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At the roots of sustainability: Mediterranean vernacular architecture

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Abstract

As numerous examples show, bioclimatic architecture is an historical, ancestral design practice. The whole history of architecture is marked by the search for living comfort resulting from the link with the land and the correct use of natural resources. In vernacular architecture, we also find this 'holistic' conception of living in which design choices (compositional, constructive, material, and technological) are deeply connected to climatic and functional issues. However, until now, studies on these typologies have usually focused more on formal aspects, leaving out sustainability ones. The spontaneous constructions of the Mediterranean area – the Sicilian dammusi, the trulli of Val d'Itria, the Sassi of Matera, the Scirocco rooms in Sicily or the houses on the Amalfi coast – are sincere, rational, and logical, and have always sought living comfort through energy and economic efficiency, even without pre-established rules or standards. For example, the absence of wood and clay, the abundance of limestone and sand, led to design the Amalfi Coast dwellings essentially of stone, abandoning tiles, bricks, and wooden floors. The structure without sharp corners results from the limestone which was not tender enough to allow a good squaring. The dammusi were built with the same stones used to reclaim the land to form the terraces on which they stood. Their domed roofs were made of stone covered with a layer of earth and a mixture of volcanic pumice as insulation, and a layer of red tuff and milk of lime as waterproofing. The paper aims to investigate these peculiar vernacular typologies to trace the remote origins of sustainability in their morphological and technological characters. This study could also trigger a reflection on strategies for the contemporary design of sustainable architecture inspired by the tradition of these climatic regions.

Keywords: *Mediterranean architecture, sustainability, vernacular buildings.*

1. Introduction

Today's interest in sustainable architecture began in the 1970s, when the oil crisis and rising energy costs posed the great challenge of sustainable design, combining energy saving, health and living comfort. As numerous examples show, bioclimatic architecture is an historical, ancestral design practice. In fact, the whole history of architecture is marked by the search for living comfort resulting from the link with the land and the correct use of natural resources. In the Italian vernacular architecture, we also find this 'holistic' conception of living, in which design choices (compositional, constructive, material and technological) are deeply connected to climatic and functional issues.

In fact, since ancient times Mediterranean architecture has been an effective example of bioclimatic construction where the use of local materials - exploited for their physical and mechanical characteristics such as permeability, porosity, resistance, thermal inertia, etc. - led to an initial inevitable reduction in energy waste. The anonymous designers of vernacular Mediterranean architecture tried to contrast the summer heat and achieve thermal comfort, always acting with deep respect for nature and the landscape. These spon-

taneous constructions adapted to the geomorphology with compact and elementary volumes, employing local materials and techniques and promoting the correct use of natural resources such as water and wind.
The sassi of Matera, the trulli of Puglia, the Sicilian dammusi and scirocco chambers, as well as the houses of the Amalfi coast, have been built and modified for centuries, following only a few rules based on vital needs and regardless of pure aesthetic research (Niglio, 2007). Thus, Mediterranean vernacular architecture represents the archetype of a primordial sustainability resulting from the deep complicity between nature and man (Moretti & Bori, 2005).

2. Sustainability, structure and form

Traditional southern Italian dwellings, despite their specific constructional and formal features, are always a response to climatic conditions such as the need for shade, lighting, thermal insulation and ventilation. These constructions generally fit into their environmental contexts, adapting to the territory without altering its harmony and image. In hypogean structures, such as the Sassi of Matera or the Scirocco chambers, protection from summer radiation and the maintenance of an optimal temperature were obtained by exploiting the depth.

Fig. 1. The Sassi of Matera

The famous Sassi of Matera, included in the UNESCO World Heritage List in 1993, have their origins in the Paleolithic period. They were articulated structures dug into the soft tuff, grouped in a real urban settlement on several levels. The bioclimatic performance of these caves dwellings resulted from the thermal inertia of the rock mass and the almost total absence of external openings except for the entrance. During the winter, the sun's rays penetrated right through to the bottom of the cavity, thanks also to its inclination, which prevented the summer sun from reaching the interior (Giuda, Pagliuca & Rospi, 2008).

A similar structure characterised the chambers of the Scirocco, dug underground beneath or near the villas in Palermo and the surrounding area. These hypogean rooms, with a square or circular floor plan and vaulted roof, became widespread from the 16th century onwards as a shelter from the hot African wind. Their construction was encouraged by the geological nature of the subsoil, made up of calcarenite, a very resistant but soft rock that was easy to excavate, with good thermal and acoustic insulation: characteristics that have also made it an excellent building material (Todaro, 2002). Most of the rooms date back to the 18th century, the period of the 'great holiday', when many families from Palermo left their urban houses to move to the countryside and take advantage of the coolness offered by these large caves (Di Cristofalo et al., 1989; Firrone, 2014).

Fig. 2. A chamber of the Scirocco in Palermo

But the search for thermal comfort through passive cooling was not a prerogative of hypogean structures. In the so-called 'additive' architecture, such as trulli, Amalfitan houses or dammusi, it was expressed through the use of compact forms, thick walls, and extrados roofs able to take advantage of the sun's radiation but at the same time protect against excessive radiation[1].

[1] Sometimes, however, as in the case of dwellings on the Amalfi coast, where there was the possibility of finding wooden beams to build terraced roofs, the vaults were missing. Cfr. Niglio, 2004.


Fig. 3. The Amalfitan house by Camillo Jona (1923)

The Apulian trulli, rustic architectures originally circular in shape and initially used as agricultural storage buildings, spread from the middle of the 16th century and were gradually transformed into permanent or seasonal dwellings (Bertaux, 1899). Their name comes from their peculiar dome-shaped roof (from the Greek 'trôullos'). The arid hills covered with a layer of limestone - which crumbled in layers of varying thickness to form smooth, parallel slabs - were certainly at the origin of the type developed by the Apulian farmer (Bertacchi, 1940).


Fig. 4. The Apulian trulli

The dry stone used to build them gave the structure static resistance and made it similar to a hypogean structure in terms of bioclimatic characteristics. The high thickness of the masonry and the materials used, apart from the permeability of the walls caused by the presence of micro gaps, guaranteed strong thermal inertia, acting as a thermal regulator of the internal microclimate. The advantageous bioclimatic qualities were also made possible by the conical shape of the roof, made of rings of overlapping and projecting limestone ashlars. The inclination of these slabs served to reflect oblique summer sunlight while allowing the passage of almost horizontal winter ones (Montanaro, 1989). The interiors of the trulli were completely whitewashed with lime milk, obtained from cooking the stones themselves, for hygienic reasons, but also to increase the reflection of sunlight coming through small openings. The heat stored during the day by the masonry masses was released at night through the effect of ventilation (Chiesa, 2019). In the winter months, however, the massive stone envelope facilitated the condensation of humidity inside, making the rooms inhospitable and forcing the inhabitants to open the door during the day to keep the interior dry. In order to overcome this problem, the use of planking with the function of a false ceiling was sometimes introduced to isolate the inhabited environment from the roof and prevent the rising of heat, produced in winter by the chimney, and mitigate the excessive summer radiation (Stefanizzi et al., 2016).

The dammuso, a traditional building on the island of Pantelleria, was very similar to the trullo both in terms of its original use (seasonal and agricultural) and of certain constructive aspects, such as the limited presence of openings, the vaulted roof - from which its name (from the Arabic mdamnes) also derives - and, above all, the large mass of masonry made of local stone assembled 'dry' and whose square shape derived from the cutting of the rock (Valenza, 2015). Thermoregulation was ensured not only by the thickness of the walls, built using the ancient 'casciata' technique but also by the particular shape of the dome with its lowered extrados, made of squared lava stone ashlars (Niglio, 2007). This roof condensed the hot air underneath, allowing temperatures to be kept cooler in the lower part of the house (Valenza, 2015).


Fig. 5. A dammuso in Pantelleria

Even in the traditional houses on the Amalfi coast the considerable thickness of the masonry (0.80-1.00 m) and the presence of planking inserted at the height of the vaulted ceiling contributed to thermal comfort. These dwellings were often built with dolomitic limestone rocks obtained from the excavations carried out to transform the rugged cliffs of the coast into a series of terraces. In some cases, the use of materials of volcanic origins, such as pumice and lapillus, made it possible to achieve the same objectives with smaller sections (Ribera et al., 2020). Moreover, the white lime coverings and the layout of the buildings, with porticoes, patios, pergolas, and gardens, shielded the sun's rays and created shady areas (Chiesa, 2019). Throughout the Mediterranean area, the wise use of traditional materials and construction techniques has allowed for the best possible regulation of heat inputs as well as defining a continuum between landscape and architecture (Butera, 2004; Guida et al. 2008).

3. The use of natural resources

The wise use of natural resources, such as air, water, and greenery, has actively contributed to the sustainability of these vernacular architectures (Moretti & Bori, 2005).

The morphology of the constructions, which includes cavities and domes, was designed to make the best use of the air currents thanks to them. In the Scirocco chambers, the small opening in the vaulted ceiling creates a chimney effect (Todaro, 2002, 80), allowing steam to escape, pushed upwards by the air refreshed by the flow of water through the rooms[2]. In other cases, such as Villa Ambleri Naselli Agliata (1552), one of the oldest examples, ventilation was instead achieved through an external tapered tower and a series of skylights that illuminated the long access corridor (Firrone, 2014).

Fig. 6. The corridor of Villa Ambleri Naselli Agliata in Palermo

The conical section of the roof of the trulli and the hole at the top also promoted thermal comfort, allowing the suction of hot air, which was also enhanced by the presence of a chimney in the centre of the main room (Montanaro, 1989). Sheltered from the north wind, the entrance door faced south and was normally the only opening. But in some cases, there were also small windows placed opposite each other at the top of the dome to catch the sun's rays and create a natural circulation of air.

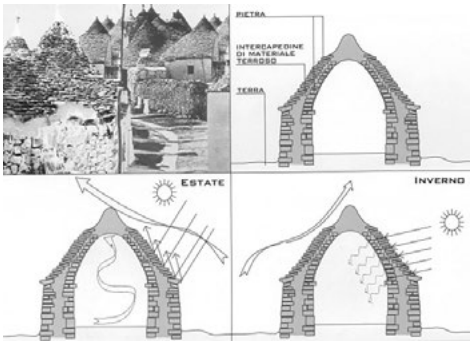

Fig. 7. Natural air circulation in the trullo

The domes of the dammusi also had the same thermal regulating function; in addition, the slits above the lintel of the entrance door caught the summer breeze and allowed the heat accumulated during the day to dissipate at night (Chiesa, 2019).

[2] The air cooling system is based on the phenomenon of evaporation. This suggests that the echo of the wind towers, which were widespread throughout much of the Muslim world, had reached as far as Sicily. The custom of finding refreshment in an underground compartment cooled by qanats (channels through which cool water flowed) is particularly reminiscent of the underground rooms of the dwellings in the historic Iranian city of Yazd.

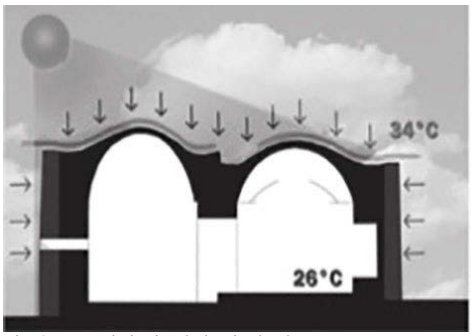

Fig. 8. Natural air circulation in the dammuso

The spontaneous architecture of the Amalfi coast was based on equivalent criteria: domes, vaults and small cracks guaranteed the circulation of air (Guerriero & Fiengo, 2021). But it is the composition of these buildings, leaning against each other and perched on high ground overlooking the sea, that played an important role in their energy efficiency. The urban layout, which followed the orography of the land, and the particular 'cluster' shape, the presence of porticoes, stairs, and terraces, protect the dwellings from the sun's rays and at night allow cold currents to be channeled through the narrow, winding alleys (Ribera et. al. 2020).


Fig. 9. The Amalfitan urban layout

In the case of the Sassi, on the other hand, an attempt was made to overcome the problems of ventilation and humidity control, typical of hypogean environments, thanks to the layout of the caves, dug obliquely into the ground (Correia et al. 2014) and to a simple opening located above the entrance door (Frediani, 2012).

The structures in Matera for the management of water resources (rain and condensation) were very complex and were made even more necessary by the aridity of the area (Guida et al. 2008). Over the years, a new man-made underground network has been added to the one created naturally since the Neolithic (Bernardo & De Pascale, 2016). A real system of rainwater capture and storage was developed, which included large storage tanks (about 2200), the so-called 'palombari'[3], fed by waterproofed and buried pipes. Each house had its cistern into which the water was channelled, previously filtered through jute sacks (Grano, 2020). This testified to the genius of a population that had to deal with the scarcity of this precious and important commodity.

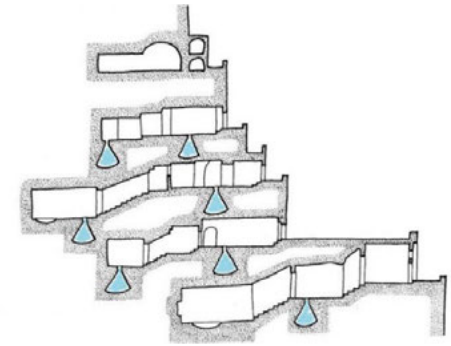
Fig. 10. The structures for the management of water resources in Matera

The inhabitants of the Palermo area, who created a true underground urbanism (Todaro, 2002, 11), also dug wells and conduits to supply water. The Scirocco chambers were built close to a natural or artificial watercourse to intercept the passage of fresh water, which evaporated and helped to refresh the air inside the cave (Firrone, 2014). In the absence of natural aquifers, the water flow was diverted through a network of canals similar to Persian qanats. This is the case in the chamber of Villa Savagnone, where there was even a waterfall. The construction of the trulli was also closely linked to the presence of cisterns, which were built near or underneath the dwellings «to guarantee the supply of wa-

[3] The largest known hand dug cistern is the 'long palombaro', 18 meters high, 50 meters wide, with a capacity of about 5 million Litres of water.

ter... and to increase the humidity of the interior spaces during the driest periods of the year». (AA.VV., 2009, 52). The inhabitants of the island of Lampedusa, on the other hand, preferred to exploit pre-existing cisterns of Punic or Roman origin by building their dammusi in the immediate surroundings (Niglio, 2007). In Apulia as in Sicily, the shape of the roofs themselves and their material composition – conical with stone slabs in the case of trulli, or vaults finished with a waterproofing and insulating layer of ground made of volcanic pumice, red tuff and lime milk in the dammusi – promoted the correct drainage and accumulation of rainfall.This was also the case in the houses on the Amalfi coast, where rainwater was collected for agriculture through channels dug into the extrados vaults (Guerriero & Fiengo, 2021).

The vegetation also contributes to regulating the microclimate of this spontaneous architecture. Pergolas, gardens, and trees, appropriately positioned, provide adequate shielding from the summer sun's rays and, at the same time, allow heat and light to penetrate the rooms during the cold months. Just think of the vine pergolas placed in front of Apulian trulli (Montanaro, 1989).

Fig. 11. Vine pergolas in front of the Apulian trulli

The 'jardinu' of Pantelleria's dammusi, on the other hand, has a different function: spaces next to the residences, defined by a high circular wall with citrus trees inside. The purpose of the enclosure, in this case, was to protect the plants from the island's strong and frequent winds and to create a water reserve. In fact, the shade generated limited the evaporation of the rainwater accumulated in the ground in winter and the condensation at night (Di Cristofalo et al. 1989).

Fig. 12. The 'jardinu' in Pantelleria

4. Conclusions

Man has always sought to create a dwelling in harmony with its context, capable of satisfying both living needs and thermal comfort requirements. This has led to the emergence of what Rudofsky called 'architecture without architects', which «does not go through fashion cycle... is commensurate with human dimensions and human needs, without frills, without the hysteria of the designer» in which the simple reliance on local building materials guaranteed the persistence of construction methods ennobled over time» (Rudofsky, 1964, n.p.).

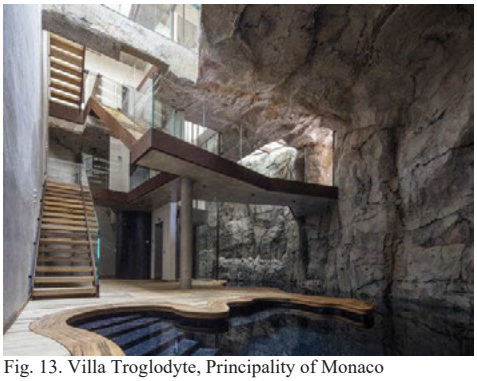

Fig. 13. Villa Troglodyte, Principality of Monaco

Today these spontaneous constructions, resulting from a slow process of evolution and adaptation to the site, are a precious legacy and a model from which to draw inspiration to make contemporary ones more sustainable. Villa Troglodyte in Monaco, designed by Jean-Pierre Lott's Paris studio, for example, is a house set in the rock and inspired by tradition. Its compact volume and the right balance between full and empty volumes create a shell with great thermal inertia which blends into its surroundings. The

use of geothermal energy, photovoltaic panels, and the recovery of rainwater and greywater make this building an example of sustainable design based on the use of natural resources.

The Villa Francesco retirement village in Mottola (Taranto), opened in 2010 and located on a promontory 320 m above sea level, is perhaps one of the most emblematic reinterpretations of the principles of Mediterranean architecture (Lembo & Marino 2012). The orientation of the buildings promotes passive solar heating in the winter, while the pergolas of vines and trees on the southern façade shelter them from excessive sunlight in the summer. The high thermal gradient between the two elevations generates air currents which are also triggered by skylights at the top - their pyramid shape reminiscent of trulli - which act as ventilating chimneys to help the rooms cool down.

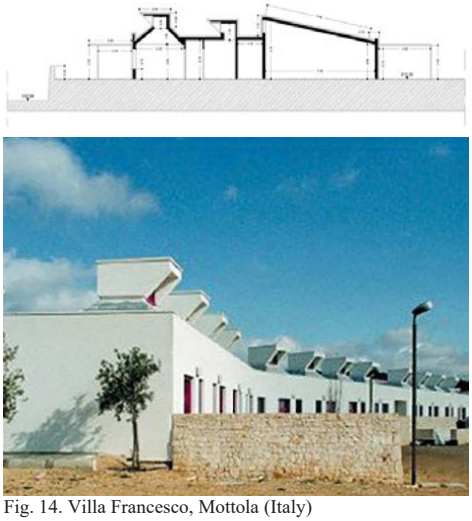

Fig. 14. Villa Francesco, Mottola (Italy)

The sustainable future comes from the past, says Mario Cucinella in a recent lecture in Milan. After talking about the wind towers, he says: «This is the past, I am not nostalgic, nor do I have the idea that the past is always better than the future. I believe that the future will always be better. But I am curious about it» (Cucinella, 2018). And this same curiosity should inspire contemporary architects to look to the past as a source of inspiration.

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