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Landscape Socioecology in the Serpis Valley (10,000–4000 BP)

Abstract: In this paper we discuss our approach to landscape modeling for the Holocene middle Serpis drainage system (central Mediterranean Coast of the Iberian Peninsula). The archaeological sequence of these valleys is marked by the initial appearance of the Neolithic package around 5700 BC. We examine how landscapes respond to the agricultural way of life, in both the short and the long term. Concepts like change, adaptation and also resilience provide conceptual frameworks to better understand the way in which humans interact with their surroundings. They also help to explain how phenomena like the initial introduction of simple cereal horticulture, or subsequent introduction of plow cultivation (Bernabeu Aubán 1995) can trigger processes with sometimes unpredictable consequences in Mediterranean ecosystems. These consequences are not inherently disastrous, but the interactions between ecosystems and humans using resources are complex and often display non-linear outcomes of human decisions. We use the concept of socioecology to characterize these closely coupled human and natural systems as these should be an important focus of interest for archaeology.

Introduction

In Spain, it is traditional for archaeologists to consider prehistory as a subfield of history that studies the past of the human groups before the existence of written documents. It is this absence of written documents that makes necessary the need for a series of special techniques and methods that constitute what is known as the archaeological method. In this sense, the archaeological method includes basic principles that converge with those of geology but which are made more complex by human contributions (intentional and unintentional) to the formation of the archaeological record. In other academic traditions, however, prehistory does not exist as a subfield of history, and archaeology is that part of anthropology that studies the remote human past. Perhaps the most obvious consequence of these differences is that anthropological archaeology has often focused on the study of human behavior at different points in time, whereas prehistory has focused on how human groups change through time.

There has been some recent convergence of both archaeological traditions in Spain, with some of the basic concepts of history, such as the Braudelian *longue durée*, attracting the attention of anthropologists and concepts common in anthropology, such as *habitus* (of Bourdieu) or agency (Bourdieu 1990; Braudel 1980; Hegmon 2003), coming into use among Spanish prehistorians. An important common ground to both approaches to the human past is the recognition of the importance of space to human systems and their changes through time. New computer techniques for studying the combined spatial and temporal dynamics of the past offer archaeologists of both traditions the opportunity to explore new ways to study human socioecosystems (Barton et al. 1999; idem 2004; Bernabeu Aubán et al. 1999; idem 2006; Kvamme 1999). In the following pages, we briefly describe examples of our approach to an always-difficult aspect of the past, the reconstruction of landscapes through a dynamic process where ecosystems and humans interact and change together through time in a non-linear way.

This research is part of the Mediterranean Landscape Dynamics project (Medland) – a multidisciplinary effort working to study the dynamics of landuse-landscape-socioecosystem interactions. As the physical archaeological record is fragmentary and static, the Medland project aims to create a modeling laboratory where the social and ecological consequences of alternative land use practices can be recreated and tested against the archaeological record: – not only in the Iberian Peninsula but also elsewhere in the Mediterranean (Barton et al. 2006). A primary goal for this laboratory of the past is to gain a better insight into the recursive interactions of humans and landscapes at multiple temporal and spatial scales. Studies, like the ones summarized here are providing empirical data to validate and fine tune these models of human socioecology.

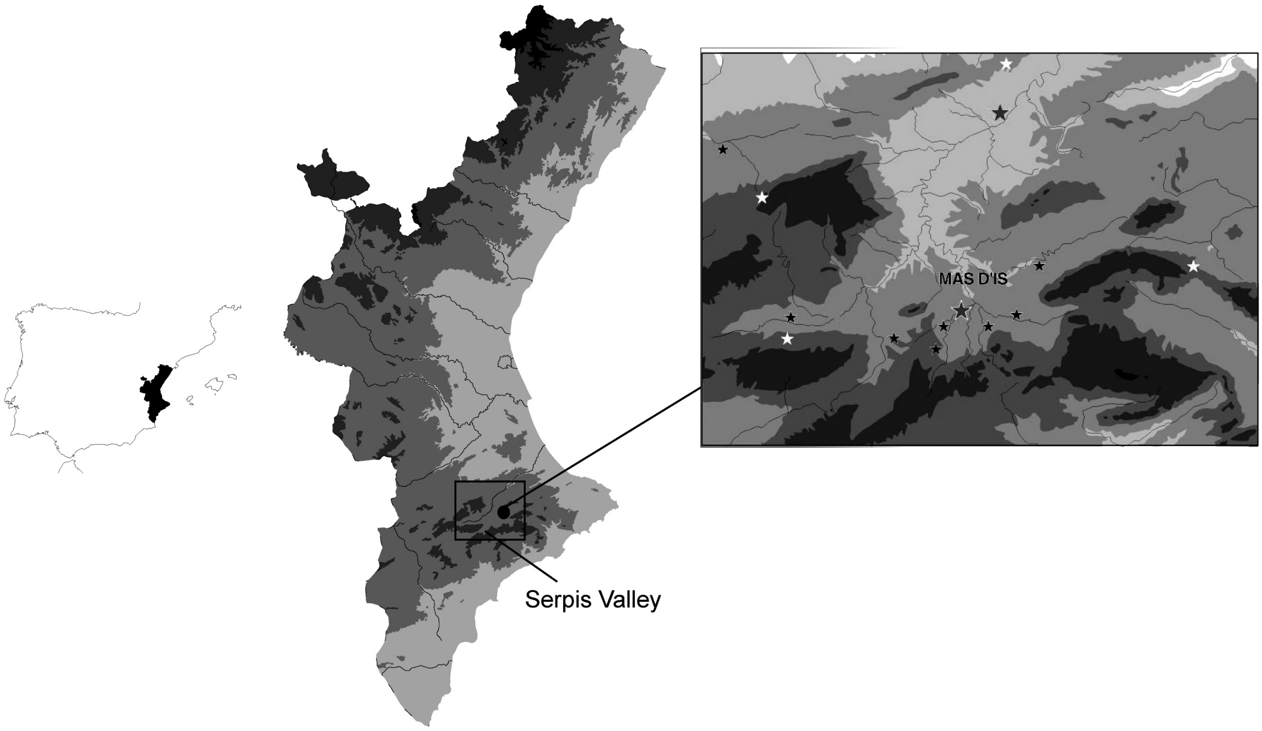

Fig. 1. Location of the Alcoy valley in the Iberian Peninsula.

Geographical Setting

Location

The Alcoy valley (or Valles de Alcoi) is the local name for the upper and middle Río Serpis (also known as the Riu d'Alcoi) basin above the Beniarrés dam *(Fig. 1)*. The total area of the basin is 736.85 km^2, with 460.77 km^2 in the upper and middle reaches above the dam. The Río Serpis is a typical Mediterranean river, with a comparatively short, steep course. Its total length is only 35.3 km. Most of its water comes from rainfall, but some karstic groundwater feeds the main river year-round making it a permanent stream – albeit a meager one during the summer. The Serpis drains towards the NE following the structure of the Valencian Betic system. Although in a montane setting, the Serpis valley is still near the coast. It lies 28 km to the south-southeast at Baeza Cove (next to Vila Joiosa), 53 km to the east at Moraira, and 40 km to the north-northeast at Gandía. Natural routes from the valley to the coast follow the course of the Río Serpis through the l'Orxa-Vilallonga gorge to the northeast, and the dry Vall de Gallinera and the Vall de Fageca-Famorca to the east. More difficult routes follow the Coll de Rates and Torre de les Maçanes to the south *(Fig. 1)*.

Physiographic Setting

At the northeastern extent of the Betic System, the mountains surrounding the Alcoy valley average around 1000 m AMSL, with some summits nearing 1400 m. The main valley is a structural basin, where former calcareous anticlines overturned towards the north to become a horst that surrounds like an amphitheatre several glacis of about 550–700 m in the upper part to 300–400 m in the valley bottom, and forms a more faulted structure to the south (Marco Molina 1990). The Alcoy and adjacent valleys are filled with mudstones and have been transformed by extensional tectonics since Pliocene times (La Roca Cervigón 1991; Mezcua / Martinez Solares 1983). The deepest sections are the Alcoi graben and a zone in the center of the Serpis valley, located between the Mariola, Benicadell and Almudaina sierras *(Fig. 2)*.

Climate

This mountainous region surrounding the Alcoy valley is a humid island in the Valencian precoastal semi-arid climate, with higher precipitation and lower evapotranspiration than other areas of Alicante Province (Rosselló Verger 1965, 5). The *Cabo de la Nau*, to east of Alcoy, marks an important cli-

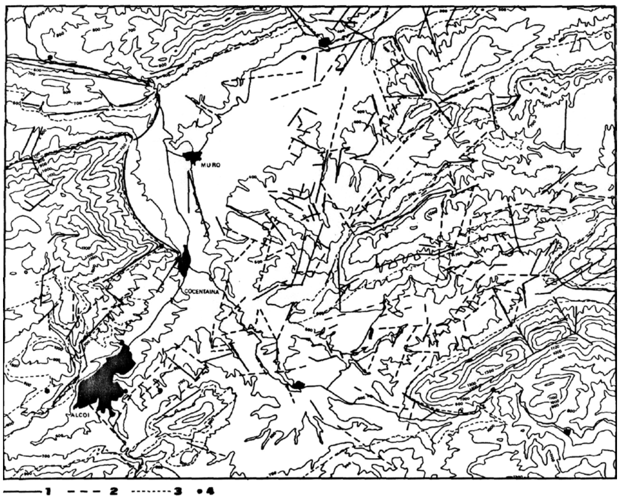

Fig. 2. Alcoy valley tectonics: (1) fault, (2) possible fault, (3) boundary between limestone and marls, (4) epicenters.

matic divide (Gil Olcina 1994; Martinez Ibarra 2006; Van Beek 2002) between a northern coastal zone open to the dominant Mediterranean flows, and a southern zone of rain shadow. Lautensach (1964, 629) describes the area around Alcoy as subhumid or semihumid, with three to four arid months instead of the five to six recorded on the coast. Annual average precipitation is usually over 500 mm, reaching more than 900 mm in the highest weather stations (Martinez Ibarra 2006, 70). The annual period of low rainfall generally lasts from June to October, with a maximum in August-September – although occasionally the dry period begins as early as in April, requiring the use of supplementary groundwater for agriculture (Lopez Gómez 1978, 114). Kunow (1966) calculated a pluvial gradient for this area of about 60 mm per 100 m that is useful for environmental modeling *(Fig. 3)*.

Prehistoric Socioecology

Archaeological Evidence

The distinctive climate along a climatic divide, topographic variation, and the location between the Mediterranean coast and interior *Meseta* has produced a diversity of ecological niches within this region that favored human presence in Late Prehistory (as well as considerably earlier). Archaeological investigations, beginning at the end of 19th century, have identified an important number of human sites dated within the Holocene. More recently, extensive surveys and excavations of Neolithic villages have provided more detailed information about human settlement in the Alcoy valley and adjacent Albaida valley (Barton et al. 1999; idem 2002; idem 2004; Bernabeu Aubán et al. 1994; idem 1999; idem 2003; idem 2006; Bernabeu Aubán / Köhler 2005; Garcia Puchol 2005; García Puchol / Aura Tortosa 2006; García Puchol et al. 2001). Despite inherent limitations of the archaeological record, the comparatively rich information available for this region has allowed us to begin to model its Holocene socioecology.

Chronology

The excavation of stratified assemblages from a number of Holocene sites *(Fig. 4)* occupied by pre-Neolithic hunter/gatherers (e.g. Regadiuet, Falguera, Tossal de la Roca, and possibly Punxó) and Neo-

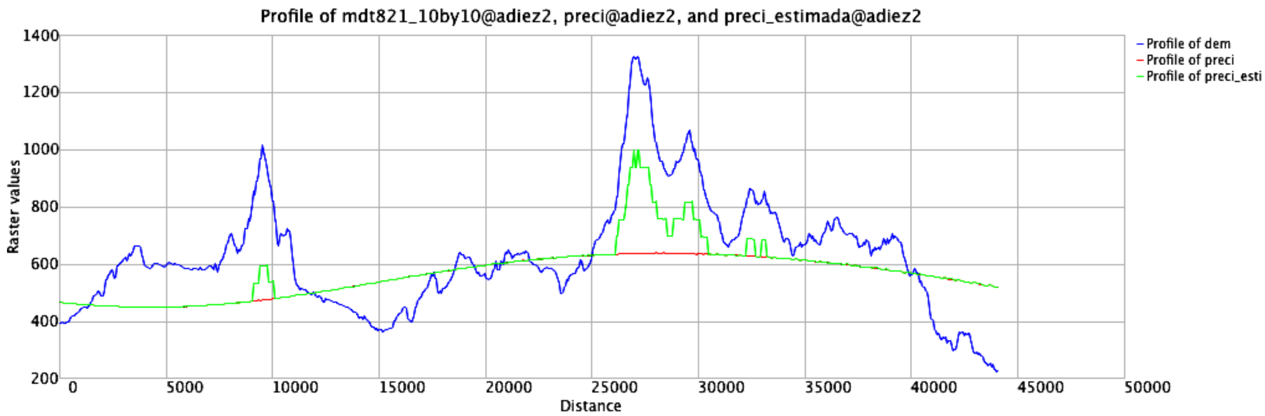

Fig. 3. Profiles of a Digital Elevation Model for the Alcoy region (upper), precipitation (bottom) and Kunow's gradient (middle).

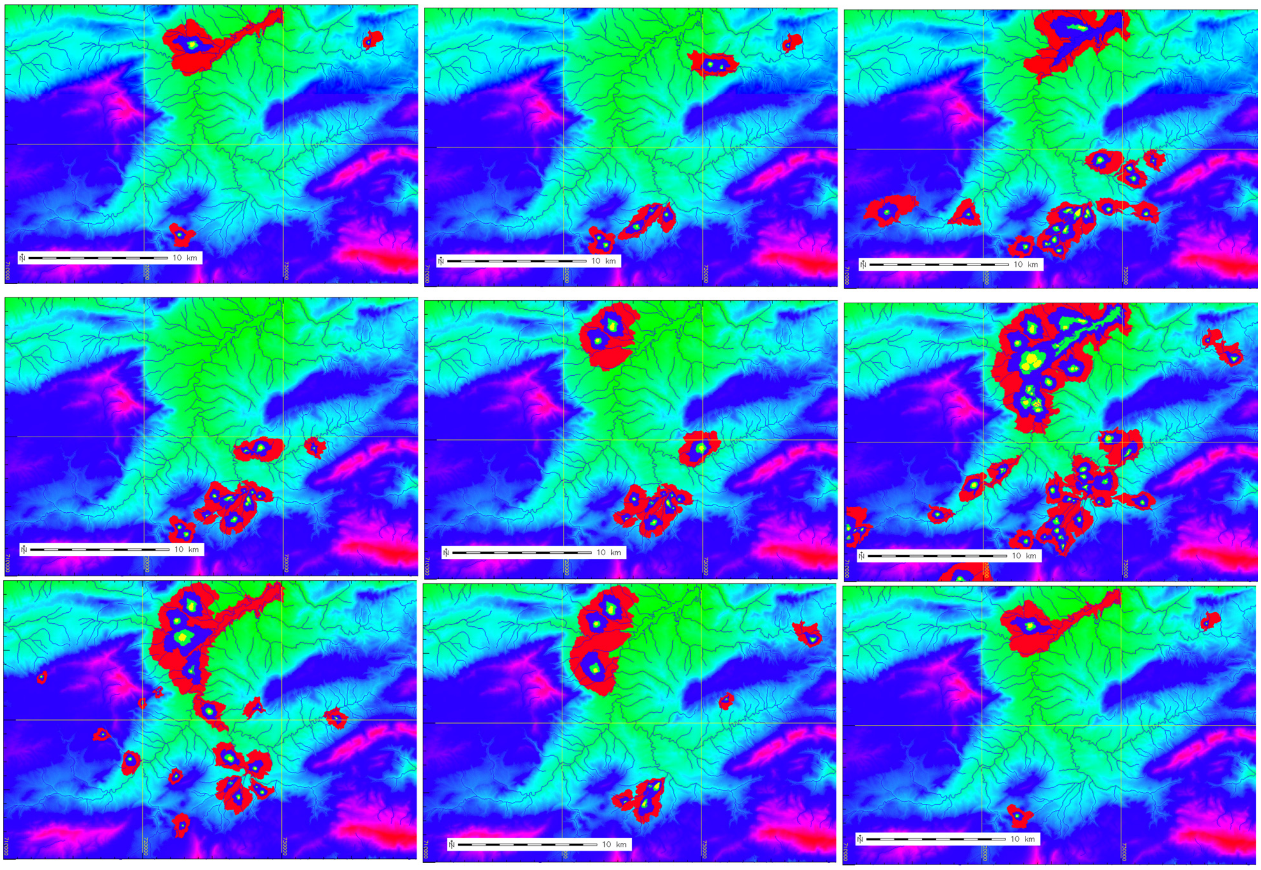

Fig. 4. Site catchment areas (walking times of 12, 24, 60, and 120 min from each site are shown as shaded bands), from left to right and from top to bottom (Late Mesolithic, Early Neolithic – NIA, NIB and NIC –, Late Neolithic – NIIA and NIIB –, Bell Beaker, Bronze Age and Late Mesolithic).

lithic farmers (e.g. Cova l'Or, Mas D'Is, Jovades, Colata, Punxó) have allowed us to build a solid chronological framework, that combines ceramic stylistic criteria with calibrated radiocarbon dates. The arrival of the first agriculturalists to the region (Neolithic I) is characterized by a Cardial ware ceramics, stylistically related to the impressed-ware ceramic tradition of the western Mediterranean. Later phases (Neolithic II) are characterized by more open vessels and a tendency towards marginalization of decoration. An extensive series of C-14 dates (mostly AMS) on short-life materials (to avoid old wood effects) suggests possible discontinuities in human activities, such as a hiatus in the two centuries before the appearance of the earliest farmers, and another between ca. 4200 and ca. 3900 BC (Bernabeu Aubán et al. 2006, Fig. 8.2). Earlier phases of the Neolithic have proven more amenable to detailed chronological subdivision than recent ones as a consequence of better radiocarbon sampling and due to problems related to the calibration curve itself. Ceramic phases of around 150–300 years can be distinguished for the Neolithic I, while only phases of 600 and 1100 years can be distinguished for the Neolithic II.

Site Catchment Analysis

Identification of resource catchments around prehistoric sites is an important aid to analyzing changes in socioecology through time. While there have been several approaches to site catchment generation proposed since GIS was introduced into archaeology, here we conceptually follow the classic proposals of Gilman and Thornes (Gilman / Thornes 1985) for the Southeast of the Iberian Peninsula, further developed by J. Vicent. However, instead of simple circles used in the earlier work, we calculate catchment areas from a cost-distance friction surface map, derived from topographic slope and transformed into minutes of walking time from each site *(Fig. 4)*. These catchment areas can be used to analyze resources available within different walking times when combined with paleoenvironmen-

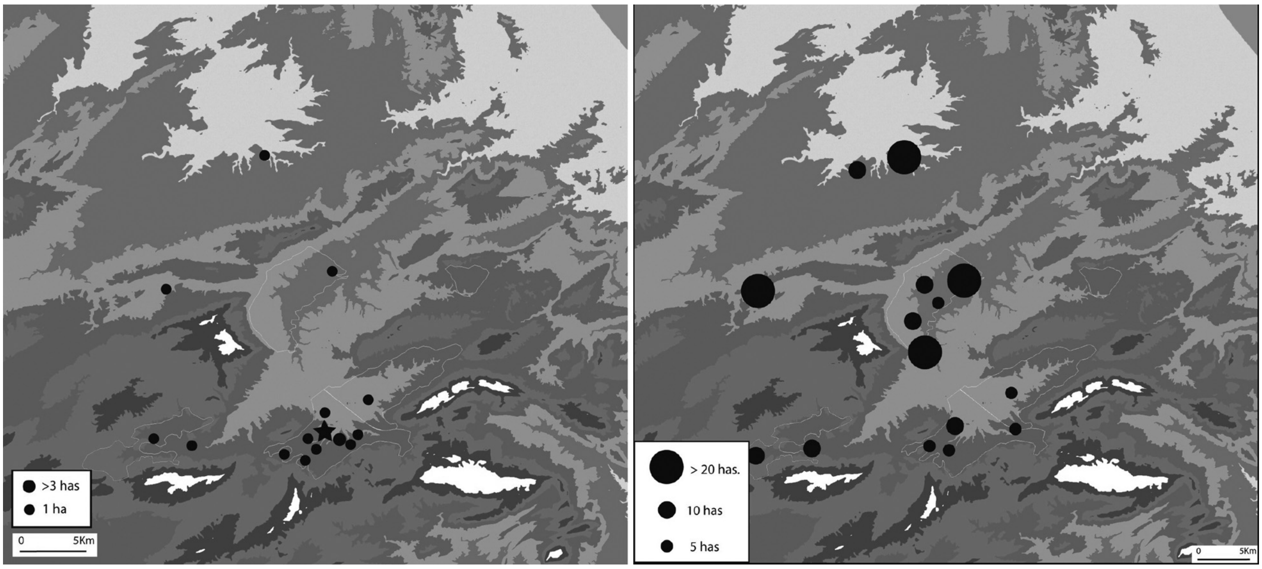

Fig. 5. Early Neolithic sites (left) and Late Neolithic sites.

tal data from other sources (e.g. Badal 1990; Dupré 1994).

Landscape Modeling and Settlement Dynamics

Prior GIS-based research has documented dynamics in land use and settlement intensity through time in this region (Barton et al. 1999; idem 2002; idem 2004; Bernabeu Aubán et al. 1994; idem 1999; idem 2003; idem 2006). We noted additional evidence for occupation cycles for the Neolithic that appear to show sites of approximately the same size in the Early Neolithic, with greater diversity – and in some cases considerable increases – in the size of the sites in the later Neolithic. The settlement patterns now visible in the archaeological record are the cumulative result of long-term human organizational dynamics at regional scales. The Early Neolithic pattern seems to represent the establishment and abandonment of equivalent, small settlements at different locales over time. The later Neolithic pattern, on the other hand, shows a different dynamic that includes both the establishment of small settlements and the growth of small settlements into larger ones.

These different patterns appear to represent long cycles of occupation and the persistence throughout time of certain socioecological relationships, which are abruptly altered at points in time. In the terminology of Complexity Theory, these different cumulative settlement patterns represent the socioecological fitness landscapes of different human niches. For simple hoe-based agriculture, settlement organization tends toward the repetition of dispersed, small, identical organizational units. For the more specialized and diverse agricultural systems of the Late Neolithic, with more intensive plow-cultivation and extensive herding, some settlements become differentially strong attractors, and grow much larger than others (McClure / Jochim / Barton 2006). These centers of attraction may initially form because certain settlements have slight differences in productive potential. The growth of these settlement locales can drive their increased strength as attractors of human settlement if they also become places with increased accumulation of wealth and prestige. We see this characterisation in some of the Late Neolithic communities (Bernabeu Aubán et al. 2006). Naturally, within each of these cycles of apparent dynamic stability, fluctuations also can occur, but these are less visible in the archaeological record.

Software Considerations

The Department of Prehistory of the University of Valencia in collaboration with other institutions (Technological and Computer Science Institute of the Polytechnic University of Valencia, Network of European Excellence EPOCH, Medland project at Arizona State University) has prioritized the use of GIS as an essential tool to manage archaeological data and carry out reconstructions of the past. A primary objective of this work is to build an Archaeological Information System, based on existing open source tools. The research presented here was carried out using GRASS (http://grass.itc.it/) and gvSIG (http://www.gvsig.gva.es/). It exemplifies the capabilties of free GIS, which can equal or exceed those of commercial systems whose high costs often put them out of the reach of students and many researchers. We used GRASS for most of the raster calculations, because of its powerful tools for modeling past landscapes. We used gvSIG for other routines such asWMS server queries and visualization of georeferenced images.

Acknowledgements

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