Use of UAV's and geophysical prospection as a way to promote pre-historical archaeological heritage

Luís GONÇALVES, Institute of Earth Sciences, Pole of the University of Minho, Earth Sciences Department, Portugal[1]
Renato HENRIQUES, Institute of Earth Sciences, Pole of the University of Minho, Earth Sciences Department, Portugal
Luciano VILAS BOAS, Independent Researcher, Portugal
Ana MS BETTENCOURT, Landscapes, Heritage and Territory Laboratory (LAB2PT), Department of History, University of Minho, Portugal,

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Introduction

The Northwest of Portugal is a mountainous region with increasing inland heights from the coast to the interior, cut by several rivers that run from northeast to southwest. Hundreds of funerary megalithic mounds are known in this area, distributed from the valleys to the high altitude plateaus, dating back from the Middle / Later Neolithic (between the end of the 5th to the end of the 4th millennia BCE) (Jorge, 1982; Sousa, 2012). It is a heritage, with high archaeological importance, that is not fully inventoried and therefore susceptible of destruction due to the forest advances, constructions or enlargements of road networks in rural and urban context. The systematic excavation of this type of monuments is time consuming and its conservation or later valorisation for didactic and tourist purposes becomes a very difficult task. Thus, it is necessary to use non-invasive methodology's that can contribute to the study, preservation and valorisation of these megalithic mounds.

Objective and methods

The objective of this work is to demonstrate that, through the use of new non-invasive technologies, it is possible to obtain relevant information about this type of monuments, which can be used scientifically and integrated into tourist-didactic projects.

The methodology used combines the inventory and the cleaning of the vegetation covering funerary megalithic monuments, with geophysical archaeological prospection (Ground-penetrating Radar) (Fig. 1 a) and remote sensing for the production of high-resolution colour orthophotography and digital surface models (DSMs) obtained from an unmanned aerial vehicle (UAV) (Fig. 1 b).

The case studies correspond to five megalithic mounts in the Serra de Corno do Bico (Chã da Mourisca, Chã da Escriba, Chã Escura 1, 2 and 3) Ponte de Lima municipality, Viana do Castelo district, and one megalithic mount in Serra do Carvalho (Tojal 1), in the municipality of Póvoa de Lanhoso, Braga district, both in the North of Portugal, in the Northern Iberian Peninsula.

Geophysical archaeology consists of a number of near-surface imaging methods used to produce maps and profiles of buried cultural remains and associated stratigraphy, usually within a few meters of the surface. Ground-penetrating Radar (GPR) has the unique ability to gather data from known depths and produce images of specific layers or horizons. This is because it transmits radar pulses into the ground and records the elapsed time from when they are sent, reflected from buried materials, and received back at the surface (Conyers, 2012). That elapsed time can then be converted to depth, and specific depth levels in the ground can be mapped individually, producing three-dimensional layered images and maps of cultural materials. In these studies GPR surveys were conducted over the mounds, with parallel profiles acquired over a grid with 25 cm of separation. The equipment used was the SIR 3000 from GSSI (Geophysical survey systems) with a 400 MHz antennae. The results obtained with the GPR prospection (Fig. 2 b) enabled the definition of the mounds stratigraphy, and to map important reflections that, integrated with the archaeological and UAV data, were important to help comprehend some constructive aspects, such as determining intermediate or

[1] Author's address: Luís Gonçalves, Universidade do Minho Departamento de Ciências da Terra, Campus de Gualtar 4710-341 Braga, email: luisgoncalves@dct.uminho.pt

Renato Henriques, Institute of Earth Sciences, Pole of the University of Minho, Earth Sciences Department, Portugal

Luciano Vilas Boas, Independent Researcher, Portugal

Ana MS Bettencourt, Landscapes, Heritage and Territory Laboratory (LAB2PT), Department of History, University of Minho, Braga, Portugal, Campus de Gualtar, 4710-057, Braga. Portugal. E-mail: anabett@uaum.uminho.pt

peripheral lithic rings in the artificial mounds that cover the funeral chambers, the location of the chambers, the presence of stone corridors and its orientation, as well as determining the degree of destruction of the chambers and stone corridors.

Photogrammetry by UAV enabled the accurate mapping of the excavation area with the production of high-resolution RGB orthomosaics and DSMs (Fig. 2 a). This information can be combined with results from future surveys, through the several stages of the excavation work, to analyse the area using vertical imagery slices. This procedure will allow the validation of the GPR data or other geophysical data as well as the 3D vertical reconstruction of the progressively exposed structures. Photogrammetry will also allow the 3D modelling of monuments and surrounding areas, giving them volume and greater visibility. This information can be used to 3D printing of mock-ups as well as the production of high-quality interactive 3D models for multimedia purposes.

Conclusion

In summary, the information obtained, it's an important auxiliary for the archaeological investigation, as resulting maps and other images, integrated with chronological and artefact information from standard excavations can often be used directly to test ideas about the past. This data is also important to the selection of better-preserved monuments for future archaeological excavations or to digitally reconstruct the archaeological, structures without the need of excavation. It is also important to state that this information can and should be used for recreational and tourist purposes, through its reproduction in informative plates and on-line information with high resolution 3D models, accompanied by explanatory texts intended for both local populations and visitors. The combination of the methodologies expressed corresponds to a praxis that is inexpensive and quick to perform in the field and can be systematically applied in the knowledge, safeguard and valorisation of the most sensitive prehistoric archaeological heritage, such as funerary megalithic mounds.

Figures

Fig.1. a) Geophysical prospection with GPR. b) Use of UAV for photogrammetry.

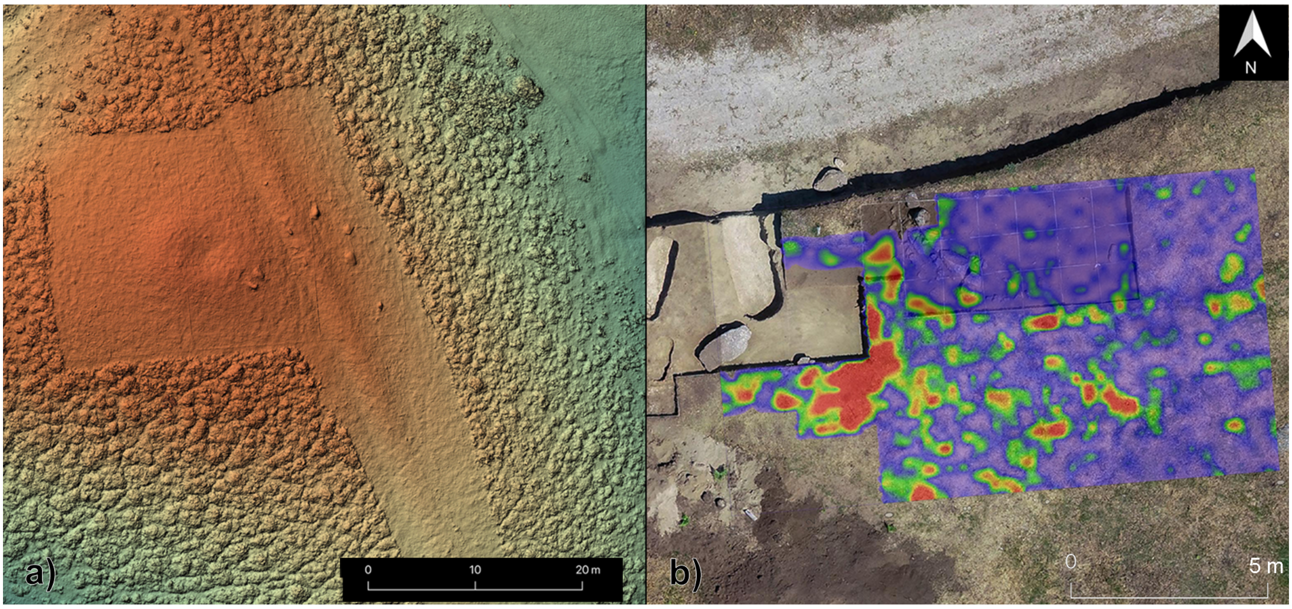

Fig.2. a) Digital surface model the Chã da mourisca mound. b) Integration of high resolution orthomosaic with GPR amplitude map.

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