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ABSTRACT BOOK

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UAVs DATA FOR MONITORISING RESCUE ARCHAEOLOGICAL EXCAVATIONS: RODO, BISPEIRA 8 AND VAU SITES IN RIBEIRADIO RESERVOIR, VOUGA CATCHMENT (PORTUGAL)

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ABSTRACT:

Rescue archaeology challenges are current in archaeological research in many ways. The usual short time to develop a fieldwork intervention is one of those challenges, demanding the selection of trained teams, which may answer to the questions raised during the process of excavation. If a well-trained team is important in order to face such questions, one should also highlight the importance of using new recording technologies that could support the team in the interpretation process of the evidences coming from the ground during excavation. One of the strategies that may answer to these challenges is the use of photogrammetric products from aerial photograph using a UAV. This technique allows, as we will see, the production of several photographic records, which may help to characterise and interpret both archaeological and geomorphological realities [1, 2]. The use of these techniques and data not only complement the traditional recording practices as they become useful tools on the way the team may observe the archaeological evidence, challenging the process of gathering and interpreting data.

This paper focus on the case of how such challenges were managed during the intervention on three prehistoric sites – Rôdo, Bispeira 8 and Vau – located at the mid Vouga's valley, which were intervened due the construction of the hydroelectric facilities called “Aproveitamento Hidroelétrico de Ribeiradio-Ermida”. This project entailed a dam and a reservoir (located at Sever de Vouga and Oliveira de Frades) which would flood a large area within were located the archaeological sites mentioned above. As the identification of the sites was made during the final works of the dam, there was little time to plan and execute the excavations needed to understand the archaeological sites. Regarding this, there was a concern about the creation of an interdisciplinary team to assure the interpretation of the geomorphological and geoarchaeological dynamics of the sites. At the same time, a challenge to use technology that could speed up the process of gathering and recording the data needed to characterize, understand and interpret the archaeological evidence both during the fieldwork and afterwards on post-excavation research.

The three prehistoric sites – Rôdo, Bispeira 8 and Vau – present stratigraphic levels with remains of human occupation dating from the Late Pleistocene and Holocene [3, 4, 5]. Due the lack of sites of these chronologies in the region, they become a very important source of information to create knowledge about

how prehistoric communities dwelt in this region during these periods. At the same time, regarding its location at the Vouga's valley, these sites are also an important source of data, which may contribute to the understanding of how these sites might have been articulated with other important prehistoric sites from the Portuguese Estremadura and from the Côa Valley. Besides the archaeological relevance of the sites, the archaeological intervention was also an opportunity to gather data regarding the geomorphological dynamics of the Vouga River. Should be noted that these geomorphological data were, in its own terms, elements that would help to understand the archaeological record. In fact, each archaeological site is located at different points of the valley, which means that each one has its own geomorphological specificities requiring different, but articulated, research concerns. This diversity also means that each site carried the possibility to create different points of observation on the geomorphology of the Vouga's valley.

The site of Rôdo is located on a flat surface corresponding broadly to a fluvial terrace, inclined towards the current riverbed of Vouga, encompassing the convex sector of a meander, inserted in the embedded valley of the river. The platform where this site is located results of a long process in which there were contributions from different dynamics: the river incision and the formation of different terrace levels and from slope erosion. Bispeira 8 is located upstream of Rôdo at a higher elevation. At this location, there was no clear vestiges of terraces and, from a geomorphological point of view; it seems that the site was formed only because of slope dynamics. Vau is located at the foot of the slopes of Teixeira's valley, a tributary of Vouga river. The archaeological remains were located at a meander in which a river beach was formed. At this location, the geomorphological context and the dynamics of the site is similar to Rôdo, i.e, the site was formed within the process of the Teixeira's incision and by slope erosion. Even so, as we will present, the archaeological and geomorphological reality observed at Rôdo and Vau have many differences. In fact, these three sites present a geomorphological and geoarchaeological complexity whose recording demanded traditional topographic methods and, at the same time, other technologies – namely high detailed orthoimage for small/medium areas – which could enlarge the observation area and allow its articulation with other points of the valley in order to contextualise local evidence with larger scales of analysis.

During the archaeological intervention there was a conjunction between classical fieldwork and new technologies, which were useful for the excavation record and later research, namely by the acquisition and analysis of images captured by autonomous unmanned vehicle (UAV) and further processing of the collected data. On the field, it was used a Hexacopter device ($\pm 2700g$ of weight), class 550 with a controller 3dr APM for Arducopter 3.6 and with a time of operation of 12 – 16 min. From a collection of approx. 600 aerial photographs (5 cm of pixel size), it was made a global orthoimage of the areas, and produced digital surface models and digital terrain models. These data were the basis for mapping the archaeological sites, the archaeological structures, and have detailed geomorphological data to analyse and to interpret the local context, namely by the DTM's. In addition, to refine the altitude data it was used several control points of the excavations sites, which were defined by classical topographic techniques (using a Leica TS02 plus 7" device) and referenced to the national geodetic network.

The image acquisition was performed from the UAV equipped with a conventional Canon Powershot sx260hs (12 megapixels) digital camera whose memory card has an application (CHDK-Canon Hack Development Kit) that allows shooting automatically within a certain time interval set by the user. The global orthoimages became an important support for the further discussion on cabinet after the conclusion of the fieldwork. The specific characteristics of flights with an UAV (low altitude flights) allow having images with many advantages, such as: excellent resolution, large overlap and reduced execution time [6]. In the processing step, the photographs obtained were verified and selected, excluding those that were blurred or captured during take-off and landing. Then, they were processed with Agisoft PhotoScan software, which generates a digital textured surface model from a cloud of points. Firstly, the program aligns the photographs according to common points or points of correspondence that are present in several images, and are invariants to the changes of illumination, to the noise of the image and also performed the basic geometric transformations as: scale, translation and rotation. These points are identified as elements of an object, and therefore the position of each photograph is rectified and the calibration parameters improved [7]. Subsequently, a dense cloud of dots is created by estimating camera positions and photographs.

The third phase was the 3D model creation from the dense cloud of points. The software reconstructs a polygonal and three-dimensional mesh that represents the surface of the study area. Finally, after the 3D model (the geometry) be completed, it was possible to add texture to the surface and generate a global orthoimages of the area. The result of this process consists of a digital surface model georeferenced from the GPS data of the photographs. Finally, the interpretation stage was carried out. Previously, the orthoimage was added to the ArcMap software (ArcGIS) and indirect georeferencing [8] was achieved through control points of the excavation sites. This procedure gave to the orthoimage more spatial precision.



Figure 1. UAV orthoimage showing the clear distinction of the two geoarchaeological units (dot line) and the axe of a surficial debris flow (arrow) affecting some of the top archaeological structures.

Thus, the intertwining of traditional and new recording techniques allowed the creation of products in which global images of the excavation can be observed with detailed recording of the archaeological features (stone structures, for example) and its stratigraphic context. At the same time, these images, by capturing the geomorphological frame of such features, were also useful tools to understand how some of them were preserved or dismantled. By giving these kind of information, these images turned to be also useful tools on the management of the excavation itself. Besides that, these visual products also revealed to be useful elements on post-excavation research, by enabling three-dimensional models that allow developing previous ideas and the emergence of new points of view. Fig. 1 is an example of how orthoimages can be used in order to understand the archaeological record to which can be added information regarding the geomorphological dynamics. In fact, the technique recreates the conditions under which the interdisciplinary dialogue can be developed and, by doing this, it makes possible the creation of new images, which can translate in diverse ways the knowledge produced during the excavations.

Given the advantages of this technology regarding the gathering and interpretation of data during the excavation and after it, and its low budget, it seems that it should be considered on the archaeological interventions.

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