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Proposals for the sustainable recovery of dry stone buildings in Puglia, Italy

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Abstract
Rural architecture in Puglia (south of Italy) is characterized by the mutual relationship between buildings and environment, typical of the spontaneous architecture of the Mediterranean basin. In fact, traditional rural buildings are an example of sustainable development, and their construction features respond to three fundamental issues: climate, building materials and morphology of the territory. Currently, the state of abandonment of the rural areas and the lack of awareness of their heritage have brought about irreparable degradation, followed by interventions incompatible with the identity of the territory. Through the conservation and recovery of sociocultural and environmental identity and the protection of biodiversity, the Puglia Region aims to protect and enhance the architectural and landscape heritage in a sustainable way with the implementation of a regional landscape plan. This study focuses on the small town of Ostuni (Brindisi), in the Apulian area of Murgia dei Trulli, known for its typical dry stone constructions. The different architectural typologies are examined and described, listing the intrinsic bioclimatic peculiarities of their components and specifying the different bioecological actions suitable for any kind of intervention: restoration, recovery, reuse, or even ordinary and extraordinary maintenance. The aim of the project is to develop guidelines for the sustainable recovery of different types of rural buildings in order to suggest minimally invasive technological systems, oriented to the use of renewable energy sources and the maintenance of traditional elements. The proposals aims to respect green building principles, using locally sourced biosustainable materials and finishes belonging to the local construction tradition. But also, merging traditional construction techniques with modern technologies and following the principle of "minimum impact" on the existing constructions.

Keywords: *cultural heritage; biocompatibility; sustainable development.*

1. Introduction

Dry stone buildings are typical of the rural environment of Puglia. They are the result of profound changes which aimed to restore uncultivated fields or to transform unoccupied ones into inhabited areas with areas of agricultural activity between the late 17th and 19th centuries. Since then, with the adoption of long-term management contracts such as sharecropping and emphyteusis, land occupation was not always synonymous with ownership. This meant that farmers and shepherds needed to build structures that could meet their living and working needs, often in dry stone. They used local stone, either stratified limestone or the scattered stones hindering agricultural activities on the ground. The territorial heritage of Apulian rural areas is therefore characterized by different kind of constructions including residential buildings; storage and food product processing buildings; shelters for livestock and farm tools; storage and auxiliary elements (wells, cisterns, water troughs, etc.).

At present, the situation of rural building heritage is two-fold. Firstly, these buildings are in a state of abandonment as they are becoming progressively obsolete and fail to meet modern housing

standards. Secondly, they appeal to new users attracted by the architectural and environmental quality, but often unaware of their historical value. Consequently, recovery interventions have often been incompatible or unsuitable, partly due to the work of technicians with little regard for the preservation of heritage, leading to alterations of the morpho-typological identity of the rural buildings.

At this point in time, when the COVID-19 pandemic has completely altered social and living dynamics, rural areas also represent an opportunity and a resource to mitigate the psychological and physical discomfort resulting from urban lockdown. To users, life in a less polluted environment, far from overcrowded cities, could represent an undeniable benefit which could improve their quality of life. Therefore, interventions on the existing buildings would be needed to adapt rural areas to the new requirements that have arisen. This includes aspects such as the recovery and enhancement of rural heritage, with a view to environmental sustainability.

The Puglia Region, with the adoption of a regional landscape plan (P.P.T.R. – Piano Paesaggistico Territoriale Regionale, D.G.R. 16 February 2015), aims to promote and achieve self-sustainable socioeconomic development through the conservation and recovery of sociocultural and environmental identity, and the protection of biodiversity.

This research aims to implement and establish the guidelines of the plan in order to create a reference tool for all those involved, from specialists to the general public, raising awareness and promoting involvement in the protection of our cultural heritage.

2. Research objectives

This research follows the reflections developed during the lockdown period caused by the COVID-19 pandemic, which forced us to live indoors without access to social spaces or green areas. This situation has inevitably changed our lives, testing both our physical resistance and our mental health. Forced cohabitation in spaces which were often small or unhealthy, not designed for certain daily activities (work, study, sports, socializing, etc.), has revealed the inadequacy of housing and has made it vital to rethink the concept of physical and mental well-being.

Professionals and academics are currently reflecting on the challenges to architecture and urbanism highlighted by the coronavirus pandemic.

The overall picture is complex. On the one hand there is the emerging collective demand for air quality, nature and spaces for social interactions, while on the other it has become increasingly difficult to provide answers for a highly individualized society, where even intermediate organizations are losing relevance (Nigrelli, 2021).

Moving to decentralized rural areas is a potential solution to this post-pandemic challenge. An example of this can be seen in southern Italy, with the phenomenon of *south working* (Magliaro, 2020), where workers and students were able to return to their place of origin. This meant that they could benefit from the possibility of working from home, which grew in popularity immediately after lockdown restrictions first eased. In this respect, rural settings may well offer the answer to the new needs which have arisen, and also provide residents with a chance to improve their quality of life. In fact the region's typical constructions show great potential given their shape, proportions, and relationship with nature, as all these elements can create a suitable atmosphere ensuring both physical and inner well-being (Flore &Venezia, 2020).

However, given the state of abandonment of this rural architectural heritage there is a need for recovery and redevelopment, adapting the existing rural buildings to the new requirements, and preparing for any similar situations in the future.

Following personal experience of the circumstances in the rural area of Ostuni, both as a freelancer and during a work experience in the Local Landscape Commission[1], a series of statements can be made.

Many of the interventions carried out between 1960 and 1990 were characterized by design choices which ignored the value of local architecture. At a later stage, a process of pseudo recovery-reuse, especially in areas with a large amount of tourism, was expressed through design solutions and execution processes typical of modern construction. Thus, the traditional construction technique of dry stone was slowly but surely forgotten, replaced by the more convenient reinforced concrete (Pecoraro, 2012). The use of non-traditional materials and construction techniques, the typological distortion of the housing unit, the arbitrary removal of lime plaster from the walls, the demolition and reconstruction of vaulted systems rather than their restoration, are just some of the most common aspects of the phenomenon. This highlights the problem of awareness of our cultural heritage and our approach to it. This concerns not only some technicians and building companies, but also private clients, who are often unaware of the value of their properties and guided by their personal preferences.

Although existing urban and landscape tools contain extensive information about the correct planning of building interventions, they require detailed study and constant comparisons. Moreover, as the current master plan has not yet been adjusted to P.P.T.R., there are occasional problems when interpreting the legislation. Hence the need for an instrument to outline the information contained in the plans, a table summarizing the specification of the possible types of degradation, as well as the recovery measures, and the permitted materials and techniques.

3. Methodology

The research began with the study of the guidelines found in the P.P.T.R., the regional planning tool, including the design criteria, materials and intervention techniques contained in the master plan, and the indications contained in the building code of Ostuni. At the same time, the characteristics of the territory and the recurring architectural morphotypologies were analysed, focusing especially on their intrinsic bioclimatic peculiarities. A review of the bibliography helped identify the relevant information sources. The most appropriate sources were obtained from research into books, publications, articles and documents related to the subject. The quantitative methodology followed identified the strengths and weaknesses of the existing documents using data compiled from the land management tools mentioned above. Although the information obtained was extensive and detailed, at times it appeared fragmented and could give rise to confusion. Therefore the existing information was then cross-referenced and implemented after a search of local biocompatible materials in use and/or proposed by research entities.

4. Subject of study

4.1. Territorial framework

The region of Puglia is divided into 11 territorial areas, considered on a subregional scale and characterized by specific relationships between physical-environmental, historical, settlement and cultural components. The area of *Murgia dei Trulli* is located in the southern part of the Murgian plateau. It is almost entirely made up of a ridge of dolomitic limestone, covered by patches of recent calcarenitic or clayey deposits (red earth). In addition, the landscape is shaped and fragmented by many karstic formations. The area's characteristically rural landscape alternates vineyards, olive groves, forests and arable

[1] The Local Landscape Commission is a collegiate technical body which delivers mandatory opinions, delegated to Municipalities and established pursuant to art. 148 of DLgs 42/2004 and art. 4 of LR 32/2008. Any intervention carried out in areas considered to be landscape heritage is, in fact, subordinate to the issue of a landscape authorization.

land. This can be seen as the manifestation of the agricultural workers' ability to adapt the stony ground of Apulia, one of the harshest and most resistant elements, to their productive purposes.

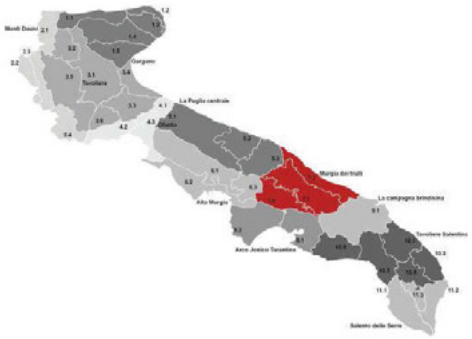

Fig. 1. The territorial area of *Murgia dei Trulli*. (Source: P.P.T.R., 2015)

Ostuni is bordered to the west by the Murgia slope going northeastwards, toward the Adriatic coast. The area is known as *La Piana degli Ulivi Secolari*. The main element of this landscape is the olive grove, recognizable by a thick density of centuries-old trees, irregularly distributed throughout the territory. Its widespread rural architectural heritage, composed of different typologies of dry stone buildings, is a vast wealth of natural and cultural resources to be protected, conserved and enhanced.

4.2. Rural housing: building morphotypes

In rural and traditional Apulian buildings, construction techniques are based almost exclusively on one recurrent material, stone.

Dry stone construction, a technology strongly integrated with the environment and rural tradition, can be identified based on the following:

- the use of calcareous and/or calcarenitic stone, small and medium in size and extracted locally;
- the minimum processing of materials and installation without binding agents or connections;
- self-build buildings;
- the integration of these buildings into the agricultural context;
- the need for continuous maintenance and initial acceptance of the precarious character of the artefacts, both historically and culturally.

The typical building structures of the rural landscape of Ostuni are represented by elementary or complex systems, classified into different typologies, depending on their function.

4.2.1. Elementary systems

There are many forms of "spontaneous" architecture found in the countryside of Ostuni, including storage rooms or dwellings for the harvest periods, such as barns, trulli, *lamie*, *casedde*, etc. These building structures can be classified as monocellular, bicellular or multicellular (when combined with previous units).

The **trullo** is characterized by a regular floor plan and conical roof, externally covered by *chiancarelle*[2] arranged in concentric circles that narrow upwards and closed off by a disk-shaped stone supporting a decorative pinnacle. Thanks to this roofing method rainwater is collected and then transported to an underground cistern. This system provides not only a precious supply of rainwater but also a resource for cooling the air around the water and lowering indoor temperatures during the summer.

Fig. 2. An abandoned trullo (Source: Farina, 2022).

[2] Limestone elements obtained from the removal of stone from the natural soil, carried out during its preparation for agricultural use. These thin plates between 3 and 7 cm thick function sinulaneously for waterproofing and recovering rainwater.

The perimetral load-bearing wall has an average thickness of 0.8-1.5 metres and consists of two walls separated by a cavity filled with smaller stones and earth. The base and the pinnacle were originally limewashed to increase water resistance.

The most frequent construction type, the trullo, consists of a circular cell which opens out onto two small rooms or alcoves. Originally, the central room was the kitchen with the fireplace on the floor, while the side alcoves housed the double bed and closet or a small room for offspring.

The ***lamia,*** a rural building with a square base, had sloping supporting dry stone walls (sometimes incorporating mortar), and the base was completely limewashed. The roof is usually made with a lowered barrel vault or a dome. These characteristically simpler constructions consist of a single room, used as a temporary shelter for the agricultural workers. It has only one low door with a window above it; the opposite wall always features a smaller window at the same height for the purposes of cross-ventilation.

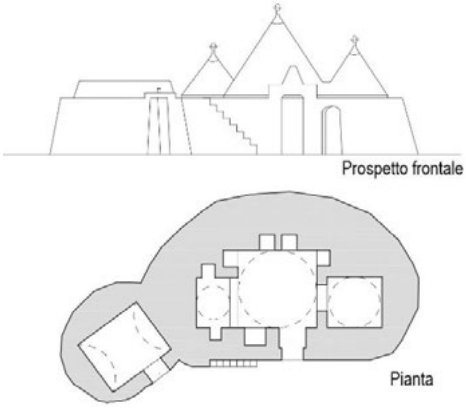

Fig. 3. Aggregative type of trullo and *lamia* (Drawing by the author, 2022).

The ***casedda***, typical architectonic structure of the territory, is built with a variation on the construction procedure used for the trulli. It is a mixed construction combining the base of a trullo with the roof of a *lamia*. The floor plan is rectangular or circular and usually consists of a single room, divided into two or three spaces in linear succession. The external volumes are characterized by three overlapping components. The first, the base, is the same height as the entrance door; the second is a truncated ellipsoid with a perimeter smaller than the base, while the third resembles a dome or semisphere. The masonry, built of small stones, is plastered and whitewashed and the roof is flat and semispherical. The limewashed surface finish is also a frequent feature of these buildings. These were regularly limewashed both for the purposes of hygiene and aesthetics.

Fig. 4. A typical *casedda* (Source: Farina, 2022).

4.2.2. Complex systems

The complex systems consist of freestanding buildings like farms and auxiliary elements such as farmyards, barns, cisterns, kilns, dry stone walls or millstones.

Fig. 5. Detail of a dry stone wall (Source: Farina, 2021).

The **farm**, known locally as a “masseria”, is a large complex permanent rural residence, often with multiple overlapping floors, central to the agricultural organization of large estates. This typology spread throughout the rural territory, and was particularly common between 1400 and

1800. It consists of various extensions of privately owned land and related buildings, which combine residential and productive needs and are managed completely independently. The layouts of these constructions are usually compact farms, linear closed courtyards, fortified enclosures etc. In general, these take the form of a real rural village, composed of several buildings such as the manor house, the accommodation for servants and farm workers, the out houses, animal shelters, stores and other additional elements.

Fig. 6. Masseria Fontenuova (Source: Farina, 2021).

4.3. Bioclimatic characteristics

In line with the principles of modern bioclimatic architecture, Apulian rural architecture represents the response of a society culturally linked to its territory, in terms of climate, orography and landscape.

The construction features are a response to three fundamental issues often encountered:
- Climate: the relationship with a climate alternating between winter frosts and hot summers;
- Building materials: a limited variety of building materials available on-site;
- Morphology of the Territory: the adaptation to geo-morphology, orography and hydrology of the territory (P.P.T.R., 2015).

The main concern for rural buildings is the provision of solutions to counter the long summer heat. The system of orientation to limit exposure to prevailing winds highlights the in-depth knowledge of the characteristics of the territory, together with the development of bioclimatic constructive strategies and systems which exploit the few local resources available to satisfy basic comfort and living needs.

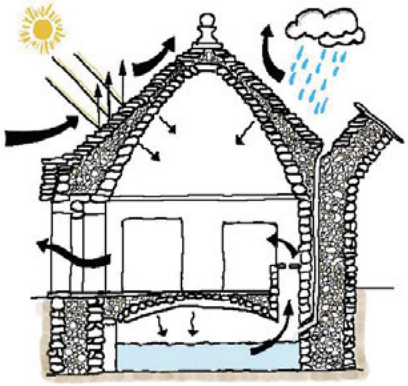

Fig. 7. Bioclimatic characteristics of a trullo (Drawing by the author, 2022).

A recognizable and predominant feature is that of the thick external masonry which protects from extreme external climatic conditions (harsh winters and long hot summers), combined with few small openings (doors and windows). In fact, this system exponentially increases the thermal inertia of buildings and implements a thermal shift between night and day, giving rise to real heat exchanges. The mixture of lime, red earth and clay used to seal the ashlar (stone masonry) helps to delay the entry of the thermal flux of solar radiation and to insulate and protect from heat dispersion during the winter. The external finishes are also of importance: the typical white limewash reflects the solar radiation, thus avoiding heat accumulation. The collection and reuse of rainwater, stored in underground cisterns waterproofed with hydraulic lime, is an example of sustainable water management.

Fig. 8. An example of sustainable intervention (Source: Farina, 2019).

Fig. 9. An example of sustainable intervention (Source: Farina, 2016).

Fig. 10. An example of sustainable intervention (Source: Farina, 2018).

Fig. 11. An examples of incompatible intervention (Source: Farina, 2018).

Fig. 12. An examples of incompatible intervention (Source: Farina, 2016).

5. Conclusion

The protection and enhancement of architectural and landscape heritage is a fundamental task for the preservation of our history and culture. Among the heritage, rural architecture is one of the most typical elements, witness to the local population's capacity for adaptation to geographical and environmental conditions.

At present, with a pandemic affecting the entire world population, the rural context has acquired greater importance as a result of the requirements made apparent by the lockdown period. Thus, greater emphasis is placed on the need to enjoy open spaces, in contact with nature, in a less polluted environment, far from physical and structural limitations imposed by the city. For residents it represents, in essence, a possibility to improve their quality of life. At present, part of the rural building heritage is in a state of abandonment or degradation. This can be attributed to several factors, including lack of maintenance, necessary for its conservation. It is precisely this kind of intervention, carried out by the agricultural workers and inhabitants themselves, which has preserved the typical rural buildings. However, inadequate interventions have stripped these places and territory of their natural identity. It is therefore essential to put into practice building interventions aimed at the enhancement of architectural and landscape heritage through the conservation and recovery of sociocultural and environmental identity, the protection of biodiversity and sustainability. In this regard, greater awareness and involvement of the local population are necessary and should be encouraged. This research attempts to provide a tool which can be of use to technicians, building companies or individuals, as well as serving as a model applicable in other territorial contexts.

Thus, the general principle to be pursued is that any maintenance work, recovery, etc. should be part of a collective action, tending for landscape and architectural conservation.

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