



Historical development and environment adaptation of the traditional cave-dwellings in Tajuña's valley, Madrid, Spain



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ABSTRACT

The combination of the diverse environmental and natural characteristics (geography, climate, geology, relief ...) and cultural ones (society, economy, history) has conditioned the constructive traditions, the forms of the dwellings and the function of the vernacular architecture in the valley of Tajuña river, southeast of Madrid. This work analyzes the culture of vernacular underground dwellings in this area through the study of the history and society, and the relationship with the natural and climatic environment. Vernacular architecture answers all these characteristics offering a clever adaptation to human life. Diverse energetic achievement mechanisms make this comfortable habitat possible, as for example, the orientation and ventilation according to relief, the use of local materials or the defense against thermal oscillations. These are bioclimatic strategies inherent to vernacular architecture. As a result of the research, there are several criteria and bases for the preservation and maintenance of this traditional, unknown and under the risk of disappearing heritage.

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1. Introduction

The revision of vernacular, traditional or popular architecture from the point of view of architectural sustainability and in relation with the environment—both human and natural, mainly climatic—restores to its full value the lifestyle that gave sense to this architecture and that has now become obsolete [1]. Interesting teachings about the social and economic adaptation can be understood thanks to this enhancement [2], and also the environmental adaptation needed for the sake of responsible and effective architectural sustainability. These teachings are the base to define the criteria for long-place preservation and maintenance, as well as to adapt them to new technical and functional requirements.

The study of the constructive logic of any traditional architecture—in this case, the underground dwellings in the southeast of Madrid—helps to complete the functional and formal knowledge of these architectures. In this respect, inter-disciplinary review of

vernacular or traditional architecture from the point of view of sustainability and energy efficiency has given interesting results. Several research groups are proposing the study of vernacular architecture beyond the traditional approaches: anthropological, typological, geographical, constructive and even folkloric and traditionalist. However, the first researchers of the Spanish traditional architecture had already observed the right adaptation to nature of this architecture: «the study of the natural environment and the human environment is critical because the popular dwelling ... has imprinted the sign of the geographical environment and the human factor: it does not only depend on the heritage or the environment, but both at once» [3]. García Mercadal urged us to «see in these [underground] dwellings more than ancestral survival, based on a state of misery, but a successful adaptation to geographical environment. Due to their orientation and arrangement, they allow more sunlight and ventilation than in most of the village houses amongst streets» [4]. Despite such statements, the interest of researchers from the Spanish traditional architecture derived from a historical and functional point of view to a housing concern once the Spanish Civil War (1936–1939) ended. After the fratricidal confrontation, it was necessary to rebuild the war-torn regions. The scarcity of building materials made builders look back to traditional construction, whose analysis concerned issues of public health [5].

Despite the proximity to the city of Madrid, where there also were cave houses in neighborhoods in use until the 1980's, the settlements in Lower Tajuña valley have not been studied as one

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would have expected. Rather, the classic compendium of popular architecture collected some examples, but dealt with this architectural type, in some cases, in a superficial way. García Mercadal offers a general vision of the cave-dwelling in Spain. In Madrid, he only cites the caves of Perales de Tajuña [4]. Torres Balbás also only notes the caves of Perales when he speaks about the “rudimentary housing” and the inhabited caves [3]. Among the various articles that Gonzalo de Cárdenas y Rodríguez wrote in the journal *Reconstrucción* about Spanish popular architecture, there is one dedicated to the caves. This article is the first monographic study of the caves. The text is accompanied by layouts of the caves [5]. The importance of this article is that it is written in a time when this dwelling type had revived –«type of current housing, which has not only survived, but continues to be built in our days» – due to the socio-economic circumstances of the Spanish post-war. The author documents several caves to illustrate the article. Gonzalo de Cárdenas invites the reader of the article to «turn our eyes to those houses which are one of the most characteristic examples of our popular architecture» as opposed to the marginal treatment done by other scholars, architects and administrations [5]. In 1947, Demetrio Ramos performs a comprehensive study about the geography of Lower Tajuña region, dedicating special attention to the caves. After describing and analyzing the physical and geographical environment, Ramos studies the human geography of its inhabitants, dedicating an important extension to the house and, in particular, to the cave housing. This study is particularly important because the author has accounted for the caves and places in relationship with their neighborhoods. This study was published at the peak time of underground dwelling. The author also makes a formal and constructive analysis of several types of caves establishing a denomination [6]. In the seventies, two great compendiums about Spanish popular architecture were published. However, Luis Feduchi only slightly speaks about the caves in Fuentidueña and Estremera de Tajo [7], while Carlos Flores does not cite Madrid’s caves and he only focuses on underground housing of La Mancha when he discusses the architecture of the Southern Plateau [8]. Pablo Navajas does not deeply deal with the subject of cave houses in his book on vernacular architecture in the territory of Madrid, but nevertheless, he presents a very interesting bioclimatic architectural and urban analysis of the various geographic units of the territory Madrid [9]. The article of M^a Dolores Sandoval León and Luisa Bartolomé Tejedor [10] continues the method and summarizes the article of Ramos [6] updating data. Their aim is «to show the precarious situation and critical habitat of caves on the banks of Tajuña river, as well as offering an updated first-hand material to help understanding better this type of housing» [10]. This article is very important because, in addition to dealing briefly with typological and constructive aspects, it provides data collected on site through interviews with local authorities and inhabitants of the caves. This data is a census of caves that can be compared to previous inventories to show the accelerated abandonment of cave dwelling. However, the article only speaks about the towns directly irrigated by Tajuña river: Carabaña, Morata de Tajuña, Perales de Tajuña, Tielmes and Titulcia, plus Fuentidueña de Tajo. Therefore, the article does not deal with the towns of Valdaracete, Valdela-guna, Chinchón, Valdilecha, Brea de Tajo, Estremera, Villamanrique de Tajo or Ciempozuelos in which also excavated architecture has been traditionally developed. In addition to these studies, the cave houses of southeast Madrid are also covered by other authors, such as Maldonado Ramos [11], Martín García [12] and Rodríguez Ariza [13]. Finally, the encyclopedic work about architecture and urban development in the Region of Madrid [14] analyzes the architecture and urban development along the history of each of the municipalities studied, dealing with cave housing types. In conclusion, these publications have studied the phenomenon of cave houses

from the traditional view point of architectural typology, history, culture, and ethnography. However, they have not catalogued completely the underground dwellings. This deficiency has been corrected in this full investigation from which this article is extracted. Two advances have been published: one at the national level [15], and other dealing at a regional level [16].

Moreover, in the last two decades, numerous international studies in the field of analysis of materials and construction systems of traditional architecture and its influence on energy behavior have been published as complementary to the formal point of view on vernacular architecture and bioclimatic perspective in desert [17] or tropical [18] climates and also in several countries or regions in Japan [19], Turkey [20], Oman [21], China [22–24], Italy [25], Greece [26], India [27,28]. Some of them have completed the analysis with simulations and experimental works: ancient vernacular architecture [29], Kerala [30], Turkey [31], China [32], Vietnam [33], Greece [34], Italy [35] or India [36,37]. In Spain, this type of studies concerning energy behaviour have been limited, in most cases, to industrial buildings, such as the analysis of traditional wine cellar caves [38,39] or the Galician traditional agricultural dry storage structure named “hórreo” [40,41]. In relation to residential building, in 2004, Cañas & Martín published a study on the characteristic elements of Spanish vernacular architecture that contribute to the bioclimatic suitability of buildings, and the most common strategies for adapting such constructions to the climate based on the study of classical documental sources [1]. However, the largest Spanish vernacular architecture bioclimatic analysis is collected in the book *Habitar sostenible—Living sustainably*—in which a cave house situated in Morata de Tajuña is analyzed [42]. In addition, this research article abstracted from the work developed by the authors, aims to provide a critical overview of the studies published to date on Madrid underground architecture, completing the knowledge of its typology, constructive and bioclimatic characteristics. The study also includes the conservation state of these constructions, allowing to point at their risk of disappearance, while raising a number of criteria to promote sustainable conservation of this heritage.

The research method has combined the documentary work with field work. Documentary works consisted on the collection of previous documentation and the study of traditional building techniques, as well as the geographical cataloguing and territorial analysis, both natural and historical, as well as socioeconomic. With the support of the field work and the collected documentation in standard cards, authors have made drawings and surveys necessary for the analysis, as well as the graphic interpretation of the construction processes of the selected buildings. Finally, once typological and constructive aspects were understood, a bioclimatic analysis has been performed through the mechanisms of energy use of the elements of the underground vernacular architecture in Tajuña Valley. This bioclimatic analysis includes the systematic study of the mechanisms of vernacular architecture that, in the study case, are mainly the location of the cave houses, their correct orientation, ventilation and the use of the thermal inertia of the ground. Then, through the hygrothermal chart of Givoni (1969) energy requirements for indoor environments of this geographical region have been considered. The study is based on the analysis of thirty case studies documented in 14 villages in which underground dwellings in the southeast of the Region of Madrid are located.

2. Territory, architecture and energy of the cave-house

2.1. Geographical catalogue of the Spanish underground architecture

Cave houses and underground dwelling are two different architectural types (Fig. 1). The first one is formed by the cave

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