabian vegetation in the areas between them. Soils also vary from north to south, affected by local topography. The northern Negev is characterized by reworked loess and the southern regions by coarse desert alluvium.

These geographic gradients are also reflected in the cultures and economies of the region (e.g., Rosen, 2009). The Beersheva basin, in

the northern Negev, coinciding today with an isohyete of 200 mm marks the southern edge of dry farming subsistence viability. The central Negev Highlands have been used over the millennia as grazing grounds. With the development of run-off irrigation agriculture, appearing in the Negev around the Iron Age (ca. 900 BC), farming in the wadis was also practiced periodically, achieving a peak of intensity in the Byzantine period with the construction of massive and extensive raised field systems and dam terracing across the tributary streams. In the southern Negev, rainfall was insufficient for run-off irrigation vegetation cover in much of the region was inadequate to service herds. In the Arava, the spring systems served as settlement foci.

The issue of environmental and cultural gradients is integral to the question of desertification. It is precisely in these transition zones that desertification will be felt first and most intensely (e.g., Safriel, 1987). In terms of human productive potentials, the region between the 200-300 mm isohyete, the threshold values for cereal farming and therefore on the edge of subsistence dry farming viability, is inherently sensitive to environmental fluctuations (regardless of the cause of these fluctuations). Minor shifts will result literally in the presence

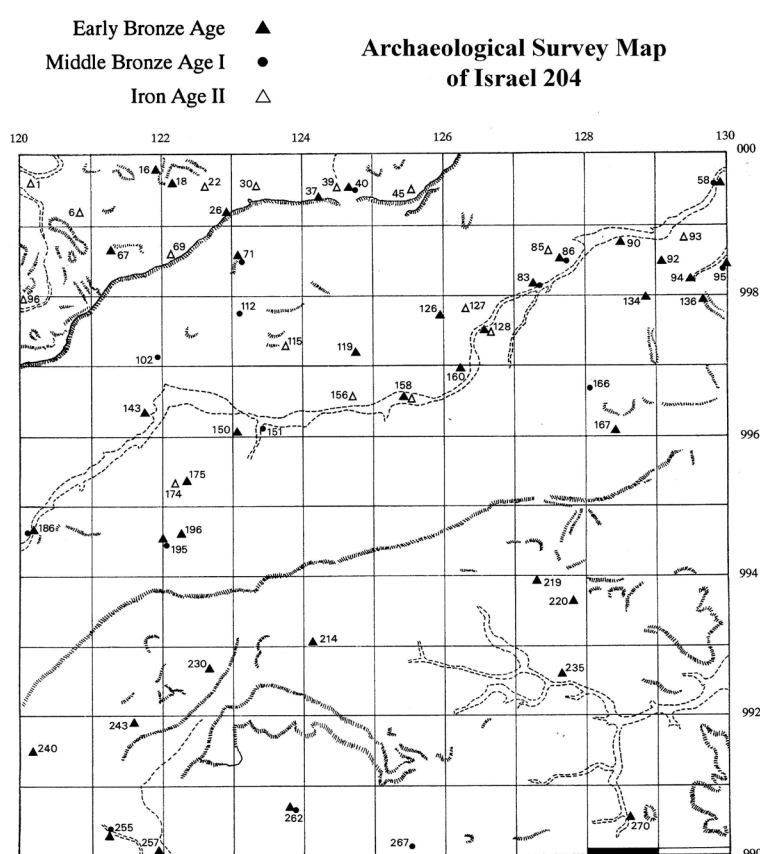


Fig. 2. Example of site distribution maps from the Early Bronze Age, the Intermediate Bronze Age (=Middle Bronze Age I), and the Iron Age from Survey Map 204 in the south Central Negev (Rosen, 1994).

or absence of cereal farming potential. Similarly, grazing zone of the central Negev, along with its potential for run-off irrigation, is susceptible to major fluctuations in productive potential that may result from only minor environmental shifts (Bruins, 2012). Such fluctuations are well documented in the paleoenvironmental record (Rosen, 2007). It is of note here that Enzel *et al.* (2008) suggest that climatic changes in the Mediterranean zone cannot be translated to similar order changes in the southern zones, and were reduced in magnitude as they shifted south. Rosen (2007) has summarized the general sequence of climatic and environmental changes based on a range of proxy data. For the purpose of this review, key points are the general fluctuations evident in the sequence, the PPNB climatic optimum followed by the 8.2 k event (as mentioned earlier), the cyclical lower scale wet-dry cycles in following periods, the humid episode in the Chalcolithic period, and again ca. 3000 BC Cal, the 4.2 k event of climatic deterioration and instability, which may have acted as a climatic trigger event to social collapse

in some regions, the low scale fluctuations of climate in the classical era, and the Little Ice Age in the Middle Ages. These climatic trends are, of course, much more complex than cycles of wet and dry, and different combinations of global and local climatic factors, scales of intensity, and microenvironments affected societies in different ways (Rosen and Rosen, 2001).

Archaeological florescence and decline in the Negev

The archaeological record in the Negev (Table 1 for general chronology and periodization), as based on intensive and systematic surveys of 100 sq. km blocks conducted by the Archaeological Survey of Israel (e.g., Fig. 2), presents an almost cyclical picture of periods of demographic florescence and decline (Fig. 3; Rosen, 2009). The survey monographs include maps of site distribution by period, which in turn can be converted to schematic settlement maps (e.g., Fig. 4). These reflect three basic patterns of settlement in the region, agricultural settlement

Table 1. Approximate chronological chart for the Negev and adjacent regions. Note that survey data, based on surface collection, are imprecise

Age	Period
Ottoman	1700 - 1917 AD
Middle Ages/Early Modern	900 - 1700 AD
Early Islamic	640 - 900 AD
Byzantine	300 - 640 AD
Roman	100 - 300 AD
Nabatean	200 BC - 100 AD
Hellenistic	333 - 200 BC
Babylonian/Persian	600 - 333 BC
Iron Age II	1000 - 600 BC
Iron Age I	1200 - 1000 BC
Late Bronze Age	1550 - 1200 BC
Middle Bronze Age	2000 - 1550 BC
Intermediate Bronze Age	2200 - 2000 BC
Early Bronze Age III	2700 - 2200 BC
Early Bronze Age II	3000 - 2700 BC
Early Bronze Age I	3800 - 3000 BC
Chalcolithic Period	5000 - 3800 BC
Pottery Neolithic	6250 - 5000 BC
Pre-Pottery Neolithic C	6700 - 6250 BC
Pre-Pottery Neolithic B	8500 - 6700 BC
Pre-Pottery Neolithic A	10,000 - 8500 BC
Epipaleolithic	18,000 - 10,000 BC
Paleolithic	1.5 million - 20,000 years ago

areas, regions of pastoral encampments, and buffer regions with little evidence for cultural presence.

In this context it is important to note that the issue of archaeological evidence for the presence of nomads in these desert regions is moot. Plenty of archaeological evidence for small ephemeral sites, tent camps, pastoral shelters, and seasonal encampments has been found in different periods (Rosen, 1992). Periods for which such remains have not been found can be confidently interpreted as periods of significant demographic decline.

Several features of these graphs and maps require further discussion. First, all of the site frequency-chronology graphs exhibit structurally similar cycles of rise and fall. That is, each of the 100 sq. km blocks shows periods of site abundance and periods of site number decline, to the point of essential absence and presumably areal abandonment.

Second, and no less significant, the patterns nevertheless vary from region to region and even from survey block to survey block. Thus, comparing patterns in the northern Negev to those in the central Negev, the Chalcolithic period (the late 5th millennium BC Cal) shows a major settlement peak in the northern Negev, but is virtually absent in the Central Negev. Similar differences are present in both the Early Bronze Age II and the Intermediate Bronze age (early and late 3rd millennium BC). Within the central Negev, the patterns show rough congruence in terms of presence- absence (florescence-decline), but vary in terms of the relative ranking of site frequency intensity from period to period (for the periods of archaeological presence). Thus, for example, some survey blocks show greater peaks at the beginning of the third millennium BC (Early Bronze Age II) and others at the end of the same millennium (Intermediate Bronze Age).

Finally, two periods coincide in all areas as periods of major decline (Fig. 4b, d), with virtually no evidence for archaeological evidence for presence, the second millennium BC (the Middle and Late Bronze Ages), and the first half of the second millennium BC (the Middle Ages after the Early Islamic period). Each of these periods shows a long time span with virtually no evidence for even the smallest scale archaeological presence, much longer than other periods of archaeological nadir.

The reasons for geographic variability undoubtedly have to do with functional variability of different settlement systems in the different geographic regions in different periods. Thus, for example, the Chalcolithic site peak in the northern Negev is a village farming florescence (Gilead, 1988), which simply could not have occurred farther south due to greater aridity. Similarly, the presence of Intermediate Bronze Age sites in the central Negev should probably be tied to specific copper trade systems (Cohen, 1992) which did not link to the northern Negev. The difference in settlement peak ranking between different areas of the central Negev may also tie into varying trade systems.

Negev archaeology and desertification

These archaeological data, reflecting chronological patterns of land use in the Negev over the past seven millennia, have implications

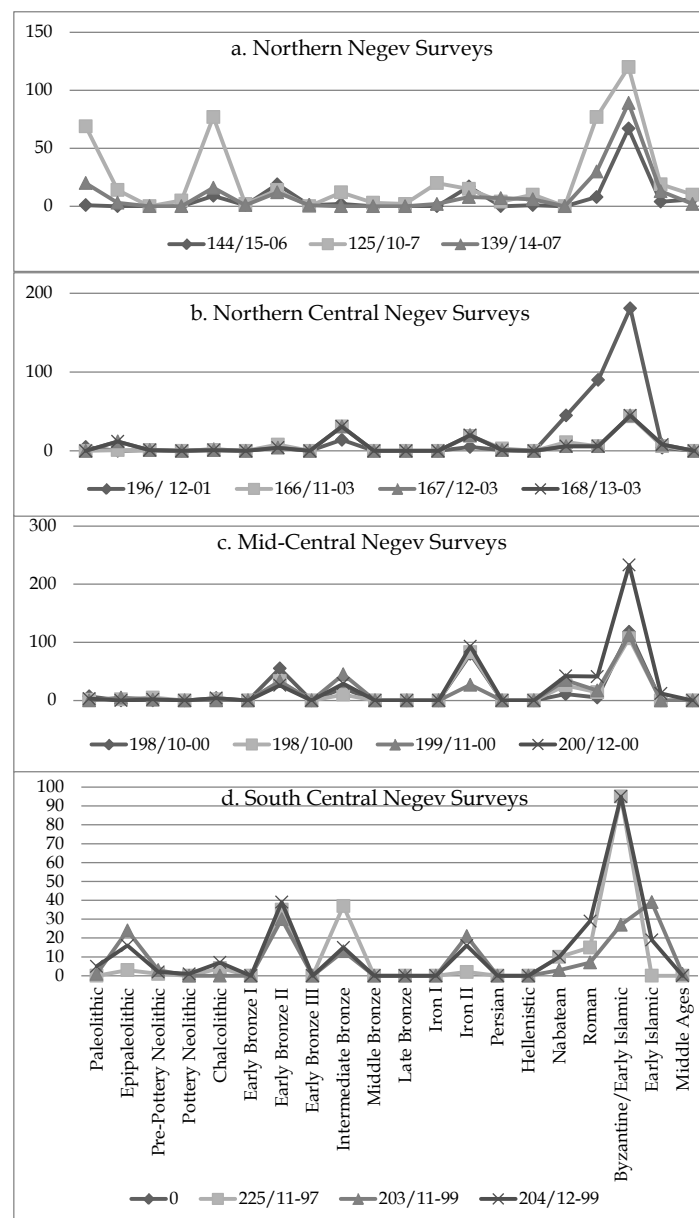


Fig. 3. Site frequencies by period in different areas of the Negev according to the Archaeological Survey of Israel. Each line represents the site frequencies within a surveyed 10 x 10 km square. (survey map 144, Beit-Arieh, 2003; 139, Govrin, 1991; 125, Gazit, 1996; 168, Cohen, 1981; 167, Cohen, 1985; 200, Haiman, 1991; 198, Haiman, 1986; 199, Haiman, 1993; 203, Haiman, 1999; 204, Rosen, 1994; 225, Avni, 1991).

for the study of desertification processes in the past. These include defining desertification in the long term, examination of the relationship between pastoralism and desertification in the Negev in the past, and determination of the causes of desertification and human abandonment in the Negev.

Research on desertification has a long history in the Negev. For much of the early

part of that history, evidence of civilizational collapse has served as a proxy for desertification (e.g., Huntington, 1911; Lowdermilk, 1945; Reifenberg, 1955), irrespective of perceived causality. In the sense that desertification is a human problem, one that impacts human populations often with tragic consequences, civilizational collapse in arid and semi-arid zones, under environmental stress by definition, is not an unreasonable definition (e.g., Thomas

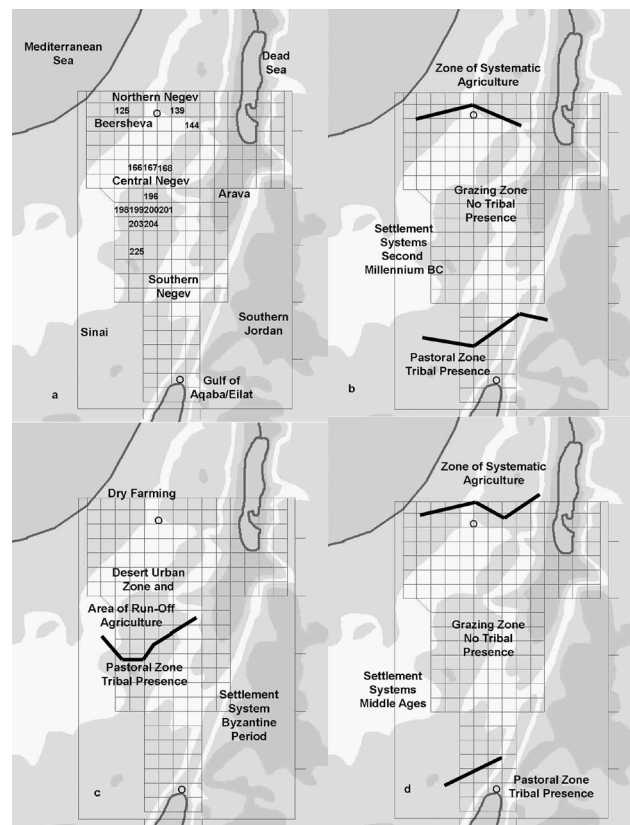


Fig. 4. Schematics of settlement systems in the Negev in different periods: a. The Archaeological Survey of Israel grid system with areas systematically surveyed and published (each grid square = 10x10 km); b. Second millennium BC system; c. Byzantine system (note proximity of pastoral tribal zone to settled zone), d. Middle Ages system (see Rosen, 2009).

and Middleton, 1994; Warren and Maizels, 1977), albeit difficult to quantify or measure objectively. If people were not impacted, it is questionable whether the issue would be considered as crucial as it is. Similarly, it is not clear the desertification would be considered a necessarily negative trend were not people involved; change of itself is not negative.

In this light, the repeated cycles of expansion and contraction of human settlement in the Negev, or its reciprocal, the contraction and expansion of the desert, can be viewed as episodes of environmental amelioration and desertification. In some cases, environmental degradation can indeed be associated at one level or another with the contraction part of the cycle, although human causality is not directly evident. On the other hand, given the obvious repeated re-colonization or expansion after periods of demographic decline, the issue of irreversibility is not clear (Walker *et al.*, 2002), at least not from the human economic perspective.

In fact, over the long term, human presence in the Negev has consistently grown (Rosen, 1987), probably contingent on new technologies and social adaptations. Nevertheless, the question of the relationship between human activities and desertification in the sense of land degradation remains. The Chalcolithic settlement collapse in the early 4th millennium BC Cal will illustrate the problems associated with trying to establish a causal link between land degradation on a large scale and human activities. In fact, it is unlikely that human activities in the sense of direct negative impacts on landscapes were responsible for human abandonments, even in those cases where environmental linkages can be established.

Chalcolithic settlement in the northern Negev (Gilead, 1988; Levy, 1986; Lovell and Rowan, 2011), roughly dated to the second half of the 5th millennium BC Cal, is characterized by a relatively dense linear village farming system along the primary drainage of the region, Nahal

(Wadi) Beersheva. Some sites achieve sizes of several hectares and the general population size is estimated in the thousands (Winter *et al.*, 2010; Fletcher, 2008). The Nahal Beersheva, today an ephemeral stream, apparently experienced an episode of perennial flow in this period of general climatic amelioration (Goldberg, 1987), enabling simple floodwater farming (Rosen and Weiner, 1994) and perhaps some interfluvial agriculture as well (Katz *et al.*, 2007). Faunal evidence indicates sheep and goat herding as well (Grigson, 1987). Although this settlement system originated in a colonization event in the mid-5th millennium BC, it seems to have stable and ever prospering for several hundred years. This is especially evident in the presence of one of the earliest copper smelting industries in the world (e.g., Golden, 2010). Nevertheless, as reflected schematically in the graphs, by 3700/3800 BC Cal, and perhaps somewhat earlier, all of the Chalcolithic settlements along Nahal Beersheva have been abandoned. No continuity is evident with the succeeding settlement phase in the Early Bronze Age I, several hundred years later (Gilead, 2011; 1995).

The stratigraphic column from Nahal Beersheva from around the Chalcolithic site of Shiqmim (Goldberg, 1987) shows alluviation in the Chalcolithic period and a disconformity with sediments attributable to the Byzantine period (ca. 500 AD Cal) resting immediately on the Chalcolithic formation. Thus, a major change in water regime, a transition from an alluvial to an erosional regime (land degradation) occurred coincident with the abandonment of the site of Shiqmim, and apparently linked to the end of a humid episode (Goldberg and Rosen, 1987; Rosen, 2007:99-101). Furthermore, given the relatively low population levels (high perhaps by prehistoric levels, but low relative to 19th/early 20th century populations of the northern Negev), it is simply difficult to link human over-exploitation to this episode of desertification.

With respect to overgrazing as a cause of desertification in the Negev in the deep past, two points are to be noted before a brief review of case studies. First, the earliest direct evidence for the presence of domestic goats is found in dung layers dated to ca. 6200 BC Cal in the *Makhtesh* Ramon, located in the central Negev (Rosen *et al.*, 2005). These layers reflect the use of rock shelters for seasonal stabling. They need not

reflect the very earliest penetration of domestic animals into the region, but faunal evidence from sites from earlier periods indicates hunting rather than herding (e.g., Dayan *et al.*, 1986; Horwitz *et al.*, 1999); thus, the history of desert pastoralism in the region goes back some 8000 years. Perevoletsky (1995) has noted a long term co-evolution of grazing and plant communities in the region, and a Holocene pollen diagram from another nearby rock shelter (Babenki *et al.*, 2007) shows plant community fluctuations over the millennia attributable to climatic change, but no essential changes in the basic components that can be attributed to large scale anthropogenic degradation or overgrazing.

Second, estimates of pastoral population are difficult to make. For example, several hundred seasonally occupied Early Bronze Age (in this case, the first half of the 3rd millennium BC Cal) campsites spread out over several hundred years over an area of about 1000 sq. km of systematically surveyed area probably reflects a human population on the order of hundreds. This is substantially lower than 20th century Bedouin populations of tens of thousands in the general region; again one must question the impact of such low populations as to cause significant landscape degradation and desertification (as opposed to achieving some degree of equilibrium), and human social collapse.

Two periods, as reflected in Figs. 3, 4b and 4d, are especially appropriate for this discussion, the transition from the third to second millennium BC in the central Negev, and the transition from Late Antiquity to the Middle Ages, also in the central Negev. Each shows an antecedent period with much archaeological evidence for desert pastoralism, succeeded by long periods of virtual absence of human presence in the region.

Pastoral presence in the central Negev in the third millennium BC is characterized by two distinct periods of pastoral florescence (Fig. 3), one in the first half of the millennium and another in the second. Although arguments have been made for continuity between them, stratigraphy of sites (e.g., Rosen, 2011:33-58) and rock shelters (Rosen *et al.*, 2005) indicate some kind of occupation gap. Following the second phase (the Intermediate Bronze Age),

the second millennium BC, the Middle and Late Bronze Ages, is virtually void of sites with little evidence for human presence except for possible short term grazing episodes.

The long term absence of sites after a period of marked pastoral presence suggests a possible scenario of overgrazing, landscape degradation, and consequent demographic decline. However, close examination reveals great difficulties with this reconstruction. Although environmental deterioration is evident at the end of the third millennium BC in increased erosion and climatic instability, this can be tied to the global 4.2k event and is evident throughout the Near East; as a large scale event transcending the Negev, it can hardly be attributed to local causes (Rosen, 2007:80-100). Furthermore, this period of climatic and environmental perturbation coincides with a demographic expansion into the desert based partially on pastoral exploitation, so that demonstrated degradation does not seem to have affected pastoral (or other economic) productivity. Furthermore, given that the expansion apparently did not precede the climatic/environmental degradation event (although admittedly, dating is imprecise), then it could not have acted as a trigger event, even given the problems of scale. Finally, the second millennium BC, which saw the re-urbanization of the Mediterranean zone with the abandonment of the Negev, is also a period of relative environmental stability. Thus, the putative effects of overgrazing could not have been realized in degradation in second millennium BC.

The first half of the second millennium AD shows a general abandonment of the Negev (excepting the Arava) similar to that of the second millennium BC. Unlike the earlier period, the transition between the sedentary and nomadic zones lies about 100 km farther south (Rosen, 2000; Avni, 1996), the result of the development of run-off farming and the expansion of agriculture deep into the Negev Highlands (Fig. 4c; Evenari *et al.*, 1982). The history of human presence in this period is complex (Rosen, 2007:15-171). Desert urbanism evolved on the Roman/Byzantine periphery by the 5th-6th centuries AD, achieved a demographic peak on the order of 20,000-30,000 people, and had declined (with much of the rest of the Eastern Empire) by the late 6th century AD (e.g., Shershefski, 1991). The desert

towns incorporated a network of elaborate and sometimes massive run-off irrigation systems in their immediate periphery. A rural hinterland, based on homesteads and hamlets, extended 20-30 km south of the urban zone, also based on run-off irrigated farming, generally simpler in conception and construction (Haiman, 1995; Rubin, 1990). Farther south, beyond the rural hinterland, zones of mixed pastoralism and farming and pastoralism without evidence for farming can be defined archaeologically (Avni, 1996; Rosen and Avni, 1993; Rosen, 1987). Archaeological surveys and excavations indicate long term stable relations between the pastoral nomadic groups and their sedentary cousins, textual evidence for occasional tensions notwithstanding (Mayerson, 1994).

The 7th century saw the continued decline of urban centers, the rise of clusters of agricultural villages and, of course, the rise of Islam. There is debate about the nature of the settlement changes; Haiman (1995, 2012; also see Magness, 2003) has suggested that the newly developing villages were the result of early Islamic state policies for sedentarizing nomads, while others have suggested that they reflect the resettlement of urban populations as the cities decline (Avni, 1996; Rosen, 2000). The pastoral system on the edge of the settled zone continued in parallel to this developing village system.

By the 10th century AD, and probably somewhat earlier, both the village and pastoral systems had ceased to exist and the central Negev was again abandoned for on the order of 500-800 years (depending on where one places the abandonment and later re-colonization chronologically). There is evidence of gullying and backwearing following the abandonment of the terrace systems (Avni *et al.*, 2006; Avni, 2005), and for backwearing and incision sometime following the abandonment of the pastoral sites in the southern zone (Ben-David, 1997). It is not possible to securely tie any specific climatic episode to these complex settlement processes (*per contra* Issar and Govrin, 1991), which are best seen as the consequences of the geo-political transitions of the period.

Given this picture, it is difficult to see overgrazing as a cause for the ultimate desertification of the Middle Ages in the region. Run-off irrigation plots would actually benefit from herds grazing on stubble and manuring

the fields as a matter of course. Economic decline resulted from geo-political changes and degradation was caused by abandonment, not *vice versa*.

In this context it is also important to note that since the re-colonization of the central Negev in the 18th century (or perhaps somewhat earlier) by modern Bedouin tribes (Bailey, 1980; Rosen and Goodfriend, 1993; Israel, 2006), a long term increase in productivity can be traced, especially in the first half of the 20th century as Bedouin groups adapted ancient agricultural terrace systems to their own farming needs (Meraiot, 2011). Apparent declines in productivity more recently should be linked to the impact of modern geo-political events on local systems, and not supposedly inherent tendencies in the natural of pastoralism or pastoral societies.

Final Notes and Review

All modern science is based on the Lyellian principle of uniformitarianism, that natural processes acting at present also acted in the past (and by extension will do so in the future), and that these same processes acting today may be used to explain the world in the past and the present. A crucial requirement for the application of this principle, often unstated, is that initial conditions be controlled (the basis of experimental science) or comparable (the basis of historical science). Trivially, if initial conditions are not equal (within the parameters of the investigation) then outcomes will be skewed.

The uncritical assumption that modern pastoralism and its associated processes and effects are equivalent to those of historical, ancient, and prehistoric times – that the initial conditions of grazing are equivalent – is deeply flawed. Contrasts between ancient and modern pastoralism are profound, including demographic differences of orders of magnitude, differences in basic herd species and composition, contrasts in the technologies of exploitation (e.g., dairying, wool exploitation, foddering, motorized vehicles, etc.), the effects of modern borders and the modern state on mobility, and huge differences in the size of markets, market demands, market proximity, etc. (Rosen, 2008). Thus, modern studies of pastoralism as they relate to landscape

degradation can have little direct application to the study of past pastoral societies.

The issue is not only academic. If a causal link between past pastoral societies and desertification could be established, it would suggest that pastoralism in the arid and semi-arid zones is inherently damaging; if such were the case, then modern processes could freely be extrapolated backward and forward in time, justifying political actions against pastoralists merely for the practice of pastoralism. The fact remains that there is no evidence for linkages between pastoral practice and large scale landscape degradation in the Negev in the pre-modern past; in modern times, such linkages, indeed established ecologically, have more to do with the social perturbations associated with regional geo-politics than with traditional pastoral practice. In the Middle East linkages between the past and the present play crucial roles in national identities and ideologies; it is crucial for the future of the region that planning and development be based on critical understanding of process and context and not received wisdom and belief.

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