An Ecological Framework for Diachronic Changes in Human Settlement in the Loukkos River Valley, Morocco

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Introduction

Colonization in the Mediterranean world has long been viewed as a set of interactions between estertified ethnic categories or as a process of top-down political policy. Human Behavioral Ecolog (2013) offers an approach to human mobility and settlement focusing environmental factors which can shed new light on the sociopolitical development of the ancient Mediterranean. HBE is intended to bridge the hunter-gatherer and agro-pastoral traditions of the region, and it has been recently applied to more complex societies (e.g., Smith and Winterhalder 1992; Winterhalder and Smith 2000; Coile and Jones 2013), including the Classical world (Kienast and Winterhalder 2009; Jazwa and Jones 2017). Here, we explore the idea that the HBE model might be applied to the Loukkos River valley of northwest Morocco (Figure 1), the hinterland of the primary site of Lixus. Located as a “nores” or “Roman” city, Lixus was a major city on the Atlantic coast of North Africa, occupied from the sixth century BCE through the fifth century CE (El Khayari 2004; Akerraz et al. 2007). An IFD model of the territory around Lixus thus serves to advance an understanding of the development of the city within its Moroccan context, which brings together environmental and regional factors at work in the settlement of the hinterland. This IFD model uses topographic determinations of water supplies as the principal unit of study, and then employs additional factors to create a ranking of sites.

Survey Strategy

Surveys were conducted by teams from INSAP and UTK in July-August 2016 and July 2017 in the uplands of the Loukkos valley following an N × N sampling transect 0.5 km in width (Figure 3). Existing field boundaries serve as the limits of topographic units (TU). After assessing visibility in each cell, site members were spaced at 10-m intervals and walked straight across the field. They collected all artifacts within 1 m of their line, creating a systematic collection of finds within 20% of the total area of the TU and a sample, consisting of temporally diagnostic material that had remained unaffected, was made following the systematic pass. Finds were inventoried, and ceramics were quantified by sherd count, weight, and estimated vessel equivalents in the project database. The distribution of faunal classes were used to transport (transport, storage, consumption, and cookware classes), determined probabilistically across three cultural periods.

The Ideal Free Distribution

Although developed to understand the structure of the human population (Fretwell and Lucas 1969; Sutherland 1969), the HFD has recently received attention in the anthropological and archaeological fields for its application to human settlement and subsistence patterns (e.g., Winterhalder et al. 2010). The HFD can be applied on different geographic scales.

To establish a particular IFD model, the relative suitability of different habitats is calculated using the spatial distribution of a chosen set of environmental resources and the cultural factors influencing their value. The IFD predicts that people will first settle the habitat with the highest basic suitability. As people move into the habitat and population density increases, competition for and depletion of resources causes the suitability to decrease. Eventually, suitability is depleted to the levels of other habitats with lower basic suitability and it is advantageous for people to expand to other less-suitable habitats. (Figure 2). This continues until people occupy all potential habitats.

Model Construction: Rankings were constructed based on three primary variables: Net Primary Productivity (Figure 4), distance size, average elevation, distance to Lixus, distance to the Loukkos river, and distance to the coast. We used the 2011 (10-m resolution) Digital Elevation Model for the region for all locations within 22 km of Lixus. Ephemeral streams were modeled as points with at least 15,000 points flowing into and water bodies required at least 25,000 points (Figure 5). Rankings were calculated using a Monte Carlo methodology for such data types. Census data for the Loukkos valley (Figure 1), sites investigated during survey (Figure 5), and fields walked during survey (Figure 6).

Ceramic Abundance Estimation: Identifiable and datable ceramics were classified according to one of three functional classes, transport (potsmelter), storage (dishes), and preparation/consumption (asplanche and tableware). Fragments were assigned a date range (a, b) based on their artifact production. Monte-Carlo methods were used to approximate the estimate of the frequency allotted in each class period with n = 10,000 samples of a such that x = b - 0.5 x 1.0 for each sherd. The mean of Monte Carlo samples was then calculated for each period. Only data from the systematic sample from each TU was used for each site, with the mean divided by surface area to calculate sherd density as a measure of abundance, and also weighted to find the relative frequency of each functional class.

Methods

Table 1 - Sites investigated in this study, with estimated primary time period for each. Sites are ranked in order of the percentages of ceramics attributable to the primary time period. Significant levels of ceramics are estimated as in Figure 5.

Results

- Incredible survey of the large Loukkos River valley probably offers further testing of the predictions of the IFD at the watershed level, as it has been done frequently in other geographic areas (e.g., Winterhalder et al. 2010; Jones and Jazwa 2017). However, the sites included are not as high ranked.

- Sibyls with the highest abundance ceramics tend to be found in the top two ranking quartiles. Prominent exceptions include TU 505 and TU 653.

- Two of the top three ranked sites, El Adeb and Tabernae, were targeted because they are the location of known prominent sites. High rankings are driven by high NPF and large water-shed size, a proxy for water availability.

- High ranked fields tend to be the locations of recorded sites.

Discussion

This preliminary study demonstrates the potential benefits of using the IFD to better understand settlement patterns in the Loukkos valley. Our initial findings suggest that we have applied appropriate variables to modeling settlement locations on each of the scales described in this paper. However, the IFD has not been applied on scales as small as individual sites or agricultural fields, providing challenges that were not present in present archaeological applications. We show here that ecological models are consistent with the archaeological record, with sites with high ceramic abundance also ranked high in the IFD. The next season of survey in 2018 can profit in targeting fields with a high ranking, and the scale of survey and site distribution data can be used to test the predictions of the model and understand changes in settlement patterns.

References

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