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Climate-responsive strategies of vernacular architecture in Albania and Portugal

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ABSTRACT: The influence of climate on vernacular architecture is widely recognised. In the case of the Mediterranean Sea, its influence on climate ranges a wide variety of territories and cultures. Therefore, it is relevant to study how the climatic factor has modelled vernacular architecture in those territories and if there are common features. In this exploratory study are qualitatively compared the climate-responsive strategies of vernacular architecture from two countries located on opposite sides of the Mediterranean basin, namely, Portugal and Albania. The pragmatism of these strategies, developed on the need of adaptation to a specific climate and territory, may contribute to reduce energy consumption and waste. The study allowed showing points of similarity between strategies used in the two countries and, understanding how these strategies influence indoor comfort conditions. The results of the study can be used to develop and integrate these strategies in the current construction context, contributing to its sustainability.

1 INTRODUCTION

The climate is undoubtedly one of the geographical constraints with more influence on buildings, at several levels. In this scope, vernacular architectural is a good example on the diversity of strategies to overcome climatic constraints, as synthesised by Supic (1982). To suit climatic conditions, vernacular architecture developed specific mitigation/adaptation strategies. In this type of architecture, closely related to local conditions, it is possible to see that architectural form and climate-responsive strategies vary from region to region. Nevertheless, it is also possible to see similarities between vernacular buildings from distant origins. In several cases, these similarities are in vernacular buildings from regions with the same type of climate.

The case of the Mediterranean basin is an interesting subject since it is a wide area with a large variety of territories and cultures under the influence of the same climate. Therefore, it is relevant to study how the climatic factor has modelled vernacular architecture in those territories and if there are common features. Therefore, conceived in a low-tech context, vernacular architecture developed ingenious passive strategies to mitigate the effects of climate and assure the best comfort conditions possible. In a recent past, as a result of standardisation of buildings, vernacular knowledge was forgotten and mechanical active systems started to be routinely installed and operated, even if not necessary (Healy, 2008). Moreover, the use of these systems led to a condition of thermal monotony that was delineated and maintained based on norms of thermal comfort that configure standardized and homogenous “comfort zones”, that are now contested due to its energy-intensity (Healy 2008). Relying on these systems, the

majority of modern buildings does not show any particular concern about the relation with the surrounding environment, which is reflected in more energy consumption and consequent environmental impacts. Therefore, there is a need to learn and import climate-specific know-how from vernacular passive building technologies into our contemporary climatic responsive building practice.

Thus, the study of climate-responsive vernacular strategies is important nowadays to understand how they can contribute both to minimize energy consumption and guarantee thermal comfort and which are the common strategies for the same type of climate. In this context, several studies conducted in territories under the Mediterranean climate have revealed the good thermal performance of these vernacular buildings (Fernandes and Silva, 2007, Martín *et al.*, 2010, Cardinale *et al.*, 2013, Philokyprou *et al.*, 2017). So, there is potential to integrate this kind of strategies in contemporary passive building design.

In this sense, this paper presents an exploratory study where are qualitatively compared the climate-responsive strategies of vernacular architecture, and how these strategies are perceived to influence indoor comfort, from two Mediterranean countries distant from each other, namely, Portugal and Albania.

2 METHODOLOGY

In this exploratory study, is applied a qualitative analysis and comparison on the climate-responsive strategies used in Mediterranean vernacular architecture from Albania and Portugal. The application was on cases/examples from southern part of Portugal and the central part of Albania, both in urban and rural dwellings. The aim is to understand points of similarity and difference between the strategies used in both countries. The results will allow to comprehensively understand if there is a correlation between the type of climate and the strategies used in vernacular architecture.

3 CHARACTERIZATION OF THE MEDITERRANEAN CLIMATE IN SOUTHERN PORTUGAL AND CENTRAL ALBANIA

The Mediterranean climate is a type of temperate climate mainly from the regions in the Mediterranean Basin, but it also can be found in other parts of the world. In the case of Albania and Portugal, they have a temperate climate – Type C, according to Köppen-Geiger climate classification (AEMET and IM, 2011, Climate-Data, 2017, WeatherOnline, 2017), and in this paper the focus is in the regions with a climate sub-type Csa (temperate with hot and dry summer) (Fig. 1).

In the case of Albania, the territory is divided in the coastal lowlands, in the west part, and the highlands especially in the east, north and south part. The Riviera coastal part has a typically Mediterranean climate and from north to south temperature decreases around 5°C. In the coldest month daily temperature varies between 18°C and -3°C and in the warmest month temperature is above 22°C. The annual average rainfall is around 1000-1500 mm in lowlands and about 1800-2550 mm in some northern areas (WeatherOnline, 2017).

In Portugal, the mainland territory is divided into two sub-types of climate: i) most of the northern part and west coast have a climate sub-type Csb (rainy winters and dry or temperate summer sub-type); ii) the southern part has a climate sub-type Csa (temperate with hot and dry summer). In the southern part, summer is the harsh season. The mean values for maximum air temperature vary between 32-25°C, reaching sometimes maximum temperatures of 40°C or 45°C, being July and August the hottest months (AEMET and IM, 2011). The annual average rainfall is below 500mm, being July the driest month (below 5mm) (AEMET and IM, 2011).

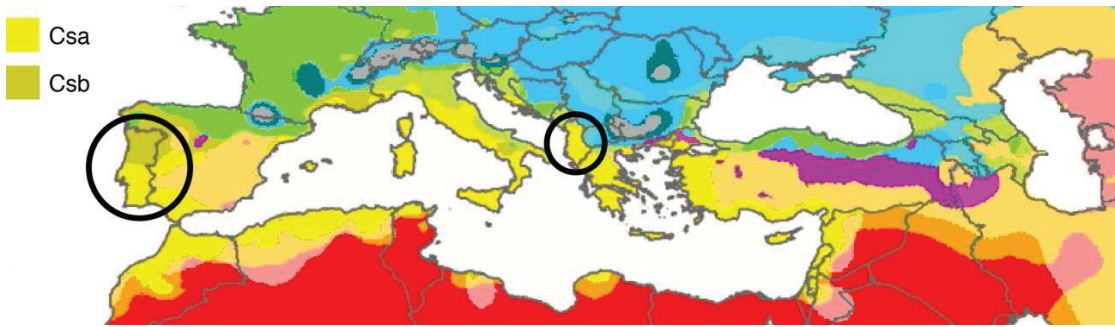


Figure 1. Portugal and Albania climate map (adapted from (Peel *et al.*, 2007)).

4 VERNACULAR CLIMATE-RESPONSIVE STRATEGIES

In the past, when energy was not readily available and active systems did not exist, builders had to experiment and develop passive ingenious systems that optimize indoor comfort and respond to particular human needs and climatic conditions through the available resources (Turan, 1990, Oliver, 1998, Fernandes and Mateus, 2012, Jones and Nichols, 2012). In this section are presented and compared climate-responsive vernacular strategies used in both countries with the same purpose. The use of *patios*, vegetation, heavy mass walls and light colours, are common passive strategies. Some of these strategies are discussed below.

4.1 Urban layout and buildings orientation

The use of a compact urban layout is common in regions with hot summer periods (Fig. 2). This layout is more adequate than modern orthogonal and wide grid street planning, since the compact urban fabric provides more shade between buildings. Thus, it minimises heat gains in summer and reduces internal heat losses in winter. At street level, narrow streets and covered galleries provide shade and protect pedestrians from harsh summer periods (Fig. 3) (Koch-Nielsen, 2002). In the case of the narrow streets, they function as "urban-patios", storing cool air during the night and allowing that during the morning the walls and pavements of these streets remain colder than ambient air (Fernandes, Mateus, *et al.*, 2015).

Regarding sun exposure and orientation, buildings seek the south quadrant to maximize solar gains in winter and to reduce them during summer. The façades facing the south-quadrant facing façades are the most common to receive less radiation during summer and more in winter. At the same time, east and west facing façades have less area exposed to minimise direct heat gains, and the rear façade (without or only with a few openings) is oriented to the prevailing winds.



Figure 2. Compact urban layout. (left) Évora, Portugal; (right) Tirana, Albania.



Figure 3. (left) Narrow street,(center) covered gallery (urban), Portugal; (right) covered gallery (building of MuzeuEtnografik, Kavaje), Albania.

4.2 *Patios, waterand vegetation*

At the scale of buildings, due to their advantages the use of *patios* and vegetation is frequent.

In what the *patios* concerned, these are a passive cooling strategy that is intrinsically related to the presence of Roman and Arab cultures in both countries. This feature allows minimising sun-exposed surfaces, maximising shade and ventilation and also natural light and ventilation for indoor spaces. The presence of vegetation and water elements is frequent (Fig. 4). Their presence has a positive influence on the microclimate around buildings. An experiment conducted in southern Portugal during summer showed that air temperature in the *patio* always remained lower than those recorded for the city centre, with a maximum difference of around 9°C during daytime (Fernandes, Mateus, *et al.*, 2015). This is due to the effect of evapotranspiration and shade from plants and evaporative cooling of water. The use of vegetation is useful to provide shade and to increase air moisture via evapotranspiration process, helping to cool the air streams before entering the building. Since a green ground absorbs only 10% of radiation, it also allows reducing the heat island effect (Koch-Nielsen, 2002). The presence of water elements, as fountains or wells, serve to cool the air by evaporation (evaporative cooling).



Figure 4. Patios containing vegetation and water elements. (left) Portugal; (right) Albania.

4.3 *Natural ventilation and shading*

The promotion of natural ventilation for overnight cooling is an important passive strategy in a hot climate. It was possible to found several ways to foster natural ventilation that were integrated into windows and doors or in walls. Taking advantage of night cooler air, the promotion of air circulation inside the building by stack effect allows removing diurnal thermal loads and increasing thermal comfort. The ventilation openings that use grids allow simultaneously ventilation and shading from intense light and radiation without compromising

privacy and security (Fernandes *et al.*, 2014). The use of wood in window frames and shutter works as thermal insulation, retarding undesirable heat gains by these building elements (Fig. 5). In some cases, originally window systems functioned without glass.

The use of vegetation as shading as multiple applications, not only shading the ground but also applied as pergolas and as a shading screens for façades (Fig. 6).



Figure 5. Shutters and ventilation grids. (left) Portugal; (right) Albania.



Figure 6. Use of vegetation for shading. (left, center) Portugal; (right) Albania.

4.4 Building envelope, materials and colours

The building's envelope is the shell and the major area of contact to outer environment. Thus, its thermal performance has great influence on indoor environment. In a climate with hot summers, the envelope has to deal with intense solar radiation and mitigate its effects on indoor comfort. Some mitigation strategies pass by: i) reducing the size of windows-openings, retreating them into the façade to get more shade (Fig. 7); ii) the use of light colours; iii) and heavy thermal mass materials to dampen the heat flux.

The type of colour that is used on façades has influence on indoor temperature (Givoni, 1994). The traditional whitewashed surfaces (facades, terraces and floors) (Fig. 8) are an important element to mitigate solar radiation, allowing a reflectance of about 90% of all the radiation received (Koch-Nielsen, 2002).



Figure 7. Small openings. (left; center) Portugal; (right) Albania.



Figure 8. Use of light colours. (left) Portugal; (right) Albania).

Regarding materials, the main building materials in the regions under analysis are rammed earth and adobe blocks. The greatest number of adobe constructions in Albania belong to the Ottoman period. Its implementation is present especially in the center part of Albania, both in urban and rural dwellings. These buildings are scattered in Tirana, Elbasan, Kavaja, Peqin, Lushnje, etc. A small presence can be found also in Kucove, Peshkopi. In Portugal, the southern part of the country is dominated by the presence of rammed-earth buildings.

The high mass that characterizes this type of building systems allows them to respond appropriately to the summer heat, stabilizing indoor temperature and moisture, as shown by several studies (Martín *et al.*, 2010, Fernandes, Pimenta, *et al.*, 2015). In the case of Portugal, the envelope and internal partitions have a heavy thermal inertia (e.g., thick rammed earth walls, vaulted ceilings) (Fig. 9). During the day, the building systems accumulate heat and delay the heat flux, allowing that the indoor temperature remain cooler than outside. During the night, they release the accumulated heat, both indoors and outdoors, being necessary to remove internal loads promoting overnight ventilation cooling. The hygroscopic inertia of these building systems have the capacity to regulate air humidity (Berge, 2009), i.e., absorbing when moisture is excessive and releasing it when the air is too dry. Thus, it is possible to stabilize moisture by passive means within 40-60% —the most appropriate range for human health and comfort (Morton, 2008), as shown by Fernandes *et al.* (2015). The plaster used in these buildings are mainly made of lime or mud whitewashed. Another advantage of using these materials is that they have low embodied energy and can be easily recycled (Fernandes *et al.*, 2013, 2014). In the case of the adobe buildings in Albania, but similar for Portugal, the foundations for the walls are made of river stones (Fig. 9), up to the main entrance level, usually 10 or 20 cm up to the sidewalks or the court level, in order to protect the walls from the rain water and to not let also the water from outside to enter inside (Muka, 2001, 2007).



Figure 9. Heavy mass materials. (left) rammed-earth wall, Portugal; (center) Vaulted ceiling, Portugal; (right) stone foundation for adobe wall, Albania (image source (Muka, 2007)).

5 CONCLUSIONS

Despite the distance between Portugal and Albania, it was possible to find commonalities regarding passive vernacular strategies used in both countries. They are mainly due to the influence of Mediterranean climate, but it also can be affirmed that there is a common influence from Roman and Arab cultures. The strategies used in the two regions show similarities. From the examples presented in this paper, these strategies are more oriented to a passive cooling purpose, where a climate with hot dry summers is not a coincidence.

Taking into consideration previous studies on the thermal performance of vernacular architecture within the Mediterranean climate, the strategies presented in this paper are effective in achieving indoor comfort conditions by passive means alone. Thus, this indicates that they still are effective nowadays. The challenge now is to adapt them to new contemporary buildings and, at the same time, comply to current buildings' thermal legislation. Nevertheless, with the optimisation of these strategies it will be possible to reduce waste and energy consumption for acclimatisation. The simplicity and pragmatism that characterise these passive strategies can contribute to reduce the dependence on mechanical system to achieve comfort conditions and thus on fossil energy. So, there is a need that construction professionals relearn from low-tech and low-energy vernacular passive strategies. However, an integration between tradition and contemporaneity, using the best of both in technologies and materials, must be sought. It is up to designers to use their creativity to improve and adapt these techniques to new functional building requirements.

Therefore, this is an on-going research work and further research work is needed to understand the feasibility and adaptation to modern buildings, namely, systematised quantitative studies and surveys. More detailed and comprehensive data on vernacular strategies would be useful to develop guides on climate-responsive and energy-efficient buildings.

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REHAB 2017 - 3rd International Conference on Preservation, Maintenance and Rehabilitation of Historical Buildings and Structures aims to proceed with the discussion on built heritage and the preservation of its legacy, that was established in the previous editions of the event. The importance of conservation of historical constructions (built landscape, urban fabrics, buildings, and engineering works) are of utmost importance to preserve the cultural references of a community and was deeply discussed in March 2014, in Tomar, and July 2015, in Porto.

Under the main topics of discussion, subjects of preservation and rehabilitation methodologies and technologies, as well as the importance of the economic and social impacts of preservation practices are here covered as the main leading guidelines for the conference debate.

Furthermore, different communities' scales (local, regional, national or even worldwide) and authenticity interpretation raise different questions and approaches, and therefore different solutions that are worthy to study, to compare and to experience.

The sustainability approach is again covered, highlighting the importance of the commitment between heritage preservation and technical requirements related to its occupancy and use, such as energy efficiency or materials recovery.

Inclusivity is also an important aspect to be discussed as public historic sites and buildings need to be adapted to receive different kind of visitors (children, elderly or handicapped persons) and to establish an adequacy with the perceiving of the physical environment and information contents.

As a Special Chapter, Earthen Buildings are brought into a particular approach highlighting the complexity of their preservation, maintenance and rehabilitation. Earthen buildings techniques are in many cases of a great importance for local economies and access to housing.

The Editors