Journal of Archaeological Science 41 (2014) 482–492

Contents lists available at ScienceDirect

Journal of Archaeological Science

journal homepage: http://www.elsevier.com/locate/jas

Anthropic activity markers and spatial variability: an ethnoarchaeological experiment in a domestic unit of Northern Gujarat (India)

Bernardo Rondelli [a,*], Carla Lancelotti [a,b], Marco Madella [a,c], Alessandra Pecci [d], Andrea Balbo [a], Javier Ruiz Pérez [e], Fernanda Inserra [d], Charusmita Gadekar [f], Miquel Ángel Cau Ontiveros [c,d], P. Ajithprasad [f]

[a] Complexity and Socio-Ecological Dynamics (CaSEs), Department of Archaeology and Anthropology, Institució Milà i Fontanals, Spanish National Research Council (CSIC), C/Egipciaques 15, 08001 Barcelona, Spain
[b] Department of Information and Communication Technologies, Universitat Pompeu Fabra, Barcelona, Spain
[c] Institució Catalana de Recerca i Estudis Avançats (ICREA), Barcelona, Spain
[d] Equip de Recerca Arqueològica i Arqueomètrica, University of Barcelona (ERAAUB), Barcelona, Spain
[e] Facultat de Geografia i Història, University of Barcelona, Barcelona, Spain
[f] Department of Ancient History and Archaeology, MS University of Baroda, Vadodara, Gujarat, India

A R T I C L E I N F O

Article history:
Received 15 November 2012
Received in revised form
6 September 2013
Accepted 11 September 2013

Keywords:
Anthropic markers
Ethnoarchaeology
Spatial interpolation
Geostatistics
Chemical residues
Spot tests
ICP-AES

A B S T R A C T

Spatio-temporal understanding of past domestic activities is a key aspect of archaeological reasoning. The identification of markers of particular anthropic actions through time has become a fundamental issue. Chemical analyses of archaeological floors are an essential tool to investigate and identify anthropic markers of past human activities. This paper explores the relative spatial variability of chemical residues of floors in an ethnographic context to provide a constructive basis to experiment with spatial analysis for the detection and interpretation of anthropic activity markers. These markers are recognised as anomalies and tendencies in the *relative* spatial distribution of chemical residues embedded in the floor. The experiment has been carried out in a controlled environment and serves to test the methods and assumptions to be used in archaeological contexts. Spatial interpolations (IDW, Map Algebra and PCA) were performed and allowed the identification of anomalies in the distribution of residues that can be associated with specific activities (fuel use, food preparation and consumption, use of fireplaces). Geostatistics (Ordinary and Regression Kriging) was used in order to contribute to the identification of trends related to the use of space and the connected activities (e.g. inner versus outer space, storage versus cooking). The results show how the integration of different techniques can improve data interpretation.

1. Introduction

This paper shows the potential for the detection and interpretation of anthropic activity markers by using spatial interpolations to explore the relative variability of floor chemical residues within a controlled ethnographical context in Northern Gujarat (India). The work illustrates different techniques for spatial interpolation and analysis, discusses their potential and limitations and provides an example of how these can be combined in order to detect relative patterns in the distribution of chemical residues. This exercise was carried out within a long-term research perspective on the significance and development of anthropic activity markers at domestic, settlement and landscape level (French et al., 2009; Lancelotti, 2010; Lancelotti and Madella, 2012; Sulas and Madella, 2012). The concept of anthropic markers was initially used in pollen and soil micro-charcoal studies to define changes in vegetation composition due to human activities (intentional forest fires, agriculture, etc.; see for example Moore et al., 1991: 189–191). Disciplines such as linguistics, biology or chemistry have also thoroughly developed a definition of 'marker'. However, this notion is still used uncritically in archaeological contexts and needs further development, both in terms of reference libraries and identification protocols, before it can be routinely used. The difficulty in defining this concept within

* Corresponding author. Tel.: +34 934423489.
E-mail addresses: bernardo.rondelli@imf.csic.es, bernardorondelli@yahoo.it, bernardorondelli@gmail.com (B. Rondelli).

0305-4403/$ – see front matter
http://dx.doi.org/10.1016/j.jas.2013.09.008

archaeology can be related to the complexity of human behaviour and the wide spectrum of possible signatures resulting from the same action (including the possibility of equifinality).

People tend to recurrently use specific areas of their living space (or of the landscape) for certain activities and even when the same activity is carried out in more than one location, this rarely occurs as a single episode (Barba, 1986, 2007; Ortiz and Barba, 1993). Indeed, this enduring use of space produces an accumulation of residues (chemical and/or physical) in the deposit, which represent the result of the activity that produced them. The accumulation of the same residue(s) within an area allows the detection of differential spatial concentration(s) of particular residue(s). Ethnoarchaeology and experimental archaeology (Barba and Ortiz, 1992; Middleton, 1996; Pecci, 2003; Pecci et al., 2013) drive the inferential reasoning that creates the model(s) connecting the concentration of particular residues (proxies) with a specific activity. We define this/these model(s) as 'anthropic activity marker'.

It can be argued that many factors, others than activities, can affect the chemical composition of a spatial feature such as a floor. Indeed, the same material used to plaster the floors has its own chemical signature and, similarly, processes of floor maintenance can influence the chemical/physical signatures. However, we assume that all these can be considered as a background "noise" value that can therefore be discounted (see Barba, 2007: 441) and that the activities carry out "on top" of this noise will be the ones creating a real difference (these points will be discussed in more detail below).

Chemical analyses of archaeological floors have been a primary tool to investigate and identify past human domestic activities. Solid, liquid or semi-liquid substances released during a specific activity are incorporated or absorbed in the floors and they can be extracted and analysed (Barba, 1986, 2007). Research into this has been carried out in different parts of the world involving the study of different archaeological and ethnoarchaeological contexts, from single rooms and buildings to entire regions (for an updated review see Middleton et al., 2010; Pecci et al., 2013; Salisbury, 2013; Vyncke et al., 2011; Wells and Moreno Cortés, 2010; Wilson et al., 2009). Ethnographic contexts offer privileged settings to the study of anthropic markers of domestic activities as they allow for the possibility of correlating chemical residues with witnessed activities. This important link is achieved through direct observations and non-structured interviews to the people living in the domestic compound. Ethnographical contexts offer the chance of experimenting with data in a controlled environment, providing an important support to archaeological theory building (see for example Boivin, 2000; Lancelotti and Madella, 2012; Milek, 2012) and increasing our understanding of temporal rhythms and spatio-temporal uncertainty. Throughout this paper we use the word '*experiment*' and the concept of '*experimenting with data*' not in the traditional sense of experimental archaeology as an "imitative experiment to replicate past phenomena" (Mathieu, 2002: 12) but in the sense of a test under controlled conditions to provide evidence for or against a hypothesis. Spatial interpolation of chemical values is a common method in archaeology for extrapolating spatially continuous variables from discreet point samples. However, spatial techniques detecting chemical differential concentrations did not entertain critical reflexions on their limitations, advantages and comparative usefulness (Dore and López Varela, 2010; Fernandez et al., 2002; Middleton et al., 2010; Pecci et al., 2013; Salisbury, 2013; Terry et al., 2004; Vyncke et al., 2011; Wells, 2010).

The present research was developed within a domestic compound in North Gujarat (India) with the specific aim of improving the archaeological reasoning and interpretation of past domestic activities in the Indus Civilisation. During the 3rd millennium BC North Gujarat was occupied by settlements pertaining to the Indus Civilisation and witnessed the emergence of urban sites with fortification walls and clear urban planning (Kenoyer, 1991, 1998; Possehl, 2002). Within these sites many domestic structures have been identified and 'floors' detected by the archaeologists. The presence of complex domestic structures drives the question of how the space was used in them. The ancient 'floors' are often thought to have been constructed using techniques that are currently employed in traditional Indian villages (involving the use of a mixture of sand, clay, dung and water). Qualitative description

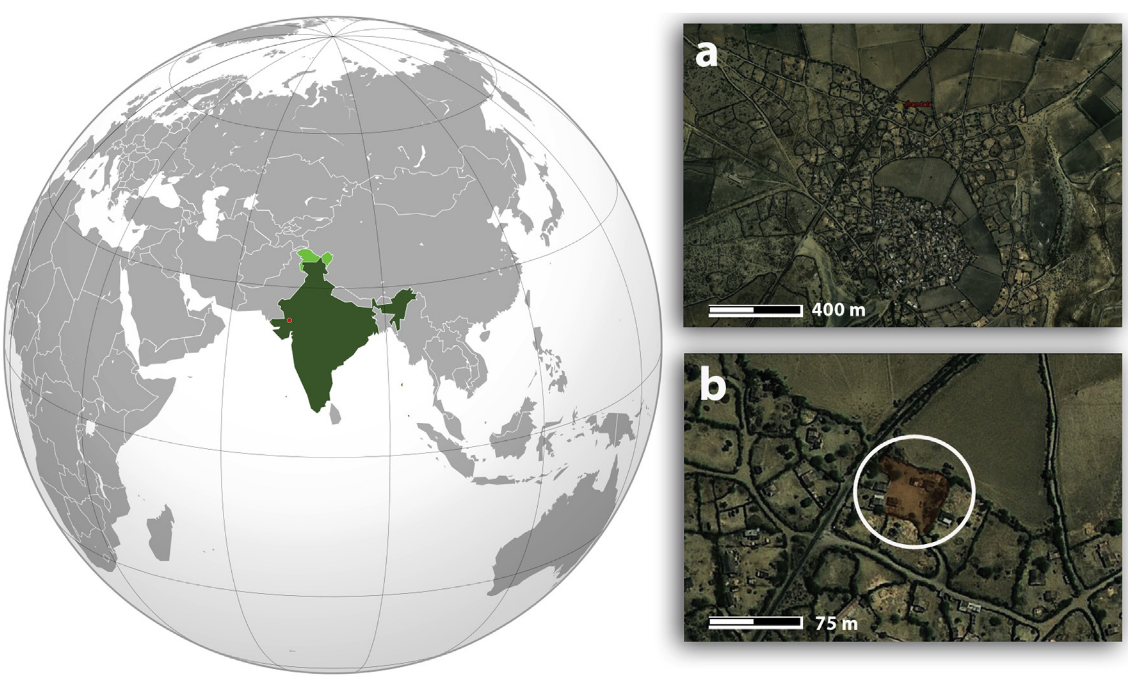

Fig. 1. Location of Jandhala in Northern Gujarat (India) with satellite imagery showing (a) the village and (b) the studied compound (b) (SPOT Imagery acquired on May 2009 and retrieved on September 2012 from Google Earth, Copyright 2012).