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**THE INHAVIT PROJECT: SUSTAINABILITY-LED APPROACHES
FOR THE REHABILITATION OF THE CULTURAL BUILT
HERITAGE OF MONTESINHO NATURAL PARK
RESEARCH OVERVIEW AND INITIAL FINDINGS**

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Keywords: Vernacular architecture, rural depopulation, conservation of built heritage, energy retrofitting, field survey, research methodology

Abstract: The INHAVIT research project, funded by the Portuguese Foundation of Science and Technology (FCT), aims to study and identify the social, economic and environmental vulnerabilities that may be contributing to the current state of progressive abandonment of the rural villages of Montesinho Natural Park (MNP), in Portugal. Once the vulnerabilities are better understood, the main research question is whether the conservation and retrofitting of the rural built heritage in MNP can help reduce these vulnerabilities and how. The present paper intends to show the structure of the research project, focusing on the research methodology and specific tasks designed to tackle the project objectives. It also presents the preliminary results obtained from the first two field survey missions carried out at the MNP whose primary purpose was getting a screening of the park's current state regarding the loss of authenticity of its vernacular heritage.

1 INTRODUCTION

The depopulation of the rural world brings territorial inequalities within a country in terms of development, infrastructure or access to employment and social services. This phenomenon is intense in most Mediterranean countries, such as Portugal, where there are drastic differences in terms of population between urban and rural areas. This phenomenon is apparent in the Montesinho Natural Park (MNP) villages. Data from the Instituto Nacional de Estatística (INE) indicates that the villages lost almost 70% of their population between 1960 and 2011 and the ratio of older people has increased steadily during the last decades [1].

The INHAVIT project, *Sustainability-led approaches for the rehabilitation of the cultural built heritage of Montesinho Natural Park*, funded by the Portuguese Foundation of Science and Technology (FCT), aims to study and identify the social, economic and environmental vulnerabilities that may be contributing to the current state of progressive abandonment of the rural villages in the park. The present research is based on the idea that cultural heritage conservation can be a driver and enabler for sustainable economic development. Cultural heritage can be an essential asset for economic growth, not only in terms of tourism, but also in terms of job creation, promotion of local craftsmanship for specialized jobs in cultural heritage preservation, city center revitalization, or increase in property values [2]. Specifically, the valorization and preservation of vernacular architecture is a key element of cultural identity and a witness of the past, but it can also become a privileged factor for local development [3]. The research ultimately intends to study and characterize the cultural built heritage of MNP and assess its vulnerability, aiming to conclude with recommendations for specific actions to safeguard it. These actions are expected to have a substantial impact, create awareness, and engage local communities in promoting sustainable, resource-efficient, low carbon, and climate-resilient settlements [4].

Additionally, recent investigations identify Portugal in the top three EU countries regarding fuel poverty risk [5], mainly due to the overall poor quality of residential buildings, which are still to attain satisfactory thermal comfort standards [6]. The building stock includes vernacular dwellings, whose inhabitants are increasingly ageing. This is an important risk factor, since research shows that insufficient thermal insulation can lead to high winter mortality rates [7]. This threat will even increase in the future with climate change leading to extreme weather conditions, and that is why research into the socio-economic and environmental vulnerabilities that may be contributing to the current state of progressive abandonment of Montesinho villages is of utmost importance.

Vernacular architecture is not particularly energy efficient, which can be broadly explained because of the scarcity of resources, resulting in the use of poor materials, lack of proper construction details and low maintenance. Nevertheless, local communities have traditionally adapted their buildings to the local conditions of the place, including climatic ones [8-10]. There are fundamental lessons to extract from vernacular architecture, including construction strategies and principles that can be integrated into contemporary bioclimatic design and rehabilitation practice [11,12]. The research project focuses on traditional construction solutions, acknowledging that retrofit solutions for the vernacular heritage cannot attend solely to technical requirements and must respect its authenticity. The risk of vernacular heritage disappearing due to a global homogenization construction, which is related to an increase in living standards and a consequent abandonment of buildings that do not reach those standards, has already been highlighted by ICOMOS [13]. As a result of this progressive abandonment, the vulnerability of

vernacular architecture towards climate increases. The INHAVIT project addresses the concept of village retrofit [14], aiming to propose energy retrofitting interventions for Montesinho vernacular housing, based on traditional solutions and local materials that respect vernacular architecture authenticity, as well as to find solutions intended for the energy self-sufficiency of the village, based on renewable energy generation [15,16].

Although this project is comprehensive in scope, a particular focus will be given to energy-related aspects at two scales: the micro (i.e., the individual building) and the macro-scale (i.e., the village). The central research hypothesis is that supporting decisions for creating a more resilient vernacular built environment in rural settlements prone to depopulation may attract and host strong local communities. This approach also aims to contribute to safeguarding the rural vernacular heritage by creating awareness and promoting its occupation by improving its living conditions.

Besides the energy perspective, the vernacular heritage is vulnerable to other socio-economic threats that lead to the above mentioned problems of mischaracterization (loss of authenticity) and abandonment. Thus, the INHAVIT project also intends to explore the socio-cultural characteristics of the villages following a methodology based on systematic ethnographic observation and detailed field work [17]. Nevertheless, the rural built environment is also particularly susceptible to natural hazards [18], including fire, floods or landslides. One of the main objectives of the INHAVIT project is to characterize all socio-economic and environmental risks that affect the MNP villages, as well as to identify factors and parameters that contribute to their vulnerability. As a result, the project also expects to offer strategies at the building and village level to mitigate risk and decrease the vulnerability of the built environment, while safeguarding the rural vernacular heritage of MNP.

The present paper is firstly intended to show the structure of the research project plan, focusing on the research methodology and specific tasks designed to tackle the project objectives. To illustrate the proposed methodology, the paper presents and discusses the preliminary results obtained from the first two field survey missions carried out at the MNP to get a rapid screening of the state of conservation of the park in terms of the loss of authenticity of its vernacular heritage.

2 INHAVIT RESEARCH METHODOLOGY

The research tasks involve actions addressing: (1) characterization of the built environment at the village level and detailed large-scale 3D surveys of selected rural settings; (2) architectural and construction characterization of selected representative vernacular buildings of the park; (3) development of a novel multi-vulnerability and multi-hazard risk assessment framework based on socioeconomic and environmental drivers that contribute to the susceptibility of the depopulation and abandonment of the villages; (4) numerical energy performance assessment of representative buildings, calibrated with data obtained from the long-term monitoring of their thermal performance; and (5) recommendations for efficient rehabilitation and energy retrofitting interventions for MNP vernacular housing, mainly focusing on bioclimatic solutions and local materials that respect their authenticity. Table 1 shows a summary of the research methodology showing the five research tasks and associated goals.

Table 1: Research tasks and goals.

Research task	Goals
1 Characterization of the built environment at the village level	Assessment of the level of authenticity and overall state of conservation of the MNP vernacular heritage.
2 Architectural and construction characterization of vernacular buildings	Understanding of architectural typologies, structural and constructive solutions, and constituent materials
3 Socio-economic and environmental risk assessment	Development of a novel multi-vulnerability and multi-hazard risk assessment framework based on socioeconomic and environmental drivers.
4 Numerical energy performance assessment	Quantitative evaluation of the energy performance of selected representative vernacular examples.
5 Recommendations for retrofitting interventions	Definition of conservation and retrofitting strategies for the built environment based on local solutions and respecting the authenticity

2.1 Characterization of the built environment

The first tasks concern the on-site study and characterization of representative rural settlements in the Montesinho Natural Park (MNP). The project focuses on identifying rural villages in the park that still contain representative vernacular buildings with relevant heritage value. The first surveys are thus intended to assess the state of conservation of the vernacular heritage in the park in terms of authenticity. The main objective is to identify buildings that still preserve vernacular characteristics. Conservation strategies will be defined that outline the most significant attributes of the vernacular heritage in the park and establish how to manage changes over time to ensure the heritage values are retained over time.

Detailed large-scale 3D surveys based on aerial photogrammetry of selected rural settings will be carried out to better understand other attributes, such as urban layout and surrounding natural environment (e.g., hydrography, vegetation, topography, the interface between the built environment and forest masses, etc.). This information is essential to evaluate the vulnerability of these villages to different natural hazards, namely drought and fires.

2.2 Architectural and construction characterization

Characterizing the rural built environment also involves selecting representative vernacular buildings to perform a more detailed characterization at the building level. The primary objective is to identify the architectural typologies, structural and constructive solutions, and constituent materials. This comprehensive study is particularly important to investigate how different parameters can influence the energy performance of

vernacular constructions. Indeed, some buildings will be subjected to long-term thermal performance (indoor air temperature relative humidity) and energy and water consumption monitoring, intended to understand their energy performance. All the collected information will also be important to define appropriate retrofitting solutions that respect the authenticity of vernacular architecture.

2.3 Multi-vulnerability and multi-hazard risk assessment framework

The project aims at identifying and characterizing threat parameters contributing to the vulnerability of villages and vernacular buildings in MNP. The threats to the conservation and preservation of the authenticity of the villages and built heritage are mainly socio-economic and environmental. The social aspects include, among others, demographic threats, such as those related to the predominance of older people, small growth rate, migration, etc., which partially explain the progressive villages and buildings abandonment, reduced social support or low level of education and cultural consciousness. The economic threats deal with reduced monthly incomes, reduced diversity of subsistence sources, or reduced job mobility, mostly related to the demographic profile. The environmental threats focus mainly on climatic change, with increasing frequency of extreme temperatures, reduction of rainfall and potable water availability. It also promotes the increase in the probability of the occurrence of devastating forest/rural fires. Additional threats for the villages are also related to accessibility to infrastructures (roads, cultural/medical/sports facilities, telecommunications, distance to medical treatments, healthcare equipment, etc.).

After identifying the threats, a list of vulnerability factors and parameters that contribute to the vulnerability of the villages and buildings will be derived. This will help to develop a natural and anthropogenic (multi-vulnerability and multi-hazard) risk assessment framework based on collected vulnerability parameters in MNP, which can also be applicable in other similar contexts. Ultimately, strategies may be defined to mitigate the risk and improve the resilience of the rural settlements of the park, preventing their ongoing depopulation process.

2.4 Numerical energy performance assessment

One of the research hypotheses of the project is that one crucial aspect that contributes to the progressive abandonment of the rural architectural heritage is the poor quality of residential buildings, unable to provide adequate thermal comfort. People tend to undervalue traditional buildings and subsequently relocate to modern housing, associated with better living conditions and greater comfort and safety. Nevertheless, despite rural architectural heritage not being energy-efficient, several projects have identified strategies and principles within the vernacular heritage that can be integrated into sustainable architectural design, and adapting vernacular architecture to appropriate current thermal comfort demands is critical for local regeneration and sustainability.

This is one of the main propositions of the INHAVIT project. For that matter, the project involves the numerical energy performance assessment of representative vernacular buildings, calibrated with data obtained from the long-term monitoring of their thermal performance. The numerical campaign will also include the simulation of identified energy retrofitting solutions for these vernacular constructions and quantitatively assess their efficiency.

2.5 Recommendations for retrofitting interventions

One of the primary expected outcomes of the project is to provide recommendations for efficient rehabilitation and energy retrofitting interventions for MNP vernacular housing. The retrofitting solutions will prioritize traditional bioclimatic solutions and local materials already identified as traditional in the country's Northeastern region. The project will provide recommendations at two interlocking levels:

(1) at the level of built heritage, showing different ways of interventions in terms of energy efficiency, mainly aimed at increasing the thermal comfort of existing buildings. They will also seek to define possible conservation and maintenance plans for the buildings, following a criterion for conservation that respect the cultural significance of the vernacular heritage, aligned with existing guidelines and charters;

(2) at the village level, showing different intervention possibilities to provide a rural village retrofit, based on: (a) reaching high energy efficiency of the housing; (b) use of local materials with low environmental impact; and (c) energy self-sufficiency based on energy generation, e.g., small hydro power obtained for ancient water mills. This level also considers the village as a whole, aiming at the valorization of the rural settlement, which can become an attraction for new inhabitants and tourists by promoting sustainability and decreasing the social and environment vulnerability.

3 PRELIMINARY SURVEY ON THE STATE OF CONSERVATION OF THE VERNACULAR HERITAGE IN MNP

The preliminary results obtained from the first two field survey missions carried out at the MNP to get a rapid screening of the park's state regarding the preservation of the authenticity of its vernacular heritage are presented and discussed in this paper to illustrate the proposed methodology. A total of thirteen villages were surveyed (Figure 1), resulting in preliminary statistics about the number of buildings that still conserve the vernacular construction system, materials and architectural features, among other characteristics of the rural built environment in the park.

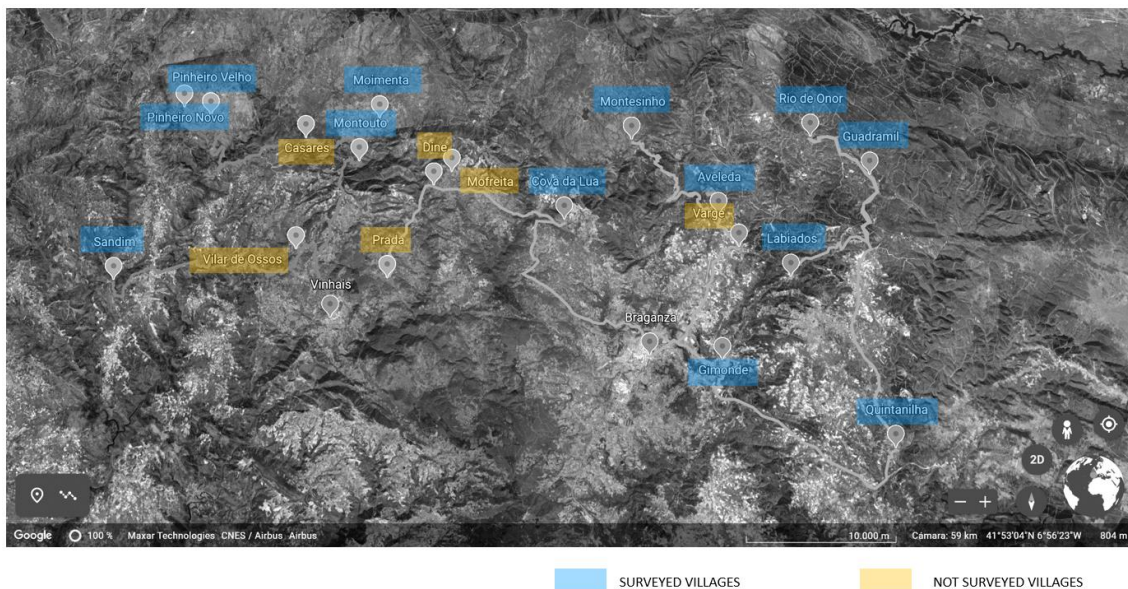


Figure 1: Surveyed villages in MNP

The missions revealed that the rural settlements are highly altered and at risk of losing their vernacular heritage values. Figure 2 shows a graph with the number of buildings surveyed in each village that still preserve vernacular characteristics (defined as “vernacular” in the chart). Overall, around 60% of the buildings inspected can be identified as vernacular. Nevertheless, most of the buildings marked in green have also been further mischaracterized due to subsequent alterations, e.g., alteration of the roof materials or the addition of reinforced concrete elements to mention a few examples.

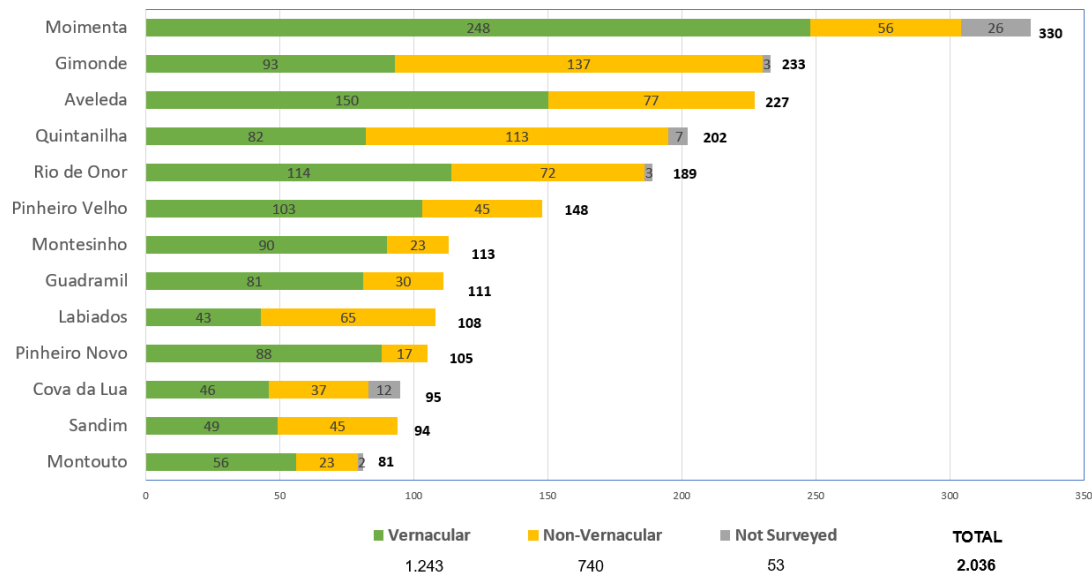


Figure 2: Number of buildings surveyed and number of buildings that still preserve vernacular characteristics, even with alterations.

The field surveys allowed to map the results, locating the remaining vernacular buildings in the villages. As an example, Figure 3 shows as an example the results from the village of Aveleda. The maps show the amount and location of the surviving vernacular examples and those that are preserved without interventions. In most villages, the amount of such buildings is low, rarely exceeding 20%. Indeed, in some villages, there are no vernacular constructions in their original state, i.e. with no alterations.

Moreover, many surviving examples that still preserve the vernacular construction systems are not inhabited, which confirms the vulnerability of the vernacular constructions and their high risk of obsolescence. An analysis of the percentage of abandoned buildings correlated with the analysis of the buildings without interventions shows a clear tendency for the most abandoned villages to be the ones with fewer alterations (Figure 4).



Figure 3: Maps showing the number of vernacular buildings in Aveleda (left) and the number of vernacular buildings that have not been altered (“vernacular building”)

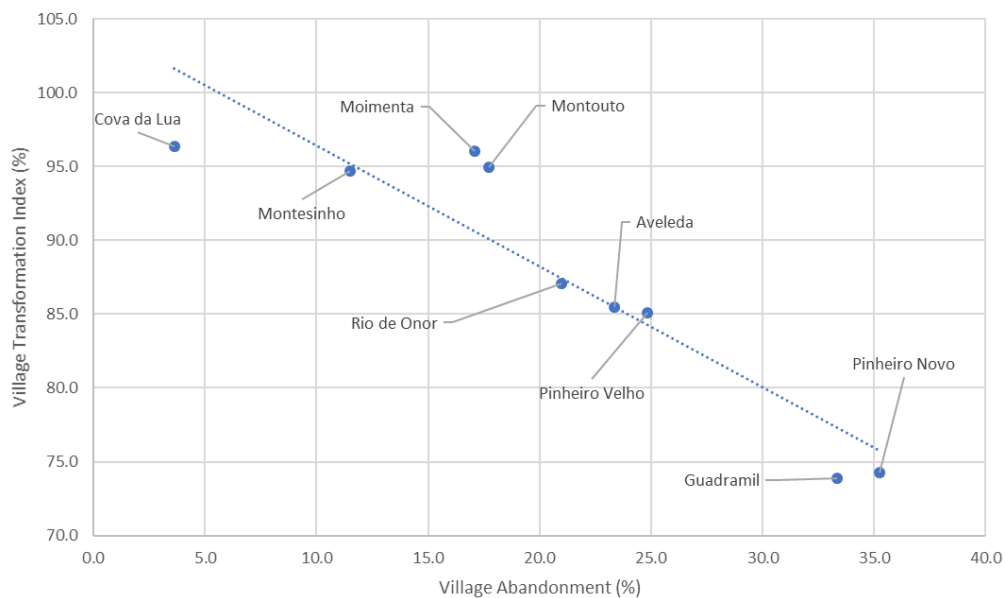


Figure 4: Correlation between the level of transformation (percentage of alterations) and level of abandonment of the villages

4 CONCLUSIONS

The paper has shown the research methodology that has been proposed by the INHAVIT research project to establish a conservation strategy for the vernacular heritage that is eventually able to create a more resilient built environment that is able to attract

and host strong local communities. The proposed methodology is based on the hypothesis that preserving the vernacular heritage can play an active role in mitigating the depopulation process currently ongoing in various Mediterranean countries. Even if the research focuses on the specific case of the villages in the Montesinho Natural Park, the methodology and lessons learned can guide other geographies prone to similar phenomena.

The paper has also presented some preliminary results from the first survey fields carried out. The surveys focused on evaluating the current level of mischaracterization of the villages. Results confirm that there are only a few surviving vernacular examples without alterations. The villages have suffered the usual transformation process of vernacular architecture, whose inhabitants try to adapt to their changing needs. The inhabitants have progressively shifted to modern constructions built with non-local materials, like concrete and steel. Indeed, those villages that are less transformed are also the villages that also have the most significant number of abandoned buildings. The research project will assess the possibility of rehabilitating and retrofitting the vernacular heritage to adapt to the current standards of comfort while ensuring that the heritage values and authenticity are retained over time.

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