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TERRITORY AND DRYSTONE WALLS. COMPARATIVE OF CASE STUDIES IN CENTRAL AND SOUTHERN PORTUGAL

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ABSTRACT

Since becoming settled, Man had the need to shape the territory in his benefit, gaining ground for agricultural activity. Drystone walls were the way found to overcome sharp slopes. The way these walls are arranged in the territory is not random, as it may seem at first glance: they are disposed in the best way to facilitate the agricultural activity, taking into account the natural factors of the territory where they are located, such as orography, climate or geology. Taking as study cases two regions in Portugal under slightly different climate regimes, one located in the Algarvian Barrocal and the other located in the Center, we intend to compare and advance with explanations as to the way drystone walls are disposed and their relation to the territory. To achieve the objectives bibliographical and photographic studies, as well as interviews with the inhabitants of these areas, and cartographic and field surveys were carried out. Whereas the purpose, materials and construction characteristics were achieved by the previous, their disposition and relationship with the orography were carried out by the latest. Particularly, field surveys were made by digital stereo-photogrammetry applied to several overlapping nadiral photographic images from different perspectives acquired by an unmanned aerial vehicle along its flying pathways that allowed for very high-resolution geographic data. Where such surveys were not made, cartographic data were used instead. Through the dissemination of such vernacular heritage, it becomes valued and known. In this way, people will attribute cultural and patrimonial value, protecting it, especially the local population that tends not to attribute any value to this "minor" heritage, contributing to its disappearance. There are still not much works about this subject in the areas analyzed here, so this paper has an added value, in order to disseminate and create added value to these kind of heritage.

KEYWORDS: Drystone walls; territory; vernacular heritage; Barrocal; Cernache do Bonjardim; Portugal.

1. INTRODUCTION

With the sedentism of Man, there was a need to obtain land for the development of agriculture. In this context, drystone walls appeared as a solution for the domestication of the territory, building terraces. Drystone walls are made of mortar-free stones joining them, working only by gravity and depending on the master builder's skill and knowledge to solve this natural puzzle. Terraces were the most effective way Man could cultivate on steeply sloping land, while, at the same time, sustaining soil and reducing erosion caused by floods. Thus, the first reason for the existence of terraces is agriculture [1]. They perfectly demonstrate the interaction between man and the environment [2], and characterize the territory in which they are inserted [3].

Drystone walls favor new economies, contribute to greater infiltration of water into the soil, decrease water erosion, retain the vegetation layer and most nutrients, among other ecological, economic and social benefits [2, 4]. This issue is extremely important in the case of Algarvian Barrocal, where soil water retention is fundamental and, in the case of Cernache do Bonjardim, is very important as a fire retardant. These are the two areas under study in this article and to which we will refer later.

Since terraces are artificial plains, their maintenance must be careful, as otherwise materials may be transported or altered by erosive agents, making their rehabilitation difficult [2]. This maintenance is difficult to do and when they lose their agricultural use, the deterioration of these walls and this agricultural system is increasing over time, with numerous landslides [1]. This degradation is a reflection of the shift from the traditional agro-forest-pastoral economy to own consumption or abandonment of agriculture.

The abandonment of terraces and agriculture favors uncontrolled forest growth, which increases the risk of a forest fire, as well as rural depopulation, reducing assets to act quickly in the event of a fire. On the other hand, rural property consists mostly of small parcels, and generally those of the same owner are scattered, making their exploitation difficult; These difficulties, coupled with the lack of available labor, make this type of construction very expensive and contribute to its degradation [2, 4, 5], therefore, it is preferable to maintain and restore those that still exist and are being used, or those that are landscaped most valuable [6]. All of this favors the gradual replacement of traditional walls with masonry or concrete walls or regular stones of exaggerated dimensions (Figure 1).

Figure 1: Upper: terrace with a dry stone support wall partially replaced by a masonry wall in the Cernache of Bonjardim area; Bottom: terrace with a recent wall, built with regular stones of exaggerated dimensions for this context, Algarvian Barrocal (authors)

These landscapes, by forming the territory, help to develop an identity, reflecting relationships between the natural environment and people, both in the past and in the present, suffering progressive changes. The territory is slowly built based on specific interconnected dynamics of a natural, social, cultural and economic nature. What gives the territory such a total value, however, is its cultural dimension, carrying it with significance as it accumulates experiential and emotional knowledge [7]. This significance is attributed by the local population, because the way in which one creates and gives significance to the environment around us depends greatly on the cultural traditions, cultural identity and cultural aspirations of the populations, which does not always coincide with the significance and appreciation that professional groups attribute to it [8]. For these reasons, there are territories with the same basic characteristics (orography, geology, soils, climate, etc.) but which can generate different landscapes because they depend on the cultural heritage and *modus vivendi* of that place. The imminent danger of losing these landscapes is real in Portugal, especially in the countryside, due to internal factors such as the aging of the rural population and external factors such as globalization, with the *one fits all* philosophy, leading to a gradual generalization of the landscape, endangering traditional socio-economic systems [7, 9–11].

One way to counteract this tendency is to improve knowledge of the relationships between cultural and biological diversity in a given territory [12]. Whenever a landscape is characterized, it is contributing to make the population aware of its value to the territory where it is inserted [10], as its characterizing element.

Taking as case studies two different areas in Portugal, one in the Algarve, in the South, and the other in the Center, we intend to compare and advance with explanations regarding the arrangement of the drystone walls and their relationship with the territory where they are inserted.

To achieve the objectives bibliographic and photographic studies, as well as interviews with the inhabitants of these areas, and cartographic and field surveys were carried out. Whereas the purpose, materials, and construction characteristics were achieved by the previous, their disposition and relationship with the orography were carried out by the latest. Particularly, field surveys were made by digital stereo-photogrammetry applied to several overlapping nadiral photographic images from different perspectives acquired by an unmanned aerial vehicle along its flying pathways that allowed for very high-resolution geographic data. Where such surveys were not made, cartographic data were used instead.

2. CASE STUDIES

2.1. Framework

The following case studies are two pilot zones of approximately 70 Ha (696 263,3 m^2), a perimeter of approximately 3600 m (3591,6 m) and defined in a rectangle of approximately 1230×567 m. They are located in the parish of Cernache do Bonjardim (CB), defined according to CAOP2011[1], municipality of Sertã, in central Portugal and Algarvian Barrocal (BA), Algarve, southern Portugal (Figure 2). Both zones have different historical, climatic and geological characteristics.

For Portugal, the Köppen-Geiger classification (1936) identifies three types of climate, based on climatic normals between 1971 and 2000 [13]: *i*) temperate climate of Csa subtypes, with dry and hot summer in the Southern Montejunto-Estrela mountain system, such as BA; *ii*) type Csb, with mild summer in the northern regions of the same mountainous system as in CB; *iii*) arid climate of subtype BSk, cold mid-latitude steppe climate south of the mountainous system referred to above. As a consequence, we have the climatic characteristics presented in Table 1.

[1] Administrative and Organizational Chart of Portugal, 2011.

Thus, it can be concluded that for the Cernache region, the Barrocal region has a higher temperature (warmer) and less precipitation (drier), although concentrated at shorter time intervals.

Figure 2: Location of the study areas in Portugal (authors, based on Google Earth, accessed on 3/3/2019)

Table 1: Summary of climate characteristics of case studies (authors)

Cernache do Bonjardim	Barrocal Algarvio
The violence of cold, heat and dryness, gradually attenuated with the approach to the coast; Average temperatures: +10ºC (winter) e +22ºC (summer); Minimum winter and maximum summer temperature: -5ºC and +40ºC; Average rainfall: 125 mm/month (winter) and 10 mm/month (summer); Maximum rainfall: 80 mm/day.	Always high temperatures, temperate winters and very hot and dry summers, great light, clear sky, light rain; Average temperatures: +12ºC (winter) and +24ºC (summer); Minimum winter and maximum summer temperature: -1ºC and +40ºC; Average rainfall: 115 mm/month (winter) and 1 mm/month (summer); Maximum rainfall: 155 mm/day.

The two areas studied have very different geological characteristics. The Cernache pilot zone is constituted of rocks from the ante-Ordovician schist-graywacke complex [14], consisting of shale and sandstone-greywacke rocks, which formed during the Upper Precambric and Cambric [15], more than 485 million years [16]. In this area, the orography is characterized by a relatively soft relief, with altitudes around 400 m above sea level. In general, the rocks that occur in this territory are little permeable to water, so that the runoff of rainwater occurs mainly at the surface, with high erosive potential, forming permanent streams and creeks. It has lithosol-like soils, which correspond to undeveloped, thin soils, with little nutrient value [17, 18].

On the other hand, Barrocal is characterized essentially by the occurrence of limestone and dolomites. In the studied area there are marl and limestone that originated during the Upper Jurassic era [14], some 150 million years ago [16] and were deposited in layers in a marine environment [19]. Due to its chemical composition, which allows its dissolution by water, limestone is karstified. Due to rapid infiltration, surface water is generally scarce; in case of heavy rain, part of the rainwater flows to the surface with high erosive power. The relief corresponds to an area of hills around Cerro de São Miguel, which reaches an altitude of 410 m above sea level. The soils of the region consist of calcium rhodochromic luvisols [18], also known as “terra rossa” with a clayey B horizon and a red color [17].

As a consequence of the above mentioned characteristics, the territories in question present, in the case of CB, a verdant landscape with abundant water, allowing both upland crops such as olive, very characteristic of this territory, as well as irrigated crops; in the case of BA, a landscape with brownish tones in a red-colored terrain, where there is a lot of heat and water scarcity, allowing mainly dray farming crops such as carob and almond trees, very characteristic of this territory.

2.2. Arrangement of drystone walls in the territory

The way these walls are arranged in the territory is not random, as it may seem at first glance: they are disposed in the best way to facilitate the agricultural activity, taking into account the natural factors of the territory where they are located, such as orography, climate or geology.

For this analysis, we considered the drystone support walls of the two pilot zones shown in Figure 3. There were some difficulties to be able to define the drystone support walls in the case of BA because there was a survey with the same area of the zones presented in Figure 3, whose image has vegetation (Figure 4), making the identification of the walls difficult. The available data was another difficulty, since in the CB zone, in Figure 3, the level curves are represented every 25 m and in the BA area of the same figure, every 10 m.

From Figure 3 and about the two pilot areas, the following can be concluded:

- In CB the major concern is the increase of the agricultural area; already in BA, the major concern, and therefore the largest role played by the walls, is in reducing erosion caused by the flood and to provide greater contact between water and the ground, creating a larger percolation bed and increasing the infiltration.
- In CB the walls are mostly practically parallel to the level curves, while in Barrocal they are approximately parallel. The reason for this detail in Barrocal is thought to be related to the need to slightly increase the slope to form zigzags to allow more water to seep into the soil.
- In BA some walls are approximately perpendicular to the level curves, intersecting the bottom of the valley. These walls are thought to function as a draining layer, directing the water into the valley and bringing more water to the terraces. This is not the case in CB, where there are many water resources.
- In BA there are walls arranged in zigzag, like “rooster's foot”, and the access to the terraces is made by ramps that are part of this structure so that the water velocity is reduced and the contact time of it with the soil is increased. In CB this case was not verified. This is partly because rainfall is more distributed over time, with no major problems of water erosion due to water velocity. In this pilot area, the access to the terraces is mainly made by stairs with different types.
- In BA some walls intersect the water lines and are perpendicular to their current direction - orthogonal arrangement [20]. This is because the plain of these streams is the ideal place for farming, especially vegetable gardens, creating terraces. Due to the steep slopes in this pilot zone, there are no fields of sufficient width or sufficiently irrigated for horticultural activity; thus, the valleys located in the stream plains are the few places where this is possible. In the case of CB, vegetable gardens happen on terraces, usually simultaneously with the vine culture [1]. In this pilot zone, there is no need to resort to similar solutions as in BA because the fields are more fertile and have more water.
- In BA there are U-shaped retention ponds systems, i.e., guard walls, which help to retain water, have a U shape and lie on the slope, while in CB there are walls with the same shape - U - but which are located in the thalwegs, taking advantage of the narrow valleys.
- Although not verified in the BA pilot zone, in this region some walls were built, not for agriculture, but for delaying the inflow of rainwater to the valley, where there is agriculture. This reduces the water velocity, preventing the entrainment of plant species planted in the valleys [20]. No such cases were found in CB.

Thus, we provide the main differences found between the two pilot zones, which present different geology, soil, climate and, consequently, different needs to be met by the drystone wall system. The relationship of these structures with the territory in which they are inserted exists in the way they are "placed" on the ground, depends: on the orography, which makes the use of the slopes more or less difficult; on geology, which originates the soils; on climate, which allows more or less natural irrigation. All these factors condition the cultivated forest species, characterizing the landscape and identifying the territories where they are inserted.

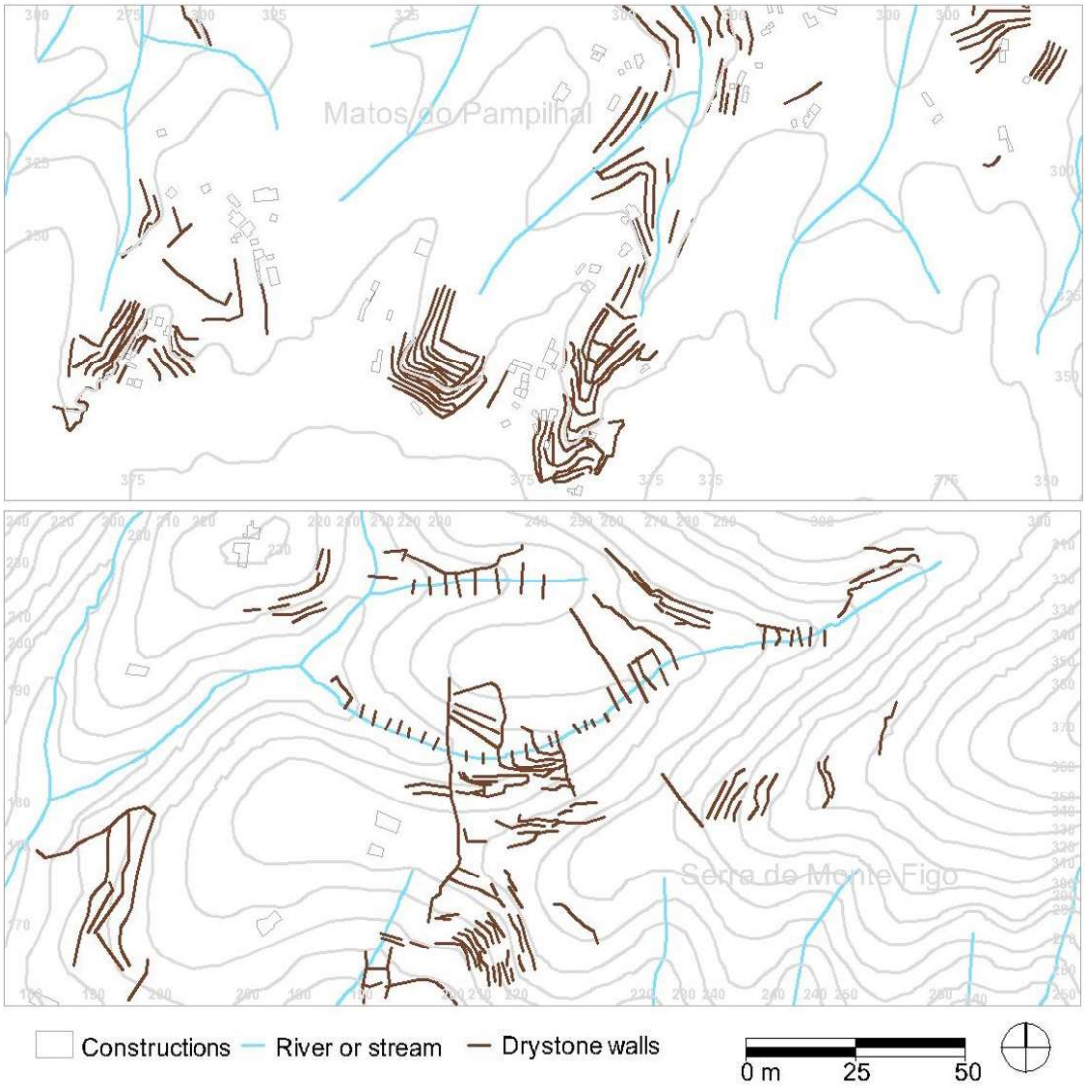

Figure 3: The arrangement of drystone walls in a pilot area. Upper: Matos do Pampilhal, Cernache do Bonjardim; Bottom: Serra de Monte Figo, Algarvian Barrocal (authors)

3. CONCLUSIONS

Despite the danger of disappearance and deterioration, rural terraced landscapes can have a future, starting with the social enhancement of these spaces and the design of integrated solutions that, at the same time, improve the living conditions of local populations and make them more attractive spaces for their reuse, rehabilitation and maintenance [2, 20]. The inspiring projects already implemented in other countries, such as Hercule, TERRISC, PATTER, among others, include an economic aspect - they create jobs and promote tourism, a heritage aspect - an awareness of artisans for the preservation of local culture and identity, and an environmental aspect - drystone walls enhance biodiversity and allow rainwater drainage, retaining nutrients, which is not the case with cement walls [5, 6].

Figure 4: Field survey of the Algarvian Barrocal pilot zone (authors)

But a future for the terraced landscapes with drystone walls is only foreseen if there is a financial interest, otherwise they will continue to be abandoned; it is, therefore, essential that agro-forest-pastoral production is adapted to present circumstances, offering new agricultural and also tourism and leisure services [4]. New economies such as tourism need to be used today as another way of boosting agriculture. Without this agriculture, tourism does not have to exist, because what it seeks is this rurality and ancestral knowledge, as well as the drystone walls that form the terraced landscape: the first reason for their existence is agriculture, and without it, they become obsolete and disappear or degrade [3]. But, for this, it is necessary to know and study the walls, making a survey and characterizing them typologically, so that they can be valued and estimated and not continue to be underused as in most areas in Portugal.

The heritage linked to terraces goes far beyond the retaining walls, such as the partition walls of property and other constructions that were intended to support agricultural activity, like the access stairs to the terraces, the corrals, water-use systems or mills [2] which, like walls, are in danger of disappearing into obsolescence unless they are converted or get new functions, as happened in some cases. The theme of drystone constructions was given international importance when, in 2018, UNESCO classified them as Intangible Heritage of Humanity [21], due to knowledge and uses related to Nature and the Universe, which demonstrates the timeliness of the theme.

It has been shown that while in CB the main concern is the increase of agricultural land, in BA the main concerns are the increase of water infiltration in the soil and the decrease of erosion caused by rainwater. Although there is still not much work about this subject in the areas analyzed here, this article has an added value, to disseminate and create added value to this kind of heritage. When studies on vernacular heritage are published, it is valued and made known. In this way, people will attribute its cultural and patrimonial value, protecting it, especially the local population who tend not to give any value to this “minor” heritage, contributing to its disappearance.

It has also been shown that the landscape of drystone walls is the identity of each territory, reflecting the culture and history of each space; that deserves to be preserved; whereas it is urgent to give them new uses when agriculture is abandoned; but above all, they have the potential to survive and to be monetized.

This article is another contribution to the reading and appreciation of this heritage that resulted from generations and generations of practice to reach us today and grant the territories where they are inserted more personality and identity.

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