The Barrocal - Dry Stone Technique and Construction

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Abstract

This work aims to publish the dry stone heritage of the Barrocal region, Algarve, southern mainland Portugal. Throughout this work, it was discovered that these buildings are, for the most part, in ruins. Their rehabilitation and dissemination would be possible because they have a great cultural value and a sense of belonging to these places, among the population that still lives in this region. The methodology for carrying out this work was based on four phases: 1) contextualization of studies developed in Portugal; 2) identification and classification of dry stone constructions, according to their use and typology; 3) registration and analysis of these constructions with the aim of obtaining constructive and geometric data; 4) proposals for conservation and promotion, both of construction techniques and buildings. This survey is original, as it has not yet been carried out from this point of view. There is some work on dry stone, but mainly focused on walls. The fact that this heritage is not valued and has lost its usefulness means that it is at serious risk of disappearing. With better knowledge of this type of heritage, it is possible to make people value it and develop strategies to promote it, thus managing to maintain it. Through the dissemination of this work, it is hoped that this type of heritage will be valued and preserved. In practice, with the Algarve being the most touristic area in Portugal, the reuse or definition of new functions of this heritage can be an added value for tourist activity.

Keywords: *Dry stone, Photogrammetry, Barrocal area, heritage, vernacular architecture*

1. Introduction

The growing interest in the dry stone heritage on the part of the Universidade do Algarve (Algarve/Portugal) and specifically from the Department of Civil Engineering, has allowed to develop this study together with the Higher Technical School of Architecture of the Universitat Rovira i Virgili (Catalonia/ Spain) and the Fundació el Solà (Catalonia/Spain).

The general objectives of this work are to identify, analyze and value the dry stone heritage present in Portugal, focusing attention on the Algarve region and more specifically on the Barrocal area. The constructive heritage, the needs to be resolved and the type of stone present in the environment have characterized the constructions of each specific place. It is for this reason that, within a few kilometers of distance, there are constructive and formal varieties.

The Algarve region, located in the south of Portugal, is one of the areas with the most tourists in the country that has focused most of its economy on tourism, often without taking into account cultural and sustainable tourism. The main focus of the economy on tourism has meant a progressive abandonment and devaluation of other income-generating sectors such as agriculture. Consequently, the progressive abandonment of cultivation implies an abandonment and ignorance of the construction technique of dry stone and its constructions. Focusing on dry stone structures from the Algarve area can become a tool to revalue agriculture, rural heritage and promote cultural and sustainable tourism.

The methodology used during the project is based on recording and analyzing the Barrocal construction typologies. The process is based on accurately recording different dry stone constructions in order to analyze them and extract construction and geometric data about the constructions. The study has focused on a specific area of the Barrocal because it is the area with the greatest presence of dry stone constructions in the Algarve. In order to develop the registry, the technique of digital photogrammetry has been used as a tool for massive data capture. The photogrammetric models obtained have been processed with mesh and texture processing programs.

The recognition of the place and the collection of data has been carried out through visits and campaigns that began in December 2018 and ended in October 2020. During the months of September and October 2020, is the period in which most of the data collection survey campaigns have been carried out.

The Algarve is the southernmost area of Portugal (FIGURE 1), with an area of 5,412 km2 and 438,406 inhabitants [1]. The capital of the region is Faro. The Algarve region, although surrounded by the Atlantic Ocean, has a great influence from the Mediterranean Sea. It is characterized by a great diversity of landscapes and a temperate climate throughout the year.

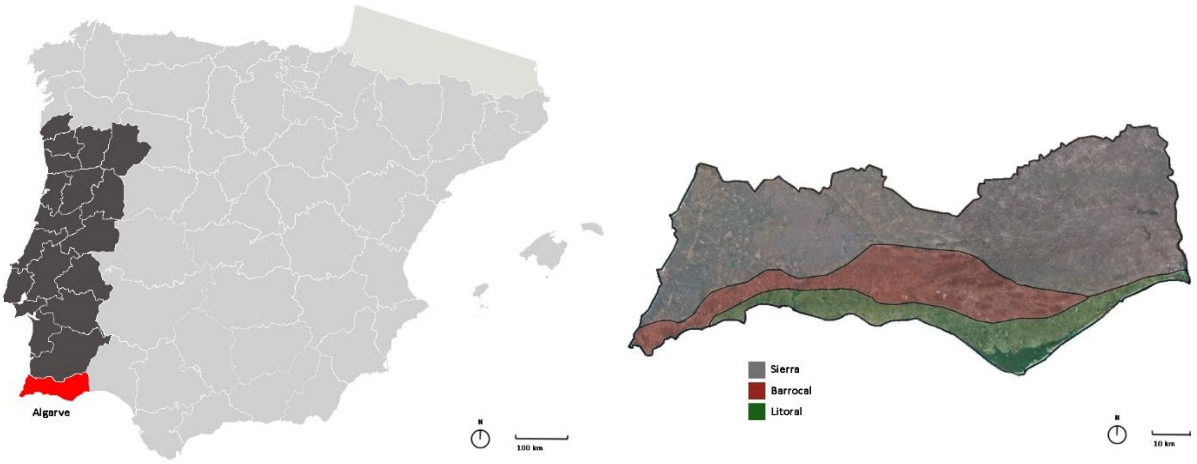

Fig. 1. Location and situation of the Algarve and the Barrocal (authors)

From a legislative point of view, the Algarve corresponds to the district of Faro, subdivided by 16 municipalities: Albufeira, Alcoutim, Aljezur, Castro Marim, Faro, Lagoa, Lagos, Loulé, Monchique, Olhão, Portimão, São Brás de Alportel, Silves, Tavira, Vila do Bispo and Vila Real de Santo António. On the other hand, geographically, it is divided into three strips: the Litoral (Coast), the Barrocal and the Serra (Mountain) - FIGURE 1. The Litoral is the area that borders the sea and the one that concentrates the greatest economic activity in the region, being the tourism the main economic engine. The Barrocal is the area located between the Litoral and the Serra, and the main agricultural exploitation area of the Algarve region. The Serra is the largest area, with approximately 50% of the surface of the Algarve.

According to the Algarve walking route guide carried out by Turismo de Portugal [2], there is another division from an environmental point of view in which the Algarve is divided into five zones: the Vicentine Coast, the Serra, the Barrocal, the Southern Coast and the Guadiana Zone. Of these five areas that are developed in the guide, there is only a mention of the dry stone heritage in the Barrocal area where it shows the walls that mark the paths for walking routes.

Dry stone constructions have a significant and historical value of the landscape and can become a reference for the territory's identity along with the vernacular constructions that are present in the area. Due to the characteristic of the construction technique, this heritage is completely integrated into the landscape that surrounds it and shows how the transmission of knowledge from generation to generation is capable of respectfully taking advantage of the resources that nature offers or adapting to the required needs, such as driving the flock, sheltering, storing or conveying water, preparing fields and fixing the soils. The dry stone technique and constructions have accompanied different civilizations since prehistory. The interest generated by both the technique and the constructions has been addressed through different disciplines such as archaeology, architecture, ethnology and landscaping.

2. Materials and Methods

2.1 Study case

The Barrocal is the area of the Algarve, as detailed above, with the largest presence of dry stone constructions. With the aim of being able to fully analyze the dry stone constructions in this region, a delimited study area has been chosen. The criteria in choosing this area have been: prior knowledge of the place, diversity of dry stone constructions, state of conservation of the present constructions, availability of people with knowledge of the territory. Taking into account the aforementioned criteria, the chosen area has been a delimited area in the “Serra de Monte Figo”.

The study area is an area where parts of the present farms are still cultivated and with a notable presence of walls of different characteristics and other isolated dry stone constructions. The notable presence of buildings and the variety of typologies have been the determining factors in choosing this specific area.

In the study area, four dry stone construction typologies have been detected: walls, threshing floors, lime kilns and sheepfolds. The state of conservation of these depends on the use and maintenance they have had over the last 50 years. While the walls have been preserved, the other buildings have progressively deteriorated until they practically disappeared.

The analysis and study have been developed through aerial photographs, photographs during data collection campaigns and applying the technique of digital photogrammetry. Digital photogrammetry is a technique that has been used in the process of recording walls, lime kilns and a threshing floor. All constructions need topographic documentation to be able to be studied and analyzed. The dry stone constructions were not made on plans unlike other constructions, they were built directly through the knowledge acquired from past generations and the observation that could be made. Digital photogrammetry, as an indirect measurement tool, allows massive data capture automatically and in a three-dimensional manner. This means that in a short time interval, maximum information can be obtained from each study element. The data obtained is processed to obtain a three-dimensional model through which the analysis can be developed. The possibility of obtaining an object in two and three dimensions allows the developed analyzes to be diversified using different programs.

Due to the large number of constructions that exists and the lack of use, preserving them is an expensive and difficult task. It is for this reason that the availability of an exhaustive record of constructions allows us to establish priorities when investing in conservation and dissemination.

2.2 Photogrammetric study

Digital photogrammetry, Structure From Motion, as a massive data capture tool, has allowed three of the four typologies of dry stone constructions located in the study area to be recorded. In the photogrammetric study, a wall, a threshing floor and two lime kilns were analyzed. Due to the poor state of conservation, the sheepfold has not been recorded using the digital photogrammetry

technique.

Massive data capture techniques are frequently used in cultural heritage studies [3]. Modeling and monitoring allow analysis and protection of different heritage elements [4,5]. These tools have many applications and are a theme which is present in different investigations [6]. Specifically, relating photogrammetry to vernacular architecture, studies have been carried out on dry stone constructions [7,8,9]. Photogrammetry allows rapid reproduction of 3D colorimetric characteristics of the studied object and is a useful method for dry stone constructions, which often have irregular geometry, an environment with the presence of vegetation and complex access. The process of obtaining the three-dimensional model, for each of the dry stone constructions studied, consists of three main steps: taking data, generating the three-dimensional model and obtaining results.

Data collection: Through the data collection campaign, photographs of the studio elements will be taken. During the photo taking process, the buildings are geolocated using GPS coordinates and a topographic ruler is used to indicate known points and scale the model. The camera used to take the photographs was a SONY 6100 with an E PZ 16-50mm F3.5-5.6 OSS lens.

Generation of the three-dimensional model: The program used to obtain the three-dimensional model has been Agisoft Metashape Professional used with a Windows 10 operating system. Firstly, the program aligns the introduced images looking for common points between the images and scaling the set based on the measurements that was attributed to the known points of the topographic ruler. Secondly, once it is verified that the images are correctly aligned, a dense cloud of points is generated where all identified points of the images are drawn. Then, from every 3 points, a plan is generated, forming a grid of the set. Finally, the texture is applied to the grid using the colors which were identified in the images. The obtained result is the scaled and textured construction of dry stone in three dimensions. Due to the fact that dry stone constructions tend to be surrounded by vegetation, to get a model suitable for processing it is necessary to clean the grid, eliminating imperfections.

Getting results: The Agisoft Metashape Professional program allows you to obtain ortho-images of the model from all possible points of view and sections. To receive drawing results such as elevations and sections, the AutoCAD and Rhinoceros programs have been used. Finally, to obtain results related to the geometry, volume and surfaces of the different analyzed constructions, the 3D Reshaper program was used. The named programs have been used with a Windows 10 operating system.

3. Results

Dry stone walls are the most visible construction of the dry stone technique. The analyzed wall has the function of terracing the land so that it can be cultivated. To build a dry stone wall, the slope is prepared by cleaning it of any vegetation it may contain. Subsequently, a trench is dug at the bottom about 20 centimeters from the ground to guarantee good settlement of the wall. Finally, the wall is built using the largest stones at the bottom and placing gravel in the part in contact with the ground to guarantee a correct distribution of the ground forces. To prevent the wall from overturning, it is tilted slightly towards the interior of the terrain (FIGURE 2).

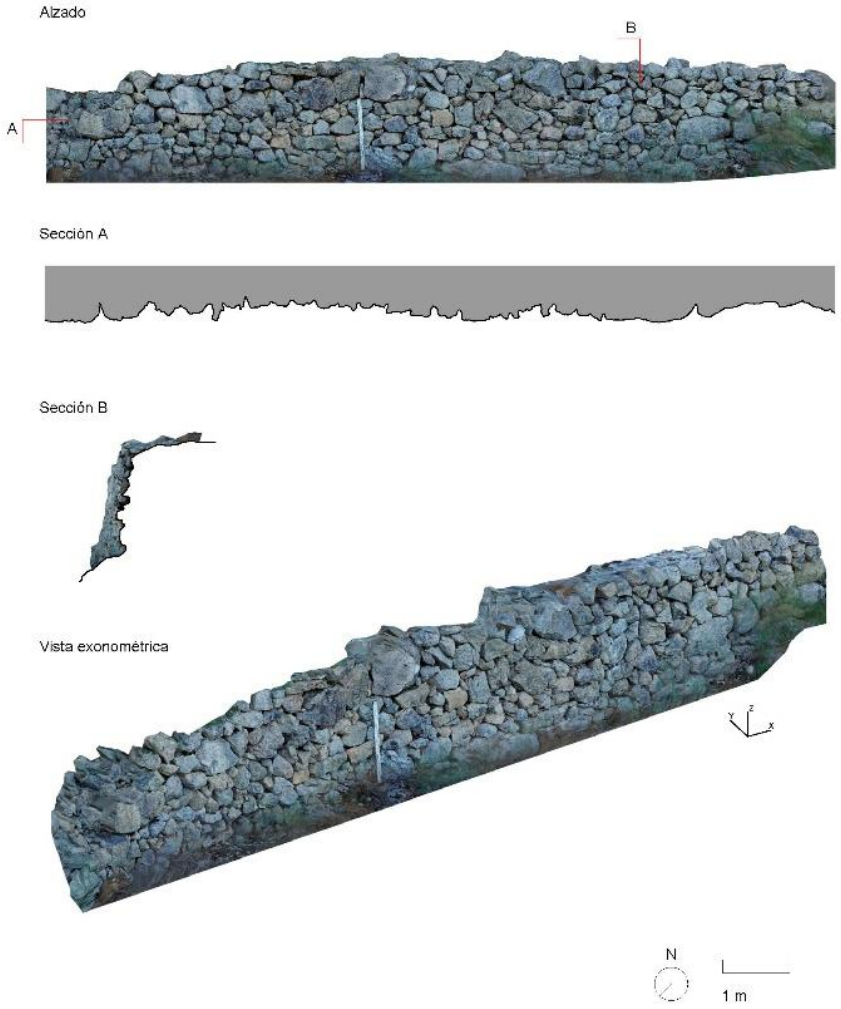

Fig. 2. Planimetry and model obtained from a wall (authors)

The threshing floors were built in the parts of the farm that were flatter, touched by the wind and close to the home or place where the harvest was stored. Because the aim was to have the smallest unevenness, it was essential that the surface be flat, so it was necessary to build a perimeter wall in the lowest part of the unevenness (FIGURE 3).

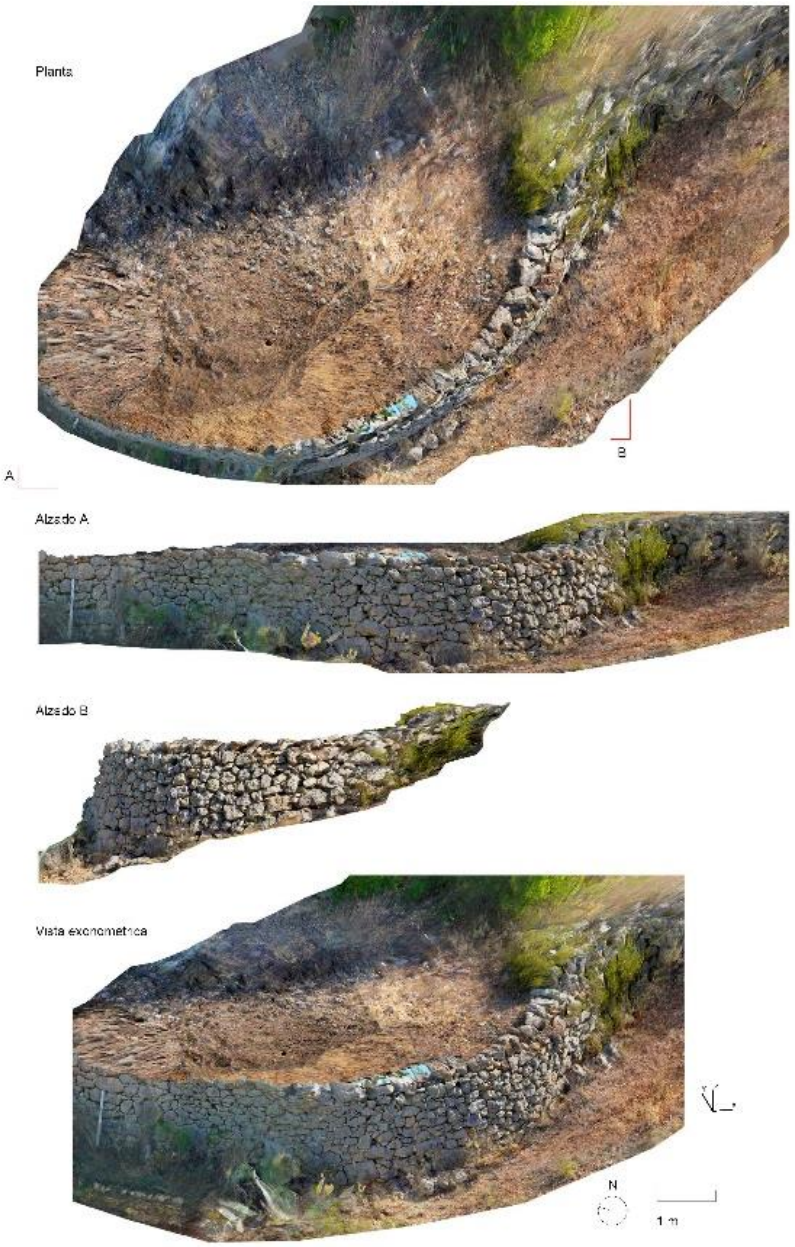

Fig. 3. Planimetry and model obtained from a threshing floor (authors)

The lime kilns were built next to uneven terrain to facilitate the entry of firewood through an opening at the bottom. The covering stone was completed at the top of the slope. The two localized kilns in the study area are located next to a slope. By analyzing the remains of the two ovens, the construction process can be deduced. Firstly, once located in a place with an unevenness, the basis was excavated in a circular shape and the side walls were covered with a circular stone wall as a way to retain the earth. The part of the oven located at the bottom of the slope was the entrance to the oven to be able to introduce the firewood. From a sufficient height to provide the necessary heat, the dry stone dome was built using the course approximation technique. The dome was covered with earth to maintain the heat for longer.

The dimensional results obtained through the generated 3D models are shown in TABLE 1.

4. Discussion

Once the need to conserve and promote the dry stone technique and constructions has been identified, the conservation criteria applied must be established: what should be conserved, how it is conserved and what kind of problems are presented by these constructions. Unlike other built heritage, vernacular heritage does not have defined action guidelines on how to act at a global level in a rural environment or at the level of each individual case.

Due to the large number of constructions throughout the territory, in the vast majority of cases they are abandoned and in poor condition, it is impossible to plan a reconstruction or maintenance of all the constructions. In order to develop a criterion for action in this regard, it is necessary to study the typologies and characteristics of the buildings that exist in each of the areas. It should be

noted that the problems and criteria for action in one area should not be the same in another. The dry stone heritage is very specific to each of the areas and the criteria must take this into account and follow this specificity.

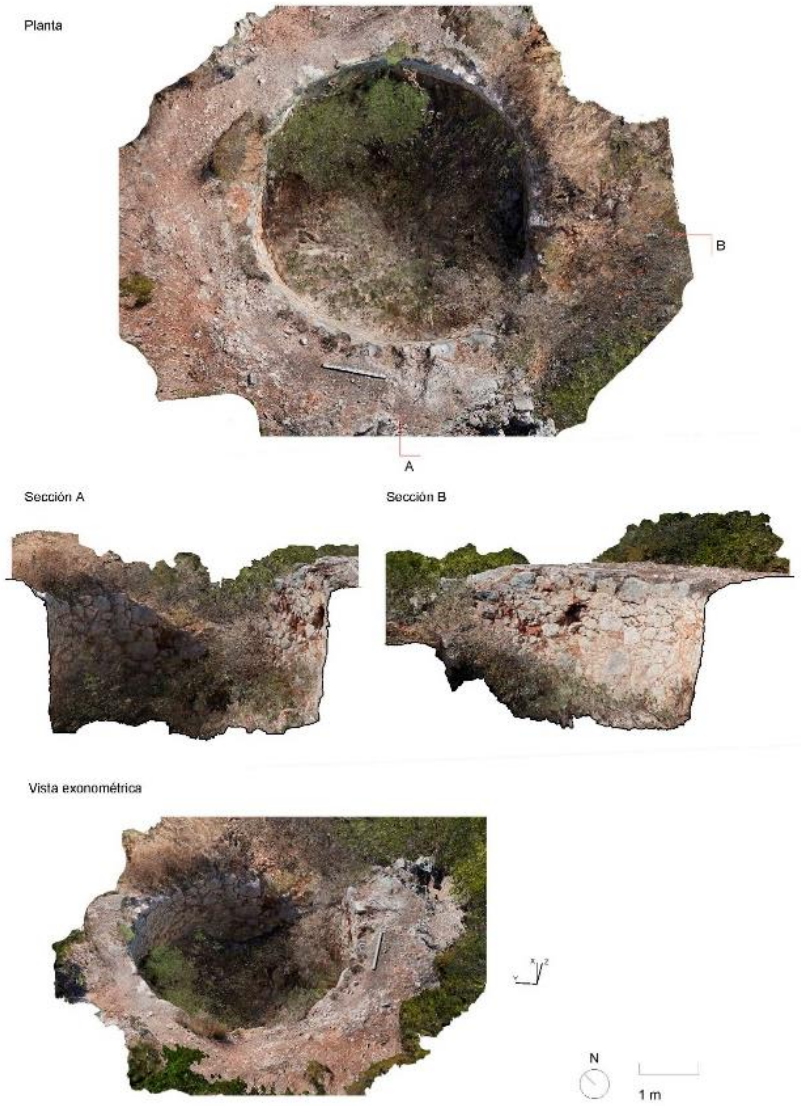

Fig. 4. Planimetry and model obtained from a lime kiln (authors)

The study of the buildings in a specific area allows us to identify the construction typologies, identify the state of conservation and detect conservation problems surrounding heritage. Conservation problems can be: the abandonment of farming fields, the replacement of constructions with other mechanisms or the use of other materials such as concrete.

Tab. 1. Dimensional and geometric characteristics of heritage elements (authors)

Type of construction	Width (m)	Height(m)	Radius (m)	Slope (degrees)	Minimum visible face dimensions of stones (m^2)	Maximum visible face dimensions of stones (m^2)	Amount of stones/m^2	Volume (m^3)
Wall	11,71	1,94	-	6	0,0045	0,3843	24	-
Threshing floor	-	1,99	5,36	10	0,0017	0,277	48	-
Lime kiln	-	2,85	2,46	8	-	-	-	47,74

Starting from the basis that not all dry stone constructions in an area can be conserved, priority must be given to those areas and typologies where it is possible to apply the reconstruction, recovery and conservation criteria. The established priorities may be linked to the uniqueness of the constructions, the proximity of population centers or the generation or recovery of new dynamics around the fields that have been abandoned. The reasons for investing resources and efforts in the recovery and reconstruction of dry stone constructions must be linked to permanent or intermittent use throughout the year. The restricted use will favor its conservation.

Once the constructions that need to be intervened in an action area have been identified, the action criteria must be defined. The

operations carried out around dry stone constructions must use the dry stone construction technique both to give a unified criterion to the constructions and to maintain knowledge of the construction technique. It is necessary to highlight that any intervention in dry stone constructions is part of the vernacular heritage of the intervention area.

We are faced with a living and changing heritage. Dry stone needs the hand and knowledge of people to maintain and value it among present and future generations.

5. Conclusion

The diverse, important and significant dry stone heritage that exists in Portugal in general and in the Algarve in particular is largely unknown at both regional, national and international levels. Although research [10-18] and some actions have been carried out in this regard, it is currently not one of the priorities within the majority of sectors that deal with both tangible and intangible heritage.

The construction technique and dry stone constructions are a fundamental tool to revitalize areas that want to promote quality cultural tourism. Both the technique and the constructions explain the history and traditions of a place. Depending on the type of stone, the constructions are different from one another and their properties and characteristics are change. The groups of constructions form the humanized rural landscape, the result of the immense work of generations and generations to take advantage of the resources that the environment offers and to obtain food and benefits.

In order to value dry stone heritage and recognize it as an element of identity and promotion, it is necessary to know it. Although it is a heritage that is very available to everyone, due to lack of knowledge it is ignored. It is for this reason that one of the objectives of this work has been to identify and record different construction typologies located in the Algarve.

Going deeper by recording three construction typologies using the digital photogrammetry technique has made it possible to capture the current state of a representation of dry stone constructions and obtain dimensional measurements of each of the analyzed elements. The recorded constructions are different and reflect the different data that could be obtained through the application of precise tools. The obtained data allow us to know the characteristics of the constructions and, consequently, the particularities of the construction technique.

Systematically applying the registry of dry stone constructions in the Barrocal or in the Algarve would make it possible to develop a rigorous inventory of the present typologies, evaluate the state of conservation and thus have sufficient criteria to invest in the recovery of the most significant specimens.

Finally, conservation and dissemination measures must be the beginning of a national dissemination plan to study, conserve, develop and disseminate the tangible and intangible heritage of dry stone constructions.

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