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Patch-based survey methods for studying prehistoric human land-use in agriculturally modified landscapes: A case study from the Canal de Navarrés, eastern Spain

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ABSTRACT

In landscapes whose surface has been modified by terracing and other agricultural land-use, the spatial and temporal patterning of prehistoric settlement can be difficult to detect using traditional, site-orientated archaeological survey methods, especially for small-scale societies. In these contexts, methods that can reveal occupational patterns at landscape scales, without the need to pinpoint specific sites of human occupation, can be especially useful. We employ a stratified, randomly selected patch-based survey strategy to examine socio-ecological dynamics from the Middle Paleolithic through Bell Beaker (Chalcolithic) periods within the Canal de Navarrés, eastern Spain. We divide the study region into survey strata according to differences in topography and vegetation communities and use a random selection of demarcated, terraced fields as data collection patches. All survey data is digitally recorded using tablets in the field, creating a streamlined and more accurate workflow, where observations of artifacts, soils, ground visibility, and photographs are georeferenced and ready for analysis in a GIS. Surface artifact densities, estimated from sampled patches, are used to generate prehistoric land-use maps and empirical Bayesian methods allow us to track shifts in occupational patterns through time. Regional reference collections of well-dated lithic artifacts provide the "prior knowledge" required to make estimates of the probability of prehistoric occupation in each sampled patch. This combination of field and analytical methods makes possible the study of regional-scale land-use dynamics in agriculturally modified landscapes.

1. Introduction

For decades, archaeological survey methods have focused on identifying sites through concentrations of artifacts on the surface of the landscape. But in recent years, research aims have widened beyond sites to include the spatial, temporal, and non-linear interactions between human and ecological systems (Barton et al., 1999, 2002; 2004; Carey et al., 2006; Arikan, 2012; Diez Castillo et al., 2016). New social-ecological systems science in archaeology now focuses on multiple types of landscape-scale data, including the continuous distribution of surface artifacts (Dunnell, 1992; Bevan and Conolly, 2002, 2006; Bintliff, 2005). This approach is particularly effective when examining the diachronic interactions between prehistoric land-use, ecological systems, and their influence on landscape evolution (Barton et al., 2004, 2010).

Such a perspective has played a primary role in driving our research over the last three decades in eastern Spain. Survey in the Mediterranean Basin is often stymied by landscapes that have been modified through intensive agricultural land-use, resulting in

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complex palimpsests of archaeological material (Cherry, 1983; Barton et al., 1999; Llobera et al., 2010). We have worked to develop alternative field and analytical approaches that can overcome these challenges. Multiple seasons of fieldwork and experimental methods in the Serpis Valley have resulted in a suite of techniques that consider geomorphology, taphonomy, ground visibility, and relative chronology to evaluate changing patterns of prehistoric land-use (Barton et al., 1999, 2002; 2004; Bernabeu Auban et al., 1999, 2001; 2008; Pardo Gordó et al., 2009, 2015).

As part of *Mediterranean Landscape Dynamics Project (MedLanD)*, a collaborative project between Arizona State University, the University of Valencia, and other organizations, we are now applying the methods developed in the Serpis Valley to a new study area in the Canal de Navarrés, Valencia, Spain. This paper presents our initial results as a case study that examines the challenges and our solutions for evaluating prehistoric land-use in landscapes intensively modified by agricultural terracing. We incorporate patch-based survey methods, digital data collection, and Bayesian statistical methods to systematically evaluate the distribution and intensity prehistoric land-use in this study area.

2. Regional setting

2.1. Environmental setting

The Canal de Navarrés (255 m.a.s.l., 39° 06′ N 0° 41′ W) is a flat-bottomed, northwest-southeast oriented tectonic valley located at the intersection of the Iberian and Baetic systems in Valencia, eastern Spain (Fig. 1). The valley is circumscribed by three low-lying ranges: the Massís del Caroig to the west, the Serra de Sumacárcer to the east, and the Serra d'Enguera to the south. Tributaries of the Riu Xúquer actively drain this area from both the north and south. Due to tectonic influences and the formation of transverse alluvial fans during the Quaternary, the valley is semiendorheic, resulting in the formation of lakes, peatlands, and travertines throughout the Holocene (La Roca et al., 1996). The modern lakes of Playamonte and l'Albufera d'Anna are evidence of these processes.

This region is situated in the Mesomediterranean belt, a transitional zone between coastal and inland climate zones in eastern Spain. The mean annual temperature is ~16 °C and the region receives an average annual rainfall of 550 mm. The Mesomediterranean belt experiences typical Mediterranean seasonality, with hot, dry summers and mild, wet winters (Carrión and Van Geel, 1999). Modern vegetation communities consist primarily of *matorral* species (including *Quercus coccifera* and *Pistacia lentiscus*) with some *Pinus halepensis* in the uplands. In lowland areas, agriculture has replaced most endemic vegetation. Regional palynological studies have revealed multiple fluctuations in vegetation diversity over the last 30,000 years related to global changes in climate (Dupré et al., 1998; Carrión et al., 2010). But the modern distribution and diversity of matorral vegetation may have been influenced by the introduction of fire associated with Neolithic agricultural practices during the middle Holocene (Carrión and Van Geel, 1999), resulting in the replacement of Pinus dominated forests with more fire-tolerant genera such as *Quercus, Cistus, and Ulex*.

2.2. Previous archaeological research

2.2.1. The Canal de Navarrés

Archaeological research in the Canal de Navarrés is limited, but current evidence for occupations span from the Middle Paleolithic to the present. Previous work focused on endorheic areas throughout the valley, targeting late Pleistocene and early Holocene occupations. Excavations in the vicinity of Las Fuentes revealed Mousterian lithics and preserved *Pinus nigra* trunks with radiocarbon dates of more than 40,000 years BP (Aparicio Perez, 1981). Excavations prior to development at another nearby lake, l'Albufera d'Anna, documented geometric lithic forms dating the late Mesolithic (Aparicio Perez, 1973, 1979). The subsequent recovery of pottery remains from l'Albufera d'Anna, indicates a possible Neolithic component (Martí Oliver et al., 2009). Additional evidence of Neolithic occupations is confined to an isolated occurrence of early Neolithic cardial pottery at Covacha de la Bellota (Fletcher Valls and Aparicio Perez, 1970) and the late Neolithic open-air site of Ereta del Pedregal.

Ereta del Pedregal is located within a peatland between the modern communities of Navarrés and Playamonte (Fletcher Valls et al., 1964; Pla Ballester et al., 1983; Juan Cabanilles, 1994, 2008). Initial investigations in the 1940's and later excavations in the 1980's revealed early examples of stone building construction, a circular stone enclosure, and numerous artifacts. These include lithics and decorated bone associated with Late Neolithic (6000–4500 BP), Chalcolithic (4500–3800 BP), and early Bronze Age (3800–3250 BP) (Pla Ballester et al., 1983). Ereta del Pedregal established the chronology of middle Holocene occupations for the Canal de Navarrés and has been used to interpret the context of other isolated finds throughout the valley.

2.2.2. Regional archaeological research

The Canal de Navarrés is comparatively under-studied in contrast to nearby valleys throughout southern Valencia. The regional chronology of Middle Paleolithic (approximately 100,000–30,000 BP) and Upper/Late Upper Paleolithic (30,000–10,000 BP) occupations is reconstructed through well-documented sites such as El Salt, Cova Beneito, Cova de Parpalló, and Cova de les Cendres (Barton, 1988; Villaverde et al., 1998; Riel-Salvatore and Barton, 2007; Villaverde Bonilla et al., 2012). Middle Paleolithic chronologies were developed at El Salt and Cova Beneito through a combination of radiocarbon dating and Uranium series dates from travertines underlying occupational contexts. Upper/Late Upper Paleolithic industries recovered from Cova Beneito, Cova de Parpalló, and Cova de les Cendres have shaped the interpretation of late Pleistocene occupations and chronologies throughout the region (Mallol et al., 2012; Villaverde Bonilla et al., 2012).

Regional Mesolithic and Neolithic chronologies have been built through several decades of systematic excavations in caves, rockshelters, and open-air contexts. Evidence of hunter-gatherer occupations during the Mesolithic (11,000–7600 BP) has been primarily identified through diagnostic lithic technologies, including geometric, triangular/trapezoidal microburins and microliths. Regionally, the early Mesolithic is represented by burials and associated artifacts recovered from El Collado (Garcia Guixé et al., 2006; Gibaja et al., 2015). Important late Mesolithic sites identified throughout the region include Abric de la Falguera (García Puchol and Aura Tortosa, 2006) and Cueva de la Cocina (Fortea Perez, 1971; García Puchol et al., 2009; Bernabeu-Aubán and Martí-Oliver, 2014; García Puchol et al., 2017).

The earliest Neolithic occupations date to 7600–7500 cal. BP at multiple sites, including Mas d'Is (Bernabeu Auban et al., 2003), Abric de la Falguera (García Puchol and Aura Tortosa, 2006) and Cova de les Cendres (Bernabeu Auban, 1999; Bernabeu Aubán and Molina Balaguer, 2009). By 6500 cal. BP, cardial ceramics and evidence of domesticated plants and animals were widespread (Sites include Cova d'En Pardo: García Atiénzar, 2009; Cova de l'Or: Martí-Oliver, 2011; Cova de la Sarsa: Garcia Borja et al., 2011). Although excavations in caves and rockshelters have provided reliable ceramic and lithic chronologies for the Valencian Neolithic period, open-air sites such as Mas d'Is (Bernabeu Auban et al., 2003), Niuet (Bernabeu Aubán et al., 1994), Les Jovades (Bernabeu Auban and Badal Garcia, 1992), and Ereta del Pedregal (Fletcher Valls et al., 1964; Pla

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