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A look on the intrinsic sustainability of Aeolian vernacular architecture

Rosa Caponetto[1], Giada Giuffrida[2]
Department of Civil Engineering and Architecture, University of Catania, Catania (IT), [1]rosa.caponetto@unict.it; [2]giada.giuffrida@unict.it.

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Abstract
The vernacular architecture of the Aeolian Islands can be seen as the result of a stratification of empirical knowledge, linked to socio-economic, cultural, and environmental needs of local communities. This homogeneous and specific heritage is characterised by a constructive code which is the direct expression of the necessities dictated by the geo-morphological context, the environmental conditions and the availability of local resources. These constraints have strongly influenced the local "modus aedificandi", characterised by an intrinsic sustainability. In particular, adaptation to local orography and climate, and to main wind directions, has promoted the adoption of several bioclimatic strategies (as the use of massive walls and roofs, cross ventilation and shading systems provided by verandas/porches) and of resources reuse (like rainwater collection). The smart use of traditional and locally available natural building materials for the realisation of the main constructive elements is another manifestation of this heritage sustainability. But the arrival of "modernity" (closely linked to industrialisation) has often compromised these aspects, neglecting the concept of continuous maintenance, choosing new, synthetic and (quite often) not compatible materials for recovery interventions, repurposing spaces and substituting and/or altering original uses.This contribution highlights the sustainability of Aeolian architecture and the traditional technical solutions used in this peculiar archipelago composed by volcanic islands. It also reports some "bad practices" introduced in the 60s and 70s to refurbish traditional buildings. Finally,a programmatic and more conscious approach to the recovery of Aeolian architecture, by the use of more compatible and sustainable interventions, is proposed. This choice is fundamental to respect the memory of vernacular heritage in general and, in particular, of Aeolian one, included in the UNESCO World Heritage Site list since 2000.

Keywords: *Aeolian islands; vernacular architecture; sustainability.*

1. Introduction

Vernacular architecture represents the physical and cultural result of the long process of trial and error adopted by local communities to design their life-spaces, in close relationship with the morphologies of places, local available resources, climate conditions, environmental constraints and socio-economic contexts (Oliver, 2006). In a world conscious of globalisation, industrialisation and cultural (and architectural) homogenisation negative outcomes, the vernacular architecture has been interpreted as a huge database (Rashid & Ara, 2015) of environmental, architectural and technological solutions with strong features of sustainability. As a matter of fact, in the last years (Nguyen et al*.,* 2019) vernacular architecture has become a topic which is investigated all over the world at an increasing rate because it is believed to be an important resource from which programmatic and specific principles for contemporary sustainable architecture (Correia et al*.,* 2014) can be derived from. Local building cultures offer a catalogue of solutions which can be addressed in terms of environmental, socio-cultural, and socio-economic sustainability (Dipasquale & Mecca, 2016). As clearly exposed by these authors, environmental

sustainability refers to the ability of vernacular settlements to be integrated in the environments without inducing negative impacts (as changes in the climate or in the landscapes, production of pollution or waste materials) thus benefitting from natural or climatic resources available on site and protecting communities from the risks intrinsically connected to territories. Concerning socio-cultural sustainability, vernacular architecture embodies building cultures as a fundamental aspect of identity, for the entrenched local knowledge and know-how, care of personal and community welfare and social cohesion, reflecting a certain ensemble of intangible values. Finally, concerning socio-economic sustainability, the authors highlight the capacity of vernacular architecture of producing an added value in a certain region to guarantee social welfare, as well as favouring autonomy, promoting local activity and employment and saving resources.

It is interesting to note that transformations can occur over time, especially from a social and economic point of view, leading to an obsolescence of the tangible heritage even more than the intangible one (see, in this regard, the issue of the abandoned villages). In order to avoid the abandonment that could follow obsolescence, it is necessary to intervene by rediscovering tradition, recognising its vocation and potential.

Vernacular building and landscape solutions can be assumed as the ground from which contemporary sustainable architecture can root and derive its methods and techniques, enhancing them through contemporary know-how and technologies, to answer the social and environmental challenges of the 21st century.

Sicilian territories are constellated with vernacular architectures that have intelligently and wisely responded to the characteristics of places and times.

Our research group had previously carried out a study on the constructive characteristics of Aeolian architecture. Technical elements were classified according to the technological system scheme indicated by the Standard UNI 0051, and the durability of the units belonging to the load-bearing structure and to the envelope was investigated. To this end, inspections, photographic and technical-constructive surveys and graphic representations were carried out.

By means of statistical surveys, the presumed average durability of each technological element (traditional or "modern") was assessed, specifying the most recurrent pathologies and indicating the causes that produced them. A representative sample of professionals from the building sector (technical offices, building firms, professionals) was involved in this process.

In the following contribution we propose a reflection on the intrinsic sustainability of Aeolian vernacular architecture, focusing on the peculiarity of the geo-morphological context in which it is built and the resources it make use of. Finally, considerations are made on possible safeguarding strategies of its distinctive features, which were "betrayed" by disrespectful interventions in the 60s and 70s.

2. Sustainability of Aeolian architecture

Aeolian architecture denotes a homogeneous and specific housing style, which is intrinsically linked to local culture. It is characterised by a construction code, which is direct expression of necessities linked to environmental conditions, historical genesis and locally available resources. The geomorphological characteristics of volcanic places, the climatic factors (high degree of solar radiation, minimum temperature range, low amount of rain) and the limited quantity of available economical and material resources have strongly influenced the traditional constructive technology (Todesco, 1995). The archipelago is included in the catalogue of the Intangible Cultural Heritage of Humanity: in 2000, UNESCO placed the Aeolian Archipelago among the 691 sites in the world protected by virtue of their “environmental and/or cultural characteristics” (World Heritage List).

Traditional Aeolian architecture was strongly influenced by the architecture of the sixteenth century of Campania region, which was grafted onto a previously Greek-Roman and Islamic architecture. Before that, the first settlements occurred as far back as the Neolithic age between 5500 and 4000 BC. During the following centuries, the archipelago was populated by Etruscans, Carthaginians, Greeks and Romans, then by Arabs, Normans and Spaniards; nevertheless, most of the current villages were built in the nineteenth century (Todesco, 1995).

The original element of the typical architecture is a single cubic or parallelepiped shaped box, with only one entrance door and two windows, generally round (Caponetto et al*.,* 2003). Inside the house, the kitchenette was located on a side, and the beds on the other. The building had the function to defend the inhabitants from possible external attacks.

Today, it is possible to identify two possible different building types in the Aeolian archipelago: the vertical one (in steep areas) and, most frequently, the horizontal one (in flat areas). Both types are generated using a box - type construction, through the superimposition or combination of cubic elements (rooms), and have similar building characteristics. The other vernacular buildings are a combination of these two types.

Figure 1 shows the combination of cubic elements for the "horizontal type": originally, only a single cubic box and a terrace composed the house. Subsequently, another "box" was put beside the first, in place of the patio. This one rotated and adapted to the needings of everyday life by the use of several functional elements. Typical elements of the traditional building are:

- The *bagghiu*, a large terrace placed at the front of the building.
- The *bisòlo*, small masonry walls which delineate the terrace, at times adorned with colourful majolica tiles.
- The *loggia*, the roof of the terrace, composed by a trellis of wooden beams covered by canes. This element had the important function to create a filter shaded space between indoor and outdoor, protecting the terrace floor from direct solar radiation thus ensuring a reduction of temperature during the warmest summer days.
- The *princu*, a washbasin made of stone that lies on the *pila*, an outdoor tub employed to do the laundry.
- The *furnu*, a domeshaped oven positioned at the side of the terrace, which lies on a base where firewood is stored.
- The *astricu*, the horizontal roof. This element has two important function: as massive element of the envelope, it dampens the effects of the cold winters and the warm summers; as functional roof element, it collects rainwater thanks to the raised edge of the terrace (element which is called *petto di palumba* - dove's breast -), and conveys it to an underground tank.
- The *occhi di ventilazione* (ventilation eyes), located in the upper part of the walls and used to convey outside the heat stored inside the building box during the warm summer days.

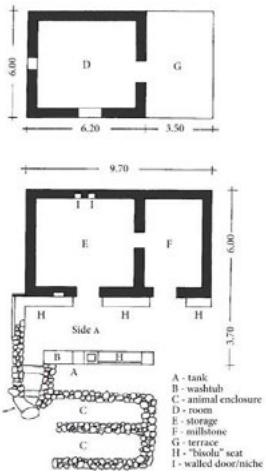

Fig. 1. Example of horizontal type house (Source: Todesco, 1995)

As mentioned above, the typical architecture of Aeolian Islands is strictly linked to the environmental conditions and to the locally available resources. The geomorphological characteristics of the locations and the climatic factors have strongly limited the local *modus aedificandi*. Architectural and technological choices delivered unique places and cultural facts of the Mediterranean area (Sapienza et al., 2021).

Footings are made of lava stone, with lime and pumice mortar. They are very shallow: the height is less than 40 cm for a single-storey house and less than 70 cm for a multi-storey one.

Walls were usually built with shapeless stone (quarried in the islands) and mortar (rich in lime and pumice, a coarse lava lapillus locally called *rupiddu*). Subsequently to the Messina earthquake (1908), rough-hewn stone masonry was used, with horizontal mortar layers (spaced vertically every 70 cm). For the internal walls, either tuff or lava stones were often used. The solid ground floor was made of lime and pumice stone (sometimes with a crawl space).

The traditional intermediate floor was made of timber beams, with a main and a secondary order or unhewn chestnut trunks, on which a canes mat was laid. On the top of the mat, a special conglomerate, composed by volcanic lapilli, lime mortar and fine pumice, was then casted. The *astricu* flat roof was usually 12 -15 cm thick. It was realised similarly to the intermediate floor, by installing beams made with local chestnut trunks, on which was placed a canes mat, a layer of broken stones whose flat side rested on the canes mat and finally, the conglomerate for the screed (realised with volcanic lapilli, lime mortar and fine pumice).

A careful ramming of the surface layer was performed when it was still fresh, to completely saturate the voids and therefore reduce porosity, thus ensuring the water tightness of the terrace.

The *astricu* had the important function to collect the meteoric waters, which were channeled and thus transported into the cistern, generally located under the house, through the drainpipes realised with *terracotta* elements.

The external staircases, connecting the ground floor with the first floor, generally consisted of solid basalt steps laid on a rampant masonry arch; inside, wooden stairs were used for all the floors. The traditional plaster, applied in two layers, was made with a lime-based mortar with very fine lapilli aggregate. Lapilli, used in both plaster and astricu mixtures, were readily available in the volcanic archipelago and reduced capillary water absorption. A lime-based painting was used until the 1970s, to protect plasters and to sanitize walls: indeed lime is known to have caustic properties (it eliminates mould and prevents its reappearance) and hygroscopic behaviour (it allows walls to breathe). As regards the floor, for interior and exterior spaces coloured ceramic tiles (coming from the town of S. Stefano di Camastra, in Messina province) or pressed cement tiles (sometimes decorated with marble flakes) were used. The external floors (for storage spaces and terraces) were often made of lime and pumice. Traditional frames of doors and windows were made of chestnut wood and coloured wih oil paints.

Over time, several factors have influenced and modified the building process. This has led to a progressive technological transformation extraneous to the local culture, which will be discussed in the following paragraph.

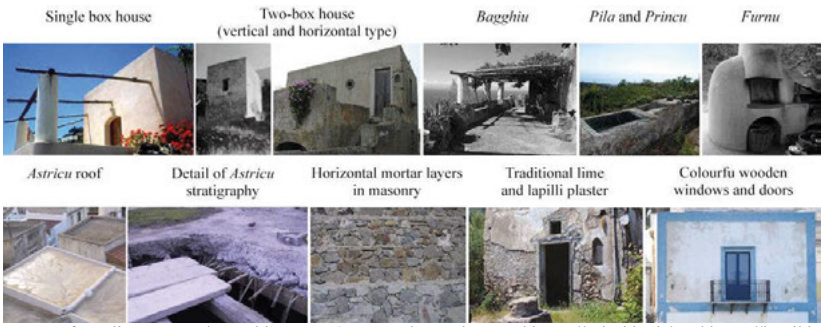

Fig. 2. Elements of Aeolian vernacular architectures (Source: the Authors and https://scirokko.it/ and https://it.wikipedia.org/)

3. The betrayal of modernity

As abovementioned, local building procedures were influenced by various factors: the exhaustion of several natural resources; the closure of stone quarries and the consequent introduction of new (and industrial) building materials imported from Sicily and southern Italy in general; the higher cost of building materials arriving by maritime transport; the low availability of experienced workers; new building procedures considered appropriate for a rapid execution of the work, but not thought for a long-lasting maintenance of the technological units' performances.

All these factors have radically transformed the Aeolian built environment. Building technologies and typological models foreign to the local culture, have sometimes been passively imported, determining a relevant and diffused technological and environmental decay.

For instance, starting from the 1920s, the *pomicemento* blocks (for loadbearing walls and partitions) made of pumice and cement mixtures, were produced in Lipari Island and exported. The *pomicemento* blocks did not resist well to shocks, and they also showed durability issues when left unplastered: in this case the blocks experienced chalking phenomena.

In the 1960s, the reinforced concrete conglomerate (cast in place) was introduced for the realisation of loadbearing frames (with hollow bricks infill) and for hollow block floors. This technology was soon abandoned as concrete reinforcements were severely damaged by the marine environment.

Floors made of lightening bricks (*pignatte*) and reinforced cast concrete were used between the 60s and 70s but were abandoned due to the insufficient expertise of the workers (especially with regard to the execution of the conglomerate casting). Today, this type of floor is being replaced. From 1970 onwards, the floors have been made of prefabricated joists and lightening bricks.

For the exterior surfaces, from 1970s a plaster made of marble powders with a new finishing in lime paste and white cement was used. In the last decades the "Terranova" plaster (a premix plaster composed of lime, a small amount of cement, selected silica and quartz sands, solid inorganic pigments) began to be used, but its high cost hindered its diffusion. Since the mid-1980s and up to the early 1990s, coloured plastic paintings (whose use is absolutely not recommendable from a restauration point of view) were introduced onto the Islands. This type of paintings immediately showed widespread exfoliation linked to their poor breathability, which, together with moisture present in the wall, led to the formation of bubbles that then cracked; its use ceased in the early 90s. Another "modern" plaster used is the *bucciardato*, it is realised in three layers with finishing in cement, lime and marble flakes and it has a better performance (in terms of durability) compared to other new plasters. Nonetheless, this type of plaster is also less breathable and sustainable, both in environmental terms (due to the presence of cement) and in economic terms (due to higher installation costs).

Fig. 3. Examples of inappropriate interventions on vernacular Aeolian architectures (Source: the Authors)

The durability of the *astricu* relies on that of the floor below: if this element undergoes slight deflections, cracks are caused in the waterproofing layer. Cracks can also be caused by thermal excursions. In the past, lime mortar and pumice were periodically (every 1-2 years) injected into the cracks (in dialect, *ciacche*) to carry out the necessary maintenance of the extrados, to avoid water infiltration and damages of the layers. In recent decades, the use of asphaltic and bituminous sheats to waterproof the external surfaces of flat roofs began. Waterproofing sheats have little durability (when not protected by pavings) and they are totally incompatible with the aesthetic properties of traditional buildings: Aeolian houses roofs contribute significantly to characterise the local landscape and should not be transfigured by such visually impactful technologies.

Another solution, recently introduced, for waterproofing roofs, consists of two-component elastic cementitious mortars. This intervention in itself may not be inappropriate, but it is often accompanied by the closure of underground cisterns, which being walled up, do not longer perform the function of collecting rainwater.

Traditional windows and doors realised in chestnut wood, were usually recovered every two years by using paints with waxy products to soften the wood essence. Some of them have been substituted with PVC and aluminium framings which present deformations, due to high temperatures, chromatic alteration, due to solar radiation, and diffuse corrosion due to marine aerosols.

4. A new environmental awareness

In addition to the unappropriated interventions on the historical built heritage of the 60s – 70s, the Aeolian islands have also witnessed a phenomenon of unrestrained urbanisation in the same years, with a proliferation of interventions (at urban, landscape and naturalistic scales) that posed a risk to the environment. Indeed, from the second postwar, the Islands were introduced in a wider circuit of mass tourism, which determined a heavy anthropic pressure on their fragile environmental system, especially in summer seasons. After the inclusion of Aeolian archipelago in the UNESCO Heritage List in 2000, the need to safeguard and sustainably develop the territory became more pressing. For this reason, in 2001 a Landscape Territorial Plan of the Aeolian archipelago was approved (*Piano Territoriale Paesaggistico*, 2001) which led to the imposition of various protection regimes on the territory. In 2007 was designed the management entity of the National Park of the Aeolian Islands (2007), and in 2012 was published The Unesco Aeolian Islands Management Plan (Angelini, 2012). The Management plan offered a program of actions for the knowledge, protection, and valorisation of the heritage, and a plan of action for social, cultural and economic growth, aiming at creating differentiated offers from the territory, and wishing to regulate the tourist flow.

It is important to highlight that there are Islands (as Lipari or Vulcano) that have suffered more than others the advent of modernity. Today, the Islands are under greater observation as the Landscape Territorial plan of the Aeolian archipelago requires all Aeolian municipalities to adopt a suitable urban planning instrument (regulatory plan) before any tranformation activity can be authorised in the area. At a building scale, the possible interventions today are limited to the renovation of existing buildings, without extensions, changes in type or intended use (also in the case of ruins). Residential or tourist activities are considered incompatible if not carried out in existing structures. Buildings and artefacts of architectural, environmental, cultural, historical and testimonial value are subject to building recovery with focus on cultural and productive re-functionalisation.

At a glance, Aeolian Islands are still in an embryonic state of environmental sustainability. It is worth to mention that the recommendations of the Landscape plan found important oppositions from Island's property owners, who perceived

them more as an obstacle to satisfy a general demand for building growth than as an adequate response to the enhancement of the area's specific resources.

In the 2017 Legambiente report it is affirmed that the minor Italian islands are an ideal laboratory for sustainability. The major challenges which must be there addressed regard innovative and economically sustainable solutions on energy and water, on circular economy and sustainable mobility (Legambiente, 2017). Regarding energy, Legambiente report suggests a system based at 100% on the use of renewable resources (as sun, wind, tides, water and earth). Contemporary Islands energy system relies on obsolete and contaminating energy plants, powered by diesel or fuil oil, with supplies arriving via tankers at high costs. Yet, in the Aeolian context, the installation of plants for the production of energy from renewable sources (such as photovoltaic, solar thermal, wind power) seems to be incompatible with the need to preserve the landscape, while the hypothesis of geothermal energy does not seem to be feasible due to the costs and the nature of the soil.

As a matter of fact, an essential objective for changing the energy model on the islands concerns the push to energy efficiency interventions, i.e. those which could reduce the need for electrical and thermal energy, for instance in buildings. These interventions pass through a recovery of historical building techniques (with appropriate processes and materials), attentive to thermal insulation and rainwater recovery, to be integrated with efficient technologies for the energy distribution from renewable sources, even if produced off-shore. Attention to sustainability must start from a recognition of the intrinsic qualities of the built environment, from a focus on reproposing and preserving traditional expedients aimed at limiting resources consumption. A virtuos management model is intended to be achieved for water resources as most of these Islands nowadays rely on barges and desalination plants (Legambiente, 2017). At the same time, reduction of consumptions and recovery of water are not even addressed (whereas they were in the past, as testified by the abovementioned rainwater collection system). Similarly, waste represents an emergency on the Islands: the strategy in this case is the push towards waste sorting, recovery of organic waste for production of compost, which must be accompanied by adequate informative campaigns and collecting protocols (Legambiente, 2017). In fact, these strategies represent a return to a sustainable approach intrinsic in traditional culture: in the past, living on an island meant regimenting the consumption of raw materials and minimising waste, facilitating recycling. Finally, access on the islands to vehicles of non-residents should be limited if not outright banned, especially during the tourist season. This limitation is already present in many Aeolian islands (Legambiente, 2017). Sustainable mobility on islands should also aim to the creation of a public mobility alternative, and to the diffusion of lighter forms of mobility.

5. Conclusions

This work focused on the sustainability of Aeolian vernacular architecture. As all types of vernacular heritage, Aeolian architecture represents the result of a stratification of empirical knowledge, linked to socio-economic, cultural, and environmental needs of local communities. Traditionally, local communities were in charge of maintaining their own traditional constructive processes or system of knowledges.

During the 60s and 70s, Aeolian vernacular architectures have experienced strong and inappropriate modifications, due to the increased housing pressure caused by the advent of mass tourism. This caused a crisis of cultural and constructive knowledges' system, which is fragile and sensitive to social, economic and environmental changes. The effects of globalisation and industrialisation on vernacular architectures have brought to cultural homogenisation and adoption of standardised project solutions which can imply

high resources consumption and inappropriate material choices. The main risks of interventions on vernacular buildings are due to the replacement of existing materials and to the contrast between industrial and craft production.

The adoption of correct management tools, encouraged by the UNESCO, for a wise and sustainable use of local environmental, natural and built resources is a first step towards the safeguard of traditional constructive processes or system of knowledges. These can be seen as key elements for the sustainable development of our built environments as well as expressions of social diversity and sources of practical and technological culture connected to places. The new sustainability must be rooted in tradition, culture and history of the places. The new way of living must, on the one hand, take into account the renewed needs and, on the other, rediscover the sustainability of the *modus aedificandi* and the *modus vivendi* of the past. It is necessary to minimize energy and resources consumptions by reusing waste (both in everyday life and in construction), in a circular economy approach. Today, Aeolian islands live an important transition towards more sustainable forms of living, being energy, water, waste and mobility management the sectors where more control is needed. Due to the connection that vernacular buildings have with these sectors, it is important to define new valorisation strategies which can, at the same time, preserve the identity of the architectures and improve their environmental performances. As regards the cultural built heritage, it is necessary to realise the necessary interventions (as those aiming at decreasing energy needs and improving envelope's performances), thus avoiding the mutation of peculiar characteristics and materiality of these architectures, also by adopting sustainable building materials and compatible processes. A precarious balance between tradition and innovation, fragile and dynamic, which must focus on the preservation of the past through its enhancement in the future.

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