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Landscape Archaeology and the Exploitation of Natural Resources in the Eastern Levant: A Neolithic Case Study

Introduction

Although much of the landscape of the eastern Levant, including Jordan, now appears to be a harsh marginal environment, it has supported substantial human populations for over a million years. Given the rich cultural developments of the area, much of this barrenness is deceptive. Even if humans have adapted to harsh arid conditions, however, we know that the environment also has changed throughout the millennia, and during certain times it was more favorable than at present. A major question for researchers to ask is, how much of the modern barrenness of the environment has been humanly induced and how much is due to climatic change? This paper examines this issue from an interdisciplinary perspective.

For the vast majority of the huge time span that humans have occupied the region, it appears that they existed harmoniously on the landscape. While hunters and gatherers may have had impacts on the environment, these generally had short-term effects, with disruption of the ecological balance rarely having been severe or long-lasting.

This changed dramatically with the Neolithic period. During this critical time of cultural development, the exploitation of Jordan's natural resources by people began to have an irreversible environmental impact (cf. Simmons *et al.* 1988). Beginning about 10,000 years ago, in conjunction with the domestication of plants and animals, human settlement on the landscape changed profoundly. It was during this time that the first settled, permanent villages and exploitation strategies based on agriculture, herding, and the use of wild resources appeared.

Previously, I (1995) outlined a tentative model examining the environmental impact of Neolithic settlements in Jordan. This model is based on an interdisciplinary study of recently excavated Neolithic settlements in Jordan, and draws heavily on the research of colleagues such as Gary Rollefson, Ilse Köhler-Rollefson, Zeidan Kafafi, Rolfe Mandel, and the late Jonathan Davis. The model is briefly summarized below.

We now know that these Neolithic developments were substantially different than those closer to the Mediterranean coast, and proposed that huge settlements such as 'Ayn Ghazāl (Rollefson *et al.* 1992; Simmons *et al.* 1988; Simmons and Rollefson 1988) and Wādī Shu'ayb (Simmons *et al.* 1989), located in central Jordan, represented unique desert-edge adaptations. Other recently investigated sites in southern Jordan, such as al-Basṭa (Nissen 1990) or as-Sifyia (Mahasneh, this volume), appear to follow the same pattern. These settlements were initially founded during mid-Neolithic, with earlier developments (such as PPNA) apparently occurring further to the west. The author suggested that natural population increase in the west associated with sedentary Neolithic economies there ultimately depleted local environments and that an adaptive strategy was to expand eastward, towards the desert margins. Large sites such as 'Ayn Ghazāl perhaps served as population "magnets," with the consequence of dramatic population increase centered into a few, nearly urban centers (Simmons 1995).

This constellation of activities had substantial ecological consequences, ultimately straining the landscape. This was particularly acute on the large Jordanian sites, since these were situated in ecologically precarious zones to begin with. While this pattern of population aggradation and pooling of scarce resources was initially adaptive, it, too, began to deplete the environment. This resulted in critical resource shortages that first required an economic split between farmers and pastoralists, and ultimately resulted in the abandonment of the large villages and an increase in pastoral activity at the end of the Neolithic. This cultural response may, in fact, be the beginning of the classic Near Eastern dichotomy between the "desert" and the "sown" (cf. Köhler-Rollefson 1992). All of these cultural developments were occurring, we believe, against a backdrop of steadily deteriorating climatic conditions (cf. Davis *et al.* 1990).

We know, from the archaeological evidence, that Neolithic peoples had a severe impact on the natural landscape (Rollefson and Köhler-Rollefson 1989; Simmons *et al.* 1988). At issue, however, is how to systematically document this. Using modern technologies, as well as traditional methods, how do we convincingly demonstrate human versus natural impacts on the environment? That is what needs to be addressed. In order to do this, a brief summary of some contemporary technologies may be of assistance, to be followed by the use of a geoarchaeological example from our studies at 'Ayin Ghazāl and Wādī Shu'ayb.

Remote Sensing

Certainly one of the most promising advances in archaeological interpretation on a regional scale is the application of Geographic Information Systems (GIS), a sophisticated application of remote sensing technology. There are now numerous examples of the applicability of this technique to archaeology, and Jordan is well poised to take advantage of this powerful tool with the development of the JADIS site data base. While applications of GIS may be tailored to address specific archaeological questions, a major use may be in assessing the impact of human activities on the landscape, both through time and for particular periods.

While "settlement" archaeology has always attempted to analyze the distribution of humans on the landscape, GIS offers a powerful enhancement. As one example, it is now possible to examine the geographic distribution of sites belonging to particular cultural periods, and see how these vary through time. This will allow researchers to determine the landscape preferences, and presumed resource availability, of specific cultures. Even within the same cultural groups, such analyses can allow an examination of the diversity of landscape practices exhibited by the distribution of sites. The often misused concept of site catchment analysis may now be more rigorously and objectively applied.

Another application of GIS is in modelling the impacts of environmental change (either humanly induced or climatic). GIS technology allows visible simulations of numerous dependent or independent variables. For example, how would an increase in rainfall effect the percentage of available arable land within a particular area? If we applied this sort of modelling to the 'Ayn Ghazāl and Wādī Shu'ayb examples, coupled with reliable paleoenvironmental data, we could perhaps determine if these settlements were indeed located at deserts' edge when occupied. We could also determine whether patterns observed at these sites are repeated at contemporary settlements located in markedly different ecological setting, such as in the Wādī Faynān (Najjar 1994) in the al-Ghawr.

Another aspect of remote sensing to interpreting the past is simply in locating buried sites. Of considerable potential is satellite imagery, employing Landsat technology (Sharer and Ashmore 1993:213-215). Surface, and even buried, features, both cultural and natural, can be observed from space. These areas can then be visited on the ground, and systematic survey can be undertaken in the hopes of locating exposures or paleosols that might contain cultural remains.

Thus, it is clear that remote sensing and GIS technology have tremendous advantages to addressing precisely and realistically how past humans used the landscape. But they are not without limitations. We must remember that the information obtained by remote sensing is only as good as the data upon which it is based. This requires careful and judicious application of archaeological data in the construction of GIS and other data bases. It also requires ground verification to ensure that what is being entered is an accurate reflection of what is really on the ground. Archaeologists, who are notoriously borrowers of technologies from other fields, must be careful in their use of these methods, and must not fall prey to being in awe of what seem like precise scientific techniques that really have but trivial applications to real archaeological issues.

Geoarchaeology

While recent technological advances have enhanced archaeological interpretation, there are more traditional methods that also supply us with tremendous environmental information. Certainly one data set that is absolutely critical in understanding past human interaction with the landscape is paleoenvironmental reconstruction. There are, of course, countless ways in which to do this, some more robust and compelling than others. But it should be intuitively obvious that before we can understand how people interacted with their environments, we must first understand what those environments were like. Perhaps one of the most powerful tools here is the use of geoarchaeology.

It has become apparent over the years that archaeological sites are subjected to numerous transformations during both their formation and after they are abandoned. Often these are subtle, and documenting them requires the expertise of geological specialists. Again, a mistake can be made by assuming that any geologist will be able to provide answers to archaeological questions. All too often geological consultants without a proper understanding of archaeology are used on projects. It is, however, no longer imaginable doing a project without some geological input. It simply is too important to ignore, and often geoarchaeologists will be able to provide insight that might have been overlooked, misinterpreted, or simply not understood by the archaeologists. The final portion of this paper demonstrates this.

A Geoarchaeological Case Study from the Neolithic

This study is to present an example of the application of interdisciplinary research oriented towards understanding Neolithic interactions with the landscape. At sites such as 'Ayn Ghazāl (Mandel and Simmons 1988) and Wādī Shu'ayb (Simmons *et al.* 1989), which contain both Pre-Pottery Neolithic and Pottery Neolithic components, as well as sites containing only Pottery Neolithic components, such as Abū Thawwāb (Kafafi 1988), we have observed enigmatic thick layers of cobbles in the deposits. Such deposits also may be present at al-Baṣta and other Neolithic sites. The interpretation of these layers has been difficult and unsatisfactory.

One plausible interpretation, however, has come as a result of geoarchaeological analysis during which we proposed the following hypothesis. Based on archaeological, climatic, and geological data, we believe that the combination of renewed summer drought in the Levant, the impacts of expanded human population, agriculture, the intense herding of sheep and goats, and deforestation for fuel, together caused an environmental crisis that has dominated human adaptation in the region ever since (Davis *et al.* 1990).

Modern climates in the Levant rarely if ever include summer precipitation. However, paleoenvironmental research employing General Circulation Models of the atmosphere (GCM's) consistently shows that a major aspect of climate from between 11,000 to 7,000 years ago was the enhancement of summer monsoons. These are driven by summer heating over the continents; stronger heating about 9,000 years ago drew significantly more precipitation from the subtropical oceans into continental interiors as summer thunderstorm rains.This both increased summer precipitation amounts and expanded the area of summer precipitation. The Levant appears to have been on the edge of the expanded areas of summer precipitation.

We hypothesize that increased summer precipitation indeed affected the Levant at precisely the time that the Neolithic began in earnest. This issue, of course, is an immensely complex one. For example, McCorriston and Hole (1991) and Moore and Hillman (1992) offer alternate climatic scenarios for stimulating agricultural origins, suggesting increased dryness. What is at issue here is that a variety of paleoenvironmental data often present conflicting interpretations. It also is important to realize that **increased** precipitation, as proposed here, does not necessary translate into increased **effective** moisture. It is thus possible to have short-term and intense seasonal precipitation in conjunction with overall increasing aridity.

As proposed here, this increased precipitation initially helped propel the Neolithic. By about 9,000 years ago, however, summer precipitation had declined and ceased altogether by about 7,000 years ago. This corresponds with increased humanly induced environmental degradation, brought about by intense farming and herding, and eventual abandonment of major Jordanian centers at the end of the Neolithic.

Precise evidence for this monsoonal incursion into the Levant is scant but tantalizing. Loss of agricultural productivity may have begun with erosion by summer torrential rains of land previously forested but now cleared for fields, pastures, and settlements. Evidence for this is in the form of slope instability at several Jordanian Neolithic sites. This appears as fine-grained colluvium and slopewash interlayered with cultural debris, and as layers of the aforementioned comparatively well-sorted cobbles at sites such as 'Ayn Ghazāl, Wādī Shu'ayb, and Abū Thawwāb. The cobble layers may be attributed to debris flow that was caused by torrential summer thunderstorms — the physical manifestation of the increased monsoonal pattern. Erosion could have been accelerated via debris flows that mobilized the cobbly sediment, especially if surrounding vegetation had been substantially reduced by human activity. Thus we suggest that the cobbly layers observed at these sites indicate increased incidence of torrential precipitation. Because torrential precipitation is much more common during the summer than the winter, this constitutes plausible evidence of an early Holocene monsoonal incursion into the Levant.

While there may be alternate explanations for the presence of the massive layers of cobbles at sites such as 'Ayn Ghazāl, Abū Thawwāb, and Wādī Shu'ayb, we are convinced that they represent concrete examples of a constellation of both humanly induced environmental degradation in conjunction with heavy summer precipitation. In their zeal to increase arable land and obtain fuel, Neolithic peoples cut down the very vegetation that previously had served as a retardant to erosion. Without the vegetation, there was no resistance to increased slope wash, accelerated by torrential summer rains, with the result that the settlements were subjected to annual "floods" of cobbles. These activities influenced Neolithic settlement landscape activity, ultimately contributing to the forced abandonment of major villages.

This is but one example of the types of interdisciplinary approaches that may be of considerable benefit to our understanding of how ancient peoples affected their environment. By applying both traditional methods, such as geoarchaeology, and modern technologies, such as GIS, coupled with ground verification, to other major Neolithic sites, this model could be refined, verified, or refuted. This is a major direction to which researchers should direct future investigations.

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