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Journal of Cultural Heritage
Journal of Cultural Heritage 10S (2009) e3–e9

Original article

Addressing the challenge of detecting archaeological adobe structures in Southern Peru using QuickBird imagery

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Received 24 May 2009; accepted 22 October 2009

Abstract

For thousands of years, people throughout the world have built homes, communities and temples using earth materials, mainly in arid and semi-arid lands where generally other building materials were quite scarce. In the arid regions of Peru, from the 3rd millennium B.C. to Inca age, several civilizations shaped sand, clay and water into bricks (known as adobe) to build ceremonial centres, pyramids and towns. The detection of adobe archaeological buried remains by means of remote sensing techniques is a challenge as difficult as engaging, since the adobe has a composition quite similar to the neighbouring earth material. In this paper, Very High Resolution (VHR) satellite imagery have been used to identify archaeological features linked to the presence of shallow and outcropping adobe structures in some test sites selected from within the Ceremonial Centre of Cahuachi (Southern Peru). Both vegetated and non-vegetated areas were investigated. The promising results we obtained pointed out that the use of Earth Observation (EO) technologies can open new perspectives to detect adobe settlements.

Keywords: Adobe; Archaeological remote sensing; QuickBird; PCA; NDVI; Cahuachi; Peru

1. Research aims

Adobe is a sun-dried earth building material dating back to 8000 B.C. that has been widely used for thousands of years, mainly in arid and semi-arid lands where, generally, other building materials were quite scarce. Even though such material is highly vulnerable to destruction by weathering, especially wind and water erosion, a number of archaeological settlements have been found in different areas of the world (Southern Europe, Middle East, Africa, India, Asia, North Africa and South America). Earthen constructions have a long history in the Andean coast of South America, where the hyperarid climate promotes outstanding preservation of the archaeological setting.

The application of Earth Observation (EO) techniques to detect adobe remains is one of major challenges to archaeological investigations due to a subtle geophysical contrast between the archaeological deposits and the surrounding areas.

In this paper, Very High Resolution (VHR) satellite imagery from QuickBird (QB) have been used to detect archaeological adobe structures. Preliminary investigations have been carried out in three significant test sites selected from within the Ceremonial Centre of Cahuachi (South Peru) which is one of the most remarkable examples of adobe architecture from the Nasca culture. Moreover, its extension (around 25 km^2) makes it the biggest Ceremonial Centre in adobe in the world and gives a clear idea of the importance of the Nasca civilization.

During excavations carried out over the last 20 years, a number of massive monuments, pyramids, platforms, tombs, and artefacts were found. The need for an extensive settlement survey has driven forward this experimental approach in order to assess the potential of EO for locating and documenting unknown adobe archaeological settlements.

2. Introduction

For Andean archaeology, the detection of buried adobe structures by using noninvasive techniques is a challenge as crucial as complex. It is crucial due to the widespread use of adobe from

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doi:10.1016/j.culher.2009.10.005

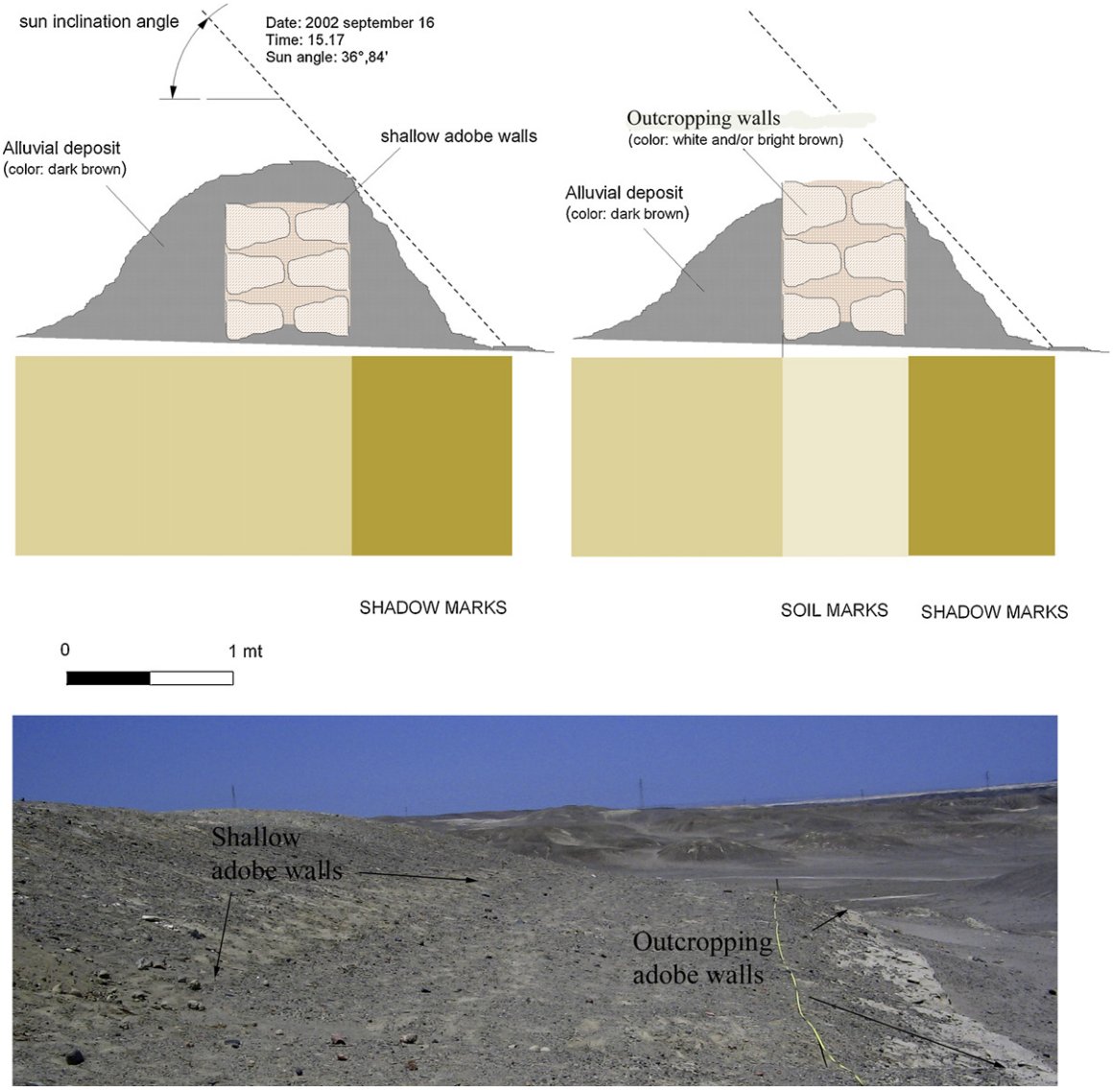

Fig. 1. Cahuachi: typical archaeological features related to shallow and outcropping adobe walls.

the Formative age (i.e. 900–500 BCE) to Inca Emperor (15th century A.D.). The earthen building material was employed to build huge ceremonial centres, monuments and towns by several civilizations which flourished in the arid regions overlooking the Pacific ocean (such as, Mochica in Northern desert coast of Peru, Nazca near the Southern coast of Peru [1]) and in the highlands of Andes.

Such a challenge is complex and engaging due to the subtle physical contrast between earthen remains and the surrounding subsoil, as evident by comparing aerial images of adobe archaeological sites taken before and after the excavation. For example, this has been done for some test sites in the Nasca Ceremonial Centre of Cahuachi [2], a 25 km^2 area composed of about 40 mounds which preserve pyramids and terraced platforms. This comparison puts in evidence three important facts: (i) the subsurface adobe structures are generally not visible from an aerial view; (ii) surface wall remains are more easily detectable due to the high contrast in brightness values between the clay of the surfacing adobe walls and the surrounding alluvial deposits which cover most of the archaeological site (Fig. 1); (iii) microrelief linked to shallow walls are detectable thanks to the small shadow produced on the ground (Fig. 1).

So, the possibility of successfully using remote sensing technologies for the detection and documentation of adobe archaeological setting can open new perspectives not only for the Andean Archaeology but also for the study of earthen archaeological sites in Turkey, Northern Africa and Middle East.

In this paper, VHR satellite data from QB were used to investigate adobe archaeological structures in Southern Peru. Three significant test sites were selected from within the Ceremonial Centre of Cahuachi (in the Nasca territory). Results from our analyses pointed out the capability of QB data in locating and mapping spatial features linked to archaeological adobe structures.